PISA's Influence on Thought and Action in Mathematics Education

By Zulkardi Zulkardi

Chapter 15
PISA's Influence on Thought and Action in Mathematics Education

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Abstract This chapter contains short descriptions from contributors in ten countries (Chile, Denmark, France, Indonesia, Iran, Israel, Korea, Singapore, Spain and USA) about some ways in which the PISA Framework and results have influenced

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thinking and action about mathematics education. In many countries, the PISA results have been a call to action, and have stimulated diverse projects aimed at improving results, principally for teacher education but also some involving students. PISA resources, including the released items, have been used as a basis for assessment as well as for teacher development. Some countries have established national assessments with noticeable consistency with PISA ideas. In many countries, PISA's concept of mathematical literacy, with its analysis of what makes mathematics education useful for most future citizens, has been extremely influential in curriculum review and also for improving teaching and learning. Countries have also incorporated or adopted the way that PISA describes mathematical competence through the fundamental mathematical capabilities.

Introduction

The aim of this chapter is to review some of the ways in which PISA has influenced thinking about mathematics education in a variety of countries around the world, and to document some of the actions that have followed from this influence. The chapter consists of ten separate, short pieces that are contributed by citizens of various countries. This collection is designed to complement the more substantial contributions from Germany, Italy, Japan, and Taiwan in the earlier chapters of this volume. Invitations to contribute to this chapter were issued to people who were likely to be in a position to make a sound judgement, sometimes because of their involvement with the national team implementing PISA or sometimes because of their long term involvement with curriculum and teaching issues more generally or for their other special interest. However, these are generally personal pieces and do not represent all the action or opinions in a country, nor are they definitive evaluations of the local influence of PISA. Instead they are personal reflections (some more so than others) written from the point of view of people involved in various ways with the national agendas. To assist in interpretation, the sections begin with a very brief description of the contributors' local roles. Contributions are presented alphabetically by country name.

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In drawing conclusions about the extent of influence of PISA around the world, it is important for readers to know that contributions were not solicited or selected from countries where PISA was known to have been especially influential. It is also relevant that everyone who was invited to contribute had something to report about their country.

When the contributions are reviewed as a set, it is evident that PISA has had a substantial influence on both thought and action in many countries. The country ranking and the mean scores of students and their distribution have been important, sometimes to affirm national directions as in the case of Singapore, but more often as a stimulus to action especially where student performance has been lower than expected. The type of action taken is varied. In some countries, including Spain, international assessment has been supplemented by new forms of national assessment, sometimes based around a PISA-like framework. In Chile, the methodology of PISA assessment has also been used as a model for improving national assessment. Many countries have begun new teacher education projects, designed to promote mathematics education that better equips students for their futures in response to lessons learned from PISA. Some countries, including France and Denmark, have used the resources provided by PISA in these and other projects, especially using PISA items as a model for assessment items or a source of ideas for more complex items that share a PISA philosophy. Greater complexity and depth, and a fuller assessment of all phases of the modelling process is possible when items are to be used away from the very demanding context of the multi-country, multi-language, tightly-timed PISA survey. Some contributions, including those from Iran and Indonesia, also highlight classroom activities for students.

These contributions also show the impact of the PISA Mathematics Framework on thinking about the goals of mathematics education and the conceptualisation of the mathematics curriculum. A strong theme is the desire and need in many countries to give more emphasis to PISA's mathematical literacy with its emphasis on mathematics for all citizens across all parts of their lives. However, it is also the case that there has been considerable thought generated about the adequacy of mathematical literacy as a goal of mathematics education and how this can or should be balanced in a school mathematics curriculum with attention to intra-mathematical goals such as mathematical structure and attention to mathematics as a discipline studied for its own interest and beauty. Several contributions, including from Israel and Korea, report on the thinking stimulated by PISA ideas within curriculum review processes. For example, in Korea, a new series of textbooks gives more attention to contexts through a 'story-telling' approach that presents real or fantasy contexts to motivate and illustrate mathematical principles. This resonates with the 'educational modelling' approach outlined by Stacey in Chap. 3. Fundamental debate about the nature and goals of a good mathematics curriculum has also been a feature of the response in the USA.

An important aspect of the impact of PISA on thought about mathematics education has come through the prominence that PISA has given to mathematical competencies (called the fundamental mathematical capabilities in the PISA 2012 framework). Several contributions, including from Spain, report how these have been used to guide curriculum and assessment, and how the competency view, described more fully by Niss in Chap. 2 of the present volume, has been consistent with other influential initiatives in the early years of this century. The contributions from France, Indonesia and Chile also record the incorporation of PISA-like mathematical competencies in revised curriculum priorities.

