CREATION OF THE METHODOLOGY OF THE DEVELOPMENT OF FUNCTIONAL MATHEMATICAL LITERACY IN THE 8TH FORM OF MAINSTREAM SCHOOL

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Abstract.*The article deals with the aspects of the development of functional mathematical literacy of students with moderate special educational needs. Creating the methodology of the development of functional mathematical literacy of students with moderate special educational needs the action research was organized, where 9 eighth form students with moderate special educational needs, 9 parents of these students, 7 teachers of mathematics and 4 special educators participated. It has been found out that the development of functional mathematical literacy of students with moderate special educational needs educated in mainstream schools can be successfully organized when the methodology of its development is based on the combination of the concepts and theories of pragmatism, constructivism, social participation, empowerment, mathematical literacy, practical applicability of mathematical knowledge.*

Keywords: *action research, functional development of students' abilities, mathematical literacy, methodology, students having moderate special educational needs.*

Introduction

Problems and relevance of the research. Having restored the independence of Lithuania the process of the reform of the system of education has started, in which one of its important components is making special education closer to mainstream education when in fact the whole concept of the functioning of special education has changed (Ambrukaitis, 2013). The ideas of integration and inclusive education have expanded education areas into various contexts of the educational system in order to ensure the use of all possible resources and effective meeting of learners' needs. In UNESCO Policy Guidelines on Inclusion in Education (2010) it is emphasized that inclusive education, when a person is in the centre of the process, is useful for a teacher and all students – both who do not have special needs and who have them because of disability or other reasons. A student with special educational needs educated together with peers has the opportunity to take their experience, learn to communicate together with his/her peers who are more advanced and skilful, creating the conditions to learn while teaching others, and develop positive attitudes towards people's differences, form value attitudes acceptable to modern society. Here the teacher's disposition to involve all students into the

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learning process that takes place in the classroom, to create conditions for everyone to be educated according their abilities, to set adequate learning aims relevant to everyone, to choose suitable strategies of evaluation and self-evaluation of achievements is very important. Students with moderate special educational needs educated in mainstream classes of comprehensive schools can experience the influence of the especially large number of negative factors aggravating and destroying their self-esteem, if the needs of such students are not taken into account and the students are not helped or inappropriately helped to learn, socialize, and get involved into the classroom activity. Since the number of students with special educational needs in mainstream schools has increased, the teachers face the challenge – how to work in a classroom where students of different abilities learn. It has to be stated that in the practice of mainstream schools of Lithuania there is still a lack of more elaborate researches that reveal the educational impact of empowering educational systems and techniques for senior form students with moderate special educational needs educated in mainstream schools and focused on the development of these students' functional mathematical literacy on the development of mathematical skills. It stimulated us to conduct the research in order to create the methodology of the development of mathematical literacy, to more purposefully model various strategies, methods, instruments that help to develop students' general skills and apply them in practice.

Research aim – applying the action research to create the methodology of the development of functional mathematical literacy of 8th form students with moderate special educational needs in mainstream school.

Research methods: Creating the methodology of the development of functional mathematical literacy of students with moderate special educational needs the action research was organized, during which *group discussions, observation, analysis of documents, interviews with the research participants* took place. To process the data the methods of *content analysis* and *statistical data analysis* have been applied. It was aimed to ensure the feedback criterion by planning and discussing the educational process and conducted activities with all participants of the research performing the comparative characteristics of students' works performed at the beginning and at the end of the research.

Research sample: In the action research 9 eighth form students with moderate special educational needs, 9 parents of these students, 7 teachers of mathematics and 4 special educators participated. The main principles followed in selecting the participants of the action research are: 1) students with moderate special educational needs educated in the 8th forms according to the adapted or individualized programme of mathematics; 2) the principle of voluntary resolution, therefore, written agreements of all the participants of the research to participate in the action research were received. A mainstream school for the action research was selected by convenience sampling.

