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CHANGES IN CONNOTATIVE PERCEPTION OF NOTIONS FROM THE AREA OF SCIENCE EDUCATION AT A SCIENCE CAMP

ZMIANY W KONOTACYJNYM POSTRZEGANIU POJEĆ Z OBSZARU NAUKI ZAOBSERWOWANE PODCZAS OBOZU NAUKOWEGO

Abstract: The main reason of children's low interest in the study of natural science subjects is the inability to link the knowledge acquired at school to subjects such as chemistry or physics with real life outside the classroom. Their ideas about the scientists are often mistaken and glamorized. With the effort of the Vebor camp, these ideas are corrected and shifted towards reality. The research was focused on the perception of children of selected concepts before and after the camp. There are many researches fields dealing with science camps or teaching outside of school. Our research has used the semantic differential method, which we have seen only sporadically in research on this subject. The results of the research are mostly positive and show that the scientific camp has a positive impact on the understanding and perception of children of selected aids from the area of science and education. Very interesting are the results, for example, when the term of "teacher", where the connotative perception of the term has changed from very negative to highly positive with statistical significance of 99 %. Many of the more interesting results are presented in the article.

Keywords: science camp, semantic differential, connotative perception, education, science

Introduction and theoretical background

One of the major priorities teachers have to sort out these days is to keep students motivated for learning. Students' indifference to the curriculum and own education leads to lack of knowledge in many respects. They do not find the educational and pedagogical processes attractive nor interesting. The results of a long-standing programme for international student assessment PISA, which analyses literacy of 15-year old students to face the challenges of the future [1]. show that students have not sufficient knowledge in the area of natural sciences. It is caused by the continuous predominance of transmissive approach to learning and lack of inductive approach.

Getting familiar with nature in nature is an interesting way how to teach students about learning in nature and about natural sciences. In comparison with passive learning of facts from the teacher while sitting in a classroom, once a student spends certain amount of time

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in nature actively looking for answers from the fields such as chemistry, biology, geography, and physics, he will be keen to learn more about the subjects [2]. In the past three years, we have participated in a world-wide project named SciCamp. Its aim was to examine the effect of science camps on the education of children. The camps "help young people to find role models in scientists and engineers. One of the goals is also to encourage girls to find their role models in science" [3]. "The science camp is a local programme for scientific education which offers a lot of activities for young people from 6 to 20 and which aims to extend their knowledge and develop their skills also in the area of technology, engineering and mathematics (STEM). It lasts at least two days and usually involves a sleepover within the camp premises" [4].

Twenty years ago, a similar idea came from the cooperation of the Department of Chemistry and the Department of Biology at the Faculty of Education of Trnava University in Trnava, Slovakia, when there was created the Department of Scientific Field Research. This department allows students of primary and secondary schools to spend a few days in nature and in the laboratories, which broadens their knowledge in the area of natural sciences [5]. A similar project known as Vacation school Lipnice has been annually taking place in the Czech Republic. Its aim is to develop students versatily, using the principles of experiential learning. The main goal is to stimulate human creativity and courage.

For the purposes of our research, we formulated the following research question: What is the effect of the science camp on connotative meaning of various notions from the area of science and education?

Realisation of the research, location and camp description

Research done for the purposes of this article was dedicated to examination of students' connotative perception of notions related to school environment and whether it got influenced after participating in the science camp.

Research was carried out in the past two years during the sessions of science camp for children. In the first camp session, there were 20 children. It took place in July 2016 in the western part of Slovakia. In the second camp session, there were 25 children. It took place in August 2017 in the northern part of Slovakia.

Both camps were situated in a peaceful environment of the forests. The location was selected with the intention to get children closer to natural sciences and encourage them to learn about fields which might have seemed too difficult for them until then. Interdisciplinary character of this project led to connection of natural sciences with humanities so the children developed their skills and abilities not only in chemistry, biology, maths, physics, or geography, but also in history and language studies. The second camp had an international character and its language of communication was English. Both camps were overnight and lasted one week. Learning process included games, experiential activities and excursions. Even though there were children of different age at the camps, one of the key ideas of the project was to develop relationships, teach the older to help the younger and the younger to learn from the older. Children were divided into several working teams with regard to their age and nationality as each group had to consist of all age categories and at least two countries of origin. Individual groups were led by the team leaders, who are either working in science and education, working on their PhD degree, or teachers. Their role was to guide children to complete the tasks successfully, encourage

them to work harder, motivate them, and to be there for them if they fail in any respect. One teamleader was responsible for maximum 5 children.