In summary, these reports show that since its inception, PISA has had substantial influence on developments in mathematics education through the monitoring of performance, by the resources produced, and through the stimulus to fundamental reconsideration of the goals of mathematics education that is offered by the various components of the PISA mathematics framework.

Chile

About the Contributor

Felipe Almuna is currently a Ph.D. student in Mathematics Education at The University of Melbourne. After a career as a secondary and tertiary mathematics teacher in Chile he decided to undertake further studies in mathematics education. In 2010 he was awarded his master degree at The University of Melbourne, studying how the context influences students' approaches to PISA-like problems and winning the John and Elizabeth Robertson Prize for best research essay. In 2011 and 2012, he worked again as a teacher in Chile. His doctoral research is studying the relationship between contextualisation of mathematical problems and students' performance.

PISA: A Referent for Improvement

Chile has participated in four PISA survey administrations. Participation in the 2000 administration was delayed until 2001, and then the country participated normally in 2006, 2009, and 2012. The PISA 2009 survey ranked Chile in 49th place for mathematics among 65 participating countries and in the second place in the Latin American region after the partner country Uruguay. The mean score of 421 points is 75 points (three quarters of a standard deviation) below the OECD average of 496 points (OECD 2010b).

Aside from the rankings, the PISA 2009 mathematics results revealed that less than 1 % of Chilean students reach the highest level of proficiency in mathematics with scores higher than 669 points, and 51 % of students perform at or below the lowest level of proficiency with scores between 358 and 420 points (OECD 2010b). These results confirm that Chile still lags behind the OECD average and that there remains considerable action to be taken in matters related to education. At the time of writing, the first PISA 2012 results are available, showing an average score of 423, a small but statistically significant improvement.

Chile is taking steps designed to improve the quality of education; raising educational standards in Chile is "high on both the public and government agenda" (OECD 2010b, p. 87). In this way, the PISA results have been used as a referent to monitor variations of the educational goals in order to advocate policy change, promote educational research, and learn lessons from the PISA survey methodology.

In this vein, the national mathematics curriculum implemented in the 2000s has been reviewed. Since 2009 a greater emphasis on the notion of mathematical competency and mathematical reasoning (Solar et al. 2011) is observable in it. This curricular review in mathematics has taken into account revisions and analyses of curricula from OECD countries as well as frameworks and evidence from TIMSS and PISA (Ministerio de Educación 2009).

In addition, PISA has also started to influence educational research in Chile. In 2011 the Research and Development Office (FONIDE, standing for its Spanish acronym), a section of the Ministry of Education, launched a special round of grants for researching the impact of PISA in Chile and 25 % of the participating projects were related to PISA mathematics.

PISA assessment also has been influential in the improvement of the national assessment in Chile (SIMCE for its acronym in Spanish). PISA has been used as a best-practice guide to adapt existing assessments, in guiding methodological changes in SIMCE "improving procedure, manuals, item construction, statistical analysis and keeping records" (Breakspear 2012, p. 22).

Final Remarks

As Chile did not take part in the PISA 2003 survey (where the main focus was on mathematics) comparison in mathematics is only possible between the 2006 and 2009 survey administrations. The results show that since 2006 the results in mathematics did not change significantly. Hence, the influence of PISA mathematics in Chile has not yet been greatly evident. However, PISA mathematics has been a referent for the latest curriculum review in Chile. In 2009, the release of the PISA results in both reading and mathematics produced an immediate public concern. The analysis of the results of PISA has also been taken into account by policy makers when discussing the quality of the educational system in Chile. The PISA survey has offered to Chile an opportunity to raise critical questions about the learning outcomes, distribution of learning opportunities, skills and competencies that the Chilean educational system provides to students to equip them for today's globalised world.

Denmark

About the Contributor

Lena Lindenskov is from the Department of Education at Aarhus University in Denmark. She has worked in the Danish PISA Consortium since 1998 responsible for the mathematical literacy part. Lena also was the Danish representative in the PISA 2003 Mathematics Forum.

