Mathematics Education Issues in post-Soviet Kazakhstan: An International Perspective

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Abstract

This paper provides an international perspective on contemporary issues in mathematics education in post-Soviet Kazakhstan through the lens of American experience and NCTM Principles and Standards. In particular, it addresses dramatic changes related to the curriculum, equity, and assessment issues that have occurred during the transition from Russian to Kazakh as language of instruction and the transition from a socialist to a free market economy. These global social, political, and cultural changes have affected the entire math curriculum and even affected terminology. They have also likely affected access to high quality mathematics education among underprivileged and minority groups.

General Background

Located in Central Asia, Kazakhstan is one of the fifteen former Soviet republics which became newly independent states after the collapse of the USSR in 1991. Although the Republic of Kazakhstan (its full name) has the second largest territory among the former Soviet republics and the ninth largest territory in the world, its population is only about fifteen million making it somewhat similar to Canada in terms of population density. At the same time, Kazakhstan was not well-known internationally until recently when large oil and gas resources were investigated in this country and the "Borat" "scandalous" movie has been released. Within the mathematics education community, Kazakhstan became known after its team got the fourth highest score (after China, Russia, U.S., Bulgaria, and South Korea) and ranked at the 93rd percentile among 83 participating countries at the 2001 International Mathematical Olympiad in Washington, DC.

Demographic Background

Although Kazakhstan's education system might share some common features with other societies in transition (Earnest & Treagust, 2006) or with post-colonialism in education (Dei & Kempf, 2006), it also has some specific features making Kazakhstan's case significantly different from other post-Soviet countries and, perhaps, unique in the world of mathematics education. In particular, Kazakhstan has one of the most complicated ethnic structures among the former Soviet republics. According to Fierman (2005, 2006), by the end of Soviet era, Kazakhs constituted only slightly over 40% of the republic's highly diverse (about 100 different nationalities) population, with 64% of ethnic Kazakhs fluent in Russian and, probably, about 40% of Kazakhs with weak or no knowledge of the Kazakh language. Even more, up to 78% of urban Kazakhs were fluent in Russian and only less than 1% of them were fluent in Kazakh, while the number of schools with Kazakh as the only language of instruction represented just 11.3% of all urban school in 1988-1989. Only 596 out of 2055 books and brochures were published in Kazakh language in 1990, and only 15% of all textbooks for higher education technical institutions were published in Kazakh in 2003.

Impact on Mathematics Curriculum

After the collapse of the USSR in 1991, when the Kazakh language was introduced as the state language of independent Kazakhstan, the share of Kazakh medium classes enrollment increased from 16.9% to 46.4% in urban areas and from 32.4% to 56% overall between 1990 and 2004 (Fierman, 2006). Accordingly, the change of the language of instruction required development of new curriculum and publication of new textbooks in Kazakh, as well as development of new math terminology.

At present, there are at least two major categories of math textbooks in the Kazakh language: direct translations of Soviet and Russian textbooks (Atanasyan et al., 2002a; Atanasyan et al., 2002b; Kolmogorov et al., 2001; Makarychev et al., 1997, 2004, 2005; Pogorelov, 2004), and new original textbooks written by Kazakhstan authors (Abilkasymova et al., 2005; Aldamuratova, 2001; Aldamuratova & Baisholanov, 2005; Baimukhanov et al., 2003, 2004; Bekbaulieva et al., 1991; Bukubaeva et al., 2003; Kabasuly, 2005; Kaidasov et al., 2006; Kurmanalin, 2004; Ospanov et al., 2001, 2002, 2003, 2004a, 2004b; Shakilikova et al., 2005, Shynybekov, 2003a, 2003b, 2004a, 2004b, 2004c, 2004d, 2005, 2006; Yusupov & Zauirbekov, 2004). Analysis and comparison of these texts reveals certain cultural changes in delivery of the content and some variation in terminology representing a mixture of Russian, Kazakh, and "international" words and expressions. Table 1 demonstrates some examples of such variation (or duality, inconsistency) in math terminology in the Kazakh language which can be found in different Russian-Kazakh and Kazakh-Russian math dictionaries (Abdymanapov, 1991; Bektaev, 1986, 1989; Kusaiynov, 1999).

As one can see from this table, some popular international math terms used in numerous languages around the world (such as **form**, **center**, **model**, **system**) has been replaced by new "authentic" Kazakh terms that are used now along with the "old" international terms borrowed mainly from Russian. At the same time, the table also shows some instances of inconsistency of such translations. For example, if the term **form** (previously translated as *forma*) now is translated as *tulga*, then the closely related term **formula** is still translated as *formula* (see also the entries 18 and 19: **induce** - *indutsiialau*, but: **induced** - *ykpaldangan*). The international math term **compact** can be now translated by two different related Kazakh words: *zhinaky* and *yksham*.

