LOWER SECONDARY SCHOOL STUDENTS' KNOWLEDGE OF AND MISCONCEPTIONS ABOUT ANIMAL MIGRATION: PRELIMINARY RESULTS

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Abstract. *The animal migration is one of the natural processes and is important not only for animals but also for people. Although this process is inseparable part of the nature, its incorporation into curriculum is on low level, not only in Czech Republic, but also in many other countries. The aim of the research was to identify lower secondary school students' knowledge of and misconceptions about animal migration and to identify if gender, grade and residence of respondents have an influence on it. The sample size was created by 184 Czech lower secondary school students. The researcher himself created the research tool. It was a test and consisted of 18 questions. The test questions were also analyzed by the proportional determination and also by the methods of descriptive and inferential statistics. The knowledge of migration was very low among lower secondary school students. The grade level had the strongest influence on the knowledge from the examined variables. In the conclusion part implications for pedagogical practice are suggested and also suggestions for the further research in this field of study.*

Key words: *animal migration, knowledge of migration, lower secondary school students, misconceptions about migration.*

Introduction

Animal migration is relatively long-distance movement of individuals, usually on seasonal basis. It is found in all major animal groups, including birds, mammals, fish, reptiles, amphibians, insects, and crustaceans (Dingle & Drake, 2007). The trigger for the migration may be the local climate, local availability of food, season of the year or mating (Aidley, 1981).

Animal migration has aesthetic, environmental, and economic importance for humans. For example, salmons in the Pacific Northwest head for the ocean when they are young and small, taking advantage of the productivity of the seas to grow to full size. They then return to their natal streams where they spawn, die, and decompose. They are, in essence, self-propelled bags of fertilizer, gathering important nutrients such as nitrogen and phosphorus from the ocean and delivering them to the streams where these same nutrients can then be taken up by other aquatic species or carried onshore by scavenging eagles, bears, and other animals. Migratory songbirds perform their own important ecosystem service by consuming vast numbers of caterpillars that would otherwise eat the foliage of trees and shrubs. As numbers of songbirds drop, one might predict increase in insect damage to forests or, alternatively, increase in pesticide use to counteract any increase in defoliation (Wilcove, 2008). The animal migration has other positive aspects for people. In some countries the migratory animals are source of food for people (for example in Malta or Egypt).

The issue therefore seems to be very important for all of us. However, the surprising fact is that this topic is included in the Czech curriculum of science subjects only marginally and this situation concerns other countries mainly in Central Europe as well. In the countries such as the USA and Great Britain, the situation with this issue is better, there is an active approach toward pupils and students concerning animal migration (for example see Fischman, & Hyman, 2010).

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Journal of Baltic Science Education, Vol. 14, No. 5, 2015

LOWER SECONDARY SCHOOL STUDENTS' KNOWLEDGE OF AND MISCONCEPTIONS ABOUT ANIMAL
MIGRATION: PRELIMINARY RESULTS
(P. 607-615)

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The research studies regarding problems of misconceptions about animal migration are very rare. In the research world, the studies focused on this kind of issue are very rare. This issue is solved only as a part of main researches. One study was focused on the knowledge of Inuits about life of tundra caribou and one part of interviews with Inuits was focused on the caribou migration (Ferguson, Williamson & Messier, 1998). For example Prokop, Kubiatko & Fancovicova (2007) found out misconceptions about bird migration among Slovakian lower secondary school about birds among Slovakian lower secondary school pupils. The pupils had problems with the place, where storks migrate, what is the reason of bird migration and also how long distances are birds able to fly during migration. Cardak (2009) found out that one third of lower secondary school pupils from Turkey thought the birds are migrating due to freezing. This misconception was the most often among others regarding birds. The didactic test was used as a research tool. In another study (Hummel et al., 2015), the researchers from four different countries – Germany, Colombia, Slovakia, Turkey – found out by questionnaire, except of attitudes, also students' knowledge of birds. There was a question regarding migration of hummingbird. Students from Colombia and Slovakia had the lowest level of knowledge of hummingbird migration. Kubiatko & Balatova (2014) tried to find out the common biological misconceptions among Czech university students. And one question from the test was focused on the place where storks migrate. Many students had a problem with identification of the correct place.

