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Promoting teaching, learning and informed decision-making through the lenses of international large-scale assessment: looking beyond numbers

Roger Säljö[1] · **Jelena Radišić**[2]

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Abstract Public discussion on the quality of education in different corners of the world very much relies on the data provided by the international large-scale assessment (ILSA) studies. While aware of different methodological keystones and technicalities embedded in these, the idea behind this special issue is to contribute to the understanding of how students solve ILSA items and the kinds of literacy skills they rely on. A shared element of reported studies is that they seek to document and analyse test-taking as a concrete practice using different theoretical and methodological perspectives. We find such scrutiny to be important and significant at this point in time as it offers some new lenses through which ILSA items could be inspected and further discussed.

Keywords International large-scale assessment · Secondary analyses · Teaching · Learning · Policy · Theoretical diversity · Methodological diversity

International large-scale assessment (ILSA) studies play an important role in the public discussion of education in many parts of the world. School systems are ranked and compared, and the political ambition in many countries is to use the information produced by such comparisons to reform and steer the educational system. Nowadays, there are several such international comparisons around, each with its own framework and aim. Perhaps, the most well-known one is the Programme for International Student Assessment (PISA) issued by the Organisation for Economic Co-operation and Development (OECD). PISA is a triennial international survey which aims to evaluate education systems

✉ Jelena Radišić
Jelena.radisic@ils.uio.no

[1] Department of Education, Communication and Learning, Faculty of Education, University of Gothenburg, Gothenburg, Sweden

[2] Department of Teacher Education and School Research, Faculty of Educational Sciences, University of Oslo, Oslo, Norway

worldwide by testing the skills and knowledge of 15-year-old students in the language of instruction, mathematics and science, collecting also a broad range of contextual data about the students and their schools. To date, students representing more than 70 economies have participated in the assessments, and the most recently published results are from the assessment in 2015. Around 510,000 students in 65 economies took part in the PISA 2012 assessment. PISA was first launched in 2000.

In 2008, the OECD also launched the Programme for the International Assessment of Adult Competencies (PIAAC). Like PISA, it is designed as a multi-cycle programme. The survey measures adults' proficiency in key information-processing skills: literacy, numeracy, and problem-solving in technology-rich environments, and collects information and data on how adults use their skills at home, at work and in the wider community.

In a similar vein, the Trends in International Mathematics and Science Study (TIMSS) is a series of international assessments of knowledge in mathematics and science of students around the world, taking place every four years in grades 4 and 8.[1] The participating students come from a diverse set of educational systems, and for each student, contextual data on the learning conditions in mathematics and science are collected from the participating students, their teachers and their principals via separate questionnaires.

On the use of ILSA data

Building on the existing datasets available from the ILSA surveys (e.g. publically available PISA and TIMSS datasets), a number of studies have tried to tackle the student-, teacher-, school- and/or system-related factors that provide pedagogically interesting explanations of students' performance (e.g. Ma and Klinger 2000; Papanastasiou 2002; Papanastasiou et al. 2003; Kjærnsli and Svein 2004; Linnakylä et al. 2004; Williams et al. 2005; Thorpe 2006; van Langen et al. 2006; Linnakylä and Malin 2008; Olsen Vegar and Lie 2009; Nortvedt 2013; Scherer and Beckmann 2014; Radišić et al. 2015; Nilsen and Gustafsson 2016). These studies have been based on reanalysis of TIMSS and PISA datasets aiming to untangle effects of certain contextual factors (e.g. motivation, learning styles, teachers' practices and family background) or, alternatively, they have attempted to analyse achievement gaps between particular student groups. While some studies remain focused on just a few countries, others involve a wider scope. In sum, all these studies nicely demonstrate an important intention of all international comparisons of this kind—to join forces in data collection providing the researchers with the data and thus the opportunity for secondary analyses. As a consequence, a particular body of evidence has been gathered contributing, for example, to the argument that there is a gender gap in mathematics achievement across countries and that SES contributions to the overall student achievement in various countries differ. On the other hand, some results remain specific for country groups, or even more so, for the country level.