Alignment with Educational Goals of Denmark

From a Danish perspective, the Mathematics Framework from PISA 2000 has been of great interest, as it seems to be more applicable to the Danish mathematics education than the TIMSS survey. Mathematics in use, in everyday life, and for active citizenship is a priority for compulsory education in Denmark. The PISA definition of mathematical literacy and its further description seem to be in line with the intended goals and guidelines of Danish schools. Also the fundamental mathematical capabilities (OECD 2013a) underlying the mathematical processes resemble what is known in Denmark as the concept of the eight mathematical competencies, which are described by Niss (2003) and also in Chap. 2 of this volume. The concept was incorporated into national teaching guidelines from 2003 and into the national curriculum from 2009 as described in the Fælles Mål [English: Common Goals] (Ministry of Education 2003, 2009). The concept has been discussed in teacher training courses and applied in developmental projects and research around Denmark.

As the PISA Framework is in line with Danish educational goals, one might expect relatively high Danish performance. Throughout the PISA surveys 2000–2012, Danish students performed above the OECD average in mathematical literacy with means of 514, 514, 513, 503, 500 while the mean scores in reading literacy and science literacy did not differ from the OECD average.

Actions Following

The PISA performances of Danish students have had a big impact on educational and political debate and decisions, as noted by Egelund (2008). New critical questions were raised about the level of performance and about social-economic, ethnic and gender equity factors, considering that Denmark is a rich state with a strong emphasis on social welfare. Following an international OECD review in 2004 (Mortimore et al. 2004), national tests were introduced in several subjects, for example, in Grades 3 and 6 mathematics. For the first time the national teacher guidelines for mathematics in 2003 and 2009 included sections on students with special needs, influenced by several factors including the PISA results. They showed that although the number of low performers is small relative to international figures, in a national context the number is considered to be too high.

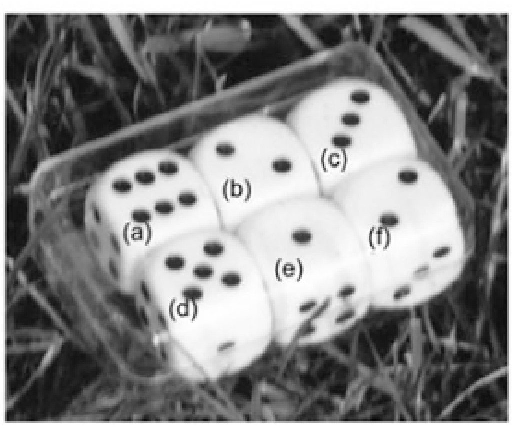
As PISA items are well described, the Danish mathematics team for PISA decided to investigate how released items can be used by teachers for formative assessment of their students and as ideas that they can develop into learning activities. We made secondary analyses of the student answers to released PISA-items based on single item statistics, together with an in-depth analysis of the written work of large samples of Danish students in PISA 2003. The results were published on the web with the title *15 Mathematics Tasks in PISA* (Lindenskov and Weng 2010). Our aim was to present rich descriptions and examples of how Danish students answer mathematics tasks when they participate in PISA surveys. We wanted to give descriptions that were rich enough for teachers to be able to relate them to their own practice. We looked into four PISA units in *Space and shape*, two units in *Change and relationship*, five units in *Uncertainty* and four units in *Quantity*. The items in these units covered all levels of difficulty.

The item *M145 Cubes*, as shown in Fig. 15.1, is categorised as *Space and shape*. The difficulty level is low, and student answers are coded in PISA just with one digit as full credit (in this case the correct answer of 1, 5, 4, 2, 6, 5 in order) or no credit for any other answer. (For further information about coding, see Chap. 9 by

Question 1: CUBES *M145Q01*

In this photograph you see six dice, labelled (a) to (f). For all dice there is a rule:

The total number of dots on two opposite faces of each die is always seven.



Write in each box the number of dots on the **bottom** face of the dice corresponding to the photograph.

Fig. 15.1 PISA released item Cubes M145Q01 (OECD 2006)

