PECULIARITIES OF THE APPLICATION OF THE KNOWLEDGE OF MATHEMATICS IN REAL-LIFE SITUATIONS AND SOLVING PROBLEMS IN CASE OF SENIOR FORM STUDENTS HAVING MODERATE SPECIAL NEEDS

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Abstract

The article deals with the peculiarities of the application of the knowledge of mathematics in real life situations of students with moderate special needs who study in senior forms of mainstream schools. The research data have been collected applying quantitative approach. By the method of questionnaire survey it has been investigated how students with moderate special educational needs who study in 8-10 forms of mainstream school are able to apply possessed knowledge of mathematics in real-life situations and solving problems of practical character, the peculiarities of their functional mathematical literacy have been assessed. The results of the research have shown that the level of functional mathematical literacy of the majority of students with moderate special educational needs who have participated in the pilot research is not sufficient, the knowledge of mathematics is not strong, students lack practical abilities and perception how and where possessed knowledge could be applied in everyday activity.

Key words: *students having moderate special educational needs, practical application of mathematical knowledge, abilities, mathematical literacy, problem solving.*

Introduction

Increasing processes of the creation and implementation of new technologies stimulate constant change of the education system. The task raised for mainstream school is not only to transfer knowledge and experience accumulated by the society but also help every student to form value system, to learn how to learn and solve problems, to develop person's competences that would help to actively function in the society and in constant perfection to adapt to changing social, economical conditions (Bendrosios pradinio ir pagrindinio ugdymo programos, 2008). It is aimed that student could use possessed knowledge and information in everyday life (Bulotaitė, & Gudžinskienė, 2004; Šiaučiukėnienė, Visockienė, & Talijūnienė, 2006; Baranauskienė, Geležinienė, Tomėnienė, Vasiliauskienė, & Valatkienė, 2010).

In the National Education Strategy of Lithuania for 2003–2012, in the Law on the Amendment of the Law of Education of the Republic of Lithuania (2011), in General

Programmes of Primary and Basic Education (2008) the mission of education is perceived as assistance to a student perceiving contemporary world, gaining the basics of literacy, cultural and social competence and becoming independent, responsible person creating own and community life. Teaching becomes rather process-oriented than result-oriented, because according to Petty (2008), it is not knowledge but skills that are priceless due to their transferability remaining after learning. The knowledge transferred is valuable and efficient only when a student understands it, is able to interpret and apply it, if he/she perceives why he/she learns. When the amount of information is increasing and informational technologies are developing it is becoming relevant not only to memorize many facts but rather recognize situations and questions that could be answered using possessed mathematical knowledge.

The informational society of today is especially mathematized, that is why the need for mathematical literacy is even more felt and it is recognized almost in all spheres of human life: household, professional activity, recreation, in the actions of civil responsibility, social actions, at work, managing personal finances, taking examinations, continuing studies, raising children, etc. Referring to the ideas of foreign scientists Dudaitė (2008) defines mathematical literacy as the ability to recognize, understand mathematics and apply its knowledge, to make reasoned decisions about present and future role of mathematics in person's private and professional life and socializing with peers and relatives, to participate in mathematical activity in such ways that correspond to the needs of the life of an individual as a constructively acting, interested and conscious citizen. It shows that in General Programme of Mathematics for Basic Education much attention should be paid to the factor of functionality because understanding and application of known mathematical concepts, mathematical methods for every student (gifted, weaker or having special needs) creates preconditions not only to know but also freely orient in practical and everyday life.