[1] A twin study the Progress in International Reading Literacy Study (PIRLS) is designed to measure children's reading literacy.

At the same time, researchers have also dealt with some conceptual issues and key decisions that shape the use of the ILSA data (e.g. Fensham 1995; Bybee 2008; McGaw 2008; Wagemaker 2008; Sellar and Lingard 2013) and particular methodological concerns (e.g. Neumann 2005; Lüdtke et al. 2007; Schleicher 2007; Nardi 2008; Abu-Hilal et al. 2013; Rutkowski and Rutkowski 2016; Maddox 2017) as well as with intervention and its effect on student achievement on TIMSS or PISA kind of items (e.g. Brunner et al. 2007; Schur and Kozulin 2008; Pavlović Babić and Baucal 2011) or teaching practices related to achievement in the international assessment studies (e.g. Santagata and Barbieri 2005; Richland et al. 2007; Papanastasiou 2008).

The impact of ILSA data and results

Impact of the ILSA data on country policies has also been scrutinised. For example, Takayama (2008) has analysed the role of local actors, in particular, national newspapers and the Ministry of Education in Japan, in mediating the potentially homogenising curricular policy pressure of globalisation exerted through the PISA league tables. Takayama has used the political-economic analysis of globalisation and education coupled with culturalist approach to education policy borrowing. He has demonstrated how the Japanese media interpreted the PISA 2003 findings in a way that echoed with the cultural, political, and economic context of the time, and how the Ministry used the findings to legitimise otherwise highly contentious policy measures. Questioning the traditional interpretation that the PISA 2003 shock caused the Ministry to alter its disputed *yutori* (low pressure) curricular policy, the paper reconstitutes the Ministry as an active agent that capitalised on an external reference (PISA) to re-establish its political legitimacy in a time of increasing neo-liberal state-restructuring.

In that respect, Baumert's (2009) remark that an important weakness of the international assessment studies like PISA and TIMSS is 'the explanatory gap', i.e. observational, cross-sectional data are not powerful enough to support certain explanations or causal inferences, is also well worth remembering. As a way to overcome this constraint, he has proposed 'to incorporate the merits of cross-sectional surveys within a broader research program. A potential focus of this kind of extended research program might be on teaching, learning, and student progress'. (p. 32). He has found TIMSS video studies as good examples in this direction as well as his own research programme in which a PISA study has been incorporated into a larger longitudinal undertaking showing findings to the effect of teacher pedagogical knowledge and students' cognitive activation as key factors for student improvement over time (Baumert et al. 2010).

Taking into account the impact of ILSA studies and the debates that have been triggered and most likely will continue to be triggered in future in academia and between various stakeholders such as researchers, educators, policymakers and the public, especially in relation to the students' final scores, it seems that the tests and the very items students need to solve in such studies need analytical attention. In the context of such high-stakes testing (not necessarily so for the students, but certainly for the systems and for policymaking) making claims about knowledge, literacy and cognitive functioning, it is important to scrutinise the concrete items and the contexts of test-taking under these specific circumstances (D'Amore 2014). While established scoring systems allow for assessment of the different levels of respondents' competences when they solve ILSA items, as in PISA and TIMSS, if they truly capture the rich variety of reasoning modalities used by the students, and indirectly by teachers, has been questioned (Rochex 2006).

The building blocks of this special issue

Putting aside methodological underpinnings and technicalities of ILSA studies, and the overall critical discussion about how to interpret them, the idea behind this special issue is to contribute to the understanding of how students solve ILSA items and the kinds of literacy skills they rely on. We consider such scrutiny especially important and significant at this point in time. Today, we see a dramatic change in our epistemological practices in society. Digital technologies provide access points (Giddens 2002) to information and knowledge in radically new manners; we remember, learn and solve problems in very different ways compared to how we did a generation ago. A critical feature of the changes in epistemic practices we see is that it is increasingly difficult to make claims that knowledge and skills reside within individuals in the ways which has been assumed traditionally, and which has been the foundation of most ILSA studies so far. Today, we rely on external tools and constant online access in most of our knowledge practices, and the skills of using such resources are only starting to be reflected in ILSA studies. A similar argument can be made in relation to collaborative and creative problem skills (e.g. PISA introduced collaborative problem-solving that is students' ability to work with two or more people to try to solve a problem in 2015, OECD 2016). The latter types of skills and competencies are becoming increasingly important in complex and diverse societies.