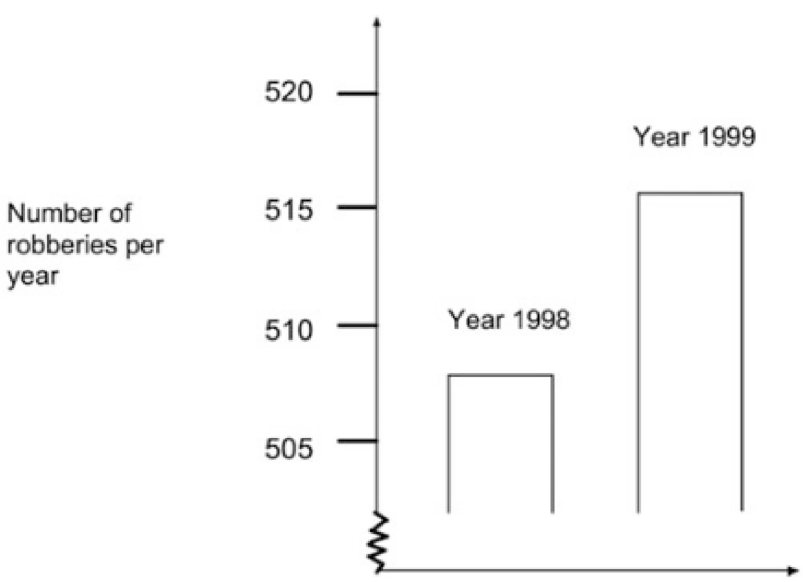
Sułowska in this volume.) We looked more deeply into 110 Danish student answers. We found three kinds of incorrect answers, and we created three second digit codes. Some students *copied* the numbers shown on the dice (answering 6, 2, 3, 5, 1, 2) another group *mirrored* them (answering 5, 1, 2, 6, 2, 3), while a third group made *calculation errors*. The two first types of answers indicate conceptual misunderstanding of 'the opposite side of a cube', despite the algebraic rule of the sum being given as a hint, and the third one indicates arithmetic problems. In assessment for learning we suggest the use of tasks like *M145 Cubes* in order to find indicators of students' thinking.

It is our general impression that for items with short answers, the most interesting information for teachers is the different types of incorrect answers. Concerning items with extended answers, it is also interesting for teachers to look into the different types of correct answers. The unit M179 Robberies (shown in Fig. 15.2) is classified in *Uncertainty*. The difficulty level is high. Full credit answers are coded in PISA with three double digit codes. Partial credit answers are coded with two double digit codes. No credit answers are coded with four

Question 1: ROBBERIES *M179Q01- 01 02 03 04 11 12 21 22 23 99*

A TV reporter showed this graph and said:

"The graph shows that there is a huge increase in the number of robberies from 1998 to 1999."



Do you consider the reporter's statement to be a reasonable interpretation of the graph? Give an explanation to support your answer.

Fig. 15.2 PISA released item Robberies M179Q01 (OECD 2006) double digit codes. OECD (2006) gives full details of the coding criteria. All nine double digit codes are represented among the Danish student answers, which we looked into further. We saw that the full and partial credit answers were longer than the no credit answers. We saw that more everyday knowledge and less mathematical knowledge were used in the no credit answers than in the other answers. The diversity of the answers—in addition to being correct, partially correct or incorrect—shows the complexity of the item, and it seems that M179 Robberies motivates students to engage in interpretation and in reasoning. Here are some examples of answers given by students in Denmark, translated by the contributor.

- Some development has taken place. We see more robberies, but not in any strong sense. It has grown with approx. eight robberies (found from the graph), and that is not very much. The journalist has exaggerated, but when you look at the graph it looks bad, but the 'titles' are close to each other, that is why a growth of eight robberies looks very big.
- Such a small growth may be random, and next year you may have a marked decline in robberies. So I think the interpretation is unreasonable.
- I don't think nine robberies is a very big growth.
- What do you mean? It is reasonable, but how can I show it?
- Reasonable. I suppose so, but you cannot precisely see how many burglaries there were in 1998. It would have been better with a line diagram.
- It would have been easier if you had shown it on a circle diagram instead.
- Yes, there is an increase, so it is a fine interpretation, but she is not reasonable when she says it is a huge increase.
- No, because it is not a huge increase, but you know journalists can say anything.
- No, it looks huge in the illustration; you see the relative height of the two columns, but looking at the numbers only an increase of about 9.

In our view, secondary analyses of this kind can support development of mathematics education away from looking at mathematical tasks as something that should be finalised with one right answer as quickly as possible towards looking at mathematical tasks as initiators for problem posing, problem solving, reasoning and communication. We have observed an interest among teachers in the secondary analyses we made. We have observed students' interest as well. Some successful students were interested in looking at different student answers, including those from other countries, while weaker performing students said they were afraid that they would get confused.

Although the concept of mathematical literacy in PISA is regarded as in line with main ideas for mathematics education in the compulsory years of schooling in Denmark, critical questions are frequently raised in the debate on the value of mathematics in PISA. For example, there is debate on whether PISA measures give valid indications of the level and structure of 15 years olds' readiness for acting and reflecting on mathematics in use.