It also raises new importance and new requirements for teaching/learning mathematics at school. Change in teaching of mathematics and methods of its teaching, the concept of mathematical literacy have been widely discussed by scientists and pedagogues of Lithuania – Ažubalis and Kiseliovas (2002), Balčytis (2000), Būdienė (1998), Cibulskaitė and Sičiūnienė (2007), Dudaitė (2006, 2008), Kiseliova and Kiseliovas (2004, 2008), Mineikienė and Vismantienė (2001), Zybartas (2000) and foreign authors – Cuban (2001), Madison (2003), Briggs (2002), etc. Mathematical teaching of students having special educational needs has been described by Perova (1984), Štitilienė (1999, 2003); Garbinčiūtė and Štitilienė (2002); Tomėnienė (2010), Tomėnienė, Tamutytė and Geležinienė (2011), Tomėnienė, Pigulevičiūtė and Skrebienė (2011), etc. Hence contemporary theory and practice of education raise the task for teachers of mathematics to constantly review the contents of the subject, to assess and reorient education priorities, to help every child to develop the most important and essential general abilities and value attitudes that would help in future to choose a profession, to find one's way in the rapidly changing society, to successfully work in it, to feel good and be happy. Undoubtedly, it is very relevant in organizing the education of students having moderate special educational needs (SEN) who tend to choose more often to learn in a mainstream school that is the closest to their living place. In the recommendations of the application of General Programmes of Basic Education meant to educated students with special needs having low (limited intelligence) and very low (mild intellectual disorder) intellectual abilities (2010) it is indicated that one of the main principles of the adaptation of general education content is the principle of practicality. Education should take place through activities and tasks of practical character, orienting towards practical needs of students' life. It is aimed that students with special needs after graduating the programme of basic education would have gained the basics of general and essential competences of subjects necessary for future studying and work.

Having reviewed scientific literature of recent years it is possible to state that the education of mathematical literacy of students with moderate special educational needs is not being discussed sufficiently, there is a lack of information about academic abilities and achievements of senior form students having moderate special education needs and integrated in mainstream schools, their application in practical activity. In order to improve this situation, to reveal the expression of abilities of mathematical literacy of senior form students and youth having moderate special educational needs, teachers of mathematics in mainstream schools and teachers of profession in vocational training schools were interviewed in 2009-2010. The data of the research (Baranauskienė, & Tomėnienė, 2010; Томениене, 2010; Tomėnienė, Tamutytė, & Geležinienė, 2011) have revealed pedagogues' opinion about the importance of the development of functional mathematical literacy of students and youth having moderate special educational needs, the necessity to improve the process of teaching these students mathematics in mainstream school, to review the contents of curriculum, developed abilities, attitudes, applied strategies and methods. The results of the research have shown that the development of functional mathematical literacy should become an important component of prevocational training of students with special needs. According to the respondents, SEN students, who come to learn to the centres of prevocational training, their level of mathematical literacy is not sufficient for studying future speciality. For youth it is difficult to apply mathematical knowledge in everyday and professional activity and real life situations. Developing mathematical literacy the main attention at school should be paid to such knowledge that students could apply in practical activity, teachers of mathematics and profession suggest. However, in order to improve mathematical education of these students it is not sufficient to refer only to pedagogues' opinion, it is necessary to know the level of functional mathematical literacy of these students. Only with an appropriate acquaintance with pupil's interests, skills, abilities and possibilities, practical mathematical abilities could start to form. It is evident that there is a lack of such knowledge about academic and practical abilities of senior students with moderate special educational needs educated in mainstream schools, therefore, the relevance of the present work is conditioned by the willingness to assess actual situation of the development of mathematical literacy of students having SEN and identify the peculiarities of practical mathematical abilities of senior form students having moderate special educational needs.

Aim of the research: To investigate the ability of students with moderate special educational needs who study in senior forms of mainstream schools to apply possessed mathematical knowledge in real life situations and solving problems.

Object of the research: Peculiarities of the application of mathematical knowledge in real life situations and solving problems of students with moderate special educational needs.

Methods and methodology of the research: The research instrument has been prepared: questionnaire (mathematical test) meant to test the ability of students with moderate special educational needs who study in senior classes of mainstream schools to apply possessed mathematical knowledge in real life situations and solving problems. The data necessary for the research have been collected performing written quantitative survey. The questionnaire that was used during the research has been created referring to the suggestions received from teachers of mathematics and profession during the research performed in 2009-2010, the suggestions of expert group, the education content described in General Programmes (2008), programme for special school (Štitilienė, 1999), recommendations for the application of General Programmes of Basic Education meant to educate students with special needs with low (limited intelligence) and very low (mild intellectual disorder) intellectual abilities (2010). The questionnaire consisted of the explanation how to fill in the questionnaire, set of mathematical formulas necessary for solution, questions to receive the demographical data about the respondents and 4 chapters of tasks of practical character. Chosen 23 tasks had to help to assess the peculiarities of the application of knowledge of students with moderate special educational needs from the main analyzed topics in mathematics solving tasks of practical character. The tasks by which students' factual knowledge, understanding, skills, their application in everyday or well known vocational and real life context were assessed were conditionally divided into 4 chapters: "Check if you know how to measure" (10 tasks), "Do you know how to apply geometrical knowledge in practice" (6 tasks), "Do you know how to apply mathematical knowledge in vocational activity" (3 tasks), "Check your knowledge in economics" (4 tasks). The respondents were given a questionnaire consisting of main mathematical topics: numbers and calculations, geometry, measures and measuring, statistics. The contents of all of the tasks are related to the environment known to a pupil, everyday situations, vocational activity. In order to better assess students' mathematical abilities several tasks were selected for the majority of task groups. All tasks are different: some are simpler and easier, other more complicated.

