

Features of empathy among students of the direction "Ecology and nature management" with different mathematical abilities and strategies for conveying meaning

Elena Suroedova^{1*}, *Dmitry Popov*¹, and *Marina Belousova*¹

¹ Don State Technical University, Gagarina square, 1, Rostov-on-Don, 344000, Russia

Abstract. Today, the entire education of the Russian Federation is being reformed, high requirements for the quality of education have been set. The restructuring and integration of the world educational process expects high efficiency of all educational activities, therefore, the problem of the study of mathematical abilities and the ability to convey meaning of students is particularly relevant today. Equally important is the problem of educating socially approved personality traits in the younger generation, including empathy. The study allowed us to establish that students with an average level of development of mathematical abilities have significantly less formed empathy, and vice versa, with the development of communicative properties, there is an increase in empathy abilities. It has been established that empathy is best formed in students of the direction "Ecology and nature management" with an active, emotionally dominant and cognitively dominant strategy for conveying meaning.

1 Introduction

Today, the entire education of the Russian Federation is being reformed, high requirements for the quality of education have been set. The restructuring and integration of the world educational process expects high productivity of all educational activities, therefore, the problem of studying the thematic abilities and abilities to convey meaning of students is particularly relevant today.

Such outstanding psychologists, teachers and mathematicians as L.S. Vygotsky[1], J. Piaget[1], V.A. Krutetsky[2], N.S. Leites [3], K.K. Platonov[4], V. D. Shadrikov [5], Agrillo, C., Piffer, L. , Adriano, A.,[6] D Tokada, T Herman and Suhendra[7] and others were engaged in the study of mathematical abilities.

Analysis of psychological and pedagogical literature has shown that there are different definitions of mathematical abilities in general and mathematical abilities of a student in particular, but there is still no established definition that satisfies everyone. There is no definition of the concept of mathematical abilities of students, especially students of technical specialties, at all. Considering this issue, it is necessary to pay attention to the fact that there are educational abilities for the assimilation of mathematical knowledge, their reproduction

* Corresponding author: suroedova@mail.ru

and independent application, and creative mathematical abilities associated with the independent creation of an original product having scientific or applied value.

The concept of mathematical abilities is considered most fully by the great Russian psychologist V.A. Krutetsky. By mathematical abilities, he understands such individual psychological features of mental activity that meet the requirements of educational mathematical activity and, at all other things being equal, determine the success of creative mastery of mathematics as an academic discipline. The well-known American psychologist E. Thorndike made a great contribution to the study of mathematical abilities. He speaks about the difficulties of mastering algebra associated with children's misunderstanding of the essence of letter designations, about the need to fight against the formal memorization. He identifies those functions that are improved and developed in the process of mastering arithmetic [5].

Thus, we can say that most people have the makings for mathematics, but some of them are expressed, while others are hidden. The task of the teacher is to find these hidden natural inclinations and show the student that he can understand and perceive such a complex science as mathematics. The main structural component of students' mathematical abilities should be the ability to identify a mathematical situation in any non-mathematical problem solved using mathematical methods. Under the mathematical abilities of students, we understand the individual psychological feature of mental activity, which contributes to the successful mastery of mathematics as an academic discipline and determines its application in solving problems of professional activity.

Meaning transfer is understood as the process of conveying meanings by verbal and non-verbal methods [8]. The phenomenality of this process is that it is difficult to grasp the factors and conditions that determine the specifics of the process of the teacher's educational work, the success and effectiveness of the educational process [8, 9]. I.V. Abakumova following A.G. Asmolov, I.V. Dubrovina, V.V. Rubtsov, A.A. Leontiev, believes that the transition from the cognitive paradigm of education to the semantic paradigm will provide a new quality of learning, determining the possibilities of designing personal development and the implementation of other personality-generating functions of the educational process [10]. D. Dautov, A. Belousova, summarizing the results of the analysis of research on joint thinking, note that one of the best types of formation of a professional image of the world is the joint thinking activity of a teacher and students [11]. We agree with the authors, because it is in such conditions that semantic dialogue can show the highest learning outcomes, moreover, in uncertain conditions, it is the only adequate form of interaction. In these conditions, one of the most important mechanisms for the implementation of semantic dialogue comes to the fore – meaning transfer. Meaning transfer is a process, according to A. Belousova, "occurring during communication, when one of the participants can convey meanings to another participant by verbal or non-verbal-emotional means" [12, 13, 14]. According to the authors, "in order to convey meaning, it is necessary to reflect the actual part of your image of the world, reflecting the place of meaning in its value-semantic content, and the task that is presented in this content" [11, 12]. In the research of A. Belousova and E. Suroedova, strategies of semantic interpretation were discovered [8].

