

# USE OF VISUALIZATION TO MOTIVATE SCIENCE AND GEOGRAPHY EDUCATION OF FEMALE SCHOOLCHILDREN

**Renata Bilbokaitė**

Šiauliai University, Šiauliai, Lithuania

E-mail: renata.bilbokaite@inbox.lt

## **Abstract**

*ICT progress and invasion in education started in post-modern age. The majority of schoolchildren tend to learn science and geography at a low level, there is a lack of specialists in scientific areas in the entire world. This research was done with the aim to identify whether visualization could stimulate female schoolchildren's motivation in learning geography and science. A survey of 1934 schoolchildren, grades 9 and 10, from general and secondary schools was carried out. This paper focuses on data of female population. Obtained results suggest that visualization as a tool in general could be highly motivating for female schoolchildren, especially for those in grade 9, learning geography: they would like to learn new topics and be more active in lessons. It was also found out that visualization stimulates science learning by girls much more than their learning of geography.*

**Key words:** visualization, motivation, comprehensive school.

## **Introduction**

Computer based visualization is an essential tool in post-modern age as technologies have expanded resources and teachers have started using ICT in the education process. ICT revolution has changed teachers' attitudes towards the learning process and their potential to control the education process. It is evident that schoolchildren have become more proficient in technologies than their teachers; however, the education process is under teachers' control. This leads to the opinion that visualization in general should be interpreted as a method or tool to reach educational goals and could be used by teacher in lessons. Visualization could be useful for science education because it can stimulate deeper motivation, better perception, attention (Giaquinto, 2007; Nelses, 1993; Rivera, 2007; Cooper, 2008; Coz, 2006; Wang, Reeves, 2007; Williamson, Jose, 2008). According to Bilbokaite R. (2009), "many invisible phenomena that could not be seen in daily life or even through a microscope are found in natural science, which is a part of empirical and theoretical sciences; science signs and models that are very puzzling for students are insufficiently dealt with in secondary education. Many phenomena connected with formulas, equations, laboratory work are very difficult for schoolchildren and, as a rule, they lack knowledge in them". Visualization could stimulate cognitive processes and thus make teaching more effective.

### *Problem of Research*

Visualization as a phenomenon in education has been explored in all the world. This means that visualization is an important research object in the entire world. It was found out that visualization can stimulate mostly male schoolchildren's motivation in classes: their interest in the topic, curriculum and also their capacity to remember and link things that have been learned previously (Bilbokaite, 2010a). These findings are true in science education. Comparing research findings on the same object among female population, almost similar results were obtained (Bilbokaite, 2010b). Still there is a lack of research in various disciplines because it is not clear whether visualization could be useful for learning mathematics or geography where schoolchildren study difficult phenomena as well.

### *Research Focus*

The goal of the research is to find out whether visualization helps to stimulate female schoolchildren's motivation to learn science and geography; whether there are any statistically significant differences in schoolchildren's opinions that visualization stimulates to learn one of the mentioned discipline more; whether there are any statistically significant differences in schoolchildren's evaluations by grades.

## **Methodology of Research**

### *General Background of Research*

The research is based on three theories. The first is *motivation theory* (Maslow, 2006) which encompasses a positive attitude as a factor that stimulates schoolchildren's motivation in the learning process. According to this conception, schoolchildren have a need for learning and it is very important to stimulate their motivation as that enables them to reach better learning results. Undoubtedly, if visualization could be a tool that helps in the learning process, then it would mean that visualization could be used as a tool to stimulate schoolchildren's motivation.

The second theory is *dual code theory* (Hodes, 1994). "It is proposed that visual and verbal information are interconnected by some contacts. Both kinds of information are connected in the consciousness, all this conditions the circumstantial perception of the object when a child encloses the visual part of the object and the verbal information encloses the side of the concepts. The visual system evidences in the perception of knowledge where spatial abilities, visual perception, encoding and transformation inter act" (Bilbokaite, 2009).

