

# TEACHING MATHEMATICS BILINGUALLY: A TEACHING DILEMMA IN TATAR SCHOOLS IN RUSSIA

Leila Salekhova, Rinata Zaripova, Andrew Danilov

*Kazan Federal University (RUSSIAN FEDERATION)*

## Abstract

The report reveals the pedagogical dilemma in the Tatar language schools in Russia where teachers face the problem of teaching mathematics and information and communications technologies in two languages - Russian and Tatar. Tatarstan is one of the republics of Russia and 53% of population is Tatar. There are two official languages, Tatar and Russian. Russian, nevertheless, is the language of government and economic exchange, and hence the language of access and power. Russian remains the most common language in urban areas of Tatarstan.

On the one hand in Tatar schools the language of instruction is Tatar and the majority of school lessons including mathematics and information and communications technologies (ICT) are taught in Tatar.

On the other hand, Unified State Exams (USE) are held all over Russian Federation in Russian language only, thus there is a crucial need to teach non-native Russian speakers in Russian, because knowledge of mathematical and ICT terms in Russian helps students to understand and complete USE tasks. Tatar school's teachers viewed bilingual education as an idea to overcome these drawbacks.

Research focuses on analysis of data taken from experiments conducted in Tatar-language school. Four lessons from two mathematics teachers were observed and video-recorded. According to the interpretive approach adopted in this study qualitative data were collected via video-recorded lessons and interviews with teachers.

Keywords: Bilingual education, Tatar-Russian code-switching, teaching mathematics.

## 1 INTRODUCTION

According to 'Bilingualism and mathematics learning' (Clarkson, 1991) there are three types of bilingual students: (1) immigrant children in 'developed' countries, (2) students in developing, and (3) indigenous groups in 'developed' countries. This division is a consequence of political rather than educational reasons. The situation in Tatarstan corresponds to the 3rd case.

Tatarstan is one of the republics of Russia. 53% of population is Tatar. There are two official languages, Tatar and Russian. Russian, nevertheless, is the language of government and economic exchange, and hence the language of access and power. Russian remains the most common language in urban areas of Tatarstan.

Tatar language is a Turkic language spoken by Volga Tatars mainly located at modern Tatarstan. Like other Turkic languages, Tatar is an agglutinative language. Russian being an inflexional language differs from Tatar. Nevertheless the official script of modern Tatar language is based on the Cyrillic script used for Russian language but with some additional letters. Several generations of Tatars speak fluent Russian, so Tatar-Russian code-switching is spoken predominantly among bilingual Tatars.

According to Siegal's (2003, p.179) classification of multilingual education which is based on the role of the learner's additional language in the society, the bilingual education in Tatar Schools can be identified as *Coexisting*, i.e. the main classroom language is a nearby language spoken by a large proportion of the population. The similarities and differences between the situation in Tatarstan and other places, for example such as South Africa, provide a broader understanding of the complexity which surrounds learning mathematics in a language different to one's mother tongue.

In many parts of the world, there are debates about the impact of the language of assessment on the teaching in mathematics classrooms, even when a bilingual policy for education may be in place. For example, in Malaysia students of Chinese schools are being tested in two languages - English and Mandarin (Lim, 2011).

In New Zealand, students enrolled in Māori-immersion schools can complete bilingual exams at the end of high school (Meaney, Trinick, & Fairhall, 2011). However, the impact of language policy decisions on assessments is not without consequences and often causes considerable debate in the communities which are affected by them.

Parents and teachers are torn between wanting what is best for the language and what is best for their children and students. This can be seen in their repeated requests in the 1990s for exams to include te reo M'aori as well as English. Once Māori-medium education was recognized by the state, parents and teachers saw it as being obligated to provide bilingual exams. Even though it took ten years for this to be achieved, parents and teachers continued to operate with this belief. (Meaney, et al., 2011, p. 74)

These examples drawn from the international contexts illustrate that when government and politics realize the necessity to ensure equal rights and opportunities for education, regardless of student's nationality or language, they try to find a compromise.

