Comparative Study on Mathematics Teachers’ Beliefs and Practices

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Background

Two main areas of math teachers’ studies

- Subject and pedagogical knowledge
- Beliefs

- The subject knowledge is only a cognitive part of teacher’s practice
- The beliefs is significantly influent on the characteristics aspects of teaching (Thomson, 1992 Schoenfeld, 1998)

“Beliefs is the bridge between teacher’s knowledge and practice” (Schmidt at ell, 2007)
Focus of presentation

- Studying the beliefs of mathematics teachers in Russian secondary schools and comparing them to the beliefs of teachers from Estonia and Latvia

- Particularly, comparing Russian teachers’ beliefs to beliefs of those Latvian and Estonian teachers who speak Russian
**Why Latvia, Estonia and Russia?**

- Common history and much common nowadays
- Great number of teachers were educated at the time of Soviet Union
- Changes in education systems

<table>
<thead>
<tr>
<th>Latvia</th>
<th>Estonia</th>
<th>Russia</th>
</tr>
</thead>
<tbody>
<tr>
<td>New standards in basic and secondary education</td>
<td>Teaching is too much based on drill and practice-methods</td>
<td>New standards of education</td>
</tr>
<tr>
<td>-principles of holism and constructivism</td>
<td>-students’ achievement is good but</td>
<td>-the priority of distributing activity-related teaching</td>
</tr>
<tr>
<td>-knowledge and skills needed for students personal life</td>
<td>-students’ self-confidence in learning mathematics and valuing of mathematics is low</td>
<td>methods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Traditions of high quality mathematics education are still</td>
</tr>
<tr>
<td></td>
<td></td>
<td>strong (TIMSS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-students are not able to apply knowledge in practice (PISA)</td>
</tr>
</tbody>
</table>
Beliefs are... conceptions, views and personal ideologies that shape teaching practice.

Constructivism
- constructivist beliefs about learning and instruction
- Pursuit of student questioning is highly valued
- Teachers generally behave in an interactive manner, mediating the environment for students
- Teachers seek the student’s point of view in order to understand student’s present conceptions for use in subsequent lessons
- Students primarily work in groups

Traditionalism
- direct transmission beliefs about learning and instruction
- Strict adherence to fixed curriculum is highly valued
- Teachers generally behave in a didactic manner, disseminating information to students
- Teacher seeks the correct answer to validate student learning
- Students primarily work alone

Cited from Brooks and Brooks, 1993, p.17
International comparative studies focused on beliefs

Teaching and Learning International Survey
- First cross-cultural teachers’ study
- Focus: working conditions, school climate, feedback, beliefs and practice
- Sample – all in-service teachers

Teacher Education Study in Mathematics
- Object – mathematics teachers
- Focus: professional knowledge, beliefs
- Sample: pre-service math teachers

Nordic-Baltic comparative research in mathematics
- Object – mathematical teachers
- Focus: school climate, beliefs, practices
- Sample: in-service math teachers
NorBa description

• 2010 – the instrument had been created by M. Lepik, M. Hannula, A. Pipere
  o English language → languages of countries participated

• The questionnaire is divided into 7 parts:
  o A. Sociodemographical information;
  o B. Teachers’ general satisfaction with their work as a teacher;
  o C. Teachers’ beliefs about two teaching approaches;
  o D. Teachers’ beliefs on effective teaching;
  o E. Teachers’ beliefs on effective teaching and learning of mathematics;
  o F. Teachers’ own use of text-books;
  o G. Teachers’ own classroom practice.
Sample and procedure

Latvia
- 374 teachers
- 95 – Russian-speaking
- Average age – 46
- Data collection – 2010/2011
- Paper and pencil form

Russia
- 1223 teachers
- Average age – 46
- Data collection – spring 2013
- On-line form

Estonia
- 326 teachers
- 92 – Russian-speaking
- Average age – 47
- Data collection – 2010/2011
- Paper and pencil form
Scales construction

Model of measurement
✓ Partial Credit Model (Wright B.D. & Masters G.N., 1982)
✓ Winsteps software (Linacre J. M., 2011)

Fit analysis
✓ INFIT and OUTFIT mnsq statistics

Dimensionality
✓ Principal component analysis of the standardized residuals based on Rasch analysis (Linacre, J.M., 1998; Smith, E. V., 2002)
Results: Part D.
Teachers’ beliefs on effective teaching

• 15 questions – 2 scales;
• **Traditional** (4 items) - reliability is 0.6;
  
  “Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly”

• **Constructivist** (11 items) – reliability 0.83;
  
  “Students learn best by finding solutions to problems on their own”

![Graphs showing logit values for Constructivism and Traditionalism across Latvia, Estonia, and Russia with significant differences (p<0.01).]
Classification of beliefs

- The results of Cluster analysis

<table>
<thead>
<tr>
<th>Constructivism</th>
<th>Traditionalism</th>
<th>Cluster</th>
<th>Estonia</th>
<th>Russia</th>
<th>Latvia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Oppositionist</td>
<td>1</td>
<td>74</td>
<td>46,6</td>
<td>63,7</td>
</tr>
<tr>
<td></td>
<td>Radical traditionalist</td>
<td>2</td>
<td>13</td>
<td>29,9</td>
<td>14,2</td>
</tr>
<tr>
<td>Middle</td>
<td>Compromise</td>
<td>3</td>
<td>11,2</td>
<td>12,6</td>
<td>14,2</td>
</tr>
<tr>
<td></td>
<td>Traditionalist</td>
<td>4</td>
<td>1,2</td>
<td>10,6</td>
<td>7,3</td>
</tr>
<tr>
<td>High</td>
<td>Radical constructivist</td>
<td>5</td>
<td>0</td>
<td>0,2</td>
<td>0,5</td>
</tr>
<tr>
<td></td>
<td>Constructivist</td>
<td>6</td>
<td>0,3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Reconsiliation of polarities</td>
<td>7</td>
<td>0,3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Teachers’ beliefs on effective teaching: conclusions

• Traditional teaching and constructivist teaching methods are not seen by the teachers as two opposites. Rather, these two approaches are seen as complementary alternatives.

