

**ICEST 2021****II International Conference on Economic and Social Trends for Sustainability of Modern Society****READINESS OF MATHEMATICS TEACHERS TO DEVELOP  
STUDENTS' FUNCTIONAL LITERACY**

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**Abstract**

The article emphasises the problem of mathematics teachers' readiness to form a relatively new educational result for Russian school, i.e. functional literacy of students. In order to identify the degree of teachers' readiness to form functional literacy of students in the process of teaching mathematics the authors conducted the research among the teachers of Krasnoyarsk and Krasnoyarsk Krai. Following observation of the educational process at mathematics lessons, interviewing and surveying teachers, carrying out diagnostic work the authors found discrepancy between teachers' self-assessment of their competencies in the field of formation of functional literacy of students and actual educational practices. Less than half of the respondents have an adequate understanding of the essence of functional literacy and methods of its formation in the process of teaching mathematics. Teachers recognize the relevance of this educational task and are ready to improve their qualification in this area. The data and the results of the study have stressed a set of professional deficits of mathematics teachers in the region in terms of subject and methodological knowledge, which is a major contributor to the formation of functional literacy of students. To address the identified deficits in the future it is planned to organize targeted personalized assistance to teachers on professional development courses, training and consulting support for the development of professional competencies in the field of achieving new educational outcomes, as well as improve the subject and methodological university education of future mathematics teachers.

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## 1. Introduction

One of the global trends in modern education is the development of students' functional literacy in various subject areas; this term implies their ability and readiness to quickly adapt and work successfully in modern society, using the acquired knowledge and skills to solve problems (PISA 2018, 2019). The paradigm of the "knowledgeable person" has been replaced by the paradigm of the "person prepared for life". The development of functional literacy of learners has now become a national goal and strategic objective for Russia. One of the priorities of today's teachers is to ensure that students will achieve relevant educational outcomes. An important condition in the new educational model is the acceptance by teachers, including those of mathematics, of the new quality of education and the teachers' willingness to provide this quality. The analysis of the current educational situation shows that many teachers of mathematics in Russian schools experience significant difficulties as regards forming functional literacy of students. This is partly due to the presence of certain professional deficits of teachers caused by objective and subjective factors.

Recently, there have appeared a number of studies on the assessment of mathematics teachers' readiness to implement work in the conditions of modern educational situation (Altynikova, & Muzaev, 2019; Gevorkyan et al., 2020). The authors studied the readiness and ability of mathematics teachers to provide STEM education (Tumasheva et al., 2020), innovative forms of educational activities (Wang et al., 2018), special education programmes during the pandemic (Mansor et al., 2021). The attention of researchers is also drawn to the objective challenges of Russian teachers in designing and organizing the educational process in school, which is aimed at the achievement of the preset educational outcomes (Pinskaya et al., 2016; Shaykhelislamov, 2019). Teachers' professional difficulties and deficits in methodological and subject competencies were also investigated in Tumasheva et al. (2021). Van der Want et al. (2018) acknowledge that many teachers facing professional problems do not talk about them and, having not found solutions themselves, they leave the situation unchanged. In a study by Stahnke et al. (2016) it is demonstrated that teachers have complications in interpreting tasks and identifying their educational potential, which also has a negative impact on the education quality.

Currently, many researchers involved in the problems of mathematics education of schoolchildren are paying much attention to the study of specialized knowledge of mathematics teachers, their impact on students' educational outcomes in mathematics. For example, Delgado-Rebolledo and Zakaryan (2020) attribute subject achievements of students in mathematics to the level of mathematical and pedagogical knowledge of the teacher. Functional literacy of learners was left out of this study. Warner and Kaur (2017) describe positive experiences of following the 2T2C model. The authors point out that for a mathematics teacher to be able to teach students 21st century thinking, skills and competencies, he or she needs to be proficient in teaching strategies and methods, as well as in the qualities that he or she intends to develop in his or her students. Russian researchers also note the importance of lifelong learning for mathematics teachers as a prerequisite for the successful development of mathematical literacy in students (Yusupova, & Skudareva, 2020). Mathematics teachers' perceptions of functional literacy and one of its components, i.e. mathematical literacy, were studied by Genc and Erbas (2019), who concluded that many teachers misunderstand the essence of mathematical literacy. In the context of our study, of particular interest are

results of Patterson et al. (2018), who revealed that the level of teachers' professional competencies is insufficient for successful formation of students' functional literacy. This experience can be extrapolated to Russian teachers of mathematics. The structure of functional, mathematical literacy of learners and the readiness of Russian teachers to form these qualities are considered in the works of Roslova et al. (2019), Roslova and Karamova (2020). A positive experience of a primary school teacher preparation for the formation of functional literacy of primary school pupils is described in Baibakova (2020).