France

About the Contributors

Franck Salles and Jean-François Chesné work together at the DEPP in Paris. Franck Salles works both as a mathematics teacher in secondary school and as a research fellow at the office for students' assessment, DEPP, Ministry of Education. Franck has shared the position of National Program Manager of PISA for France, and is the French National Centre mathematics expert for PISA 2012. Jean-François Chesné joined the DEPP, Ministry of Education, working on assessment after a career as a secondary mathematics teacher and at the University Paris 12 where he was in charge of initial training for mathematics trainee teachers and professional development for in-service teachers. He heads the office of the evaluation of educational activities and experimentation. He conducts research on teaching practices and students' skills in mathematics in compulsory schooling. He was a member of a national jury for the recruitment of mathematics teachers and is a textbook author.

The Common Core of Knowledge and Skills and Complex Assessment

Unlike some other OECD countries, France did not experience a 'PISA Shock' after the first results of PISA from the year 2000. Nonetheless, PISA led to questioning of the adequacy of what is taught in French schools, especially in respect to how students use their knowledge in real-life situations. Thus, at an institutional level, PISA has had an influence in shifting the nature of knowledge towards a more applied and useful one.

In 2006, the law addressing the future of schooling in France amended the lower secondary curricula and established a *common core of knowledge and skills* (Legifrance 2006). This reform explicitly states that it was based both on recommendations of the European Union regarding '*key competences for lifelong learning*' (European Communities 2007) and on the PISA Framework. PISA's notion of mathematical literacy is underlying the *common core* as is clear from its definition:

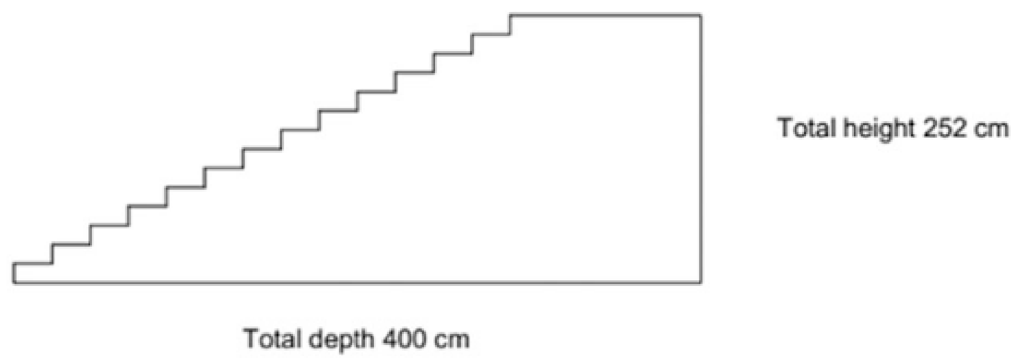
> knowledge and skills which are necessary to master at the end of compulsory education in order to successfully continue training, build one's personal and professional future and play a successful part in society. (Legifrance 2006, ANNEX)

As a result, skills and competencies connected with pure content have come to play a new and important part in curricula.

In mathematics, the *core* outlines skills such as *reasoning*, *communicating*, *implementing*, *handling information*, which are employed in four clusters of content (*numbers and operations*, *geometry*, *measurement*, *data handling/uncertainty*). This is very similar to the fundamental mathematical capabilities and the content

Question 1: STAIRCASE *M547Q01*

The diagram below illustrates a staircase with 14 steps and a total height of 252 cm:



What is the height of each of the 14 steps?

Fig. 15.3 PISA released item M547 Staircase (OECD 2006)

categories of the PISA 2012 Mathematics Framework (OECD 2013a) and its predecessors.

