Analytical competences and positioning - experiences and results from Latvia

Pauls Jurjans, Margarita Pukite, Ludmila Babajeva, Manuel Fernandez, Dr. Rudite Andersone, Dr. Irina Maslo, Dr. Andra Fernate, Dr. Lena Lindenskov*

University of Latvia, Latvia,

*Danish School of Education, Aarhus University, Denmark
The goal of the study

To make an investigation into the relationship between pupils’ performances in mathematics and their beliefs and positioning as doers of mathematics in lower-secondary classrooms in Latvia as a starting point for the future joint comparative study.
The research questions

1. What is the relationship between pupils’ performances in mathematics and their beliefs in Latvia (grade 9) like?

2. What is the relationship between pupils’ performances in mathematics and their positioning as doers of mathematics in Latvia (grade 9) like?

3. What is the relationship between pupils’ beliefs and their positioning as doers of mathematics in Latvia (grade 9) like?
• ‘Analytical competence’ refers to being a doer of mathematics (Cobb, Gressalfi & Hodge 2009);
• Beliefs as a phenomenon or as a situated process and action (Schoenfeld 1985 and 1992; Goldin 2002; Goldin et al. 2009; Leder et al. 2002; Kislenko et al. 2007; Maass and Schläglmann 2009; Perrenet & Taconis 2009);
• Concept of positioning (Davies & Harré 1990) as a basic component in the understanding, describing and planning of classroom activities and interactions (Wagner & Herbel-Eisenmann 2009).
Research methodology
Informants

• Voluntary participants of urban schools – 343 pupils from lower-secondary (grade 9) 16 classrooms of different types of schools.

• 231 girls and 112 boys.
Project design on the national level:

- Performance of internal assessment
- Semi-structured interview:
  1) What is mathematics?
  2) What is mathematical thinking?
  3) How to solve a mathematical problem?
- Six pupils (two from each level group) were interviewed by the researchers;
- Interviews were transcribed;
- Analysis of written responses and interviews;
- Performance of external assessment.
- Beliefs and positioning of collected data were related with pupils’ performances.
Research stages

- A semi-structured interview for qualitative and the performance assessment of mathematics for quantitative data collection – **spring, 2010**;

- Primary and secondary qualitative and quantitative data processing - **summer, 2010**;

- Data analysis and interpretation - **autumn, 2010**
Primary and secondary qualitative data processing

Qualitative data processing
- coding of notes,
- metacoding,
- finding of linkages, implicants and
- interpretation was done implementing AQUAD 6 software.

The statements were coded according to the structural components of analytical competence:
• **Primary data analysis** was done implementing **descriptive statistics** (analysis of frequencies, central tendency, variability, crosstabs).

• **Secondary data processing** was done taking into account the exact sample, **non-parametric statistical methods** were used (Spearman’s rank correlation coefficient, Kolmogorov-Smirnov Z test), etc.
1. What is the relationship between pupils’ performances in mathematics and their beliefs in Latvia (grade 9) like?
Internal assessment

[Bar chart showing count by gender (girls, boys) across high, middle, low levels]
External assessment

![Bar chart showing marks distribution by gender]

- **Marks**
  - 10: 7 (girls), 3 (boys)
  - 9: 13 (girls), 17 (boys)
  - 8: 15 (girls), 17 (boys)
  - 7: 24 (girls), 9 (boys)
  - 6: 26 (girls), 30 (boys)
  - 5: 34 (girls), 33 (boys)
  - 4: 28 (girls), 23 (boys)
  - 3: 4 (girls), 5 (boys)
  - 2: 6 (girls), 3 (boys)
  - 1: 3 (girls), 1 (boys)

- **Count**
  - X-axis represents the count of marks.

- **Gender**
  - Blue bars represent girls.
  - Green bars represent boys.

Frequencies of beliefs

<table>
<thead>
<tr>
<th></th>
<th>A: operating with formal systems</th>
<th>B: mathematical models</th>
<th>D: school discipline</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>414</td>
<td>330</td>
<td>287</td>
</tr>
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</table>
### Spearman rank correlation among internal (level), external assessment (marks), gender and beliefs conceptual codes

<table>
<thead>
<tr>
<th>Codes</th>
<th>Level</th>
<th>Marks</th>
<th>Gender</th>
<th>Bel_A_op_form_syst</th>
<th>Bel_B_create_models</th>
<th>Bel_D_math_school</th>
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</table>

* p<0.05; ** p<0.01 Asymp. Sig. (2-tailed)
2. What is the relationship between pupils’ performances in mathematics and their positioning as doers of mathematics in Latvia (grade 9) like?
Performances (external assessment) and positions