A shared element of the studies reported here is that they seek to document and analyse test-taking as concrete practices. The authors want to scrutinise which cognitive activities and responses that the items trigger and that emerge at the student level. This implies that we temporarily avoid privileging the items as indicators of 'literacy' or 'scientific literacy' at a general level, but rather look at them as concrete challenges that students are expected to solve in the particular context of their regular classrooms where they go about learning mathematics, language, science or problem-solving.

Conversely, contributions in this special issue represent a mixture of theoretical, methodological and empirical extensions to both PISA and PIAAC designs. While the first and the last contribution discuss implications of ILSA studies from the perspective of policy and particular methodological affordances that could strengthen ILSA's design, the remaining five articles are mostly examples of secondary analyses with a clear ambition to inform teaching and learning practices in different educational contexts, thus taking a step further and beyond the numbers presented in the league tables.

The first contribution, authored by Guri A. Nortvedt, addresses the policy implications of participation in the ILSA studies. Nortvedt uses the example of Norway and its involvement in the PISA process for this discussion. Nortvedt problematises the implications arising from such participation in the context of mathematics education in Norway, and she focuses on insights into teaching, learning and assessment practices that can be taken from the PISA study. A particular aspect of this discussion relates to ILSA's contribution to changes in educational policy and reform perspectives of the policymakers with respect to schools, teachers and students. At the same time, Nortvedt does not neglect specifics of the Norwegian cultural context, and the influence of the so-called Nordic model, as the guiding principle in organising the system of education.

This article is followed by a contribution by Jelena Radišić and Aleksandar Baucal focusing on teachers' reflections about PISA items and the possible pitfalls students may encounter while solving them as the teachers see it. In addition, the article analyses how teachers interpret the notion of applied mathematics in their own teaching. Teachers' narratives were built around two released PISA 2012 mathematics items, the Drip rate and Climbing Mount Fuji

items, respectively. Results indicate teachers' concordances as to the reasons why either of these two items may be difficult for their students (e.g. specifics of the narrative used in the item). In addition, their suggestions about how to make the items more familiar to the students mostly implied de-contextualising them in the sense of reducing the significance of the content of the items and making them more formal in the mathematical sense. At the same time, the authors emphasise that many teachers had difficulties to clearly verbalise which procedures students are expected to follow to be able to solve the tasks, although verbalization of this kind is expected from the students when in class. Finally, on the issue of introducing applied mathematics in their own classrooms, teachers exhibit some willingness to do so at a declarative level, but they question the purpose of such an initiative,

The contribution by Aleksandar Baucal, Dragica Pavlović Babić and Smiljana Jošić problematises the meaning of an incorrect answer appearing on the PISA items. The authors focus on whether an incorrect answer can be seen as just reflecting lack of competence on the part of students. In addition, they probe into what distinguishes 'false' from 'true' incorrect answers. Observing the process of solving an item when students work individually as well as when they work in triads, the authors focus on six students who responded incorrectly to one PISA question in mathematics or science when they solved it individually. The chosen methodological approach allows the authors to observe the same students in a situation of dialogical problem-solving in order to identify exactly why they had made an incorrect choice. The results of this study illustrate that there are interesting differences between different types of incorrect answers and that trajectories of finding a solution will vary given the differences in the types of error a student may make. In other words, the results of the analysis signal the many different ways in which an answer may be incorrect.