On the other hand, structurally and pedagogically, the new Kazakh math textbooks generally reflect the most traditional features of old Soviet math textbooks. Some of these features are:

- light weight and small size format, "ascetic" black-and-white print and diagrams
- very focused and concentrated content
- rather formal presentation of the material
- emphasis on formal math skills and techniques
- large number of exercises and practice problems
- elements of challenging problem solving

Table 1. Examples of Variation in Kazakh Mathematics Terminology

	English Term	Kazakh Translation 1 (Loan-Word from Russian)	Kazakh Translation 2 (not based on Russian)
1	scheme	*skhema*	*sulba*
2	form	*forma*	*tulga*
3	formula	*formula*	*formula*
4	figure	*figura*	*pishin*
5	cube	*kub*	*tekshe*
6	oval	*oval*	*sopak*
7	center	*tsentr*	*Ortalyk*
8	norm	*norma*	*Kalyp*
9	analysis	*analiz*	*Taldau*
10	model	*model'*	*ulgi*
11	system	*sistema*	*zhuiye*
12	interval	*interval*	*aralyk*

13	compact	*kompakt*	*zhinaky, yksham*
14	group	*gruppa*	*top*
15	monotone	*monotondyk*	*birsaryndy*
16	localization	*lokalizatsiia*	*tonirikteu, zhergiliktendiru*
17	optimization	*optimizatsiia*	*tiimdileu*
18	induce	*indutsiialau*	
19	induced		*ykpaldangan*

Probably, the most extreme cases of these features are provided by the six cited geometry textbooks for grades 7 through 10 currently used in Kazakhstan (Bukubaeva et al., 2003; Kaidasov et al., 2006; Shakilikova et al., 2005; Shynybekov, 2003b, 2004c, 2004d, Yusupov, 2004). The size of all of these textbooks is about 5 inches by 8 inches and the thickness is ¼ inch or less containing from 87 to 128 pages (and as little as 40 pages in the case of 3D geometry text for grade 10 by Kaidasov et al., 2006). However, the number of themes in the five plane geometry texts is big enough and ranges from 29 to 45 (16 themes in the 3D geometry text) covering most of the elements of the Euclidean plane geometry and trigonometry with definitions, complete proofs, and numerous problems and exercises. Besides that, the grade 8 texts contain elements of analytical geometry (including ellipse, parabola, and hyperbola in the text by Shynybekov, 2004c). At the same time, the grade 9 textbook already contains elements of 3D geometry including prisms, pyramids, cylinders, cones, and spheres. The level of mathematical rigor of the texts can be illustrated, for example, by the proof by contradiction of the Thales' theorem's general case for grade 8 (i.e., when the corresponding pairs of segments cut by two parallel lines from the two sides of an angle are not necessarily commensurate, Shynybekov, 2004c).

Impact on Equity and Assessment

Given all the above-mentioned demographic and linguistic factors and percentages along with the fact that Russian was the major language of math instruction before 1991, it is not surprising that the introduction of Kazakh as the language of instruction and the severe post-Soviet economical and ideological crisis structurally changed underprivileged and minority groups based on language, socioeconomic status, and region of residency (e.g., Kazakh speaking versus Russian speaking, rural versus urban, South versus North). Moreover, the above-mentioned curricular features of the new Kazakh math textbooks, probably, might not meet the needs of some underprivileged and minority groups and might deepen the inequality and differentiation between low-income/ high-income, rural/urban, and Kazakh/non-Kazakh speaking students.

In addition to the curriculum and terminology changes, the transition from Russian to Kazakh has required new forms of assessment and preparation of a new generation of math teachers who would be able to teach math in Kazakh in the new post-Soviet social and political realities. However, teacher preparation became extremely difficult due to the long-lasting structural economic crisis and poor funding of education. Meanwhile, recently introduced controversial state assessment of all students based on a unified high-stake multiple-choice testing may disadvantage various underprivileged groups, thus exacerbating existing inequality and social stratification. This highlights and emphasizes all the uncertainties of mathematics education in post-Soviet Kazakhstan in transition and determines the importance of the following big unanswered questions:

- Given all the dramatic political, economical, social, demographic, and language changes after the collapse of USSR, who in reality are now underprivileged groups with respect to mathematics education in post-Soviet Kazakhstan?
- Furthermore, what kind of math terminology should be developed and/or accepted in newly independent Kazakhstan?
- Given all the above-mentioned realities and historically deep Soviet traditions, what type of national math curriculum does Kazakhstan need in terms of traditional versus reform based math instruction?
- And, finally, what should be the major goals of mathematic education in oil and mineral resources rich Kazakhstan in the 21st century?

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