Empathy is becoming one of the most important qualities of a modern person today. The world is changing, it is becoming more demanding, rational and pragmatic. Empathy is a regulator of interaction and communication between people, manifested in the desire to help and support other people. The ability to empathize and compassion contributes to the development of humanistic values of a person, it accompanies his personal growth becoming one of the leading signs of any modern personality. The concept proposed by I. M. Yusupov defines empathy as an integral phenomenon linking the conscious and subconscious information of the psyche, the purpose of which is to "penetrate" into the inner world of another person or an anthropomorphized object [15]. According to V.V. Boyko, empathy is

a special reflection of interaction partners, which is based on emotional responsiveness and intuition, but rational perception also plays a significant role [16]. Formed empathy is an important psychological quality for establishing mutual understanding between people, the basis of empathy and formation of communicative competence and prevention of interpersonal conflicts. However, in the course of theoretical analysis, we have not identified studies on the problem, which is the novelty of our research.

The purpose of the study: to explore the features of empathy of students with different levels of mathematical abilities.

The object of the study are the students with different levels of mathematical abilities and abilities to convey meaning.

The subject of the study is the features of empathy of students with different levels of mathematical abilities and abilities to convey meaning.

Hypothesis: students with different levels of mathematical abilities and strategies of meaning transmission may have different features of empathy.

2 Materials and Methods

In the course of the study, the methods of literature analysis, the psychodiagnostic method and the method of mathematical data processing were used. The following tools were selected for the diagnosis of mathematical abilities, meaning transfer strategies and empathy characteristics of students: The methodology for diagnosing the level of empathic abilities of V.V.Boyko; The methodology for diagnosing empathy of I.M. Yusupov; The test "Analytical mathematical abilities"; the Amthauer intelligence structure Test; The questionnaire "Strategies of meaning transfer" by E. Suroedova.

Statistical processing of the results was carried out using the following methods: the nonparametric Mann-Whitney criterion for independent samples, the Kruskal-Wallis H-criterion for independent samples, descriptive statistics, quantitative and qualitative analysis of the results, the method of comparative analysis. The calculation was made in the program "SPSS 17.0 for Windows".

Characteristics of the disciplines studied: In total, the study involved 80 students of 1-2 courses of the DSTU, studying in the direction of "Ecology and nature management" aged 17 to 20 years. Of these, 40 subjects were men, 40 subjects were women. The average age of the subjects was 18.6 years.

3 Results and Discussion

In the course of the study, using the Amthauer test for subtests 5 Arithmetic problems, 6 Numerical series, 7 Spatial imagination, 8 Spatial generalization, we established the average values, which are presented in Table 1.

Table 1. Average values on the scales of the Amthauer Intelligence Structure TSI test.

№ subtest	X average
5 Arithmetic problems	4.8
6 Numerical series	4.7
7 Spatial imagination	5
8 Spatial generalization	5.3

The diagnostic results of the four subtests of the Amthauer TSI Intelligence Structure Test in the empirical group revealed the following peculiarities:

Using the Analytical Mathematical Abilities test, quantitative data on the levels of analytical and mathematical abilities in the empirical group were obtained. It was found that

26% of the surveyed students have an average level of analytical and mathematical abilities. In this group of students, the craving for mathematical knowledge is most pronounced. 73% of the surveyed students revealed a low level of analytical and mathematical abilities. That is, these students have no interest and orientation to the study of mathematics, their analytical and mathematical abilities are poorly developed. In the empirical group, not a single student with a high level of analytical and mathematical abilities was identified.