There are other research studies which examined the issue of animal migration in more detail. The authors explored the knowledge of animals and some of them are mentioned in the research studies of authors (for example Kattmann, 2001; Murat, Kanadli & Unisen, 2001; Prokop & Rodak, 2009; Randler, 2008; Randler & Wieland, 2010; Strommen, 1995; Trowbridge & Mintzes, 1985). To the best of researcher's knowledge, there is no research done on identifying students misconceptions about animal migration.

The aim of the research was to determine lower secondary school students' knowledge of and misconceptions about animal migration. In the research, whether there are any differences in knowledge and misconceptions with respect to gender, grade and residence of respondents has also been examined.

Methodology of Research

General Research Characteristics

In order to determine students' knowledge of and misconception about animal migration, a research was designed in which participants were asked to a series of test. This research was conducted in the 4 lower secondary schools in Czech Republic. The first intention was to choose the schools and respondents randomly. But the majority of selected principals refused the realization of research, so the respondents are selected by conventional sampling. The conventional sampling is useful for in a preliminary studies of an issue, to identify what may be the key features to investigate in more details or to test the effectiveness of the survey procedure and survey instruments (Newby, 2014). On the request of school principals, their location and name are anonymous. The respondents were assured that their responses would only be used for research purpose and would not affect their final exam scores. The test was administered in a group format among respondents during the June of 2014.

Respondents

As it was mentioned above, the respondents were from four public lower secondary schools located in Czech Republic. The schools were chosen randomly, but the majority of selected principals refused the realization of research, so the participants were selected conventionally. Ethical considerations were discussed and approved by the principals of the schools. The number of respondents was 184 in total. The participation of students on the research was voluntary, so this fact led to relatively low amount of respondents in entire research. The students, who refused to fill the test, were performing other activity regarding to biology. The sample size is adequate for the research. The observed power was calculated for every value of ANOVA. Its value was between 0.75 and 0.86, it signalized the sufficient sample for the study and also the availability of the using ANOVA (for the detailed explanation see Green, 1991; MacCallum, Browne, & Sugawara, 1996; O Keefe, 2007; Thompson, 2006 and others).

There were observed some categorical variables like gender, grade and residence. The town has got more than 5000 inhabitants and village lower than 5000 inhabitants. Numbers of respondents in the groups of variables are presented in the table 1.

Journal of Baltic Science Education, Vol. 14, No. 5, 2015

ISSN 1648–3898   LOWER SECONDARY SCHOOL STUDENTS' KNOWLEDGE OF AND MISCONCEPTIONS ABOUT ANIMAL
MIGRATION: PRELIMINARY RESULTS
(P. 607-615)

Table 1.   Basic demographic characteristics of respondents.

Gender	Male	Female		
	94 (51 %)	90 (49 %)		
Grade	6th	7th	8th	9th
	70 (38 %)	17 (9 %)	47 (26 %)	50 (27 %)
Residence	Town	Village		
	141 (77 %)	43 (23 %)		

Research Tool

The research tool was a test constructed by the researcher. By the construction of questions, researcher came out from the publicly and common known kinds of information about animal migration. All kinds of information are possible to find out in normally accessible media like TV, internet, books, schoolbooks and others. The test contained open-ended, multiple choice and graphic questions. The first part contains demographic questions (gender, grade and residence) and the second part consists of 18 questions regarding animal migration. Most of the questions were graphic. The questions were divided into 4 categories: (1. General questions about migration (3 questions); 2. Fish, amphibians, reptiles (5 questions); 3. Birds (7 questions); 4. Invertebrates (3 questions)).

The research tool was piloted. The first version contained 26 questions. The pilot version of the test was distributed among 20 students (5 from each grade). On the basis of their responses and comments, five questions were eliminated from the final test. The students wrote, that problematic questions were too difficult for them and they did not understand, what they should answer. The next step was determination of content validity, which was assured by three experts – a biology teacher from lower secondary school, a didactic of biology, a zoologist. All of them were asked to comment on the questions. Their comments were incorporated in the test and three questions regarding mammals were eliminated from the test. That is the reason for the absence of any questions dealing with mammals and final version of the test included 18 questions.