The last theory is *feminist discourse* (Ślęczka, 2005). This theory allows the researcher to assume that women psychology could be different from men psychology. Therefore, female sample has been chosen and is analyzed in this paper. Data results are interpreted independently from male data results and this provides a deeper insight into the evidences of female population.

### *Sample of Research*

Data results are valid because the sample was selected according to the formula for social sciences research. The sample of the research is 1934 students of grades 9 and 10. The method of random sampling of basic and secondary schools including gymnasias classes was used. Almost all the participants were from cities, only 5.2% of the sample was from rural areas. All characteristics of the sample are presented in Table 1.

**Table 1. Data characteristic of sample.**

|                            | Sex<br>N / % |        | Class<br>N / % |      | Age<br>N / % |      |      |     |     | Location<br>N / % |          |
|----------------------------|--------------|--------|----------------|------|--------------|------|------|-----|-----|-------------------|----------|
|                            | Male         | Female | 9              | 10   | 14           | 15   | 16   | 17  | 18  | Town              | District |
| <b>Geography<br/>N=782</b> | 449          | 333    | 403            | 379  | 64           | 405  | 301  | 11  | 1   | 756               | 26       |
|                            | 57.4         | 42.6   | 51.5           | 48.5 | 8.2          | 51.8 | 38.5 | 1.4 | 0.1 | 96.7              | 3.3      |
| <b>Science<br/>N=1152</b>  | 508          | 644    | 546            | 606  | 10           | 288  | 561  | 288 | 4   | 1130              | 22       |
|                            | 44.1         | 55.9   | 47.4           | 52.6 | 0.9          | 25   | 48.7 | 25  | 0.3 | 98.1              | 1.9      |

### *Instrument and Procedures*

The research instrument was developed by the author of the paper. Indicators were taken from a pilot research. The research included various aspects of the use of visualization in science education. Data analysis and interpretation of the statements in this instrument were made. 67 statements were given, five scales and eight sub-scales were formed only from open-ended questions. Schoolchildren could select an answer on the Lickert scale. The internal validity of this instrument was 0.928, what means that the instrument is appropriate for research. Only one sub-scale, "The use of visualization for schoolchildren's motivation stimulation", which identifies how visualization can stimulate motivation in science and geography learning is presented in this paper.

The research was carried out in 2009-2010. Firstly, a pilot research was carried out; it focused on various things connected with deeper interpretation of a diagnostic inquiry. In 2009 schoolchildren were surveyed on the benefit of visualization in science education. A year later the instrument was used for research of the same object in geography. The questionnaires were prepared on paper and given to schoolchildren. The return of the questionnaires was 94%.