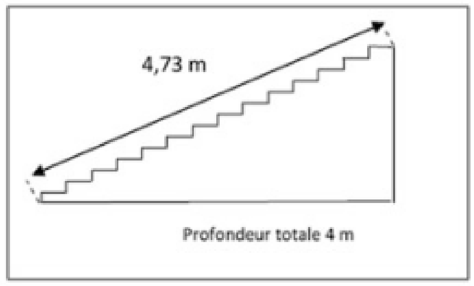
From 2008, new official instructions for mathematics teachers require developing and assessing students' skills within complex tasks through various contexts (MENJVA/DGESCO 2011). In addition to examining students' final productions, teachers must pay specific attention to their intermediate processes, partial reasoning, and spoken or written communication. This emphasis on reasoning and communicating is not only in geometry, as it often used to be, but also in arithmetic and algebra (MENJVA/DGESCO 2009a). Documents published by the Ministry of Education (see for example, MENJVA/DGERSCO 2009a, b) are often based on PISA released items. Figure 15.3 displays a PISA item M547 *Staircase* which was released after the PISA 2003 main survey (OECD 2006). The difficulty of the item is at Level 2, just above the boundary of Level 1. Figure 15.4 shows an adaptation (MENJVA/DGESCO 2011), illustrating the possibility of proposing a classical geometry problem in a real-life context. The French instructions translate as:

> For a staircase to conform to regulations, the height of each step must be between 17 cm and 20 cm. Does the staircase shown in the diagram meet these regulations? Show all of your working, even those paths which were not successful.

In the adaptation, the mathematical task has been made considerably more complex than the quite simple original, which involved only dividing the total height by the number of steps and ignoring the redundant information of 400 cm depth. In the new item, the given data was modified, Pythagoras's theorem is likely to be used, metres are to be converted into centimetres, and the question requires that the final value is tested to see if it fits in the specified range. As with many PISA

Exemple en mathématiques : l'escalier

Pour qu'un escalier soit conforme aux normes, la hauteur de chaque marche doit être comprise entre 17 cm et 20 cm. L'escalier représenté sur le schéma ci-contre est-il conforme aux normes ?



Tu présenteras ta démarche en faisant figurer toutes les pistes de recherche même si elles n'ont pas abouti.

Direction générale de l'enseignement scolaire
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Fig. 15.4 Adapted Staircase Item (MENJVA/DGESCO 2011, p. 4)

items, an alternative solution method is also possible, in this case involving scale drawing, and this makes the item accessible to more students. These modifications make it a complex task meeting official standards.

One cannot claim that these directions have had wide and direct influence on actual teaching practices in France. This very innovative reform was not followed by widespread national teacher training. The evolution of teaching practices is a slow and complex process in the centralised French educational system and still today, most teachers are not familiar with PISA. However, intermediate institutions have been strongly influenced. Teacher trainers often mention PISA, its Framework, items and their coding guidelines during initial courses about the *core*. Textbook editors update mathematics textbooks to include more and more PISA-like *common core* situations. And last but not least, national inspectors are gradually modifying national examinations to include more complex tasks in context, and are valuing partial reasoning and different forms of communication.

Indonesia

About the Contributor

Professor Zulkardi is a lecturer in the Department of Mathematics Education in the Faculty of Teacher Training and Education, Sriwijaya University, South Sumatra, Indonesia. In 2002 he got his PhD on realistic mathematics education from the Netherlands. One of his supervisors was Professor Dr Jan de Lange, the first Chair of the PISA Mathematics Expert Group. Since then, Zulkardi has been involved in many projects related to PISA, some of which are discussed in this contribution. Since 2008, he has been the Vice President of the Indonesian Mathematical Society for Education and in this capacity he started the first international journal on mathematics education in Indonesia called IndoMS-JME (jims-b.org).

General Influence of PISA Mathematics in Indonesia

As do many governments that participate in PISA, the Indonesia government uses PISA to monitor the performance of the educational system. The purpose of this contribution is to present information and describe the ways in which PISA mathematics has influenced the thought and action of some groups of people in Indonesia. These groups are the central government, teacher educators and the PMRI team (Realistic Mathematics Education, Indonesia).

Since the PISA survey was first launched by the OECD in 2000, Indonesia has participated but its results, especially in mathematics, have been low, with some instability. First, in 2000, Indonesia was ranked 39 of 41 countries in mathematics. Then in 2003, the rank was 38 of 40 countries and in 2006, 50 of 57 countries. In 2009 it decreased to 61 of 65, and to 64 from 65 in PISA 2012 (although the mean score was the same).