One notice toward number of questions, the researcher came out from the common known information about animal migration and in the second line it was an effort to adhere the basic principles of the test construction. The information about it is possible to find out in many literary sources (e.g. Azer 2003).
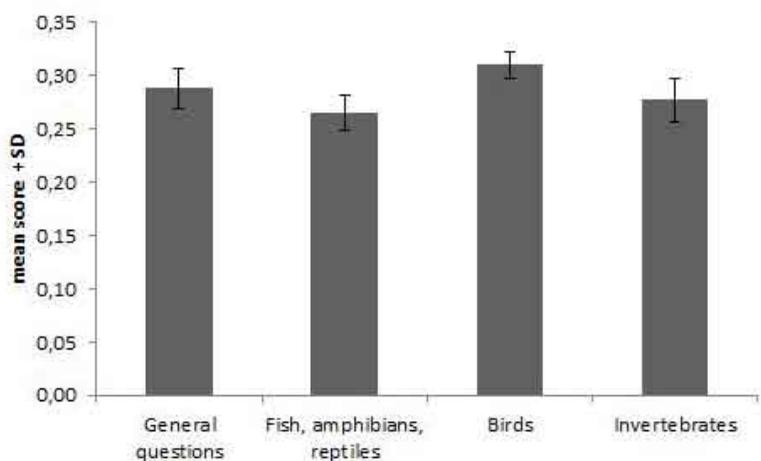
Analysis of Data

The answers of respondents were coded in numbers; number 1 was assigned to the correct answer and number 0 to the incorrect answer. The mean score indicated knowledge of students about animal migration. The mean score for the entire test and also for its categories was dependent variable and categorical variables (gender, grade and residence) were as independent variables. The ANOVA was used for the quantitative analysis of data. The qualitative analysis represented the determination of percentage success by individual questions and there were analyzed wrong ideas of students of animal migration too. A similar procedure can be found in related works (e.g. Chiang et al., 2014; Prokop, Kubiatko, & Fancovicova, 2007; Stefanikova, & Prokop, 2015).

The reliability of the test was calculated by Cronbach's alpha coefficient, its value was $\alpha = 0.80$. This value indicated high reliability of the research tool (Nunnally, 1978).

Results of Research

The score for entire test was 0.28 (SD = 0.02). It indicated relatively low knowledge of students about animal migration. The highest score was for the category "Birds" and the lowest one was for the category "Fish, amphibians, reptiles".

Journal of Baltic Science Education, Vol. 14, No. 5, 2015

LOWER SECONDARY SCHOOL STUDENTS' KNOWLEDGE OF AND MISCONCEPTIONS ABOUT ANIMAL
MIGRATION: PRELIMINARY RESULTS
(P. 607-615)

ISSN 1648–3898

Figure 1:   Mean score for categories.

General Question about Migration

The statistically significant difference was between respondents from town and village (F = 6.75; p < 0.05). The students from town achieved higher score (x = 0.31; SD = 0.03) in comparison with students from villages (x = 0.20 SD = 0.03). The statistically significant difference was also found in the category "General questions about migration" (F = 19.87; p < 0.001). But in this case the highest score was achieved by students from the 8th grade. And in the category "Birds", 6th grade students achieved the worst score. This category included three questions, the most problematic was the question "Why some birds are nesting on the north hemisphere and overwintering on the south hemisphere". Only few respondents answered correctly (on the south hemisphere is the extent of mainland lower in comparison with north hemisphere – it influences the amount of food and other factors for successful nesting).

Fish, Amphibians, Reptiles

The statistically significant difference was found out between males and females (F = 5.07; p < 0.05). The girls (x = 0.31; SD = 0.02) achieved higher score in comparison with the boys (x = 0.23; SD = 0.02). One question was dedicated to sea turtle which migrates due to reproduction to the island called Ascension (St. Helena) from the seacoast of Brazil. Approximately 40 % of respondents drew the correct way of sea turtle. The most frequent mistake was the drawing of the route in the opposite direction, from the island on the seacoast.