Research sample, methods and procedures

Our research was conducted on the sample of 45 children from 4 European countries. The first camp consisted of 20 speakers of the Slovak language. The second camp was international - including 15 children from Slovakia, 8 children from Germany, 1 child from the Czech Republic and 1 child from Luxembourg. Gender-wise, the research included 21 girls and 24 boys. The age range was from 10 to 14 years.

To examine connotative perception of notions, we used research method called semantic differential. This method allows us to measure individual psychological meanings. Besides denotative meaning (generally valid meaning of the word), each notion has also connotative meaning (hidden, subjective meaning of the word) [6]. Connotative, affective meanings, refer to the implicit, intuitive and emotional processes associated with concepts [7]. If we work with two different people, their assessments of one notion will be little or extremely different [8]. "For example, when an image of a rose is seen in a film (or other visual arts), this image of the rose itself is first and foremost a "denotative". However, the way in which a rose is shown (in vivid or faint colours, above or below the frame, from a bottom or top shot, etc.), this in fact, is the connotative meaning" [9]. Using the semantic differential method we can place the notion within semantic space defined by three dimensions. Semantic space as a three-dimension space allows us to position individual notions as we like and according to this positioning, it is possible to interpret similarities or dissimilarities [6]. Results of our research via semantic differential are accompanied with the interviews, in which students could express their ideas and attitudes in words.

Semantic differential offers a lot of data which are possible to analyse in several ways. For the statistical analysis, we used Student's T-test, D-matrix, and calculation of standard deviation.

Results

We analysed our data from two perspectives:

- According to individual notions
- According to individual items (adjective rows)

We collected 3240 data entries in total. This number was reached by the sum of all respondents, notions, and individual items (adjective rows) that entered the research [(45 respondents x 2 assessments, one before and one after the research action) x (6 notions x 6 items) = 3240].

In Table 1, the notions and their average value for individual bipolar adjectives are seen. Perception of the notion of the given adjectives changed. Each item (adjective row) had 5 degrees (1–5) while the lower the value, the more positive perception of the notion and the higher the value, the more negative perception of the notion. It is interesting to observe how the notion "Teacher" moved from 3.1 to 1.3. After the experimental activities, children started to perceive the role of the teacher as very useful. All the results were subject to statistical analysis, which clearly shows that the results are statistically significant, reaching 99 %.

Table 1

Average values of semantic differential

Adjectives	Notions and assessments											
	Before						After					
	Che.	Sch.	Exp.	Sci.	Game	Tea.	Che.	Sch.	Exp.	Sci.	Game	Tea.
Useful - Not useful	2.3	2	2.7	2.5	1.6	3.1	1.4	2	2.5	2	1.3	1.3
Active - Passive	1.6	1.7	1.7	1.4	1.4	1.6	1.4	1.6	1.4	1.6	1.3	1.4
Pretty - Ugly	2	1.8	1.8	1.3	1.5	4	1.4	1.8	1.3	1.8	1.3	1.3
Organised - Disorganised	1.1	1.3	1.3	2.7	1.6	2.1	1	1.1	1.2	1.1	1	1.2
Entertaining - Boring	2.6	2	1.9	1.7	1	2.1	1.4	2.1	1.5	2.1	1	1
Easy - Difficult	4.7	4.6	3.1	4.7	1	4.7	3.7	4.7	3.5	4.7	1.1	1.2

*Che. - chemistry, Sch. - school, Exp.- experiment, Tea. - teacher

All the notions in the adjective row active - passive show little shift towards activity. The notion "Teacher" experienced a noticeable shift in the adjective row pretty - ugly. Once again, experimental activities at the science camp positively influenced children's perception of teachers. While at the beginning children considered the notion of "Teacher" ugly, at the end of the camp, the notion was perceived pretty. Statistical analysis proved this result to be significant, reaching 99 %.

In the next adjective row, organised - disorganised, all the notions experienced little improvement, however, in the statistical analysis, this shift was not identified as significant.

The fifth adjective row, entertaining - boring, shows that any notion is perceived as clearly boring, however, the most significant shift towards positive perception is visible with the notions "Chemistry" and "Teacher", assessments of which moved from 2.6 to 2.1 and from 1.4 to 1 respectively. It is interesting to notice that after the science camp, children perceived teachers univocally entertaining. Both results were statistically significant. In the table, we can also see a little negative shift for the notions "Science" and "School". In this case, statistical analysis does not identify the results as significant. In the last adjective row, children expressed their opinion about difficulty of the notions. We did not expect major positive shift as it is obvious that learning is not considered to be easy. The notion "Teacher" reaches 1.2, which is extremely significant positive shift, as it proves that teachers motivate children to learn successfully. This result is also statistically significant, reaching 99 %. The notion "Chemistry" shows positive shift, too, even though moving from 4.7 to 3.7 is not so weighty. However, statistical analysis proved it significant. Perception of some notions did not change at all and some notions shifted negatively, such as the notion "School" going from difficulty 4.6 to 4.7. The reason for the latter one could be the fact that children discovered a new learning style which might be perceived more pleasant than traditional learning at school. This shift is not statistically significant.