In many ways the situation facing Tatar is similar to those of other countries where students learn either in a language different to their native language or in two languages with their native language being one of these. For example, in South Africa many students choose to learn mathematics in English because it is considered to be the language of power even when their fluency in English may contribute to problems in learning mathematics. Almost all research in this area has had English as the language which is being learnt concurrently with mathematics (Setati, 2005). The situation in Tatarstan provides an example where another language, Russian, with a different political, historical and social relationship is in focus.

The main aim of this study is to explore the pedagogical dilemma in the Tatar language schools where teachers face the problem of teaching mathematics and ICT in two languages - Russian and Tatar. The horns of this dilemma are, on the one side, that teaching mathematics in the native language appears to be a primary condition for access to mathematics, particularly for pupils whose language competence in Russian is still developing. On the other side, however, there is a crucial need to teach mathematics to non-native Russian speakers, because knowledge of the mathematical register in Russian gives an opportunity for graduates of Tatar schools to understand the nuances in the mathematics problems in Unified State Exams (USE), which are held all over Russian Federation and are written in the Russian language.

## **2 BACKGROUND OF THE STUDY**

The Russian educational school-system is divided into three levels based upon age: primary school level (grades 1-4), basic school level (grades 5-9) and high school level (grades 10-11).

Coming from multilingual background of Russia, students in Tatarstan can choose between Russian-medium schools (RS) and schools with Tatar language of instruction (TS). Tatar provides schooling options in a range of different native languages. These includes 997 educational institutions that use the Tatar language, 118 which use Chuvash, 37 with Udmurt, 20 with Mari, 5 with Mordovia, 1 with Bashkir, and 1 with a Jewish ethno-cultural component in the educational content. In addition, there are 53 Sunday schools that provide opportunities to study the languages and cultures of 24 ethnicities which live in the Republic of Tatarstan.

Mathematics is a required subject in the Russian school curriculum. Students learn mathematics for grades 1 to 11. In Russia children are taught to appreciate mathematics at a younger age and the mathematical education system is well developed. Mathematics education formally began in Russia in 1701 when Peter the Great founded the School of Mathematics and Navigational Sciences. The first gymnasiums were opened by decree of Catherine the Great at the Petersburg Academy of Sciences, at the Moscow and Kazan Universities. From the beginning of the 20<sup>th</sup> century the standard of mathematics teaching is sufficiently high, the system of extra-curricular mathematical education began to develop in Russia.

The key characteristics of Russian math education is the fact that teacher commonly works with same group of students for a considerable length of time. The course is broken down not into different units that the students can take, but simply into different years of schooling — in sixth grade everyone learn specific topics, and in seventh grade everyone moves on to other topics. Mathematics is taught progressively and shown how levels are connected. Pupils will usually have completed some level of calculus by the end of tenth grade.

Before 2009 mathematics was taught in Russia in different indigenous languages. In 2009, the Russian Ministry of Education and Science established USE for school graduates. All high school graduates must pass the USE, in order to enter university. Two exams, mathematics and the Russian language, were mandatory, while exams for the 9 other school subjects could be chosen by students. Consequently Russian is the language of assessment for all students who complete the USE.

The three main rationales provided for the implementation of USE in Russian were:

- the Russian is the most widespread language in Russia and it's mainly used as a medium of instruction;
- to prevent decreasing the Russian language proficiency among students at all educational levels;
- to overcome the challenging task of translating text books and study literature into vernacular languages.

However, the requirement that Russian language should be used in the USE is done for political rather than educational reasons. Thus, from the outset, influential Tatar groups, including Tatar Association of Education and Culture "Magarif" and the Tatar Public Center are against the movement to make Russian is only language for USE for several reasons.

The first one is the fear of increasing the study load, and the second reason is changing the distinctive character of Tatar schools. They claimed that school subjects, in particular Natural Science subjects, are best taught and assessed in student's native language.

However, because Russian is the language of knowledge assessment for USE; mathematics problems in the USE are formulated in Russian. This raises the question: How can a student, who studied mathematics in native Tatar language, understand a mathematical task, formulated in Russian and, provide appropriate problem solutions in Russian?