The respondents had got also problems with fish occurring out of Czech Republic. Only 10 % of respondents knew, that the place of reproduction of salmon is on western coast of North America. The majority of incorrect drawings contained the eastern coast of North America as the area of reproduction.

The problems were also with eel, it migrates from the area around eastern part of the USA to Europe. Nearly 25 % of students drew the correct route of the eel. The incorrect answers contained for example Africa as the final destination or the route was reversed (Figure 2).

Journal of Baltic Science Education, Vol. 14, No. 5, 2015

ISSN 1648–3898   LOWER SECONDARY SCHOOL STUDENTS' KNOWLEDGE OF AND MISCONCEPTIONS ABOUT ANIMAL
MIGRATION: PRELIMINARY RESULTS
(P. 607-615)

Figure 2:   Example of the wrong answer on the route of eel.

Birds

There was not found out any statistically significant difference among groups of variables. This dimension included 7 questions; some of them were problematic for respondents. Only one third of respondents showed the correct location of the migration of swallow in the map of Africa. The majority of respondents incorrectly drew the north of Africa. The correct route of cuckoos from the Czech Republic to the right place in Africa was familiar to one third of respondents. Finishing of the route in North Africa belonged among the most frequent incorrect answers.

The problematic of migration during the night was also examined. Respondents' task was to mark the correct answer to the question which one of the given birds (hoopoe, blackbird, stork, swallow) can migrate during the night. The correct answer was the first one - hoopoe. It was marked by 40 % of respondents. The majority of the respondents incorrectly marked swallow.

The waxwing is bird, which is migrating into area of Czech Republic and nearly 40 % of the respondents marked the correct answer. The most frequently marked incorrect possibility was wild duck. Other possibilities were woodpecker and great tit.

The correct route of stork was drawn by 13 % of students. The storks migrate over the land, not over the seas and the oceans. The majority of routes were over the seas as it is possible to see in the figure 3. Some students finished the route of storks in North Africa.

Figure 3:   Example of the wrong answer on the route of storks.

Journal of Baltic Science Education, Vol. 14, No. 5, 2015

LOWER SECONDARY SCHOOL STUDENTS' KNOWLEDGE OF AND MISCONCEPTIONS ABOUT ANIMAL
MIGRATION: PRELIMINARY RESULTS
(P. 607-615)

ISSN 1648–3898

Invertebrates

The statistically significant difference was among grades (F = 3.37; p < 0.05). The students from the 9th grade achieved the highest score and the students from the 7th grade the lowest one. From the three questions, the problematic one was focused on locust migration (the reason why locust migrated in the ancient Egypt when Christians wanted to leave Egypt). The amount of correct answers was approximately 20 %. To the wrong answers belongs for example a statement: "The God causes it" which was one of the frequent answers. Other wrong answers were for example "due to storms" or "due to strong winds".

The wintering area of monarch (butterfly living in the South of Canada) was also difficult for respondents. The correct area is in the South of USA. Approximately 25 % of students drew the correct area. To the incorrect drawings belongs for example a drawing of wintering only in California or only in Florida and some students drew wintering of monarchs in Cuba and some even in the area of Brazil.

Table 2.   The values of ANOVA, mean scores and standard deviations.

		Gender		Residence		Grade			
		Males	Females	Village	Town	6th	7th	8th	9th
Entire test	x	0.28	0.30	0.27	0.30	0.24	0.22	0.34	0.34
	SD	0.01	0.01	0.02	0.01	0.02	0.03	0.02	0.02
	F	1.54		1.23		10.54***			
General questions about migration	x	0.28	0.30	0.20	0.31	0.17	0.10	0.42	0.39
	SD	0. 03	0.03	0.04	0.02	0.02	0.05	0.03	0.03
	F	0.19		6.75*		19.87***			
Amphibians, fish, reptiles	x	0.23	0.31	0.27	0.27	0.23	0.18	0.31	0.31
	SD	0.02	0.02	0.03	0.02	0.03	0.05	0.03	0.03
	F	5.07*		0.02		2.61			
Birds	x	0.30	0.32	0.32	0.31	0.27	0.28	0.35	0.33
	SD	0.02	0.02	0.03	0.01	0.02	0.04	0.02	0.02
	F	0.35		0.06		2.58			
Invertebrates	x	0.27	0.29	0.22	0.30	0.23	0.16	0.30	0.35
	SD	0.03	0.03	0.02	0.04	0.03	0.06	0.04	0.04
	F	0.33		2.82		3.37*			

F - value of ANOVA, x - mean score, SD - standard deviation

To sum up, the table 2 below presents all values of ANOVA, mean scores and standard deviation for all categories and for all variables.