We also calculated standard deviation for all the notions which shows how similar are the assessments of individual respondents. If the standard deviation is high, assessments of individual respondents differed a lot, however, if the standard deviation is low, assessments of individual respondents were similar [6]. All standard deviations which we calculated are shown in Table 2. The lowest standard deviation before and after the experiment (0.2 vs. 0.1) was identified in relation with the notion "Game", which means respondents gave the most similar assessments. The highest standard deviation before the experiment was identified in relation with the notion "Science" (1.2). After the experiment, the highest standard deviations were identified in relation with the notions "Science" and "School" (1.2). It is interesting to notice that the difference between standard deviation of notions

"Chemistry" and "Teacher" were quite different before the experiment, but the values were quite highly similar after the experiment.

Table 2

Values of standard deviations

Notion	Before the experiment	After the experiment
Chemistry	1.1	0.9
Experiment	0.6	0.8
School	1.1	1.2
Science	1.2	1.2
Game	0.2	0.1
Teacher	1.1	0.5

As the selected notions had also their respective general assessments, we were able to place them in the three-dimension space. In Figure 1, you can see the differences in perception of individual notions before and after the experimental activities. We can say that the notions placed close to each other are semantically related while the notions placed further from each other are semantically different. Due to technical reasons, you can see only two dimensions in the figure, i.e. assessment and power. Some notions in the figure are literally overlapping, which means they are really similar. It is interesting to notice that while before the experiment the notion "Teacher" is placed further from other notions and is strongly negative, after the experiment, it is literally overlapping with the notion "Game" and perceived as strongly positive. Another overlap can be seen where the notion "Science" after the experiment meets with the notion "School" after the experiment, which might be interpreted that children started to connect school with the world of science a bit more than before the experiment. We can see a shift from the negative semantic space to the more positive space also with the notion "Chemistry".

We expressed similarity of notions and distance in the semantic space also statistically with the use of D-matrix. The lower the values in D-matrix are, the higher the similarity; the higher the values are, the lower the similarity. In this research, we identified the biggest similarity between the notions "Chemistry" and "School" before the experiment (D-value was 1) and between the notions "School" and "Science" after the experiment (D-value was 0, which means the respondents consider the meaning of the notions almost identical). The lowest similarity was identified between the notions "Game" and "Teacher" before the experiment (D-value was 5.3, which means that respondents do not consider game as part of the role of the teacher) and between the notions "Chemistry" and "Science" after the experiment (D-value was 6.7, which might have been caused by the effort to learn the children at the camp chemistry via games, as a subject which is fun and not to be afraid of, eventually leading to the fact that the notion of chemistry moved away from the more professionally perceived notion of science).

We collected also some extra data from the interviews with individual respondents. We asked them how the camp went and what they thought about the way of learning which had been presented to them at the camp. During the anamnestic interview, the respondents got a chance to express their opinion on the questions like: What does the word scientist mean? Would you like to become a scientist? What motivated you to enroll at the camp? In Table 3, you can see sample answers to these model questions.

However, in the catamnestic interview, the answers started to change and confirmed the results of the semantic differential, i.e. that the camp changed children's thinking about

the notions from the area of science and schooling towards more positive attitude. Sample answers are shown in Table 4.

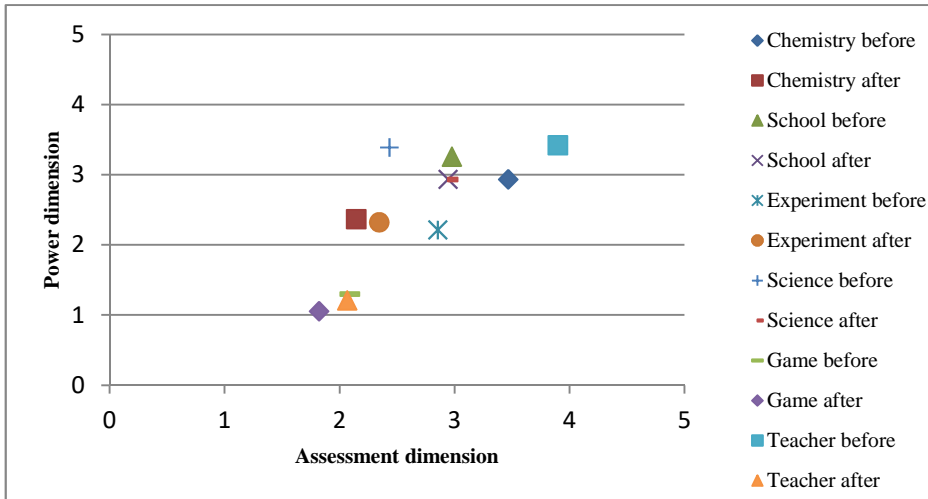


Fig. 1. Difference in perception of notions before and after the experiment pictured in semantic space