In creating the questionnaire, the format of the task was also taken into account. The quarter of tasks was multiple choice (students had only to circle a chosen answer). Solving tasks with short solution (15%) students had to write the answer of the task. Tasks requiring presenting the solution (60%) were assessed with the bigger number of points. Every student received a questionnaire with tasks that he/she could solve in several lessons. Students were allowed to use supporting means, i.e., calculators, measure tables, etc. The space for solutions was left next to the tasks, therefore, students were asked to make all the solutions in questionnaire sheets.

The results of students' task solving have been analyzed in three aspects: *knowledge and skills* (knowing, understanding, performance of main concepts and procedures); *communication* (understanding the task, rendering task solution, use of mathematical symbols and terms); *solution of practical problems* (choosing the way to solve the task, writing the answer, making elementary conclusions). All participants of the research were acquainted with the contents of the questionnaire and the rules of filling it in. Moreover, they were informed that their personal data would not be recorded.

To process empirical data quantitative data analysis and descriptive statistics have been used. The results have been calculated using Microsoft Office Excel 2007 and Microsoft Office Word programmes.

Participants of the research: In choosing the participants of the research the method of target selection has been used – "when the researcher himself/herself chooses which respondents it is more expedient to choose" (Luobikienė, 2000). In this case, the research group of quantitative research consisted of 8–10 form students with special educational needs studying at mainstream schools of Anykščiai, Pakruojis, Pasvalys and Šiauliai towns and districts. The sample of pilot research consisted of 100 respondents corresponding to the criterion: senior form students of mainstream schools having moderate special educational needs and educated according to adapted programme of mathematics.

Research results and their interpretation

Before performing tasks students in the chapter "Questions about you" had to give some information about themselves (demographical block), i.e. to write gender, age, form, to indicate who helps to do homework, to learn mathematics. During the research, the respondents were not selected according to gender or age. The main criterion for selection was that the respondents had to be 8–10 form students having moderate special educational needs and studying in mainstream schools. Having calculated the results of the research it has become clear that more boys than girls have been surveyed, i.e. 58% of boys and 42% of girls. The age of students who participated in the research is from 13 to 19. The majority of the respondents were students of mainstream schools of the age of 15–16, that makes up 67%

of all the respondents. 35 students of the eighth form, 30 of the ninth form and 35 of the tenth form participated in the research. They were asked who helps them to do homework, learn mathematics; whether students attend complementary classes in mathematics. The received data show that the main forms of assistance in learning mathematics are sessions with special pedagogue and consultations of mathematics teachers. Out of 100 respondents having moderate special educational needs 48% of all eight-formers, 50% of all students of the ninth form, 54% of all students of the tenth form attend sessions with special pedagogue or consultations of mathematics teacher. Complementary private sessions are attended only by one nine-former. It has become clear that parents do not help children to do homework anymore, girls ask for help more often (38%), boys – less often (26%).

It has been aimed to know what type of general mathematical and knowledge application abilities are developed among students having special needs. The research has shown that students having moderate special educational needs solved tasks variously. Most of application tasks were of average difficulty or difficult for students.

The results of the research have shown that students having moderate special educational needs were best at performing tasks from the fields of the contents of mathematics *Numbers and Calculations*, *Measures and Measuring*. From the field *Numbers and Calculations* the lines of operations were chosen that are related to the environment known to a student, everyday situations, vocational activity. The students were best at performing these tasks because they could use calculators.