• The largest profile of modest compromise between constructivist and traditional beliefs on good teaching envisages the complementary approach of most teachers towards teaching mathematics.

• Teachers are looking for a balance between educational requirements for innovative, discovery-oriented approaches and objectivistic epistemology of mathematics as absolute, stable knowledge obtained by routine training, following examples and oriented to subject.
Results: Part E. Teachers’ beliefs on effective teaching and learning of mathematics

**Toolbox**
- 5 questions
- reliability 0.65
- “Above all mathematical knowledge, such as facts and results, should be taught”

**Process**
- 10 questions
- reliability 0.8
- “Pupils should develop as many different ways as possible of finding solutions, and in teaching they should be discussed”

**System**
- 6 questions
- reliability 0.72
- “In teaching, one should proceed systematically above all”

Significant differences (p<0.01)

![Bar chart showing logits for Latvia, Estonia, and Russia across process, tools, and system categories.](chart.png)
## Results: interaction

<table>
<thead>
<tr>
<th>Country</th>
<th>Const.</th>
<th>Trad.</th>
<th>Process</th>
<th>Tools</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estonia</strong></td>
<td>Construcyivism</td>
<td>1</td>
<td>0.05</td>
<td>0.54**</td>
<td>0.15**</td>
</tr>
<tr>
<td></td>
<td>Tradionalism</td>
<td>0.05</td>
<td>1</td>
<td>0.08</td>
<td>0.49**</td>
</tr>
<tr>
<td><strong>Russia</strong></td>
<td>Construcyivism</td>
<td>1</td>
<td>-0.05</td>
<td>0.57**</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>Tradionalism</td>
<td>-0.05</td>
<td>1</td>
<td>0.05</td>
<td>0.48**</td>
</tr>
<tr>
<td><strong>Latvia</strong></td>
<td>Construcyivism</td>
<td>1</td>
<td>-0.18**</td>
<td>0.64**</td>
<td>-0.20**</td>
</tr>
<tr>
<td></td>
<td>Tradionalism</td>
<td>-0.18**</td>
<td>1</td>
<td>-0.16**</td>
<td>0.55**</td>
</tr>
</tbody>
</table>

**Expected results**

Strong correlation between:

- the constructivist view of teaching and process view of mathematics teaching;
- traditional view of teaching and toolbox view of mathematics teaching.

**Interesting result:**

The system scale (emphasis on proof) correlates both with constructivism and traditionalism.

Mathematics teachers in all countries consider proofs and precise and rigorous language to be the very important part of math teaching and learning (irrespective of their beliefs).
Results: part G. Classroom practices

<table>
<thead>
<tr>
<th>Block</th>
<th>T</th>
<th>1. Memorize formulas and procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2. Apply facts, concepts and procedures to solve routine problems</td>
</tr>
<tr>
<td>Block</td>
<td>C</td>
<td>3. Work on problems for which there is no obvious method of solution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Decide on their own procedures for solving complex problems</td>
</tr>
<tr>
<td>Block</td>
<td>C</td>
<td>4. Relate what they are learning in mathematics to their daily lives</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Work in an investigative manner: to try to find patterns, formulate statements and prove them</td>
</tr>
</tbody>
</table>

Teachers’ beliefs are realized in their classroom practice

<table>
<thead>
<tr>
<th>Constructivism</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Latvia</td>
<td>-0.08</td>
<td>0.12*</td>
<td>0.19**</td>
</tr>
<tr>
<td>Estonia</td>
<td>0.01</td>
<td>0.19**</td>
<td>0.3**</td>
</tr>
<tr>
<td>Russia</td>
<td>-0.04</td>
<td>0.11**</td>
<td>0.2**</td>
</tr>
</tbody>
</table>

** - p < 0.01
* - p < 0.05
Comparison of Russian-speaking teachers’ beliefs

Part D

### Differences between Russian-speaking teachers:

<table>
<thead>
<tr>
<th></th>
<th>Rus &amp; Lat_Rus</th>
<th>Rus &amp; Est_Rus</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructivism</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Traditionalism</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Process</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Tools</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>System</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Conclusions

✓ Differences between countries are statistically significant for all scales.
  ✓ Russian teachers are high in their constructivism (40% of Russian teachers are oriented towards constructivism), while among Latvian and Estonian teachers there are only 21% and 14% of constructivism oriented teachers.

✓ Most of teachers in all countries belong to group that represents the profile Modest compromise:
  ✓ 74% of Estonian, 63.7% of Latvian and 47% of Russian teachers. These teachers compromise both approaches.

✓ Math teachers’ general teaching beliefs are related with their view of mathematics teaching.

✓ Russian teachers are strongly oriented towards systematic approach to math teaching.

✓ Teachers’ beliefs are realized in their classroom practice.

✓ Russian teachers and Estonian Russian-speaking teachers differ only in their constructivist beliefs.

✓ Differences between Russian teachers and Latvian Russian-speaking teachers are significant for all scales except traditional scale.
Thank you for your attention

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