Frequencies

- High level: 109
  - F: everyday users: 26
  - E: everyday thinkers: 30
  - C: social imagination: 43

- Middle level: 220
  - F: everyday users: 61
  - E: everyday thinkers: 30
  - C: social imagination: 107

- Low level: 107
  - F: everyday users: 42
  - E: everyday thinkers: 30
  - C: social imagination: 35
Highly performing pupils consider mathematics as a game:

“Mathematics for me is as a game of figures, if you know how to play this game, then you can apply, use the figures and calculate as necessary and you can satisfy yourself that you can do it and you are maybe higher than others, because you can do the task but others can’t. Sometimes it is difficult.”
Middle performing pupils demonstrates what has been learnt in tasks, as well as the pupil thinks of its application in everyday life:

“Thinking, to compile everything as it is, to do everything right. Step by step as in the tasks, as one incorrect step can spoil everything, change the result. It is……

you get concentrated on the task, think about figures, think that you will solve it and how, and in what way, like a stitch, you continue and continue and continue pick up a stitch, then the next, see the relations in some task.”
A low performing pupil reveals that he/she finds that the teacher initiates solving of mathematical problems and the acquired abilities are applied in everyday life:

*It depends on the pupil, in fact, the teacher gives mathematical formulae and … we can sit at them as long as we solve the problem.*

“This is clear now that what we learn at school, it is the fundamentals, which remain in any case as the same problem solving approaches are used both in everyday life and at school … They do not change at once, if I have learnt it at school, for example, I sum in a column, then I don’t know at home in everyday life I do not do it in a different way, well maybe I use a calculator.”
**Spearman rank correlation among the internal (level), external assessment (marks) and position conceptual codes**

<table>
<thead>
<tr>
<th>Codes</th>
<th>Level</th>
<th>Marks</th>
<th>Pos_C_imag_thinker</th>
<th>Pos_E_everyday_thinker</th>
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*p<0.05; **p<0.01 Asymp. Sig. (2-tailed)*
3. What is the relationship between pupils’ beliefs and their positioning as doers of mathematics in Latvia (grade 9) like?
Relation between beliefs and positions

<table>
<thead>
<tr>
<th></th>
<th>C: social imagination</th>
<th>E: everyday thinker</th>
<th>F: everyday user</th>
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<tbody>
<tr>
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<td>41</td>
<td>50</td>
</tr>
<tr>
<td>B: mathematical models</td>
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<td>41</td>
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</tr>
<tr>
<td>D: school discipline</td>
<td>80</td>
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Spearman rank correlation among the beliefs and position conceptual codes

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p<0.05; ** p<0.01 Asymp. Sig. (2-tailed)
### Unexpected findings: internal and external assessment and interpersonal positioning

<table>
<thead>
<tr>
<th>Codes</th>
<th>Level</th>
<th>Marks</th>
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*p*<0.05; **p*<0.01 Asymp. Sig. (2-tailed)
1. The higher level performing pupils more believe that mathematics is about operating in formal systems and processes; they mention less that mathematics is a school discipline.
2. Internal and external assessment of performance allows concluding that *the lack of personal imaginative positioning* is characteristic of the lower level performing pupils. The pupils’ position as *everyday thinkers* in mathematics has significant relationship with low external assessment.
3. The more pupils position themselves as imaginative thinkers or doers having a personal way of understanding or dealing with mathematics, the less they have the belief that mathematics is a school discipline.
Conclusions

4. Boys had lower internal assessment and they less mentioned their beliefs, but girls more mentioned their beliefs that mathematics is about operating in formal systems and processes, and that mathematics is about creating, comparing and checking models.

5. Higher level performing pupils more express themselves in horizontal relationship, but pupils, who had lower external assessment more express themselves in vertical relationship.
Conclusions

Analytical competence refers to **being a doer of mathematics**, it is characteristic for this competence that the pupils believed that mathematics is about **operating in formal systems, but not a school discipline**, they positioned themselves as **imaginative thinkers or doers** having a personal way of understanding or dealing with mathematics, they **did not express** themselves abstractly when speaking about mathematics, but they had **practical expressions** about how to use mathematics in everyday contexts or in school-related work, they **express the use of collaborative work** with other pupils.
Thank you for attention!

Institute of Pedagogical Sciences

http://www.pzi.lu.lv/
Faculty of Education, Psychology and Art, University of Latvia
&
Danish School of Education, Aarhus University, Denmark