According to the diagnostic results, the empirical group was divided into 2 subgroups: 1 - students with an average level of analytical mathematical abilities (ALOMA); 2– students with a low level of analytical mathematical abilities (LLOMA).

To identify the strategies of meaning transfer among students, the methodology of "Strategies of meaning transfer" by Suroedova E. was used. The study revealed that all strategies of meaning transfer are represented in the sample. This allowed us to divide the sample into five groups of respondents. Then the results were converted to percentages (Fig. 1).

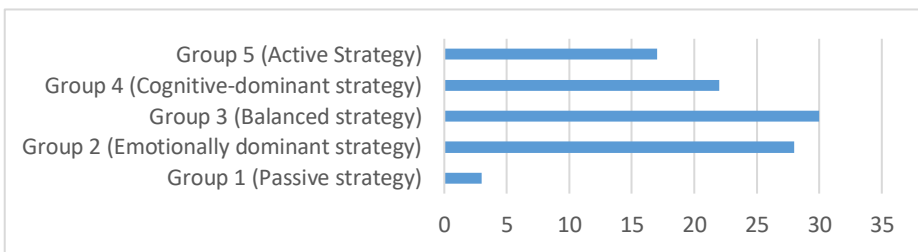


Fig. 1. The distribution of students into the groups based on the dominating transfer meaning strategy.

The results allowed us to establish that students most often have a balanced strategy of meaning transfer, which indicates an average level of verbal and nonverbal activity in the process of meaning transfer.

As a result of the diagnostics according to the methods "Diagnostics of the level of empathic abilities" by V.V.Boyko and "Diagnostics of empathy" by I.M. Yusupov, quantitative data on the prevailing type of empathy in the empirical group were obtained.

With the help of descriptive statistics, we have established the average values of the manifestation of empathy among students. The results obtained using the V.V. Boyko technique (Fig. 2) showing that the rational channel is much more pronounced than the others. The least points were scored on the scale of "Attitudes that promote empathy".

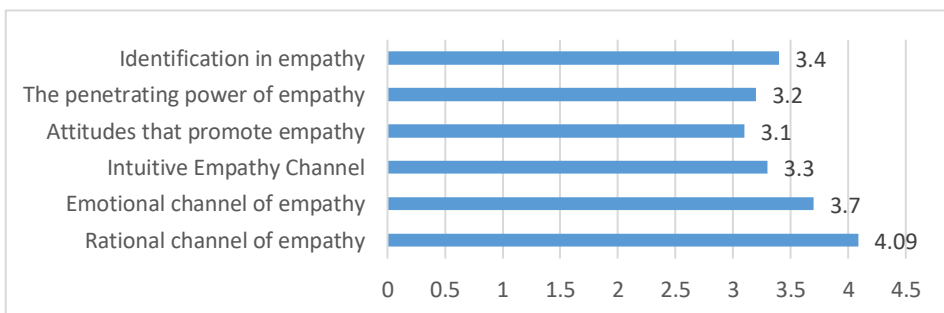


Fig. 2. Average values according to the method of V.V. Boyko "Diagnostics of the level of empathic abilities".

Figure 3 shows the results of the average values according to the method of "Empathy diagnostics" by I.M. Yusupov. From Figure 3, we see that Empathy for strangers and Empathy for parents are the most important on the scales. The components of empathy such

as Empathy for children, Empathy for animals, Empathy for the elderly are the least represented. Low levels of empathy for children and the elderly can be explained by age characteristics, since in early youth a person has not yet acquired a family and children, and communication with elderly people is quite limited. For many students, parents are at the stage of maturity of 40-50 years and are not yet associated with the elderly in the subjects.