Figure 15.5 shows the mean scores for mathematics, science and reading for Indonesia for the first four PISA assessments. One can see that there has been a steady increase in mean scores for the reading scale since 2000. The 2009 mean for science shows a drop of 10 points from a fairly stable level in the previous three

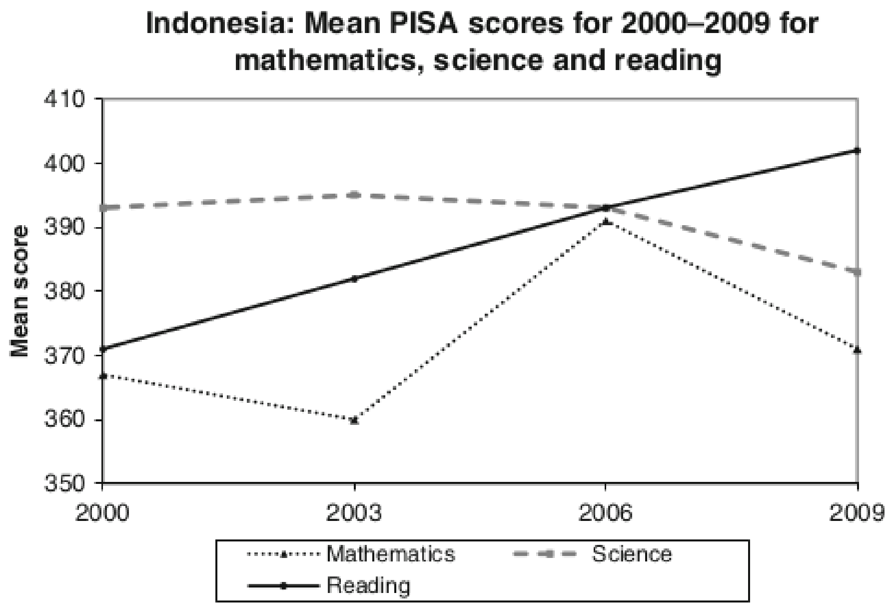

Fig. 15.5 Indonesia's mean PISA scores for 2000–2009 for mathematics, science and reading literacy (Stacey 2011)

assessments. The mathematics score has been more unstable. A different way of interpreting the data is that it has been steady, except for a relatively high score in 2006 (Stacey 2011).

PISA and RME in Indonesia

In July 2000, Professor Jan de Lange from the Freudenthal Institute in the Netherlands was invited as a keynote speaker in the National Conference on Mathematics at the Institute of Technology in Bandung. He presented new issues on mathematics education in the world, including PISA and Realistic Mathematics Education (RME). He also explained that the goals of mathematics education had changed from its earlier focus on mastering basic skills of mathematics with few applications. The new goals of mathematics education were to help students become good problem solvers and smart citizens.

A year later, the Freudenthal Institute and the National Centre for School Improvement (APS) both from the Netherlands, helped a group of Indonesian mathematicians and teacher educators headed by Professor R. K. Sembiring to set about reforming mathematics education in Indonesia. They adapted the Dutch instructional theory of Realistic Mathematics Education (RME) to its Indonesian version called PMRI (Pendidikan Matematika Realistik Indonesia). The PMRI project formally started in 2001 in four teacher education institutions and 12 primary schools in Java. By 2013, PMRI has been disseminated to the 23 of 33 provinces in Indonesia. More information about the project of PMRI can be seen at the PMRI portal http://p4mri.net and in the article by Sembiring et al. (2010).

In a 2007 national seminar on mathematics education in Palembang, Professor Fasli Jalal, the Director General of Higher Education presented, on behalf of the Minister of National Education of Indonesia, the PISA results for 2003 and 2006 on mathematics education. He urged the participants of the conference who were mostly school mathematics teachers, to learn from PISA results by improving the instructional quality and using PISA problems that had been released and were available on the web (OECD 2006, 2013b). Although that was only a suggestion, some people, including the contributor, were inspired to infuse the PISA spirit and use PISA problems in assessment and for research projects.

Zulkardi (2010) stated that there is a gap between the content of curriculum in Indonesia and the problems that were tested in the PISA mathematics. He also analysed the mathematics problems in the National Examination (UN). He found some mathematics problems were different to PISA. Most of the problems in the UN were in the low and middle difficulty levels of PISA. Therefore, he suggested to the government that some PISA-type problems should be included in the next UN so that students and teachers will be aware of the problems and these will automatically guide students to learn how to do PISA problems.

The Indonesian government has also used PISA results as one of several arguments for changing the mathematics curriculum to the new Curriculum 2013.

The PISA mathematics scores in 2009 show that the vast majority of Indonesian students are only able to understand mathematics up to level 3 of PISA, while significant proportions of students in many other countries reach levels 5 and 6. Therefore, it is assumed that the materials and the process of learning in Indonesia differ from those in developed OECD countries. Using PISA results as one of the arguments, the government of Indonesia changed the curriculum and the new curriculum was implemented starting from July 2013 at Years 1, 4, 7 and 10. The curriculum aims to include more problem solving, modelling and reasoning for mathematics and to use more information and communications technology for content and teaching delivery.

