

THREE MODELS OF EXPLANATIONS OF SWEDISH STUDENTS' DECLINING RESULTS ON LARGE-SCALE SCIENCE STUDIES

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When interpreting the performance of Swedish students in science from the perspective of large-scale studies, the national mean values of PISA and TIMSS tests over the last decade show a significant downward trend. Furthermore the TIMSS surveys (1995–2007) indicate that Sweden has experienced the most evident decline of all participating countries during this period. Additionally, the PISA tests in science show a similar, but not as drastic, development during the period from 2000 to 2009 (see Table 1) compared to the OECD mean value. The existing differences between the results of the two tests may be explained by the fact that they consist of different foci on the science area and assume different frameworks. The aim of the PISA studies is to assess the level of students' scientific literacy in relation to contemporary society, whereas the TIMSS tests are set out to evaluate students' knowledge from an international curriculum perspective (OECD 2003; 2007; Skolverket, 2008).

Year	2000	2003	2006	2009
Mean value: Sweden	512	506	503	495

Table 1: Mean value of students' performances on the PISA tests, 2000–2009.

According to the PISA result description (OECD, 2007), the Swedish results from 2000 and 2003 were significantly higher than the international mean value of all participating OECD countries, while the results from 2006 did

not diverge from the OECD mean at all. The results from 2009, however, show that the students' performances are significantly below the international mean value (OECD, 2010). Because it is not possible to find a statistical significant decline between two contiguous measurement occasions, the decline from 2000 to 2009 is obvious and unambiguous.

The question is how this descending trend may be understood or explained, as the data does not offer any simple causal explanation. Therefore, it is doubtful, from a research perspective, that any far-reaching conclusions can be drawn regarding the descending trend or tendency by considering only the national results from large-scale tests (e.g., Goldstein, 2004).

The relation between large-scale studies and science education research

Jakobsson, Säljö and Mäketalo (2009) argue that the results from surveys and tests of educational achievement play an increasingly important role in monitoring educational performance and in political discussions all over the world. The test results are used as indicators of institutional efficiency, as quality assurance measures, and as instruments through which politicians, school administrators, and teachers are held accountable (e.g., Brunner et al., 2007; OECD, 2003). At the same time, there is a discussion in the field of science education regarding the value of these kinds of tests, and several scholars have expressed critical opinions about the validity and reliability of the measurements. For example, Sjöberg (2007) and Bautier and Rayou (2007) argues that the tests do not constitute a valid representation of students' performances and knowledge at a national level and that it is hard to draw any conclusions from the results. Bottani and Vignaud (2005) also argue that large-scale studies focus primarily on one-dimensional rankings between countries that mainly serve politics rather than science. In this context, it is important to consider that the original purpose of the surveys was to create international databases with which researchers could conduct meta- or re-analyses of the results (Lundgren, 2011).

The political impact, the controversial nature of the results, and the country rankings have encouraged researchers to carry out alternative research studies or re-analyses based on available PISA data. Many of these studies have used the data for analysis of factors behind the differences in the results between countries. In this context, Fensham (2009) suggests secondary analyses of students' responses using a contextual set of items as the unit of analysis. He argues that the differences could be useful for identifying topics or science content to which science teaching is already contributing or for which there is a need for improved teaching. Mortimore (2009) stressed

the importance of including longitudinal elements and trend analyses, and of refocusing on how schools and school systems could promote enhanced achievement and increase the equity of their educational outcomes.

Conclusions from the “Large-scale Studies and Students’ Achievement in Science” project

Between 2009 and 2012, we conducted the “Large-scale Studies and Students’ Achievement in Science” research project, which was funded by the Swedish Research Council (Dnr 2008-4717). The aim of the project was to deepen the understanding of the outcomes of large-scale international studies by investigating trends and tendencies concerning the achievements of Swedish and Danish compulsory students on large-scale science tests. The main research method has been to conduct re-analyses of existing data and to relate the findings to other studies within the field of education. We also carried out a pilot study in which small groups of students were engaged in discussing and solving PISA items with different content and level of difficulties.

The preliminary results of the analyses point to the existence of different explanatory models of the described trends. For example, the descending trend in the performance of Swedish students in science could be explained from an;

- A. Increased school- and knowledge segregation perspective
- B. An epistemological and content-related perspective
- C. How science discourse and language are constituted in a classroom perspective

(Jakobsson, et al, 2012; Davidsson, Jakobsson & Karlsson, in progress; Serder & Jakobsson, in progress).

Explanations from the perspective of the reinforced segregation of Swedish schools

As mentioned above, the declining trend of Swedish students’ performances in science over the last decade can be found through re-analysis of the PISA data (e.g., OECD, 2003, 2007, 2010). A more extensive analysis (Davidsson, Karlsson, Jakobsson, in progress) shows that it is primarily the descending achievement of low- and mid-ranged performers that confirms a main part of the national trend. This becomes explicit as the *between-school variance* shows a continuous increase since the start of the measurements. Further-

more, there was a dramatic change between 2006 and 2009, which means that the discrepancy in results between schools in science has trebled over a 10-year period (from 7.6% in 2000 to 24.8% in 2009). Compared to the other Nordic countries, Sweden currently shows the highest value of between-school variance (OECD 2010). This change also becomes noticeable when studying students' performances from the perspective of different percentiles (see Figure 1).