The study of Russian and foreign educational practices proves the interest of the pedagogical community in the problem of teachers' readiness to form functional literacy of students and to find effective solutions to solve this task.

## **2. Problem Statement**

The analysis of the theory and practice of education has shown that functional literacy of students is a critical educational result, which should be achieved by schools in the present state of society development. The productive formation of this ability in the younger generation largely determines the future of the country. On the one hand, the main factor that has a substantial impact on the formation of functional literacy of students is the readiness of the teacher (in the current context – mathematics teacher) to design and organize the instructional process that ensures the achievement of this educational result. On the other hand, the ubiquitous mathematics teaching practices, as well as subject and methodological competencies of the teacher do not always ensure the teachers' readiness and ability to solve the indicated tasks. Therefore, the problem of insufficient readiness of mathematics teachers to form functional literacy of students by means of the subject area "Mathematics" is pertinent to Russian education and requires finding a solution in the theory and methodology of mathematics education.

## **3. Research Questions**

The current situation in Russian mathematics education requires addressing following issues concerning the readiness of mathematics teachers to develop students' functional literacy:

- 1) How do mathematics teachers understand students' functional literacy?
- 2) Are mathematics teachers prepared to develop students' functional literacy?
- 3) What are the professional difficulties for mathematics teachers in terms of developing students' functional literacy?

## **4. Purpose of the Study**

The purpose of the study is to identify the degree of readiness of mathematics teachers to develop functional literacy of students and the specific professional deficits of teachers in this aspect.

## 5. Research Methods

In order to achieve the goal, the first stage involved theoretical analysis of the literature on the problem in question, materials of the PISA study, the national research of education quality and findings of the Federal Institute of Pedagogical Measurement in the field of functional and mathematical literacy. The systematization and generalization of scientific search results in the task to identify professional deficits of mathematics teachers related to the formation of functional literacy of students and to address the issue of overcoming these deficits.

The empirical basis of the research conducted at the second stage consisted of the following diagnostic methods and tools: open observation of mathematics teachers' activities in general education schools, interviewing working teachers, questionnaires to determine teachers' self-assessment of their readiness to form functional literacy of students, as well as carrying out diagnostic work.

Respondents were quoted by school, level of education and years of experience. Quoting was carried out taking into account analytical conclusions of the programme of national research of education quality, in particular these criteria were met: each school was represented by at least 3 teachers, at least 32 % of respondents were above working age, 90 % should have had higher education. The sample consisted of 103 teachers of Krasnoyarsk city and Krasnoyarsk Krai.

The observation was aimed at revealing the teachers' understanding of the necessity to form functional literacy of students and new pedagogical tasks in the conditions of changing demand for quality of education.

A series of interviews with mathematics teachers discovered the following: understanding of the essence of functional literacy and its relevance in modern education; ideas about the features of designing and implementing an educational process with the focus on the formation of functional literacy of students. During the interview, teachers were asked to answer the following questions:

- 1) How do you understand functional literacy of learners in the current economic situation?
- 2) Do you treat functional literacy as a relevant educational outcome?
- 3) What new pedagogical challenges do teachers need to respond in order to successfully develop students' functional literacy?
- 4) What changes in the educational process are required to ensure the development of students' functional literacy?
- 5) What makes up the teacher's readiness to develop functional literacy of students while teaching a particular subject area?
- 6) What challenges have you encountered during development of students' functional literacy?

The questions were offered to respondents without any prior discussion or explanation, which, in our opinion, made it possible to avoid guessing the desired answer and get a more objective view of the real situation in general education schools concerning the formation of functional literacy of students and the problems arising in this regard.

The degree of teachers' readiness to form functional literacy of students was determined by self-assessment. The components of readiness (cognitive, technological, motivational and value-based ones) were specified in accordance with the structure of readiness. For this purpose a survey was conducted. A variant of the questionnaire is presented in Table 1. The respondents had to evaluate the statement using the following scale as a guide: 0 - I don't know / I can't, 1 - I know how, 2 - I can, 3- I have experience, 4 - I think it necessary.