Samples from the anamnestic interview

Table 3

Question	Answer
What does the word scientist mean?	It's a gentleman with tousled hair wearing a white coat
Would you like to become a scientist?	Not really, they're all freaks
What motivated you to enroll at the camp?	My parents made me come

Samples from the catamnestic interview

Table 4

Question	Answer
What does the word scientist mean?	It's a person who looks for answers to interesting questions
Would you like to become a scientist?	Maybe yes, even though it's tough
Will you enroll at the camp next year, too?	I guess, I liked it here very much

Discussion

Learning in nature further from traditional school environment and using miscellaneous outdoor activities is not unusual, it has a long-standing tradition. The founder of science camps, which are known rather like expeditionary learning school, is Kurt Hahn [10]. However, answering the question that we formulated at the beginning of our research is a useful addition to the existing information about the benefits of such experiences. We examined whether science camps had any effect on connotative perception of notions related to science and education. We formulated zero hypothesis:

- Connotative meaning of notions related to science and education will be in students' assessments the same before and after the camp takes place.

In order to conduct the research, we used semantic differential and interviews with respondents. We statistically analysed individual notions as well as individual items (adjective rows). In many analyses, we confirmed high statistical significance of the results, which means that after the end of the camp students' perception of connotative meaning of notions related to science and education were different in comparison to their perception from before the start of the camp. In majority of cases, we can dismiss the zero hypothesis and accept a new alternative. If we look at the research from the point of view of individual item, statistical significance was confirmed in relation with the item "organised - disorganised". It means that participation at the camp formed children's thinking about individual notions in this adjective row towards "more organised", which means they started to think of the world of science as an organised space, a space which needs rules in order to avoid chaos and achieve some results.

This research was inspired by the paper on "short-term effect on experimental field learning on students' knowledge of ecosystems" [11]. The author of the paper assessed the level of knowledge from before and after the experiment. As a research method he opted for didactic test and notion maps. The results showed that the short-term experimental learning had positive effect on students' knowledge of ecosystems. Such learning in nature proved to be positive, too [11]. In our research, we focused on connotative perception of notions from before and after the experiment, which had not been researched before.

Besides research papers on this topic, we found inspiration in many other papers on outdoor learning. For example, research from Chang Jung Christian University talked about m-learning methods [12]. The camp described in the paper was well-planned, with activities that took into consideration several factors such as age of the participants or atmosphere of the camp location. Similar research on assessment of outdoor learning was realised in the UK [13].

Our decision to do interviews as an additional source of data was inspired by the research of summer camps at Indiana University [14]. In our research, both anamnestic and catamnestic methods were used twice, once before and once after the experimental activities so that we be able to find out real effect of the science camp on students' opinions. Similar research dedicated to development of scientific thinking during a science camp and acquiring data both before and after the experimental activities was done in an English speaking camp for Asian students [15]. This camp was language-wise similar to our second, international camp.

The biggest shortcoming of our research is the little number of respondents. However, as we wanted to make this research at these two one-week long summer camps and the number of participants was limited by several factors, such as accommodation possibilities, number of teamleaders, etc., we felt lucky after we managed to increase the number of participants from 20 in the first year to 25 in the second year. Also, we believe that year by year, as our experience grows, we might be able to provide for the most optimal way how to motivate the students to learn about natural sciences and, therefore, we see a huge potential to continue our research activities in the future, which will eventually lead to an increase in the number of respondents.

Conclusion

Research results point to the importance of attractiveness of scientific disciplines. The difference in the perception of some concepts of education and science before and after

the experiment, the participation of respondents in the camp, is indeed significant in some items. Consequently, focusing more on its practicality and interestingness in learning is probably the right way to motivate pupils to study science such as chemistry or biology and so on. The research also pointed to the perception of the role of the teacher. While in a traditional school the teacher is becoming increasingly underestimated, in non-formal education he has gained respect and esteem. He has become a favourite and a model for respondents. It would be appropriate to continue research and implement these elements of education that have been used in the camp in a traditional school.

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