Methodology, organization and results of the research

For the initiation of changes in mathematical education in real-life environment, creating the methodology of the development of functional mathematical literacy of students with moderate special educational needs, planning the activities, didactic technologies, it was referred to the factors discovered in the previous stages of the research related to the concept of functional mathematical literacy of students with moderate special educational needs, the expression of skills and theoretically and empirically substantiated theoretical attitudes of the development of functional mathematical literacy of students with moderate special educational needs (SEN), the situation of education in mainstream schools of Lithuania meeting special educational needs.

The teachers of three mainstream schools, the 8th form students and the representatives of their families (students' mothers) participated in the research. In one school where one of the researchers works and three students with moderate special educational needs study (one student is diagnosed with the complex disorder, one with general educational disorders and one with the disability due to mild mental disorder), every day there was direct participation in creating the methodology of the development of functional mathematical literacy. The meetings with the participants of the action research from other mainstream schools were organized every 1,5-2 months according to the arranged schedule. To plan the action research and identify the results the data collection scheme has been created (Table 1).

Table 1. Scheme of data collection

At the beginning of the research:	→	**In the process of the research:**	→	**At the end of the research:**
* primary meetings – group discussions with the participants of the action research, introducing the aim of the action research, planned activities; * **written survey** of the 8th form students with moderate SEN who participated in the research, using the exercise book of diagnostic mathema-tical tasks created by the researchers, * analysis of students' certificates about primary/secondary evaluation.	→	*5 intermediate meetings; group discussions of the teachers of mathematics and special educators, * evaluation of students' mathema-tical achievements and self-evaluation of activity at the end of the semesters I and II – group discussions with the participants of the educational process of every student (students, parents and educators).	→	* retest written survey of the 8th form students with moderate SEN who participated in the research, using the same exercise book of diagnostic mathema-tical tasks; *group discussion of all the participants of the action research

It was decided to process the data collected during test-retest of the written survey by statistical methods, and to analyse and interpret the data collected during group discussions between teachers and all the participants by using the method of content analysis. The **action research** was chosen because it is a special research strategy integrating practical activity and scientific research. By such integration it is aimed not only to understand and interpret reality but also improve it (Kemmis & McTaggart, 1988; Cohen, Manion & Morrison, 2000, Denscombe, 2003). Practical specialists (teachers of mathematics and special educators) aimed to develop the process of mathematical education of students with moderate SEN supporting it with the factor of functionality. It was aimed that all the participants of the action research process (researcher, practical specialists, students and their parents) were equal and involved into every stage of the process (Kemmis & McTaggart, 1988); the relationships between the participants were democratic. The action research took place in cycles also comprising the feedback (loop) where primary discoveries created the preconditions for the possibilities of change. The change is implemented and evaluated as the insight for new investigations (Denscombe, 2003). The cycle was made up of the identification of the problem, planning of the intervention, implementation of the intervention, evaluation of the results: planning – activity – observation – reflection (Lewin, 1946; Kemmis & McTaggart, 1988; Cohen, Manion & Morrison, 2000). During the stage of planning the cycle the participants of the action research were identified, the action plan was discussed, the intervention is determined in order to organize the development of functional mathematical literacy in the 8^{th} form and the ways of collecting data about it.

During the action research it was referred to the teachers' insights obtained during the quantitative research about the methodology of the development of functional mathematical literacy in mainstream schools and various fields making up the components of the methodology of the development of functional mathematical literacy of students with moderate special educational needs were investigated:

- theoretical methodological approaches and principles of education − development of functional mathematical literacy based on theoretical approaches and principles ofeducational philosophies of pragmatism, constructivism (social, cognitive, pragmatic), the concepts of social participation, empowerment and mathematical literacy;
- teacher's and student's roles and positions in the process of education;
- teaching (learning) methods, replacing traditional teaching methods with active teaching methods (e.g., methods of discoveries, practical problem solving, projects, application of ICT) (Cohen, Manion & Morrison, 2000; data of the quantitative research);
- special education strategies applying inclusive approach towards the support of the process of mathematical education with the factor of functionality (e.g.: application of cognitive strategies, learning in

collaboration, peer support, self-regulating learning, mnemonic and memory strategies, etc.);