**Table 1.** Questionnaire of teachers' self-assessment of readiness for formation of students' functional literacy

Positions to be evaluated, whether the teacher is able to	Readiness components
realise the potential of mathematics in developing students' functional literacy	0 1 2 3 4
design the content of mathematics teaching in the context of developing students' functional literacy	0 1 2 3 4
create conditions for the development of functional literacy during teaching mathematics	0 1 2 3 4
use educational resources to build functional literacy during teaching mathematics	0 1 2 3 4
design student learning activities in mathematics so that they focus on developing functional literacy	0 1 2 3 4
carry out assessment of students' functional literacy	0 1 2 3 4
take into account the age and psychological characteristics of learners when developing students' functional literacy	0 1 2 3 4

To determine working teachers' readiness to form students' functional literacy and identify professional difficulties appearing while solving this pedagogical task, teachers were offered to take part in diagnostic work. The main principles of its design were oriented on the requirements for learning outcomes according to FSES, as well as comprehensiveness, variability, presence of context. The conceptual framework of the study rests on a situational approach in order to identify teachers' readiness to form students' functional literacy, which implies the manifestation of readiness in certain pedagogical situations related to the professional activity of a mathematics teacher. For accurate diagnostics we distinguished a set of subject and methodological competencies of a mathematics teacher, which dictated the structure of the work.

The diagnostic work contained 16 tasks differing in content and purpose (Tumasheva et al., 2021). The subject module consisted of 10 tasks of a subject nature, with a short answer to be written down as a number or a sequence of digits. The format of the tasks was approximated to the content of the tasks for the final certification of secondary school graduates. The tasks included in the control-measuring materials made it possible to evaluate the degree of the following groups of skills in the subject area (subject skills hereinafter referred to as SS): ability to perform calculations and transformations of algebraic expressions (SS-1); ability to model real situations in the language of algebra; ability to make expressions, equations and inequations according to the problem statement; ability to investigate constructed models using algebraic tools (SS-2); ability to perform operations with geometric figures (SS-3); ability to perform operations with functions (SS-4); ability to use acquired knowledge and skills in practical activities and

everyday life, build and examine simple mathematical models (SS-5); ability to solve mathematical tasks of higher level of complexity (SS-6). The SS-6 group of skills implies the mastery of functional literacy.

The performance of the tasks of this module was checked automatically. Here are examples of tasks of the subject module.

SS-3: The area of the cross-section of the ball with the plane  $\alpha$ , over a distance from the centre equal to 12, is  $81\pi$ . Find the surface area of the ball.

SS-5: In front of you there are four models of glass teapots of the same capacity (Figure 1). In which teapot will the hot tea remain warm longer? Justify the answer (Egupova, 2014).



**Figure 1.** Models of teapots

The methodological module contained 4 case study tasks. Their solution requires a brief description of the judgement. This module also presented 2 tasks (cases) for which a detailed, complete answer (explanation, description or justification, statement of reasoned opinion) should be given. The tasks contained descriptions of typical educational situations in the region. The open-ended structure of the tasks prevented the surveyed from guessing the correct answers. The tasks in this part of the work tested the development of methodological skills (hereinafter referred to as MS) eliciting the ability to solve professional tasks in the area of mathematics teaching methodology which is oriented towards functional literacy, namely ability to design a part of a lesson in accordance with the goals and tasks of teaching as well as students' individual characteristics (MS-1); ability to select and adjust the content, forms and methods of teaching in the context of functional literacy development (MS-2); ability to evaluate objectively functional literacy in a professional context (MS-2).

Assignments with an extended answer (methodical module) were checked by expert evaluation.

Here is an example of one of the tasks in the methodical module.

MS-2: Read the problem: Vladimir is going on a trip abroad. He needs to buy the currency of the country to which he plans to travel. Vladimir chooses a more favourable exchange rate in two banks. Bank A changes roubles into conditional currency units at 3,000 roubles per unit, and charges another 7,000 roubles commission irrespective of the amount to be changed. Bank B charges 3,020 roubles per currency unit, and the commission is 1 c.u. irrespective of the amount to be exchanged. Vladimir has established that he does not care which bank he uses to exchange money. How much money is he going to change?

