Usage of Mathematics Competency in a New Context in Science Experience from Latvia

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Introduction & Background

- In Latvia it's planned that the study content will be created with the aim to develop students' competencies (21st century key competencies);
- Competencies relate to deep learning that develops skills to generalize or transfer new knowledge and skills to unknown situations;
- Challenge for teachers - how to conduct a teaching process where students recognize *how we know it?* (acquire knowledge) and not just *what we know?* (accumulated subject matter content).

Research Questions

1)How well do 9th grade students succeed in applying skills acquired from mathematics lessons in the context of science subjects?

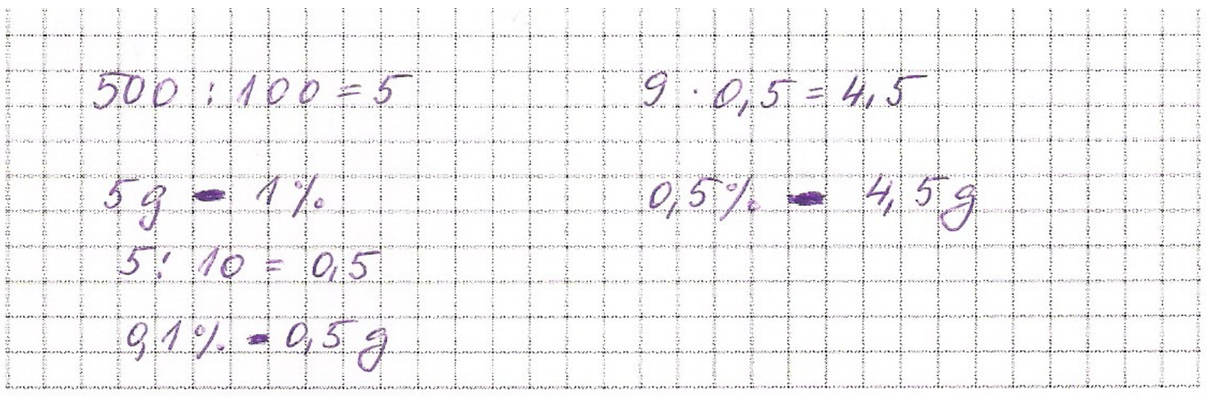
2) How are the applied skills taught in the study process in mathematics and science subjects in compulsory education?

Methodology overview

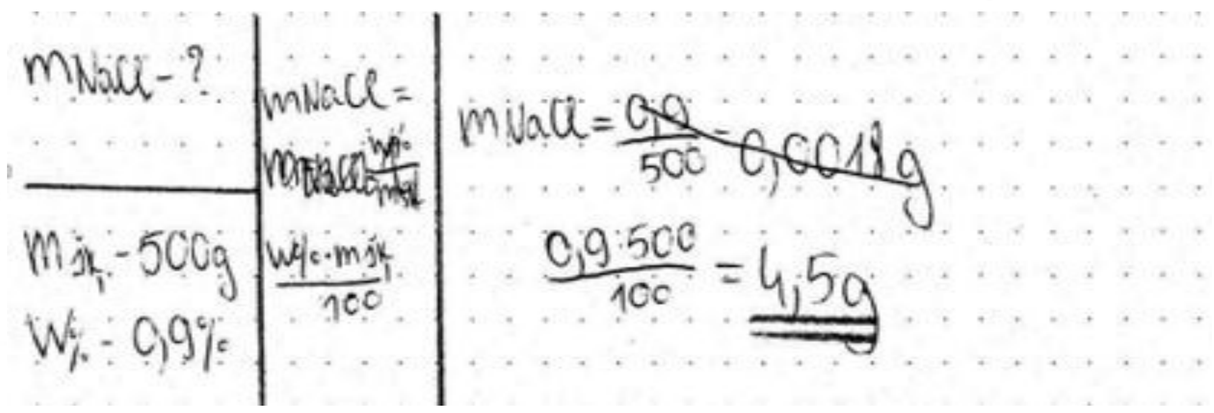
Data source	Analysis approach
National test results: diagnostic work of 14600 student assignments in grade 9 science subjects	ITEMAN software - assignments' difficulty level & IRT RASCH model - appropriateness of the difficulty level
..From witch 300 assignments from 8 schools	Qualitative in-depth analysis focusing on student's ability to transfer knowledge to a new context
Study materials & subject program examples in mathematics and chemistry	Materials offer to acquire specific questions & what tasks are included accordingly to selected criteria
9 classroom transcripts	Criteria & level description rubrics, on a scale 0-3

Task example: *Calculate the needed mass of crystal sodium chloride to make 500g saline solution – 0,9 % NaCl solution. Show your calculations!*

Student's solution approach in Math:



Student's solution approach in Chemistry:



Results on Chemistry Study Materials

- There are various mathematical techniques (%, expressing the size of a formula etc.)
- Shift from an analogical reasoning to using formulas. For calculating any value there is a given formula - increases the amount of factual knowledge learned by heart.
- Verbal reasoning is used to reveal tasks content meaning and the fact that a percent is a hundredth of.
- Mathematical calculations are mostly ready-given algorithms.

No opportunities to practice in a new context

Results on Math Study Materials

- Formally while teaching mathematics students learn concepts and skills that are needed in science subjects but...
- Predominance of formalized procedures, algorithms & recording of solutions
- Previously acquired skills and the use of them in a new situations is missing an underlying continuity
- The concept of percentage interpretation is almost never used which leads to the use of proportions

Context is mostly formal and mathematical

Performance level - groups of pupils according to IRT RASCH model

Group	Characteristics of student attainment
III group (15%)	Use knowledge and algorithms in new contexts; analyse complex information, create solutions
II group (50%)	Explain or use knowledge in familiar standardized contexts, choose appropriate approaches; structure, interpret simple data
I & 0 groups (35%)	Show elementary skills, remember, recognize simple facts, concepts or procedures
	Students are not able to show elementary skills, to remember or recognize simple facts concepts or procedures

Usage of Math skills

Grade/ Subject	Task	Student accomplishment
6 / Math	1% from quantity	43%
9 / Math	10% from volume	65%
9 / Science	Mass of the substance so that the solution is 0.9%	13%

Teaching in the Classroom (scale 0-3)

- Purposefulness and a possibility for students to construct new knowledge (1,6)
- Communication about the results (1,7)
- Realization of previously gained skills (1,5)

Main Conclusions

- Results are low where students need to apply mathematical skills in science context assignments;
- One of the reasons why this inability to apply an algorithm used in the learning process for many years could be that teaching both in mathematics and sciences is mistakenly formalized and does not emphasize the forming of a deep understanding;
- Study materials mostly don't explain context-based task solving, whereas if they are explained – there is a risk of developing misconceptions creating a wrong explanation of concepts;
- Promotion of collaboration between mathematics and science teachers in schools is needed in order to jointly analyse teaching strategies and helping students create links among subjects.

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