Discussion

The research was focused on the identification of knowledge of and also determination of misconceptions about animal migration among Czech lower secondary school students. The research produced only preliminary results, which can be used as a base for the future research in this problematic. Only a little attention is paid to this issue in school curriculum at lower secondary schools and at high schools. The students learn only small pieces of information, for example about swallows as "notifier of spring" or they refer to storks as migrating birds. The next information, which is possible to find in textbooks, is that some birds in the region of Central Europe remain, for example blackbird or great tit. But the impact of animal migration on people, nature and other aspects of migration are hidden for students. In the first phase, it is important to ascertain students' knowledge of migration, next to try to eliminate students' misconceptions about this phenomenon and after these processes, it is possible to start with learning about animal migration as such.

Journal of Baltic Science Education, Vol. 14, No. 5, 2015

ISSN 1648–3898   LOWER SECONDARY SCHOOL STUDENTS' KNOWLEDGE OF AND MISCONCEPTIONS ABOUT ANIMAL
MIGRATION: PRELIMINARY RESULTS
(P. 607-615)

The aim of the study was to identify lower secondary school students' knowledge of and misconceptions about animal migration. As it is possible to see, only few questions were answered correctly by more than a half of the students. The respondents achieved highest score in the category "Birds", but the difference from other categories was minimal. It was awaited, that the score for the category "Birds" will be significantly higher in comparison with other categories, because, as it is written in many studies, birds are the most popular animals among children (e.g. Bjerke & Ostdahl, 2004). Also, in other studies from Yil-Panula & Matikainen (2014) students had better ability to name birds in comparison with invertebrates, reptiles and amphibians. The explanation probably lies in the character of questions in the test. Students knew what the stork is, but they knew only a little about its way of life. The problem is in the incorporation of the content concerning animal migration in the biology curriculum. But this problem exists in all countries in the Central Europe. The issue of animal migration is very rare in the biology curriculum, not only at lower secondary schools but at high schools as well. The problem arises maybe also from the information presented through different sources. Nowadays, students receive information through various sources like internet, television and other modern media. And it is possible to find some kinds of basic information about animal migration in all these sources. However, most of the information is about birds, for example: "Storks migrate to Africa"; "One kind of butterfly that migrates lives in America"; "The birds migrate to Africa"; "Frogs migrate crossing the roads with traffic" and other. But it is important to notice that the majority of information about migration in textbooks and in the media is about birds, only the minimum information cover other animals. And it is very difficult to find information about mammal migration. Marginally, we can mention the influence of folk biological knowledge which can influence the understanding of different phenomenon (Hunn, 1982; Patrick et al., 2013). The misconceptions in drawing questions could be caused also by misconceptions about geography. Maybe, students do not know the correct places of continents. As we can see, they did not know where America is. It is in concordance with other authors who wrote about many misconceptions in geography (Mustafa & Secil, 2010).

The girls achieved higher score in the whole test and also in all its categories. Both boys and girls achieved the best score in the category concerning birds. The statistically significant difference was observed only in the category "Amphibians, fish, reptiles". This trend can be observed in other studies where the girls achieved a higher score (e.g. Randler, 2008). It is not only the case of animals, but the better knowledge of girls is possible to see also in the plant knowledge (e.g. Kos & Jerman, 2015; Luckmann & Menzel, 2014). Maybe, this is caused by the fact that girls have more positive attitudes toward biology in comparison with boys and it manifests itself by better knowledge. The next reason could be that in many schools in the Czech Republic the traditional style of learning process focused on memorizing with minimum of modern elements is still persisting. The modern elements could make the learning process more interesting and more meaningful.