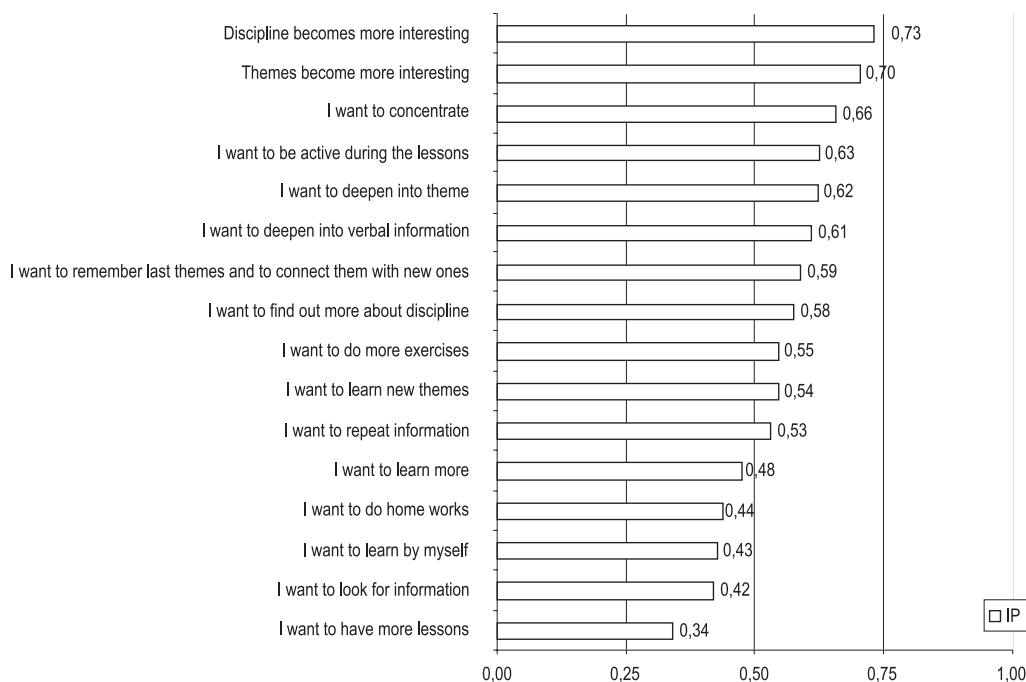
### *Data Analysis*

*Descriptive statistics:* Index of Popularity.

*Analytical statistics:* Mann Whitney U-test for independent samples. Statistically significant difference was stated when  $p < 0.05$ .

### **Results of Research**

All data is presented in tables and pictures. Below pictures author presents data analysis.

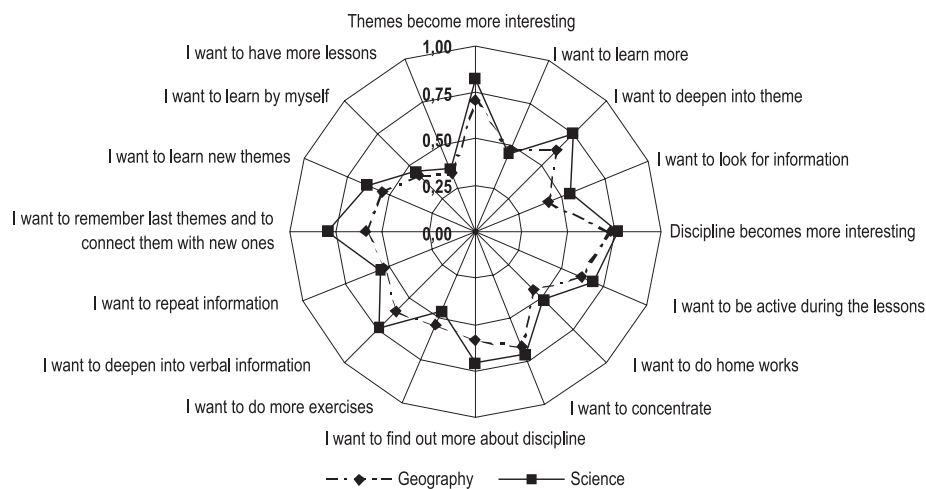


**Figure 1. Use of visualization to motivate geography education (Index of popularity).**

The benefit of visualization for stimulating motivation in geography lessons was evaluated differently by girls. Many statements were ranked higher than average; girls tended to notice that not all the indicators are linked with visualization. The statement “*Discipline becomes more interesting*” when the teacher uses visualization got the highest index of popularity in geography lessons. The statement, which shows that female students’ wish to control the processes is linked with effective learning, got lower ranking. The statement on motivation aspects in the context of supplementary learning got the lowest ranking. Female students do not think that visualization stimulates motivation to learn geography much more than usually, only 34% of the respondents would like to have more geography lessons where visualization is used.

The aim was to find out possible statistically significant differences in female schoolchildren’s evaluation of the benefit of visualization for motivation in grades 9 and 10. Data analysis is presented in Table 1 in the appendix. The content and curriculum of different grades were not an important factor for girls’ motivation to study, but slightly higher motivational aspects could be seen in grade 9. Girls in grade 9 tended *to be active in science lessons* ( $Z$  meaning  $[Z] = -3.881$ ,  $p$ -value = 0.000,  $p < 0.05$ ) and *to learn new topics* ( $Z$  meaning  $[Z] = -1.985$ ,  $p$ -value = 0.000,  $p < 0.05$ ) than girls grade 10.

