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HOW CAN WE KNOW THE DANCER FROM THE DANCE? Reflections on Cross-Cultural Exchanges in Mathematics Education

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"How can we know the dancer from the dance?" W. B. Yeats posed this haunting question in his poem, "Among School Children." We could ask a similar, if less poetic, question about mathematics education.

Mathematics, like dance, involves movement, flow, structure. Both realms of human creativity exhibit mesmerizing patterns, unexpected connections, and, at times, heart-stopping leaps of imagination. To learn to dance or to do mathematics it is not sufficient to execute individual positions in isolation, however exquisitely. The challenge is to make connections.

School mathematics curricula, like mental choreography, map movement from concept to concept – or fail to do so. In different classrooms teachers in the same country teach diverse connections. Across cultures, these differences are magnified by dramatic differences in the roles that teachers and students play. What can we learn from these contrasts about improving our own performance in the US? This is the question that connects my organization to Bulgaria and that brings me here today.

It is not an idle question. Mathematics education is an urgent priority in the US. Solid international research shows that "the longer our children study the crucial disciplines of mathematics and science, the less favorably they compare with their peers in other countries." Evidence of the US math crisis abounds. Suffice it to note that a recent national commission said that this crisis affects the future of our economy, our democracy, our national security, and our understanding of reality.

Through its projects, Best Practices in Education seeks to introduce different content and patterns of mathematics instruction in US classrooms – and thereby to demonstrate the limits and limitations of our own culturally-bound expectations for our students, and to find ways to go beyond them. Why does one have to go abroad? Because this is the most powerful way to get outside unchallenged cultural assumptions that shape schooling. BPE is just starting on this path. But we have already discovered wonderful partners, participants, and prospects both in the US and in other countries – and Bulgaria plays a special role in this regard.

Let me briefly outline two of our projects based on "changing the dance" to test the boundaries of US school children's mathematical capabilities, and more important, to

challenge the limits that teachers unconsciously impose on children even when they seek to improve their mathematics education.

Measure up – Elementary Mathematics Curriculum Based on the Elkonin-Davydov Model from Russia

How should children begin their study of mathematics? Almost universally, the starting point is natural numbers and counting. In the US, all of our research about early mathematics education and child learning is based on a more or less fixed content and progression of topics. But what makes us so sure we are teaching the right "dance"? A remarkable elementary mathematics curriculum from Russia, in use in hundreds of schools, may force us to rethink this question.

The Elkonin-Davydov (E-D) curriculum introduces children to a broad concept of number defined as the ratio of a unit of measurement to the quantity measured – months before the introduction of natural numbers and counting. First-grade children begin mathematics with direct comparisons of continuous quantities (especially, length, width, area, mass, and volume) and the use of symbols to describe the relation of compared quantities as equal, unequal, greater than, and less than. Addition and subtraction are also presented as measurement actions with continuous quantities (like water or grain), initially described symbolically, without the use of numbers. Natural numbers are presented as a specific instance of "number." Subsequent topics in the curriculum – the positional number system, multiplication and division, common fractions – are introduced as changes in measurement units. Thus children learn to go beyond their intuitive but limited concept of number as positive integers to discover how various types of real numbers and their operations are interconnected. These connections, once discovered, give children a strong foundation for advanced studies.

BPE has helped to launch pilot-trials of the E-D curriculum in the first grade classrooms of two charter schools in Hawaii, under the direction of the Curriculum Research and Development Group of the Univerisity of Hawaii. After the first few months, teachers report that six-year-old children are deeply engaged with the materials and concepts and can "talk mathematics" at a higher level than they have ever seen. Their use of algebraic symbols and the understanding of equality and inequality go beyond achievement levels of many middle school students, a finding supported by interview data from first graders and eighth-grade students.

At BPE's invitation, prominent US and Russian educators met in January 2002 to discuss the E-D curriculum and pilot trial results. As the adaptation work proceeds, BPE will continue to play various roles to support the introduction of this curriculum into US schools. The challenges ahead are significant, but even at this early point it is clear that the E-D curriculum permits children to explore and develop mathematical thinking in ways we have never before suspected them capable of doing.

Problem-solving in high school algebra – An East European-US Project

This project is still in an early stage, but it holds real promise. It involves pooling knowledge and experience from several teaching traditions to create a new body of instructional materials. The project's origins lie in two conferences held in 1999 and 2000 in Bankia and Varna respectively, organized in cooperation with leaders in the Bulgarian Institute of Mathematics and Informatics and the Union of Bulgarian Mathematicians.

At both meetings, American participants were inspired by the rich problems taught regularly in Bulgarian and Romanian classrooms, and they expressed strong interest in adapting these materials for use in US classrooms, a goal pursued at a third conference, in 2001, in Sinaia, Romania.

Participants at the 2001 meeting produced drafts of some wonderful material – and suggested an exciting strategy for moving the materials into professional development and classroom settings in the US. The strategy is actually simple, but may sound complex at first. It involves the identification of "end point problems" – problems that no US teachers would presently imagine possible to use in beginning classes, but that can be taught successfully if introduced through innovative combinations of mathematics and teaching techniques. In effect, what we did in Sinaia was to identify some of these "unreachable" problems (in the US context) and put our heads together to figure out how to make them accessible to teachers and students alike. The process involved building new points of simple but meaningful entry to complex problems, connecting problem steps in innovative ways, and discovering powerful combinations of mathematics and pedagogy. Not every experiment worked, but our ten days had enough "oh wow" experiences to bode well for project completion and impact.

One of the next steps – after the problem sets are completed and edited – may involve a contest for teams of US teachers to devise "bridges" to "end point problems" by availing themselves of pre-arranged contacts with local mathematicians and others who can offer useful suggestions and insight. Two US teachers are ready to take the lead in this and we believe that we can identify corporate sponsors. If this strategy proves successful, the project could have an impact on both professional development and classroom teaching.

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КАК ДА РАЗПОЗНАЕМ ТАНЦЬОРА ОТ ТАНЦА? (размисли върху междукултурния обмен в математическото образование)

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