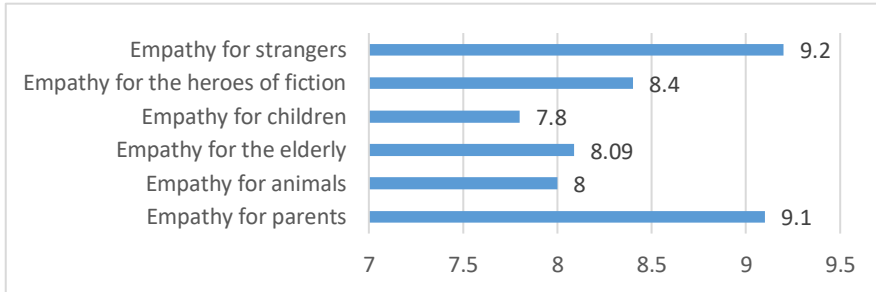


Fig. 3. The results of the study on the method "Diagnosis of empathy" by I.M. Yusupov. Average values.

To test the hypothesis that empathic abilities differ among students with different levels of mathematical abilities, a statistical analysis was carried out using the nonparametric Mann-Whitney and Kruskal-Wallis criterion for independent samples.

Analysis of the features of empathy channels in students with different levels of mathematical abilities using the Mann-Whitney criterion showed that there are significant differences in scales (Table 2): "emotional channel of empathy", "intuitive channel of empathy", "identifying channel of empathy", "general level of empathy".

Table 2. Features of empathy among young people with different levels of mathematical abilities. Method of V.V. Boyko.

Group	Rational channel of empathy	Emotional channel of empathy	Intuitive Empathy Channel	Attitudes that promote empathy	The penetrating power of empathy	Identification in empathy	General level of empathy
Average values							
ALOMA	4.15	2.55	2.6	3.15	3.35	2.45	17.25
LLOMA	4.07	4.14	4.55	3.19	3.25	3.46	21.6
Results of mathematical statistics (Mann-Whitney U-test)							
U	522.0	239.0	312.0	559.5	545.0	355.0	309.0
P	.64	.00	.03	.99	.85	.05	.03

ALOMA - Average level of mathematical abilities; LLOMA - low level of mathematical abilities

Students with a low level of mathematical abilities have a high score on the emotional channel of empathy, the intuitive channel of empathy, the identifying channel of empathy, on the scale of "general level of empathy".

In the group of students with an average level of mathematical abilities, the following is observed: a low indicator for the emotional channel of empathy, the intuitive channel of empathy, the identifying channel of empathy, on the scale of "general level of empathy".

It was revealed that there were no significant differences between the "rational channel of empathy", "attitudes that promote empathy" and "the penetrating ability of empathy" (Table 2). The following features are characteristic of both groups of students: the ability to enter into the same emotional "wave" with others - to empathize, to participate; the ability to use your empathy in time.

According to the scales of the methodology of I.M. Yusupov, it was found that there are some differences in empathy among students with different levels of mathematical abilities.

Table 3. Features of empathy in students with different levels of mathematical abilities. I.M. Yusupov's methodology.

	Empathy for parents	Empathy for animals	Empathy for the elderly	Empathy for children	Empathy for the heroes of fiction	Empathy for strangers	General level of empathy
Average values							
ALOMA	9.15	8.15	9.15	7.9	7.35	7.6	49.3
LLOMA	9.14	7.9	7.7	7.8	8.9	9.5	51.3
Results of mathematical statistics (Mann-Whitney U-test)							
U	553.0	536.0	434.5	544.5	453.5	370.0	484.0
P	.93	.77	.13	.85	.20	.02	.37

ALOMA - Average level of mathematical abilities; LLOMA - low level of mathematical abilities

The analysis of the features of empathy among students with different levels of mathematical abilities showed that there are significant differences only on one scale "empathy for unfamiliar people" (Table 3).

To test the hypothesis that there will be differences in the manifestation of empathy among students with different strategies of meaning transfer, a nonparametric criterion for disconnected samples, the Kruskal-Wallis criterion, was used (Tables 4 and 5). The results of a statistical analysis of the features of empathy in students with different strategies of meaning transfer according to the scales of the V.V. Boyko methodology allowed us to establish some differences (Table 4).

Table 4. Features of empathy among students with different strategies of meaning transfer. V.V. Boyko's methodology.