The contribution by Patrizia Selleri and Felice Carugati focuses on a fine-grained analysis of the dynamics of students' performance when they are confronted with a question from the mathematics domain in PISA 2012. The example chosen is the famous Climbing Mount Fuji item. In the context of the interaction dynamics (student vs. research assistant), students' answers were analysed from the point of view of the PISA framework, the mathematical educational framework, and the socio-psychological approach based on the theory of didactic contract. The results of the study indicate how students involved in the Climbing Mount Fuji task commit themselves to complex modes of reasoning where they rely both on mathematical characteristics of the task and their everyday school experiences. Furthermore, the interweaving of PISA performances, mathematical procedures, and the socio-psychological approach to test assessment is discussed as tools for better understanding teaching and learning activities.

The paper by Anna Maria Ajello, Elisa Caponera and Laura Palmerio observe students' mathematical competencies through the lens of their reading skills, i.e. how students' linguistic competencies relate to their performance in mathematics. Authors use data from PISA 2012, selecting for their analyses 24 mathematics items with a high reading demand and 31 mathematics items with a low reading demand. The results of the study indicate consistent gender differences, with girls scoring higher than boys in mathematics items with a high reading demand, independent of their level of reading literacy. In contrast, boys outperformed girls in mathematics items with a low reading demand, independent of their level of reading literacy. This is an interesting outcome which calls attention to the fact that what is construed as mathematics performance is connected to other skills and gender differences in complex ways.

The article by Ksenija Krstić, Anđela Šoškić, Vanja Ković and Kenneth Holmqvist contrasts low-skilled and high-skilled readers by using eye tracking for examining particular PISA items. The particular methodological choice (i.e. detecting eye movement patterns) is

grounded in the idea of gaining insight into why some students fail to solve specific tasks, which is the topic of the article by Baucal et al. as well. Controlling for students' ability through a pre-test, the findings of the study indicate reading to be less fluent in the low-skilled group. This group experienced difficulties in locating the relevant material needed to solve the task correctly. Taken together, the findings show how PISA results differentiating low- and high-scoring groups can be further complemented with insights from more fine-grained analyses of the problem-solving process, and here eye-tracking measurements may contribute.

Finally, Bryan Maddox, Andrew P. Bayliss, Piers Fleming, Paul E. Engelhardt, S. Gareth Edwards and Francesca Borgonovi report a pilot study that used eye-tracking techniques to make detailed observations of item response processes in the PIAAC survey. The eye-tracking observations help, as the authors put it, filling an 'explanatory gap', by providing data on variation in item response processes that cannot be captured by other sources of process data such as think-aloud protocols or computer-generated log-files (i.e. data kept by the machines in computer-based assessments). The methodological approach utilised provided data on fixations and saccades and, thus, provided more detailed information on test item response strategies, enabling profiling of respondent engagement, and response processes associated with successful performance, even when these include 'off-screen' behaviour.

Conclusions

All contributions in this special issue come from researchers pursuing the idea of how to effectively use the ILSA data to inform policy, practice and the assessment process at large. Across the texts, co-constructional, didactical and ethnographical perspectives were just some of the approaches used in scrutinising the phenomena in question, again allowing for different methodological choices. This has contributed to the myriad of studies that have used ILSA data so far, by offering some new lenses through which for example ILSA items could be inspected and further discussed.

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Roger Säljö. Department of Education, Communication and Learning, Faculty of Education, University of Gothenburg, Gothenburg, Sweden. E-mail: roger.saljo@ped.gu.se

Current themes of research:

Research on learning, interaction and human development in a sociocultural perspective. Issues of how people learn to use cultural tools and how we acquire competences and skills that are foundational to learning in a socially and technologically complex society. Issues that concern how the so-called new technologies transform human learning practices inside and outside formal schooling.

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Jelena Radišić. Department of Teacher Education and School Research, Faculty of Educational Sciences,University of Oslo, Oslo, Norway. E-mail: jelena.radisic@ils.uio.no

Current themes of research:

Student, teacher and school characteristics affecting academic achievement. Quality and efficacy of the education system (secondary analysis of PISA and TIMSS results). Teacher beliefs and practices and their impact on student learning. Motivation for learning. Mathematics anxiety. Emergent literacy.

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