The majority of tasks in the questionnaire (even 10) were presented from the field of the contents of mathematics, the knowledge of which is often necessary in everyday activity – from the field of *Measures and Measuring*. The students managed to perform these tasks variously (Figure 1).

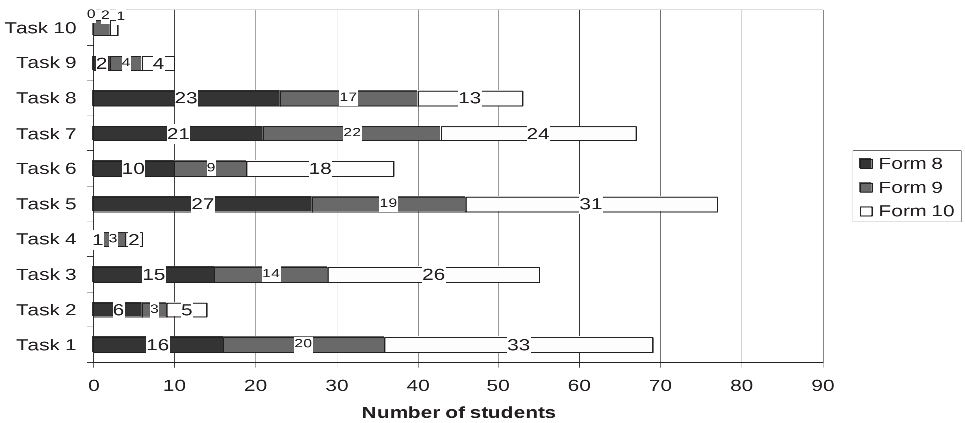

Figure 1. The results of correctly solved tasks of the chapter "Check if you know how to measure", number of students (N = 100)

As it is seen in Figure 1, the respondents were quite good at tasks that required to measure the length of the segment according to the presented ruler (task 1, 69% of correct answers), to tell the time (task 3, 55% of correct answers). The students were also quite good at the task which required to calculate how long it takes for the worker to go to work (task 5, 77% of correct answers), according to the example convert simple measurements from larger to smaller and smaller to larger units (task 7, 67% of the answers; task 8, 53% of the answers), to calculate the indications of the thermometer (task 6, 37% of correct answers). The respondents experienced difficulties with tasks that required to measure the length of a pencil and write it not only in centimetres but also in decimetres (task 2, 14% of correct answers), to draw the clock arrows so that they show indicated time (task 4, only 6% of the correct answers). The most difficult task for students was to convert concrete numbers to decimal fraction and vice versa to write fractions in concrete numbers (task 9, 10% of the answers and task 10, 3% of the answers).

In generalizing the abilities of the knowledge of students having moderate special educational needs and their application performing the tasks of the chapter "Check if you know how to measure" it has been noticed that:

• eight-formers and nine-formers were the best at measuring the length of the segment, solving the task of time calculating, according to the example convert simple measurements from larger to smaller and smaller to larger units;

• ten-formers performed all the tasks better, the most difficult ones were to write the length of a pencil in decimetres, to draw clock arrows so that they show the indicated time, to convert concrete numbers in decimal fraction and vice versa;

• 45% of the students experienced the most difficulties in telling the time from the clock with Roman numbers. The precondition may be made that students know electronic watch better because they encounter it more often in everyday life. In order to know the time the majority of students use mobile phones, computers, electronic clocks of institutions.

• the respondents made the most of mistakes converting decimal fraction to a concrete number, for example: most often the students would write 2,15 kg for 2 t 15 kg instead of 2,015 kg. Forgotten zero was the mistake the majority of students made.

In the chapter of the questionnaire "Do you know how to apply geometrical knowledge in practice" six tasks from the field of *geometry* have been presented. Students had to remember their possessed knowledge in this field solving tasks related to vocational activity (hairdresser's, builder's, surveyor's). The students of the tenth form were best at solving those. The results of correctly solved tasks have been presented in Figure 2.