Similar analysis was carried out with the aim to find out possible differences between female schoolchildren’s evaluation of motivational aspects in geography and science lessons when visualization was used. The results are given in Table 2 (see the appendix). The index of popularity was also calculated to see the popularity of schoolchildren’s answers in this case. The results are given in Figure 2.



**Figure 2. Use of visualization to motivate geography and in science education (Index of Popularity).**

Figure 2 presents female schoolchildren's opinions on visualization as a tool of motivation in science and geography classes. We can see that the index of popularity of each indicator for science classes is higher than for geography classes. The highest difference is in female schoolchildren's opinions that visualization stimulates motivation to remember topics and to link them. A wish to learn new topics is similar for science and geography classes.

It was important to present differences using a statistical method. Relying on the results, 12 statistically significant differences comparing girls' opinions on the benefit of motivational aspects for learning science and geography were found out. Analysis shows that visualization stimulates motivation to learn science. Data show that for girls science topics become more interesting than geography topics when visualization is used in lessons ( $Z$  meaning  $[Z] = -8.276$ ,  $p$ -value = 0.000,  $p < 0.05$ ). Similar differences were identified comparing schoolchildren's wish to learn the above mentioned disciplines. Girls were more willing to *deepen into science topics* ( $Z$  meaning  $[Z] = -8.072$ ,  $p$ -value = 0.000,  $p < 0.05$ ), to *look for scientific information* ( $Z$  meaning  $[Z] = -6.873$ ,  $p$ -value = 0.000,  $p < 0.05$ ), to *be active in science lessons* ( $Z$  meaning  $[Z] = -4.068$ ,  $p$ -value = 0.000,  $p < 0.05$ ), to *do homework in science lessons* ( $Z$  meaning  $[Z] = -4.394$ ,  $p$ -value = 0.000,  $p < 0.05$ ), to *be more concentrated* ( $Z$  meaning  $[Z] = -3.651$ ,  $p$ -value = 0.000,  $p < 0.05$ ) and to *find out more about science* ( $Z$  meaning  $[Z] = -7.680$ ,  $p$ -value = 0.000,  $p < 0.05$ ). On account of visualization girls also wanted to *do more exercises for science lessons* ( $Z$  meaning  $[Z] = -4.448$ ,  $p$ -value = 0.000,  $p < 0.05$ ), to *deepen into verbal scientific information* ( $Z$  meaning  $[Z] = -8.320$ ,  $p$ -value = 0.000,  $p < 0.05$ ), to *remember last topics and to link them with new ones* ( $Z$  meaning  $[Z] = -12.076$ ,  $p$ -value = 0.000,  $p < 0.05$ ), to *learn new topics* ( $Z$  meaning  $[Z] = -5.701$ ,  $p$ -value = 0.000,  $p < 0.05$ ) and to *learn on their own* ( $Z$  meaning  $[Z] = -2.029$ ,  $p$ -value = 0.042,  $p < 0.05$ ). Girls wanted to *do more exercises in geography classes* ( $Z$  meaning  $[Z] = -4.448$ ,  $p$ -value = 0.000,  $p < 0.05$ ) and this value is the only statistically significant difference evaluated as positive for geography classes.

## Discussion

Data results show that visualization could motivate schoolchildren to learn science more than geography; the indexes of popularity were rather high in the both research and this leads to the assumption that visualization is beneficial for learning these disciplines. In the previous research on the use of visualization in science classes by female schoolchildren it was stated that

“visualization as a learning tool was evaluated almost at the same level in all aspects, but girls in grade 9 more statistically significantly wanted to deepen in a topic, to be more active in lessons and to do homework. Girls in grade 10 more statistically significantly wanted to have more biology, chemistry and physics classes. It was found out that girls like to learn firstly biology, then chemistry and only then physics. Girls in grades 9 and 10 equally enjoy learning biology and physics but girls in grade 9 more statistically significantly like to learn chemistry” (Bilbokaite, 2009). Comparing these data with this research data it is evident that girls in grade 9 are definitely interested in learning topics and want to be active in lessons not only in science classes as it was stated earlier but also in geography classes. Equal indicators show similarities of the use of visualization in general in the education process. Having in mind the fact that surveyed girls were from various areas, we could firmly state that visualization could be useful for stimulating girls’ motivation to deepen in topics and be active in science and geography classes.