- applicability of contents, paying more attention to teaching the topics of the fields of mathematical activity *numbers and calculations*, *geometry*, *measures and measurements*, *combinatorics* (partially), *expressions*; the development of essential mathematical skills (measuring, application of knowledge teaching how to solve the tasks of geometric and economic character); development of all types of cognitive skills and especially important competence of learning how to learn;
- evaluative procedures of performed activity, education achievements;
- attitudes and values stimulating positive attitudes of teaching and learning;
- continuing professional development of teachers developing teaching methods, instruments and strategies of working with students with moderate special educational needs, individualization of education with regard to child's abilities.

In order to help teachers to differentiate the process of education, enhance students' interest in the opportunities of practical application of mathematical knowledge L. Tomėnienė (2014) for every section of mathematics has prepared tasks of practical character created by herself (textual tasks, tasks of project activity, practical work, relating theory and practice, meant for the development of thinking, etc.), where attention is focused on practical applicability of knowledge, integration of subjects, use of information technologies, teaching students how to evaluate their activity, develop independence. The content of the given tasks was focused on four main contexts comprising wide fields of life – personal, social, professional, scientific. Students with special educational needs were suggested developing their skills by working, investigating, mastering, consulting with their family members, peers and teachers or performing other practical activity. During such lessons it is easy for a teacher to answer the question "Why do I need it?", explain where in life the performed tasks, gained mathematical knowledge, formed skills will be useful. During each work meeting the tasks suggested by the researcher were reviewed, the suitability of these tasks for the development of functional mathematical literacy of a student with moderate special educational needs was evaluated.

During the process of the action research the attitude has been followed that students with moderate special educational needs **have to be educated together with peers adapting** the contents of the programme of mathematics for the 8th form of mainstream school, withdrawing certain topics that are not understandable to students, applying the methods of active learning and paying more attention to practical applicability of knowledge. It was aimed that the content of learning material presented by L. Tomėnienė (2014) was as much as possible related to the general content of education in the classroom, that

students with special educational needs could participate in common classroom activity and perform differentiated (facilitated) tasks presented by the researcher. It is aimed to consolidate the essential information of learning material, relate theory to practical application of mathematics. To stimulate learning motivation the examples of tasks that illustrate the environment familiar to the students were presented (the tasks for students' active performance and real-life problems which was taught to solve in real-life way were presented; real-life short examples that should help a teacher at the beginning of the lesson to pose a practical problem, project works of practical character).

In the process of the development of mathematical literacy the teachers were suggested to apply Universal Design for Learning that refers to the philosophy that it is necessary to select learning methods and ways of teaching the subject of mathematics suitable for students. The attitude is followed that not a student should get adjusted to teacher's teaching style but the contents of the subject and methods should be combined so that every student had equal opportunities to strive for the best individual results (cit. Ališauskas et al., 2011, p. 40).

Performing the action research the teachers and the researcher could observe how learning environment was changing, reflect on their actions, interaction with learners, evaluate the efficiency of the applied methods and didactic technologies in the development of mathematical literacy of students with special educational needs in the 8th forms of mainstream schools. The result of the action research – reflection on the obtained research results and preparation of the recommendations on how under particular conditions to create the programmes of the development and optimization of the activity (in this case – how to create the methodology of the development of functional mathematical literacy of students with special educational needs adapting the general programme of mathematics for the 8th form students), while the basis of the knowledge is the existence of the reality analysed *here and now*, people's (teacher's) ability to solve problems analysing their performed activity and developing the ability of students with special educational needs to relate mathematical knowledge to real life, apply in practical activity.