	Rational channel of empathy	Emotional channel of empathy	Intuitive Empathy Channel	Attitudes that promote empathy	The penetrating power of empathy	Identification in empathy	General level of empathy
Average values							
AMTS	4.1	4.8	4.6	3.1	3.7	2.8	22.5
CDSOMT	5.7	3.2	3.2	3.1	3.6	2.5	19.8
EDSOMT	4.2	4.1	4.5	3.8	4.0	3.46	21.6
BSOMT	3.8	3.5	3.8	3.8	3.4	2.0	17.5
PMTS	3.9	3.2	3.1	3.1	3.4	2.1	17.4
Results of mathematical statistics (Mann-Whitney U-test)							
H	348.0	240.00	302.0	559.5	500.0	360.0	300.000
P	.04	.00	.03	.82	.760	.05	.03

AMTS - Active meaning transfer strategy; CDSOMT - Cognitive-dominant strategy of meaning transfer; EDSOMT - Emotionally dominant strategy of meaning transmission; BSOMT - Balanced strategy of meaning transfer; PMTS - Passive meaning transfer strategy

Students with a cognitive-dominant strategy are distinguished by higher indicators on the scale of "rational channel of empathy", and students with an active strategy use the "emotional channel of empathy". The "intuitive channel of empathy" is much more developed among students with active and emotionally dominant strategies.

A study using the methodology of I.M. Yusupov of empathic properties in young people with different strategies of meaning transfer showed the presence of some differences (Table 5).

Table 5. Features of empathy among students with different strategies of meaning transfer. I.M. Yusupov's methodology.

	Empathy for parents	Empathy for animals	Empathy for the elderly	Empathy for children	Empathy for the heroes of fiction	Empathy for strangers	General level of empathy
Average values							
AMTS	9.1	8.1	9.4	7.9	9.5	7.6	9.2
CDSOMT	9.1	7.9	7.8	7.8	9.7	7.5	9.0
EDSOMT	9.4	9.5	9.0	8.0	8.4	9.3	9.1
BSOMT	8.2	7.3	7.5	7.6	8.1	8.0	7.9
PMTS	8.4	7.8	7.8	7.8	7.5	7.1	7.5
Results of mathematical statistics (Mann-Whitney U-test)							
H	570.0	294.0	228.0	450.500	386.0	370.000	366.0
P	.75	.01	.01	.63	.03	.02	.02

AMTS - Active meaning transfer strategy; CDSOMT - Cognitive-dominant strategy of meaning transfer; EDSOMT - Emotionally dominant strategy of meaning transmission; BSOMT - Balanced strategy of meaning transfer; PMTS - Passive meaning transfer strategy

It was found that respondents with different strategies of meaning transmission differ in terms of the scale "Empathy for animals", "Empathy for the elderly", "Empathy for the heroes of fiction", The overall level of empathy is significantly higher among students with active, emotionally dominant and cognitively dominant strategies than among students with balanced and passive strategies of meaning transmission.

4 Conclusion

In the course of the study, it was found that students studying in the direction of "Ecology and Nature Management" have poorly and moderately developed mathematical abilities. The communicative sphere of most students is characterized by an average level of use of speech development, the activity of using nonverbal means of communication is much higher. Empathic properties in general, at an average level, most of the study participants have the best developed rational channel of empathy, empathy for strangers and parents.

The analysis of the features of empathy of students with different levels of mathematical abilities and strategies of meaning transfer showed: 1. Students with a low level of development of mathematical abilities have a greater degree of empathy for strangers than students with an average level. In addition, students with a low level of mathematical abilities are more pronounced in the formation of emotional and intuitive channels of empathy, identification in empathy and on the scale of "general level of empathy". 2. Students with an active strategy of meaning transfer differ from other students in the greater development of the emotional and intuitive channel of emotion, and are also more inclined to show empathy for the elderly and empathy for the heroes of fiction. 3. For respondents with a cognitively dominant strategy of meaning transfer, it is more typical to use a rational channel of empathy in interaction, in addition, they are distinguished by a greater degree of empathy for the heroes of fiction. 4. Students with an emotionally dominant strategy are distinguished by a high level of development of the intuitive channel and the ability to identify. They also have a high level of empathy for animals and the elderly. 5. The overall level of empathy is significantly higher among students with active, emotionally dominant and cognitively dominant strategies than among students with balanced and passive strategies of meaning transmission.