After much discussion, teachers of mathematics in TS came to the opinion that they should teach mathematics in both Russian and Tatar. However, they were uncertain if this initiative became a benefit or an extra-load for the teachers and students of Tatar schools in Russia.

Teaching subjects such as mathematics through a second language poses a number challenges for the teachers and students. The number of researches from different countries agreed that mathematics should be taught in bilingual manner, often involving code-switch (Setati, 2005; Barwell, 2001, 2009; Poon, 2004; Meaney, Trinick, & Fairhall, 2011; Salekhova, 2012).

Code-switching occurs when a speaker alternates between two or more languages, or language varieties, in the context of a single conversation (Gumperz, 1982).

In the South African classes that Setati (1998) observed noted that code-switching was used by the teacher: to make learning mathematical concepts meaningful, to facilitate and support students' participation in discussions and to train students to work with the language of assessment. Also students commonly code-switch when they are involved in the process of building their own mathematical comprehension and mathematical communication. As a rule, they code-switch when they have problems with effective developing ideas in the second language.

Code-switching remained a difficult practice for all the teachers, both practically and ideologically. Setati and Adler (2000) argued that on the one hand in many multilingual educational settings teachers need to switch languages in order to reformulate a question or instruction, or to re-explain the concept, and they need to encourage their learners to use their main language in order to facilitate communication and understanding. At the same time, it is their responsibility to induct their learners into mathematical register in the second language and hence it is important to use it in the mathematics classroom.

Given that it has been noted elsewhere that code-switching is commonly used as a resource when students are gaining fluency in their second language while at the same time learning mathematics, it seemed relevant to see how it was used in classroom where both Russian and Tatar were used.

### 3 THEORETICAL FRAMEWORK

The study is framed by the sociocultural theory of Vygotsky (1978), its development and application for science and mathematics education done by Mercer (1995). Cummins' (2000) threshold hypothesis is also used to understand students' potential difficulties.

Vygotsky's sociocultural theory of human learning describes learning as a social process and the origination of human intelligence in society or culture. The major theme of Vygotsky's theoretical framework is that social interaction plays a fundamental role in the development of cognition. Vygotsky believed learning occurred on two levels.

Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapyschological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals. (Vygotsky, 1978, p.57)

As Mercer (1995) has argued, (mathematical) knowledge produced in the context of schooling is quite specific and is different from knowledge produced in everyday contexts. Within the context of schooling he distinguished between *educational discourse*-the discourse of teaching and learning in the classroom (e.g., ways of asking and answering questions in class)-and *educated discourse*-new ways of using language (e.g., in algebra "let x be any number"), "ways with words" (p. 82) that would enable pupils to become active members of wider communities that use this educated discourse.

[Teachers] have to use educational discourse to organize, energize and maintain a local mini-community of educated discourse. We can think of each teacher as a discourse guide and each classroom as a discourse village, a small language outpost from which roads lead to larger communities of educated discourse... Teachers are expected to help their students develop ways of talking, writing and thinking which will enable them to travel on wider intellectual journeys..., but they have to start from where learners are,... and help them go back and forth across the bridge from everyday discourse in to educated discourse. (Mercer, 1995, pp. 83-84)

In particular, Vygotsky's sociocultural theory of human learning and Mercer's development of a sociocultural theory of education provide analytical tools for describing and explaining some teaching dilemmas in multilingual mathematics classrooms.

The role of language in mathematics classrooms has been documented for some time (Ellerton & Clarkson, 1996). For example, Barwell (2008) argues that teaching and learning of mathematics perhaps more than any other subject depends on language. This is because mathematics is about relationships: relationships between numbers, between categories, between geometric forms, between variables and so on. In general, these relationships are abstract in nature and can only be brought into discussions through language. Even mathematical symbols must be interpreted linguistically.