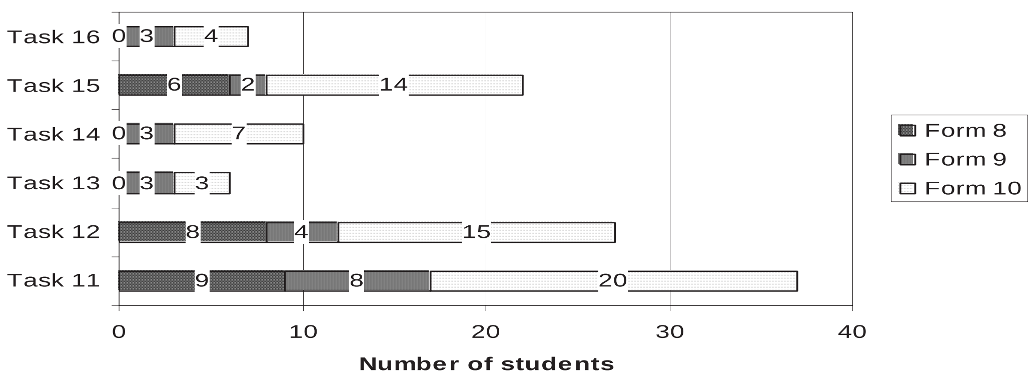

Figure 2. The results of correctly solved tasks of the chapter
"Do you know how to apply geometrical knowledge in practice", number of students (N= 100)

From the data presented in Figure 2 it may be seen that students were best at solving task 11, where they needed to cut a strip to make 9 equal parts (37% of correct answers). Half of ten-formers who participated in the research managed to correctly draw a plan of a parking lot (task 12, N = 15), to use the aid – the presented formula how to find the volume and calculate how many cubic metres the workers dug out (task 15, N = 14). It was more difficult for the respondents to calculate the areas of a rectangle and a circle (task 13, 6% of the answers, and task 14, 10 % of the answers) and a volume of a composed figure (task 16, only 7% of correct answers). Unfortunately, no eight-formers succeeded in calculating what length of linoleum is necessary for a sitting room (task 13).

Generalizing the knowledge of students having moderate special educational needs and the ability of their application performing the tasks of the chapter “Do you know how to apply geometrical knowledge in practice” it should be noticed that:

• tasks of the field of *geometry* were rather difficult for the students. Students of the eighth and the ninth form were making especially many mistakes;

• having analyzed in more detail the abilities of the students it has become clear that the students are quite good at recognizing main geometrical figures of plane and space, their main elements; however, they were especially bad at solving the tasks that required to motivate something or use the concepts of perimeter, area, volume, scale (as it has been mentioned incomprehencion of these concepts has also become especially clear on the level of knowledge). Two thirds of the respondents (78 %) were making mistakes and did not manage to draw the plan of a parking lot, although the scale was indicated in the task. Many respondents managed to use the presented formula of finding the volume of the cube, however, they inserted numbers incorrectly (e.g. $V = a^3$, $V = 3m^3$, in the given formula children did not notice that the number 3 should be multiplied three times), they did not name the units of measuring.

In performing three tasks of the chapter 3 “Do you know how to apply mathematical knowledge in vocational activity” students had to remember their possessed knowledge from the fields of *Measures and Measuring* and *Statistics*. In case of these tasks as well as in the previous ones the ten-formers were best at solving them (60–63% of all the ten-formers who participated in the research performed tasks 17–19 correctly) and it was the most difficult for the eight-formers (only 15% of the eight-formers who participated in the research performed tasks 17–19 correctly). Almost two thirds of the students did not fully succeed in solving these tasks. The results of correctly solved tasks have been presented in Figure 3.

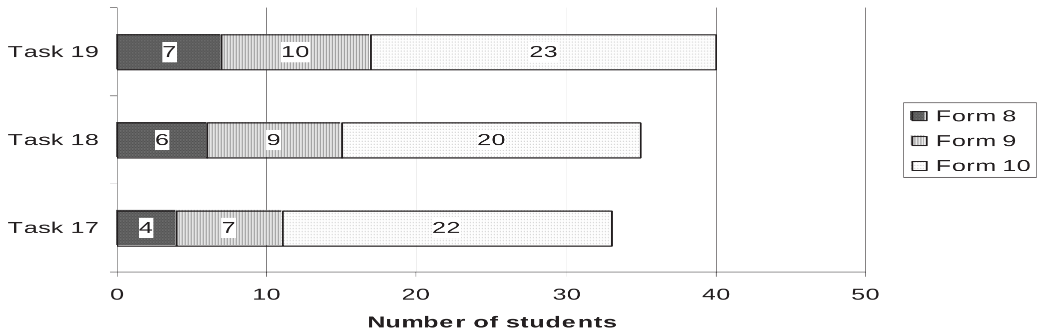

Figure 3. The results of correctly solved tasks of the chapter “Do you know how to apply mathematical knowledge in vocational activity”, number of students (N = 100)

