

HOW DOES COGNITIVE DEMAND IN OBSERVED LESSONS AND NATIONAL DIAGNOSTIC TESTING COMPARE TO PISA SCIENCE RESULTS IN LATVIA?

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Latvian students' achievement in science as measured by the PISA assessment remains in the middle of country rankings despite ten years of reforms in education. This study explored possible reasons why scores, especially the percent of top performers, have not increased among Latvian students. PISA's six proficiency levels in science were used to make comparisons. An analysis of the cognitive demand present in sampled science lessons showed that only lower and middle levels of cognitive demand were required of the students. In addition, an analysis of diagnostic national testing done at the same grade level as PISA investigated the cognitive demand required by the questions. These results also showed that higher proficiency levels (5 and 6) corresponding to higher levels of cognitive demand were not present in the national testing. This research raises many questions about ongoing instructional practices and how national testing can be changed to promote high levels of cognitive demand in the science classroom.

Keywords: cognitive demand, PISA science

INTRODUCTION

Since 2016 new education reforms in Latvia are directed towards promoting students' competencies and especially increasing critical and analytical thinking skills (NCE (National Centre for Education), 2016a). Major reforms in the country were begun in 2006 but Latvian students' performance in the science portion of PISA have remained consistent, not varying statistically from other middle-level performing countries in the last ten years (see table 1.) (OECD, 2016). The government of Latvia has made it a priority to increase scores on PISA assessment, especially its percent of top performers, as an indicator of the quality of education received by Latvian children. In order to ensure long-term economic growth, science education in Latvia must be improved. The study explored two factors that may influence the country's PISA scores.

Table 1. Latvian Student Performance PISA Science Assessment 2006 - 2015

	2006	2009	2012	2015
Latvia mean score	490	494	502	490
Top performers (% of students at level 5 & 6)	4.1	3.1	4.4	3,8
Low performers (% of students below level 2)	17.4	14.7	12.4	17,4

The focus of this research is to investigate the cognitive demand, required of Latvian school children in science classes and national diagnostic testing. The PISA assessment framework draft (OECD, 2013) defines three cognitive levels (low, medium, high) and seven performance levels that include a cognitive dimension.

The following research questions are addressed:

- 1) What cognitive demand level is present in the typical Latvian science lesson? How is the cognitive demand level of the lessons compared to the PISA proficiency levels?
- 2) What is the cognitive demand level of the national diagnostic tests? How do the cognitive demand levels compare to PISA proficiency levels?

METHOD

A total of 53 physics, chemistry, biology and general science lessons in 9 different schools were observed ranging from grades 5th to 12th. The instructional process was analysed by a team of trained experts from the University of Latvia using a lesson observation form developed by the researchers. Individual evaluations were made based on classroom observations and transcripts of complete lessons documenting the teacher's and students' activity during the lesson, tasks given and questions asked. A consensus was made on the overall level. Researchers used a 0-3 point cognitive demand rubric and the numerical data was processed using R 3.1.2 software.

National diagnostic testing in science is done in 6th and 9th grades (approximately ages 12 and 15 respectively) (NCE, 2016b). Testing is performed in order to measure skills and competencies students have developed in solving real-life science problems. Analysis is done using the Iteman and WinsSteps Rasch test analysis programs. Results are made public and used to make informed decisions about curriculum. The 9th grade diagnostic test was analysed for cognitive demand as it corresponds to the age students participate in PISA. The 6th grade diagnostic test was also analysed to give long-term trends in demand levels. Each question was assigned a cognitive level using the Structure of Observed Learning Outcomes (SOLO) taxonomy (Biggs & Collis, 1982) by each researcher independently. The evaluations were compared and a final level agreed upon. The assessment levels of the various instruments used to describe student performance are compared (see table 2).

Table 2. Levels of Cognitive Demand Scales

Level of cognitive demand	PISA proficiency level	PISA cognitive level	National testing	Lesson observation	SOLO taxonomy
High	5, 6	High	High	3	Extended abstract
Medium	4, 3	Medium	Medium	2	Relational
Low	2	Low	Low	1	Multi-structural
	1a			0	Uni-structural
Under low	1b				Pre-structural

RESULTS

1) The science lessons required overall cognitively low levels. Results showed that 81% of the material was at level 1 or 0. Only 5% of lessons observed were at the high cognitive level (level 3).

2) Results of the analysis of the national diagnostic tests (see table 3) show similar low levels of cognitive demand.

Table 3. The Levels of Cognitive Demand in Science Tests

Grade	Uni-structural	Multi-structural	Relational	Extended abstract
6.	52%	39%	9%	0
9.	32%	60%	8%	0

DISCUSSION AND CONCLUSIONS

Research was limited to a sampling of schools in the country. In addition, it is interesting to note that of all other countries in the same middle group as Latvia, only Spain showed similar tendencies in variation of percentages of top performers.

The research clearly indicates that in the sampled classrooms level of cognitive demand required of students is low. There is a tendency for teachers to choose activities that do not challenge students to develop the deeper, complex thinking necessary to succeed in problems requiring high levels of cognitive demand.

An analysis of the national diagnostic test at the 6th and 9th grade levels similarly showed lower levels of cognitive demand. Of note is that 60% of 9th grade items require medium cognitive demand, which amounts to an increase of 21% compared to 6th grade. However, high level cognitive demand questions need to be included on the national test.

As assessment influences teaching (Harlen, 2007, p. 25), the low levels of teaching may be attributed to the low levels of assessment on the national test. Previous research (Namsone & Cakane, 2015) showed that the lack of higher order cognitive activity in lessons was connected with the lack of teachers' pedagogical understanding of how to promote such discourse. As other research confirms, the design and implementation of teaching strategies that enhance higher-order thinking among students are not a simple endeavour; they challenge even the most expert teachers (Miri, David, & Uri, 2007). Teachers need to become familiar with and understand what high cognitive demand tasks require and develop teaching strategies to be effective.

It may be deduced given the consistent middle level results on PISA that Latvian teachers do a good job in preparing students in learning requiring middle level cognitive demand, such as those seen on national tests, but fall short in preparing students for tasks requiring high cognitive demand, such as those seen on the PISA assessment. The study indicates that further research is necessary to understand why high levels of cognitive demand are missing from science classes and subsequent testing.

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