Other results on the comparison of the use of visualization in the disciplines demonstrate that science education is a primary area for reaching success in education. Many factors are statistically significant and show that visualization stimulates deeper motivation to learn science than geography. Firstly, it could be true because science teachers use visualization in the education processes more often than geography teachers (Bilbokaite, 2010b). Secondly, there are many more invisible phenomena in science education than geography. And thirdly, geography is close to social sciences where abstract facts are interpreted as social events.

Methodological theories claim that visualization could be a useful tool for learning because it undoubtedly stimulates schoolchildren’s motivation to learn. Dual code theory is effective for the interpretation of data indicators which are true-to-life facts in the education process. Visualization helps to learn abstract phenomena because information is presented visually. When schoolchildren use both verbal and visual information in the learning process learning results are better. This motivates them to learn. Feminist theory maintains that data results are important for women psychology because they are the factors that promote gender psychology and education as well.

The research shows that visualization could be an important tool in the learning process; it could stimulate various motivational aspects for female schoolchildren in grades 9 and 10 in Lithuania. In general, the term *visualization* includes the use of visual aids, computer or other ICT visualization formats such as overhead projector or Power Point slides, etc. The research could seem too abstract because it does not focus on any particular visualization tool but this could serve as a background for other research on the use of one of the selected visualization tools worldwide. For example, some research could focus on the use of Power Point slides and provide comparison of obtained results. Comparative research on the object in different cultural populations could be also interesting and useful for science.

## Conclusions

The use of visualization in geography classes stimulates girls’ activity; their aim to learn and remember information; to link it with previous topics and to gain general knowledge. Visualization weakly stimulates their interest in extra-learning of geography. Girls do not want to spend their free time for education. Some stimulating factors of visualization are stronger for girls in grade 9: they want to be more active and to learn new topics.

The effectiveness of visualization for female schoolchildren was identified more in science education than in geography classes. Many statistically significant indicators show that visualization is beneficial for science education: girls want to be more active in lessons, are more willing to learn the subject and are also more interested in learning science by theoretical and empirical methods. The only motivating factor stimulated by visualization in geography classes was to do exercises.

## References

- Bilbokaitė R. (2009). Vizualizacijos pagalba merginų motyvacijai skatinti gamtamoksliniame ugdyme: diagnostinio tyrimo rezultatai. *Jaunųjų mokslininkų darbai / Young Researchers' Works*, Vol. 4, Issue 25, p. 91–96.
- Bilbokaitė R. (2010a). The Help of Visualization for Boys' Motivation Fostering in Science Education: The Results of Pilot Research. In: *DIVAI 2010 – Distance Learning in Applied Informatics – Conference Proceeding (Nitra, May 4-6)*. Nitra: UKF, p. 189–194.
- Bilbokaitė R. (2010b). Vizualizacijos taikymo lygio ir jos kitimo geografijos pamokose diagnostika: mokytojų ekspertų vertinimas. Kn: *Gamtamokslinis ugdymas bendrojo lavinimo mokykloje – 2010 (XVI nacionalinės mokslinės praktinės konferencijos straipsnių rinkinys, Kėdainiai, 2010 m. balandžio mėn. 23–24)*. Šiauliai, p. 26–31.
- Cooper L. Z. (2008). Supporting Visual Literacy in the School Library Media Center: Developmental, socio-cultural and experimental considerations and scenarios. *Knowledge Quest*, Vol. 36, Issue 3, p. 14–19.
- Cox J. R. (2006). Screen Capture on the Fly. *Biochemistry and Molecular Biology Education*, Vol. 34, Issue 1, p. 12–16.
- Giaquinto M. (1994). Epistemology of Visual Thinking in Elementary Real Analysis. *British Journal for the Philosophy of Science*, Vol. 45, Nr. 3, p. 789–813.
- Maslow A. (2006). *Motyvacija ir asmenybė*. Vilnius: Apostrofa.
- Nelses R. B. (1993). *Proofs without Words: Exercises in Visual Thinking II*. Washington: The Mathematical Association of America.
- Rivera F. (2007). Visualizing as a Mathematical Way of Knowing: Understanding Figural Generalization. *Mathematics Teacher*, Vol. 101, Issue 1, p. 69-75.
- Wang S. K., Reeves T. (2007). The effects a web-based learning environment on student motivation in a high school earth science course. *Educational Technology Research & Development*, Vol. 55 Issue 2, p. 169–192.
- Williamson V.M., José T.J. (2008). The Effects of a Two-Year Molecular Visualization Experience on Teachers' Attitudes. Content Knowledge and Spatial Ability. *Journal of Chemical Education*, Vol. 85, Issue 5, p. 718–723.