Complete the tasks:

- 1) Specify the class and the topic of the lesson in which the students may be offered this task.
- 2) State the planned educational outcomes that could be achieved by working with the task.

- 3) Identify the most effective methodology/technology that could be used to organize students' work on the task.
- 4) Suggest a variant of transforming the problem when studying another topic of the school mathematics course.
- 5) Imagine that there is a hearing-impaired student in your class. Briefly describe how you would work with him/her to solve the problem.

The results of the diagnostic work made it possible to determine the degree of teachers' readiness to form functional literacy of students, so there were identified the main difficulties and the factors causing them.

The final stage of the study was generalization, systematization and analysis of the results of the study of mathematics teachers' readiness to form functional literacy of students. The final conclusions were formulated.

## **6. Findings**

As a result of theoretical research the readiness of a mathematics teacher for the formation of students' functional literacy was defined as an integrative individual characteristic, which expresses the ability to use mathematical, methodological and general professional competencies to solve professional problems of development of students' functional literacy, coupled with positive motivation, value attitude and positive experience in this activity. The structure of readiness includes cognitive, technological, motivational and value-based components. In the context of this study, the cognitive component of readiness is of particular importance for the mathematics teacher's own functional literacy in the subject area. On the basis of diagnostics of the mentioned components one can reveal the professional deficits of the teacher in the subject and methodological area, overcoming of which will increase the degree of readiness of a mathematics teacher to create the students' functional literacy.

The results of class observations, questionnaires and interviews answered the question of how mathematics teachers understand the term "functional literacy of students". All respondents are more or less familiar with this notion and are aware that the development of functional literacy is one of the topical tasks of contemporary education. But only 34 % of respondents admitted that they set themselves the task of forming this quality of students, studied methodical experience in this area in one way or another (at professional development courses, through reading scientific-methodical literature, discussions with colleagues at methodical associations, conferences, etc.). 21 % of the respondents expressed their intention to raise their qualification in the issue under discussion. More than half of the teachers surveyed (61 %) noted that they had difficulties in unambiguous defining the essence of functional literacy in relation to the subject area "Mathematics" and confessed that they were not sure whether they had an arsenal of tools to develop this quality in students during teaching. Only 13% of the respondents stated that they had had positive experience in the formation of functional literacy of their students at the lessons and in the process of extracurricular activities (conducting fieldwork, organizing students' project activities, etc.). Teachers' ideas about the structure and content of functional literacy are somewhat scattered. Most define it as "the ability to use mathematics in practice" or "the ability to use mathematics in life". The ideas about the content

of the tasks for learners aimed at the development (assessment) of functional literacy do not correspond in full with the approaches adopted in Russian and foreign studies. None of the interviewees mentioned, for example, such aspects as multitasking, comprehensiveness, combination of different content areas to provide cognitive activities of different types for learners. In defining the context of real life and practice-oriented mathematics teaching many teachers are guided by the range of task plots traditionally present in school mathematics textbooks. Some teachers believe that the development of functional literacy in mathematics teaching is important in order to pass the state final examinations for the general secondary school course.

To summarize, we conclude that an adequate understanding of functional and mathematical literacy of students by mathematics teachers, the structure, content, conditions of literacy formation is essential for the achievement of relevant educational outcomes. The obtained results are consistent with the findings of foreign colleagues Genc and Erbas (2019).

The results of the interview showed that the requirement of formation of students' functional literacy, was fully accepted by 9-41 % of respondents, depending on their experience. Between 5 % and 16 % of teachers completely disagreed with this requirement. The majority of teachers evince a lack of understanding regarding the changes to be made in the design of mathematics teaching, in particular, in the direction of selection of teaching methods, forms and tools suitable for the development of students' functional literacy. According to the respondents, the learning of how to teach functional literacy skills usually takes place during in-service training, even though there never follows their further presupposed development and implementation in the mathematics teaching process. Teachers are least interested in designing learning events and making tasks to develop and assess students' functional literacy. Only 21 % of teachers with more than 10 years of experience and 33 % with 5-10 years of experience were able to give examples of specific teaching methods, forms and tools aimed at the development of students' functional literacy in the process of mathematics teaching.