As it is seen in Figure 3 the respondents were quite good at performing tasks from the fields of measures and measuring and statistics, which required to calculate by applying a proportion how many kilograms of apples the farmer sold (task 17, 33% of correct answers), to calculate the builder’s salary and to find out the average work salary of 4 months (task 18, 35% of the correct answers). Students were best at solving the task that required reading the data of the diagram and find out how many workers work at the hotel “Svajonė” (task 19, 40% of the correct answers).

With the task 17 it has been attempted to find out whether the students know how to apply the knowledge about proportion; with the task 18 – whether students know how to calculate the mean of the sample, with task 19 – whether students know how to read information presented in a diagram, analyze, make conclusions, related to the data presented in the diagram.

Generalizing the knowledge of students having moderate special educational needs and the abilities of its application it has been noticed that the eight-formers are better acquainted with the calculation of the mean of the sample than with the tasks of making a proportion.

During the research, the respondents have also been given 4 tasks from family economics, calculating percentage when buying in sales. The results of correctly solved tasks of this field have been presented in Figure 4.

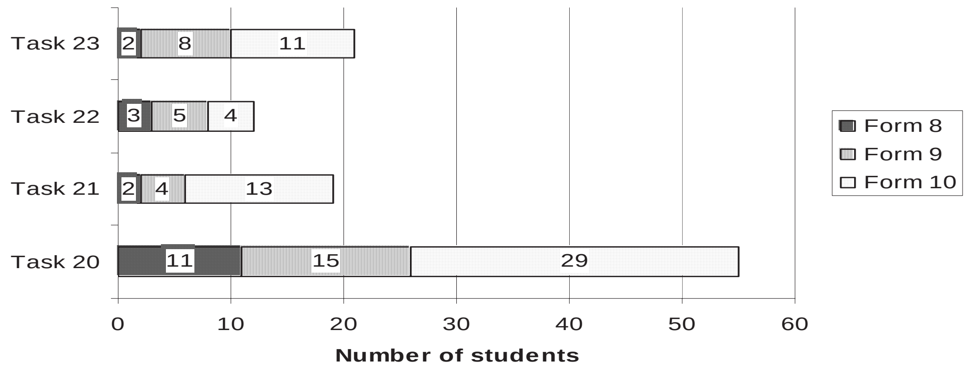

Figure 4. The results of correctly solved tasks of the chapter "Check your knowledge in economics", number of students (N = 100)

As it is seen in Figure 4, students were especially good at calculating family budget, i.e. how much money family spends for taxes and how much is left for them (task 20, 55% of correct answers). The respondents encountered difficulties in the tasks that required to calculate the discount of selling camera and find its present price with discount (task 21, 19% of correct answers) and perform banking operation – to calculate currency exchange from LTL to LVL (task 22, 12% of the correct answers). Especially many difficulties were encountered in task 23 (21% of correct answers) that required to calculate the amount of used electricity, the sum to be paid and complete filling in paying account in the electricity booklet.