## Appendix

**Table 1. Use of visualization to motivate geography education in comparative grade aspect**

| Proposition                    | 9 grade |           |              | 10 grade |           |              | Mann-Whitney U | Z      | p     |
|--------------------------------|---------|-----------|--------------|----------|-----------|--------------|----------------|--------|-------|
|                                | N       | Mean Rank | Sum of Ranks | N        | Mean Rank | Sum of Ranks |                |        |       |
| Themes become more interesting | 242     | 225.12    | 54478.5      | 207      | 224.86    | 46546.5      | 25018.5        | -0.022 | 0.982 |
| I want to learn more           | 242     | 226.20    | 54740.0      | 207      | 223.60    | 46285.0      | 24757.0        | -0.218 | 0.828 |
| I want to deepen into theme    | 242     | 232.20    | 56192.0      | 207      | 216.58    | 44833.0      | 23305.0        | -1.328 | 0.184 |
| I want to look for information | 242     | 229.35    | 55503.0      | 207      | 219.91    | 45522.0      | 23994.0        | -0.795 | 0.426 |

|  |     |        |         |     |        |         |         |        |              |
|--|-----|--------|---------|-----|--------|---------|---------|--------|--------------|
| Discipline becomes more interesting                              | 242 | 221.27 | 53546.5 | 207 | 229.36 | 47478.5 | 24143.5 | -0.693 | 0.488        |
| I want to be active during the lessons                           | 242 | 246.05 | 59544.5 | 207 | 200.39 | 41480.5 | 19952.5 | -3.881 | <b>0.000</b> |
| I want to do home works  | 242 | 231.39 | 55997.0 | 207 | 217.53 | 45028.0 | 23500.0 | -1.161 | 0.245        |
| I want to concentrate  | 242 | 232.18 | 56187.5 | 207 | 216.61 | 44837.5 | 23309.5 | -1.320 | 0.187        |
| I want to find out more about discipline                         | 242 | 231.12 | 55930.0 | 207 | 217.85 | 45095.0 | 23567.0 | -1.116 | 0.264        |
| I want to do more exercises                                      | 242 | 225.90 | 54668.5 | 207 | 223.94 | 46356.5 | 24828.5 | -0.165 | 0.869        |
| I want to deepen into verbal information                         | 242 | 229.16 | 55457.5 | 207 | 220.13 | 45567.5 | 24039.5 | -0.771 | 0.440        |
| I want to repeat information                                     | 242 | 230.58 | 55799.5 | 207 | 218.48 | 45225.5 | 23697.5 | -1.028 | 0.304        |
| I want to remember last themes and to connect them with new ones | 242 | 226.69 | 54859.0 | 207 | 223.02 | 46166.0 | 24638.0 | -0.308 | 0.758        |
| I want to learn new themes                                       | 242 | 235.86 | 57078.5 | 207 | 212.30 | 43946.5 | 22418.5 | -1.985 | <b>0.047</b> |
| I want to learn by myself  | 242 | 223.73 | 54143.5 | 207 | 226.48 | 46881.5 | 24740.5 | -0.232 | 0.817        |
| I want to have more lessons                                      | 242 | 228.45 | 55286.0 | 207 | 220.96 | 45739.0 | 24211.0 | -0.633 | 0.527        |