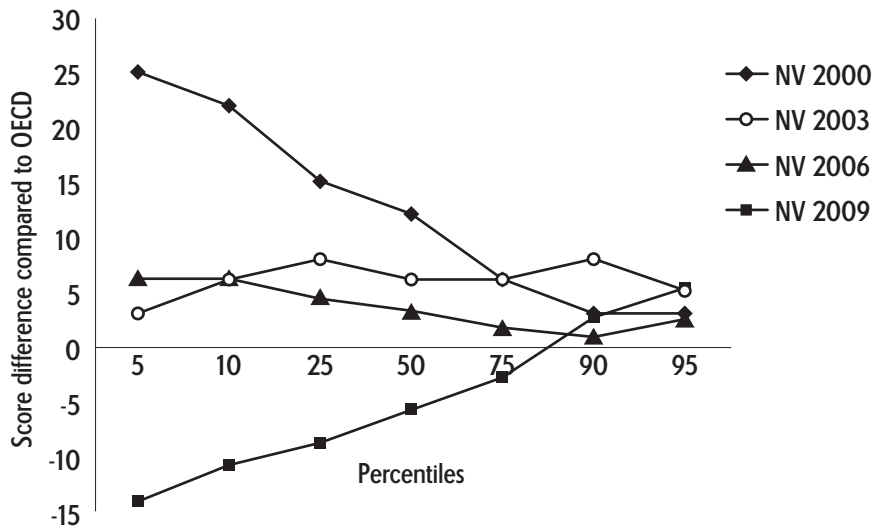


Fig 1. Percentile differences in science score between Sweden and OECD mean in PISA, 2000–2009.

The figure shows that the lowest 10% of achievers in Sweden acquired mean values in 2009 that were 30–40 points lower than in 2000, and that they currently acquire mean values 10–15 points lower than the OECD mean. However, the top 20 % of achievers perform above the OECD mean value compared to the corresponding group in other countries in all four measurements.

Explanations related to an epistemological and content-related perspective

According to our analysis, the descending trend is significantly more complex than what is revealed by exploring only the statistical mean values and national result descriptions. For example, we have used Robert's (2007) des-

criptions of *curriculum emphases* as an analytic tool for categorizing the test items in order to distinguish possible content-related trends in the PISA material. The analysis (Jakobsson, et al, 2012) show a general descending trend in items focusing on the nature of science and how new scientific knowledge is generated. There exists a similar trend concerning the use of explanatory models to solve problems in different contexts and understand that scientific knowledge is built on models. On the other hand, there is an obvious upward trend regarding tasks that measure fact-based elementary or root knowledge. This means that the results show a discrepancy in students' epistemological understanding of school science, which becomes explicit when exploring their performances on different types of assignments or tasks. An important implication is that a too strong focus on fact-based knowledge in science instruction seems to disfavor the Swedish students' performances in science.

Explanations related to science language and discourse in a classroom perspective

Another indication of an explanatory model for the descending trend could be discerned in the data material from the pilot study when investigating students' use of science classroom language (Serder & Jakobsson, in progress). The preliminary analysis of the students' conversations when solving a selection of PISA items indicates an ambiguous and indistinct relation between the use of scientific and everyday language. The mastery of words and symbols in the test appeared to be crucial for getting the point of the items posed and for being able to discuss, solve, and find answers. The definition and meaning of scientific concepts and words such as *factor*, *reference*, *pattern*, and *substance* caused difficulty for many of the students. An additional complication is that several of these terms or expressions have different connotations or associations in different contexts and discourses (such as mathematics, science and everyday life). However, these conclusions are drawn from a study that is based on a relatively small selection of students and comprises only a few different PISA items. In order to draw more reliable and extensive conclusions, additional data collection is needed that is specifically designed to explore these issues. We have applied for funding in order to conduct such a data collection in the future.

Yore and Treagust (2006) argue that a three-language problem exists for most science learners that parallels mother tongue language learning and involves moving across discourse communities of their family, school, and science (home language, instructional language, science language). In this perspective, learning how to talk, write, and read science frequently requires

explicit language tasks to be embedded in order to connect classroom talk, informal personal experiences, everyday terms, and concrete experiences to the appropriation of knowledge and established science knowledge claims. According to Jakobsson and Davidsson (2012), learning and development are related to the process of acquiring the ability to behave, act, and talk as members of particular communities. This is explained by the processes of being socialized into a community or a discourse by appropriating the meaning of words, concepts, and actions in a specific context. An important implication is that science instruction in Sweden needs to re-focus on students understanding and development of a scientific language as well as to highlight the relation between scientific and everyday language.

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