Pimm (1987) provides characteristics of the mathematics register in English, but many of these characteristics can also be seen in the mathematics registers of Russian and Tatar. Every mathematics register has its own vocabulary, which can be roughly divided into three groups:

- technical terms specific to mathematics (e.g. *quadrilateral*, *chetirehugolnik* in Russian, *durtpochmag* in Tatar);
- technical terms used in mathematics that also have unrelated everyday meanings (e.g., *set*, *mnojestvo* in Russian, *kuplek* in Tatar);
- mathematical use of words adapted from similar everyday meanings (e.g., *similar*, *podobniy* in Russian, *ohshash* in Tatar).

Mathematical language has several other dimensions, including:

- specialized syntax (e.g., the use of words like and or *if*,
- use of symbols;
- ways of talking and writing (e.g., word problems, writing a solution, giving an explanation)
- social factors.

The issue of mathematics making use of a specific register within a natural language, such as English, Russian, and Tatar implies that there is a need for students to learn this register and for teachers to

teach it. Adler (1999) used the expression “explicit mathematics language teaching” in order to underline that, language itself, and particularly talk, becomes the object of attention in mathematics class and a resource in the teaching and learning processes in multilingual mathematics classes.

Now that their [teacher’s] classes included pupils whose main language was not English, these teachers realized that they needed to be more explicit about instructions for tasks and more careful in their use of mathematical terms and their expression of ideas (Adler, 1999, pp. 47-48).

From this sociocultural perspective, the teaching and learning of mathematics in multilingual contexts needs to be understood as three-dimensional. It is not simply about access to the language of learning (in this case English). It is also about access to the language of mathematics (educated discourse) and access to classroom cultural processes educational discourse). How do teachers manage the tensions in use of formal mathematical language and informal language, on the one hand, and in the language of instruction that is not the main language of the pupils, on the other hand? (Adler, 1999, pp. 51-52).

The type of language used by the mathematics teacher to teach must match the language used by students to learn. Cummins (1981) postulated that there exists a minimal level of linguistic competence (threshold) that a student must attain to perform effectively on cognitively demanding academic tasks such as mathematics learning. Students who do not have this minimal level of competence are unlikely to learn subjects such as mathematics. This level of language competency does not refer simply to everyday language.

Cummins (1980) differentiated between social and academic language acquisition. Basic Interpersonal Communication Skills (BICS) are needed in social situations. It is the day-to-day language needed to interact socially with other people. Social interactions are usually context embedded and are considered not to be very demanding cognitively. The language required is not specialized. When a student is immersed in a second language these language skills usually develop within six months to two years. However, problems can arise when teachers and administrators think that a child is proficient in a language when they demonstrate good social second language competency. This is because teachers and administrators have not recognized the importance of fluency in academic language such as the mathematics register.

Cummins (1980) described CALP as Cognitive Academic Language Proficiency. CALP refers to formal academic learning, including listening, speaking, reading, and writing about the content of a subject area and is essential for students to succeed in school. Students need time and support to become proficient in academic areas. This usually takes from five to seven years. Academic language acquisition is not just the understanding of content area vocabulary. It includes skills such as comparing, classifying, synthesizing, evaluating, and inferring. Academic language tasks are context reduced and essential for dealing with abstract subjects such as mathematics. Cummins also advances the theory that there is a common underlying proficiency (CUP) between two languages. Skills, ideas and concepts students learn in their first language will be transferred to the second language. Thus students who have learnt the mathematics register in Tatar should be able to transfer these understandings when they learn the mathematics register in Russian.

#### **4 CHARACTERISTICS OF THE STUDY AND DATA COLLECTION PROCEDURE**

This paper focuses on analysis of data taken from experiments conducted in Tatar-language school. The purpose of the study is to understand and interpret teachers’ perspectives on the factors that could affect learning through face-to-face instructional approaches. According to the interpretive approach adopted in this study qualitative data were collected via video-recorded lessons and interviews with teachers. Four lessons from two mathematics teachers were observed and video-recorded from one Tatar school in Tatarstan Republic, Russia.

In addition the collected data were analyzed quantitatively. We calculated the percentage of time each language was used on each recorded mathematics lesson.

#### **5 RESULTS**

Table 1 shows the percentage of time each of the two languages, Tatar and Russian, were used in the classroom interaction.