The other variable was residence of respondents. This variable does not belong among often investigated ones, but some authors discovered there is not statistically significant difference among students from towns and villages (e.g. Halder et al., 2012). From the results of our research, the situation was similar. The statistically significant difference was observed only in one category "General questions about migration" and it concerned the students from villages. In all categories, except category "Birds", the students from towns were more successful in comparison with the students from villages. This fact is interesting, because it is awaited that the students from villages have a closer relationship with nature than the students from towns. The explanation may lie in the knowledge and the way of obtaining the knowledge. Students from villages are influenced by folk knowledge and theological knowledge which are not based on true science and these processes caused their worse score in migration issues.

The last evaluated variable was grade level and among grade levels statistically significant differences were found out in the entire test, and in the categories "General knowledge about migration" and "Invertebrates" statistically significant differences among grades were not observed. The results are relatively surprising and they are not coherent. The students from the 7th grade achieved the worst score in all categories except "Birds". And in all categories, 8th and 9th graders were the most successful ones. Finding of the study is not in concordance with other studies where the object of interest were animals. For example Rybska, Tunnicliffe & Sajkowska (2014) found out decreasing level of knowledge of snail with higher age. However, on the other hand, when the level of misconceptions is taken into account, the younger children have more misconceptions in comparison with the older children (Prokop, Kubiatko & Fancovicova, 2007). And, probably, this is the reason why younger students in our sample have lower knowledge and higher amount of misconception. But the very important fact is that the knowledge of animal migration is very low, only one third of the respondents answered correctly.

Conclusions

The research showed that lower secondary school students' knowledge about animal migration is not sufficient. The students also held a relatively high amount of misconceptions, which are presented in the result part and discussed in the discussion. The grade level had the significant effect on the results, but it was also possible to observe differences in gender and residence.

As it is possible to see in the results of the research, it is needed to try to improve interest and knowledge about migration of animals among students. There are some ways, how it can be done. The amount of content about animal migration in the biology curriculum is insufficient at lower secondary schools and also at high schools. Maybe some enthusiastic biology teachers can offer the information about migration that is not in the textbooks. So this is the task for curriculum makers, to try to increase possibilities, how to make available kinds of information concerning animal migration. Below only some proposals are presented which can lead to the increase of interest in this issue. One of the implications, which could lead to better knowledge of animal migration, is a different approach. Student's awareness of natural phenomena like migration could be increased via movies in the biology lessons, which can lead to better imagination of animal migration.

The next point is to try to use problem-based learning when teaching, for example, about animal migration: "What are the costs and benefits for animals when they migrate? Do animals have enough food during winter in our country? What is the food of non-migratory animals? etc.

There are other possibilities, how to increase the students' knowledge about animal migration, for example, to use direct observations of the biology of common animals. Food selection of wintering birds on feeders can be a good task for projects in biology education.

The study has got some limitations, which are regarding mainly a methodological part of the research. The research included relatively low number of respondents, which was a little bit caused by unwillingness of the school principals to allow to make research on their school. This leads to change the type of sampling. The researcher planned random sampling, but the researchers were constraint to conventional sampling. The next limitation is using only one main method (interview was used only as a method of validation), more concretely test. The solution could be used triangulation, which is used to indicate that two (or more) methods are used in a study in order to check the results of one and the same subject.

The last notice is toward further possibilities, how to continue in the research of this problematic. This research is the first in the row of researches focused on the knowledge of and misconceptions about animal migration. In this research two techniques were used, first of them was an interview, which served for the selection of wrong questions in the test, the next technique was a test. The researchers would like to extend the research among other respondents like kindergarten children, high school students, and university students and also among public. Every of these groups could bring new knowledge about the understanding of the phenomena like animal migration is. The next effort will aim into comparison of different countries, because in every country it is possible to observe animal migration.

Acknowledgement

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Journal of Baltic Science Education, Vol. 14, No. 5, 2015

ISSN 1648–3898   LOWER SECONDARY SCHOOL STUDENTS' KNOWLEDGE OF AND MISCONCEPTIONS ABOUT ANIMAL
MIGRATION: PRELIMINARY RESULTS
(P. 607-615)

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