By task 20 it has been attempted to find out whether students know how to read the data presented in the table and calculate communal taxes. It may be seen from the obtained results that this task was the best performed by the students of the tenth form (71% of all the ten-formers), 54% of the students of the ninth form and 35% of the eight-formers have also managed to solve it correctly. The respondents have encountered quite many difficulties in the task that required calculating the discount of selling camera (percentage), to find the present price with the discount of 20%. Quite many students were making mistakes in this task incorrectly choosing operation. Some students did not distinguish between the sum of discount and presented price of the item, therefore, they divided the price to the number of percent. The results of the research have shown that the knowledge of these students about percentage is not strong yet, therefore, they face difficulties in calculating partial price of the item when it is reduced by several percent. The results of task 22 have shown that only a small part of the students are able to calculate the amount of the currency to be exchanged, although nowadays when people like travelling every modern person should know how to perform such operations. To solve this task students had to make up the way of solving (to multiply then add up), to perform the operations of multiplication and addition (they could use the calculator) and make a conclusion. The most frequent mistakes: they would incorrectly choose the first operation, some students multiplied correctly but forgot to add the fee for currency exchange or selling operation. By task 23 it has been attempted to find out whether pupils know how to calculate the indications of an electricity meter and fill in the tax booklet. The majority of the students made mistakes in this task incorrectly choosing operation, some of them decided not to solve at all. The students of the eighth form experienced the most difficulties. This task was best performed by senior students – 16–19 years of age. The knowledge of the junior ones is not strong, not all of them had seen the electricity booklet, had not tried to fill in it.

Generalizing the results of performing tasks of the chapter “Check your knowledge in economics” it is possible to state that tasks 21–23 were rather difficult for students having moderate special educational needs because only one seventh of the respondents managed to perform them correctly. It is possible to make a presupposition that in the lessons of mathematics more time should be given to solving tasks of similar character, organization of practical projects and excursions. This fact should be taken into account by teachers of mathematics and authors of textbooks preparing the tasks of practical (real life) character for the lessons of mathematics. It is necessary to involve students’ parents in this activity, to acquaint children with tax paying accounts, to acquaint show how the accounts are filled in, how communal taxes and discounts for goods in the shops are calculated.

Conclusions

1. The results of the research have shown that the knowledge of mathematics of students having moderate special educational needs and learning in senior forms of mainstream school is not strong, students lack practical abilities and perception how and where they could apply their knowledge in everyday activity. The students of the eighth form experienced especially many difficulties in applying their possessed knowledge. It shows that the level of functional mathematical literacy of these pupils is not sufficient, therefore, it would be more expedient to individualize the content of education for students with special needs paying more attention to visual and practical demonstration and explanation of every separate step, only using the context that is well known for their environment and close to real life situations, to teach how to use supporting material and auxiliary calculation means.

2. 8-10 form students having moderate special educational needs who participated in the research have the best mathematical knowledge in the fields of *numbers and calculations*, *measures and measuring*. Students were best at performing arithmetical operations, calculating simple arithmetical lines, converting measurements from smaller to larger and larger to smaller units, solving the tasks of time counting. Students were quite good at performing elementary tasks in the field of statistics that required to analyze the information presented in the diagram and answer simple questions.

3. The main problems the students faced in performing tasks in the fields of the content of mathematics *numbers and calculations*, *measures and measuring* are insufficient skills in operations with fractional and concrete numbers, proportional quantities, proportions, percentage.

4. Students having moderate special educational needs experienced difficulties in the tasks of the field of *geometry* that required to motivate something or to use the concepts of perimeter, area, volume, scale (incomprehension of these concepts has also become clear on the level of knowledge). The respondents were not able to use the given formula, insert numbers and calculate the expression.

5. The results of the research have shown that during the lessons of mathematics more attention should be paid to solving tasks from the field of family economics, teaching how to perform various banking operations, calculate salaries, expenses, taxes. It is necessary to involve students’ parents in this activity to acquaint children with family budget and show practically how communal taxes are calculated and various accounts are filled in.

6. The problem typical to all the fields of the contents of mathematics is that many students performing the test did not solve verbal tasks, and those who solved experienced difficulties in reading conditions, choosing the way of solving, writing solutions and answers. In the process of education it is necessary to pay more attention to the following aspects of mathematical activity: analyzing conditions of the task, discussing possible ways of solving, modelling real life activities and imitating respective actions of problem solving.

It has been a long time since the discussions about the possibilities of educating students with various special educational needs in mainstream schools started. However, only now scholars begin to talk about deeper knowledge about senior form students with moderate special educational needs, studying in mainstream school, and adaptation of the education contents, so that the ability to apply possessed knowledge in real life situations and solve problems becomes the main factor of the subject (in this case – mathematics). Therefore, more thorough scientific research in this field is necessary and has to be encouraged.

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