As a result we found the difference in the ratio of using Russian language in grade 10 compared with grade 11. Russian was used in more than 86% of interaction in the Grade 11 but less than 53% in the Grade 10.

Table 1. The percentage of each languages used in the classroom interaction.

<i>Classroom language</i>	<i>Grade</i>	
	<b>10</b>	<b>11</b>
<b>Tatar (%)</b>	47,2	13,5
<b>Russian (%)</b>	52,8	86,5

The difference in the use of two languages appears to be because learning mathematics using Russian language begins in Grade 10 classes in Tatar-language schools. Therefore, teachers have to move smoothly from Tatar to Russian while teaching mathematics bilingually. It seems that in this first year of introducing students to learning mathematics in Russian the Grade 10 class teachers seem to alternate the use of the two languages, Russian and Tatar, in the mathematical discourse with an even distribution whereas in the Grade 11 class, the distribution favored Russian – 90% - Tartar’s 10%.

Qualitative video-recording analysis showed that the time need to study the same mathematical content is substantially increases when teaching realized through two languages. The teacher should use native language when the language of instruction is not familiar to the students in order to ensure students’ adequate understanding the messages. Consequently, the teacher should be proficient in both languages.

Furthermore we use the interview as a method for qualitative research. The teachers Mrs. A and Mrs. B were asked on the question which language they had used in teaching. The results from the two interviews were similar: students understood mathematical terms in Tatar language but they might not be familiar with the same terms in Russian. Therefore the teachers have to spend a lot of time to make students be familiar with and be able to work with Russian mathematical terminology.

Also notable is the fact that Mrs. A used mainly Tatar language as a medium of instruction but she explained the terms and new math concepts in Russian. However, she used Russian language first, but if after speaking in Russian she didn’t get response from students, then she switched to the Tatar.

Interestingly, when Mrs. B explained difficult mathematical concepts, sometimes she opted to use Tatar. This is because she wanted the students to understand quickly.

Both teachers argue that, when they make stress on teaching mathematical language explicitly, the mathematical focus of the lesson is lost. Independently they came to the common conclusions that (a) there must not be a shift of focus from the mathematical knowledge on mathematical language in bilingual teaching; (b) alternative use of two languages is a valuable educational resource that fosters learner’s mathematical understanding; (c) code-switching may give additive effects if pupils have well developed academic language proficiency in mother tongue.

## **6 CONCLUSION**

In this study, we observed that teachers teach mathematics bilingually, by means of Russian and Tatar, in schools with Tatar language of instruction (TS) in Tatarstan. The main reason for choosing the bilingual mode of teaching that USE on mathematics is conducted monolingually in Russian language and teachers must train students to know mathematical terms and understand math problems formulated in the second language. But bilingual education of mathematics has some drawbacks: the lack of time for teaching in two languages, extra-time is needed to translate the mathematical concepts.

As a result, the code-switching occurs in teachers’ practice when teachers have to explain students the instruction and the content of mathematics lessons as effectively as possible. They argue that mathematics understanding is more valuable than correct translation and interpretation of Russian words and phrases.

In this study, we observed that students can enhance their proficiency in second language when teacher uses code-switching. Consequently, code-switching is viewed as an important and valuable information and communication tool in bilingual education. This being the case, we consider that teaching mathematics bilingually might have no negative effects on students' linguistic, cognitive and educational development. Conversely, the effect of bilingual education can be positive, if the following conditions are fulfilled: (1) if students and teachers are proficient in two languages, (2) if they have strong motivation to learn in the second language. These findings confirm Cummins' threshold hypothesis and seem to be consistent with Vygotsky.

The phenomenon under consideration illustrates how a macro-level change –the need for mathematics exams to be held in Russian – has caused micro-level changes –teaching mathematics bilingually in Tatar-immersion schools. Requiring Tatar students to complete important end of secondary school examination in Russian is having an impact on how mathematics content is taught. Russia could learn from this international experience of Malaysia and New Zealand and conduct bilingual exams, which could be piloted in some of its regions.

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