**Table 2. Use of visualization to motivate science and geography education in comparative aspect**

| Proposition                              | Geography |           |              | Science |           |              | Mann-Whitney U | Z      | p            |
|--|-----------|-----------|--------------|---------|-----------|--------------|----------------|--------|--------------|
|  | N         | Mean Rank | Sum of Ranks | N       | Mean Rank | Sum of Ranks |                |        |              |
| Themes become more interesting           | 449       | 45865     | 205932.5     | 644     | 608.60    | 391938.5     | 104907.5       | -8.276 | <b>0.000</b> |
| I want to learn more                     | 449       | 556.83    | 250015.0     | 644     | 540.15    | 347855.9     | 140166.0       | -0.883 | 0.377        |
| I want to deepen into theme              | 449       | 459.14    | 206154.5     | 644     | 608.26    | 391716.5     | 105129.5       | -8.072 | <b>0.000</b> |
| I want to look for information           | 449       | 470.53    | 211267.0     | 644     | 600.32    | 386604.0     | 110242.0       | -6.873 | <b>0.000</b> |
| Discipline becomes more interesting      | 449       | 526.74    | 236504.5     | 644     | 561.13    | 361366.5     | 135479.5       | -1.875 | 0.061        |
| I want to be active during the lessons   | 449       | 502.64    | 225684.5     | 644     | 577.93    | 372186.4     | 124659.5       | -4.068 | <b>0.000</b> |
| I want to do home works                  | 449       | 498.10    | 223645.5     | 644     | 581.10    | 374225.5     | 122620.5       | -4.394 | <b>0.000</b> |
| I want to concentrate                    | 449       | 507.13    | 227703.5     | 644     | 574.79    | 370167.5     | 126678.5       | -3.651 | <b>0.000</b> |
| I want to find out more about discipline | 449       | 462.41    | 207623.5     | 644     | 605.97    | 390247.4     | 106598.5       | -7.680 | <b>0.000</b> |



|  |     |        |          |     |        |          |          |         |              |
|--|-----|--------|----------|-----|--------|----------|----------|---------|--------------|
| I want to do more exercises                                      | 449 | 596.45 | 267806.4 | 644 | 512.52 | 330064.5 | 122374.5 | -4.448  | <b>0.000</b> |
| I want to deepen into verbal information                         | 449 | 457.42 | 205382.5 | 644 | 609.45 | 392488.4 | 104357.5 | -8.320  | <b>0.000</b> |
| I want to repeat information                                     | 449 | 526.55 | 236421.0 | 644 | 561.26 | 361449.9 | 135396.0 | -1.860  | 0.063        |
| I want to remember last themes and to connect them with new ones | 449 | 415.21 | 186429.5 | 644 | 638.88 | 411441.5 | 85404.5  | -12.076 | <b>0.000</b> |
| I want to learn new themes                                       | 449 | 484.17 | 217392.9 | 644 | 590.80 | 380477.9 | 116368.0 | -5.701  | <b>0.000</b> |
| I want to learn by myself  | 449 | 524.48 | 235491.5 | 644 | 562.70 | 362379.5 | 134466.5 | -2.029  | <b>0.042</b> |
| I want to have more lessons                                      | 449 | 539.50 | 242235.9 | 644 | 552.23 | 355635.0 | 141211.0 | -0.680  | 0.496        |

*Advised by Laima Railienė, University of Šiauliai, Lithuania*

**Renata Bilbokaitė** PhD Student (Education), Natural Science Education Research Centre, University of Šiauliai, 25-119 P. Višinskio Street, LT-76351 Šiauliai, Lithuania.  
E-mail: renata.bilbokaite@inbox.lt  
Website: <http://www.gutc.su.lt>