The technique of the research is treated as semi-structured because the objectives and basis of the development of functional mathematical literacy is foreseen in advance (referring to the combination of the educational philosophies of pragmatism, constructivism and the theoretical approaches and ideas of social participation, empowerment and mathematical literacy and regarding the peculiarities of mathematical didactic process in mainstream school, the requirements of the general programme of mathematics the basis of the methodology of the development of functional mathematical literacy has been considered), and particular actions and decisions are dictated by the educational reality and individual character of the educational situation. On the basis of the tasks successfully performed by students and modified after the

action research in 2014 the didactic aid (exercise book of mathematics "Eighth-former's Mathematics", author L. Tomėnienė) was prepared for students with moderate special educational needs educated in 8th forms of mainstream schools. Therefore, teachers' remarks about the necessity of the tasks presented by the researcher and their suitability to develop functional mathematical skills of the students who participated in the research were very valuable.

The comparison of the research results of the written surveys of students performed at the beginning and at the end of the action research, using the previously created diagnostic exercise book of mathematical tasks, has shown that after the systemic and purposeful development of functional mathematical literacy based on the combination of the theoretical approaches of the concepts of pragmatism, constructivism, social participation, empowerment and mathematical literacy, mathematical achievements and the ability to apply mathematical knowledge in practical activity have improved in all three students. The students were able to much better concentrate, read the condition of the task attentively, use auxiliary aids, supporting tables, a set of formulas. Close collaboration between pedagogues and teachers, active involvement of a child himself/ herself into the construction of functional mathematical literacy have encouraged investigating the environment more actively, applying mathematical knowledge in practical activity.

The action research allowed the pedagogues to think over and regroup the activities of mathematical education developing functional mathematical literacy of the 8th form students with moderate special educational needs and the priorities: the focus on knowledge and results, the emphasis of the disorder have been replaced and complemented by the aspiration to acknowledge child's individuality and know a student, focus on assistance, taking into account student's strengths and purposeful use of teaching/learning strategies focused on practical application of mathematical knowledge in the process of education and life. It has been noticed that the participation in the research had impact on pedagogues' general competences related to personal development and person's general skills and professional skills in the field of special education (focusing the system of mathematical education of students with special educational needs on the development of functional mathematical literacy).

During the last discussion the teachers, students and their parents generalized the activities of all academic year and distinguished the most effective teaching (learning) methods: collaboration (*work in pairs was very suitable, but it was more difficult to organize work in groups*), project activity (students *liked it very much*, *I didn't think that it would be so fun,... great, I've performed many tasks, researches... while making project works we became better friends not only with classmates but also with family members; I became as if friends with my mum... and I'm not afraid to tell that I didn't succeed in something... I didn't think that there is so much mathematics in life – the projects showed it...; It was fun to participate in the projects with the child, to*

perform practical tasks..., communication with teachers has improved..., I can give advice to the teacher as well, what my child is better at...). All the participants of the action research indicated the importance of the method of peer support: teachers (*they became friends after classes as well, there's no need to tell him, he helps himself...; if O. doesn't understand, he hurries to help him...; both of them come to the consultations, earlier it never was like that...),*students (*I've found a friend..., I started to understand better... and if I don't know something, J. helps; it is quite fun to go to the consultations, when a friend is here, who will help me..., the teacher explains well but my friend somehow explains even more clearly and I understand...*), parents (*I'm glad that my child feels better in the classroom...; the child learned how to work in groups and pairs, receives assistance from friends...).*

All the participants of the action research indicated that they the students liked performing the tasks prepared by the researcher L. Tomėnienė. It was suggested making an exercise book out of these tasks ((parents – *a very good thing... if there are tasks of such practical character in one place, then parents will be able to help as well,... it will also be easier for a child... more interesting to learn),* (students – *I liked solving these tasks... it is from life, not only some formulas... I learned a lot... it would be nice if I could make the cover myself...),* (teachers – *a very good thing, there's no need to search, think... if there are tasks created for every section of mathematics – it would be nice... I also thought it would be nice to add tasks for students' self-evaluation, there would be feedback... students would learn how to plan, evaluate their activity... it would be also nice to have the rules – support material – here... I would like as many as possible such exercises...*).