The results of the survey showed teachers' confidence in demonstrating the practical value of mathematics in their lessons and thereby shaping students' functional literacy. But observation data disprove this: often in educational practice functional literacy of learners is substituted with other educational outcomes. More than 2/3 of the respondents believe that they apply teaching technologies aimed at developing students' functional literacy and know how to diagnose the level of students' functional literacy. Meanwhile, the practice and the results of the diagnostic work confirm that the majority of mathematics teachers are rather focused on the formation of the subject learning outcomes and, in addition to the tasks from textbooks, at the lessons they use the materials from the open banks of Basic State Exam and United State Exam tasks. In the mathematics teaching process, preference is given to traditional teaching methods and technologies, while case studies, projects, problem situations, etc. are used much less frequently. All this indicates a low degree of readiness of mathematics teachers to form functional literacy of students.

The results obtained during the study indicate that most teachers have serious difficulties in forming functional literacy of students in the process of teaching mathematics, sometimes even without being aware of them. We highlighted the teachers' subject and methodological deficits that have a considerable impact on the studied type of professional readiness and require first-priority elimination. Thus, according to the

results of the diagnostic work, in the subject area teachers have demonstrated proficiency in solving mathematical tasks at the level sufficient for the formation of students' functional literacy. The exception was geometric and advanced tasks, from which only 45 % and 27 % were solved respectively. Teachers showed striking difficulties in the subject area when solving the tasks requiring the ability to apply mathematical knowledge and skills to deal with real life situations. Less than a third of examinees coped with such tasks testing mastery of methods of solving practice-oriented tasks, tasks containing description of real life situations.

Among the methodological deficits, the most worrisome are the difficulties in:

- 1) formulating the goal of the lesson in the given conditions, in particular the lack of focus on the formation of students' functional literacy;
- 2) designing learning situations, focused on the formation and development of students' functional literacy;
- 3) designing the content component focused on the formation of students' functional literacy, especially taking into account the individual characteristics of children;
- 4) need to reasonably choose appropriate methods and forms of organization of students' activity, guaranteeing the formation of students' functional literacy;
- 5) objective assessment of the level of development of students' functional literacy.

The analysis of the identified teacher deficits requires more detailed consideration and is beyond the scope of this article.

## 7. Conclusion

The conducted research suggests that the problem of mathematics teachers' readiness to form functional literacy of students is acute and requires effective solutions at the level of instructional theory and practice. The study results show that many teachers find it difficult to adequately assess the degree of their readiness. The actual level of readiness of the majority of mathematics teachers to form functional literacy of students does not correspond to the modern educational demands.

The professional deficits of mathematics teachers can be divided into two groups, cognitive and activity-based. The first group includes deficits due to lack of cognitive resources: unsatisfactory subject knowledge; lack of understanding and/or rejection of changes in the educational situation; inadequate knowledge of modern professional terminology; insufficient knowledge of the particularities of designing and organizing students' educational activities in relation to the need to develop their functional literacy. The second group includes deficits arising from stereotypes regarding the activities of a mathematics teacher in general education school; scarce experience in implementing the requirements for education of new quality, applying the available subject and methodological knowledge in the changed conditions.

The following steps will help to improve the current situation: creation of a regional system for monitoring professional deficits; creation of regional mechanisms for raising motivation concerning professional development, which will encourage teachers to get rid of professional deficits, to develop their skills in the subject and methodological area; introducing modular professional development programmes

for teachers, providing personalized assistance to teachers in eliminating professional difficulties in formation and development of their professional skills.

Realization of the indicated tasks will bring about the improvement of staffing of mathematics teachers in the region, their professional development, which in turn will positively influence the quality of mathematical training of students. The solution of the problem of teachers' readiness to form students' functional literacy should start in the process of preparation of the future mathematics teacher.

Prospects for further research are to consolidate the efforts of universities, schools, and in-service training institutes in the following areas:

- 1) organizing the work on overcoming the blocking professional stereotypes of teachers and awareness of mathematics teachers of the availability of internal resources that would allow effective implementation of labour functions in a changed school environment;
- 2) developing the strategy for professional growth of teachers in the region, and designing on its basis of individual trajectories of qualitative changes in professional competencies of mathematics teachers in accordance with the requirements of the new educational situation;
- 3) provision of methodological support of educational process, directed to achievement of topical educational results in mathematics (including development of necessary methodical products, diagnostic tools, technologies of their effective application and consulting assistance) by scientific and educational organizations, involved in teacher training and professional development;
- 4) scalability of effective methodological experience in formation of students' functional literacy while they learn mathematics;
- 5) development of methodological support in the field of mathematics.

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