The study allowed us to identify some contradictions: students with an average level of mathematical abilities have less developed channels of empathy. This makes it possible in the following studies to study the influence of cognitive and communicative properties of students on empathy.

References

1. Schwartz A. Yu. *Journal of the Higher School of Economics* 16 (1): 145–163. (2019) DOI: 10.17323/1813-8918-2019-1-145-163
2. Agakhanov N. H. *Profile school* 6 (4): 3-10. (2018) DOI 10.12737/article_5b9a1960648853.29583309
3. Yezhov D.A., Sukhankina N.V. *Bulletin of Samara State Technical University. Series "Psychological and pedagogical sciences"* 18 (2): 59–74. (2021) DOI: <https://doi.org/10.17673/vsgtu-pps.2021.2.5>
4. Polovnikova E. S. *Mathematical abilities of a child and his temperament. International Research Journal* 18 (98): 36—39. (2020) doi: 10.23670/IRJ.2020.98.8.075
5. Shadrikov V. D. *Towards a new psychological theory of abilities and giftedness. Psycho-logical Journal* 40 (2): 15-26. (2019) DOI 10.31857/S020595920002981-5.
6. Agrillo, C. , Piffer, L. , & Adriano, A. Individual differences in non-symbolic numerical abilities predict mathematical achievements but contradict ATOM. *Behavioral and Brain Functions*, 9(1), 1–14. (2013). <https://doi.org/10.1186/1744-9081-9-26>.
7. D Tokada et al *J. Phys.: Conf. Ser.* 895 012077 (2017) <https://iopscience.iop.org/article/10.1088/1742-6596/895/1/012077/pdf>
8. Suroedova, E. *Agriculture faculty students' meanings translation in conditions of the development of communicative competence. E3S Web of Conferences* 13: 15028.(2020) DOI 10.1051/e3sconf/202017515028.
9. Ryumshina L., Berdyanskaya Y., Altan-Avdar I., Belousova A. *Symmetrical and Asym-metrical Approaches to Communication in Education in Distance Learning. Lecture Notes in Networks and Systems* 247: 471-481. (2022) DOI 10.1007/978-3-030-80946-1_45.
10. Abakumova I. V. *Stages in making a choice of meaning. The World of Academia: Culture, Education* 5: 103-106. (2021) DOI 10.18522/2658-6983-2021-5-103-106.
11. Dautov D. *The Ratio of Verbal and Nonverbal Components of Individual Cognitive Maps as a Reflection of the Collaborative Thinking Activity of Its Participants April International Journal of Cognitive Research in Science Engineering and Education* 9(1):51-62. (2021) DOI:10.23947/2334-8496-2021-9-1-51-62
12. Belousova A., Belousova E., *Gnostic emotions of students in solving of thinking tasks. August. International Journal of Cognitive Research in Science Engineering and Education* 8(2):27-34. (2020) DOI:10.5937/IJCRSEE2002027B
13. Abakumova, I. *Non-verbal Communication in Meanings Transmission. Lecture Notes in Networks and Systems* 247: 553-562. (2022) DOI 10.1007/978-3-030-80946-1_52.
14. Pronenko E. A. *Features of semantic processes and phenomena in team interaction. Russian Psychological Journal* 16 (1): 32-51. (2019) DOI 10.21702/rpj.2019.1.2.
15. Dupina S. A. *The study of students' personality characteristics within the framework of splitting the poles of the cognitive style analyticity/synthetics. Bulletin of Kostroma State University. Series: Pedagogy. Psychology. Sociokinetics* 27(1): 59-64. (2021) DOI 10.34216/2073-1426-2021-27-1-59-64.
16. Vetluzhskaya M. V., Abramova A. A., Serdakova K. G. [et al.] *Features of emotional intelligence and empathic abilities in medical university students. Integration of education* 23(3): 404-422. (2019) DOI 10.15507/1991-9468.096.023.201903.404-422.