During the last discussion it was aimed to find out students' mothers' attitude where it was purposeful to organize the development of functional mathematical literacy involving not only teachers but also parents and students into its planning. Mothers evaluated the usefulness of such activity based on collaboration: [*I saw school with different eyes, I learned more about my child, it was quite interesting...], [at the beginning I felt awkward, I thought I wouldn't be able to help my child, but I managed...], [now I go to school in completely different mood, willingly communicate with the teachers, try to listen to their advice and I advise myself...]*.

During the action research, having discussed the peculiarities of the organization of the development of functional mathematical literacy of students with moderate special educational needs in mainstream school together with all the participants of the research, referring to the participants' experience the methodology of the development of functional mathematical literacy of students with moderate special educational needs were created.

All the participants emphasized that the development of functional mathematical literacy is a very changeable interactive phenomenon where **didactic mathematical process** itself based on the concept of mathematical

literacy should be reflected as well as **equal collaboration** between all the members of the process of education [*thus we empower not only students to participate in planning and organization of their learning but also parents and us – teachers], and* ***relating theoretical knowledge to practice***, and suitable **adaptation/ individualization of the programme of mathematics**, focusing on the necessity of the topics for the development of general skills and not forgetting that **a student must participate in the lesson together with other students in the classroom** [*contextuality is very important, ... not all mathematical topics are suitable, it is necessary to select.., it was interesting together with teachers and mum to choose what will be necessary for me, where I can use mathematical knowledge in my life]*. According to the teachers, philosophical substantiation of education is important [*during the action research I understood how important is to perceive the essence of the theories of pragmatism, constructivism, social participation and especially empowerment... It is very important to select one's activity, to organize the process of education in the right direction ... and it gave good results ...]*.

The participants of the action research have noticed in the reflections: the teachers indicated that *[organizing education in the right direction it is possible to achieve good results... It is nice to see that students are glad as well...],* the parents expressed joy about the child's attitude towards learning: [*It is enjoyable that the child is not separated from everyone and willingly performs tasks that are related to real-life environment ... it is fun to perform project activities with the child and enjoy his successes... communication improved our relationship, the child has become more open...]*, the students indicated that [*participating in the research I gained more courage, I'm not afraid to ask the teacher, I gained more self-confidence...], [I am glad with my classmates' support and assistance...], [my relationship with parents has improved... I liked learning mathematics in a different way...*], *[I understand that mathematics can be interesting...], [To plan my learning together with my mum, teacher of mathematics and special educator was unusual but interesting and useful...*].

Conclusions

1. The performed action research permitted in practical activity together with teachers-practitioners, students, their parents to create the methodology of the development of functional mathematical literacy in the 8th form of mainstream school and at the same time change the attitude towards the educational reality of students with moderate special educational needs.
2. The focus of teachers' activity on students' needs and positive skills, didactics of the development of functional mathematical literacy, construction of success situations during the process of mathematical education and planning of the educational activity together with learners permitted the students to experience success, raised their learning

motivation. These factors conditioned not only the improvement of learning outcomes that was noticed during the retest performed at the end of the action research but also improved self-evaluation.

3. The processes of the empowerment of a student and his/her family that were developed activating equal participation in the development of functional mathematical literacy, strengthening individual potential, improved the skills of interpersonal communication and learning in action, encouraged the responsibility for one's activities initiating collaboration-based activities.
4. All the teachers who have participated in the action research not only have improved the practice of the development of students' functional mathematical literacy but also developed their professional competences, because there were meetings-discussions, during which the theory of the development of functional mathematical literacy of students with moderate special educational needs was analysed, the discussions took place, the arising problems were discussed, the gained experience was shared.

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