PISA for Students and Teachers

Kontes Literasi Matematika (KLM) is a national contest of mathematical literacy for high school students that began in 2010 (Widjaja 2011). The first KLM was initiated by the present contributor, Zulkardi, at Sriwijaya University working with about 200 junior high school students. The KLM contest begins by participants solving PISA-type problems in a written test, which is graded by a committee. Then, about 20 % of participants are chosen to compete in the semi-final, where participants have to explain their solutions or strategies in solving the problem. Lastly, from three finalists, the champion of mathematics in the province is selected.

In 2011, the second KLM was conducted in seven big cities namely Medan, Palembang, Jakarta, Yogyakarta, Surabaya, Banjarmasin and Makassar. In 2012, the contest added five new cities: Padang, Semarang, Malang, Kupang and Ambon. For the last 2 years, the grand championship of KLM has been conducted at the National Training Centre of Mathematics Education in Yogyakarta. The winners from each city participate in this national competition.

PISA results have slowly influenced the curriculum of mathematics education in teacher education. For instance, PISA has been part of the content in an assessment course at the Department of Mathematics Education Graduate Program at Sriwijaya University in Palembang. In this course student teachers learn what PISA problems are and how to design PISA problems using real-life contexts from Indonesia. Based on that course, some student teachers are doing research projects about how to design PISA-like problems.

Information About PISA

PISA was seen as newsworthy as soon as the national scores were released. For instance, Kompas, the biggest newspaper in Indonesia, has always published the PISA ranking, along with expert commentary on the PISA results and their implications for future leaders of Indonesia. Two sample articles are "70 % of Indonesian students will find it difficult to live in the twenty first century" (Erlangga 2012) and "Why Indonesian students have low achievement" (Nurfuadah 2013). However, little action followed their comments.

PISA mathematics in Indonesia has also featured in IndoMS-JME (http://jims-b.org) the *Indonesian Mathematical Society Journal on Mathematics Education*. One good article is an invited article written by Kaye Stacey (2011). Several other IndoMS-JME articles about PISA problems have been contributed by Zulkardi's research students (i.e. Kamaliyah et al. 2013). There is also a supplementary book (Wardhani and Rumiati 2011) on instrument evaluation for mathematics achievement that draws on both PISA and TIMSS, which has been prepared in the context of the project BERMUTU. In addition to the journal and news, the contributor has also designed a blog (http://pisaindonesia.wordpress.com/) that provides information about PISA Indonesia, PISA released problems, PISA-type problems and links to other blogs relating to PISA.

Summary

In summary, thinking about mathematics education has been substantially influenced in Indonesia by the ideas championed by the Freudenthal Institute and elsewhere about the need for realistic mathematics education. These ideas have been well publicised and made concrete by the PISA tests. Indonesia's poor results provide a challenge to the nation, which is being addressed in part by using PISA items as models for teaching and learning.

Iran

About the Contributors

Professor Zahra Gooya and Dr. Abolfazl Rafiepour are active contributors to mathematics education in Iran. Zahra Gooya from Shahid Beheshti University is the first mathematics educator to have had an in-depth influence on mathematics education in Iran. A celebration of her 20 years of contribution was recently organised by her colleagues. She has often written about international studies in the national journal, and many teachers have become familiar with these international developments through this path. Dr. Abolfazl Rafiepour, previously a secondary school mathematics teacher, was one of the first students to start a master of mathematics education under Professor Gooya in 2001. His master and doctoral theses analysed TIMSS data. In addition to his other work at Shahid Bahonar

University of Kerman, he is now director of Kerman Mathematics House, the second one to be established in Iran.

The Influence of PISA in Iran

Iran has participated in TIMSS since 1995, but not in PISA. Even though it has not participated as a country in PISA surveys, the PISA study has had a considerable influence on mathematics education research in Iran. This contribution documents some of the actions and changing thought that is evident in the work of teachers, mathematics education researchers, student activities and textbooks.

A number of master degree research studies from primary to tertiary levels have concentrated on mathematical modelling and applications, which is one of the focal points of PISA. Some papers are in Persian (or Farsi, the official language in Iran) including Ahmadi and Rafiepour (2013), Faramarzpour and Rafiepour (2013) and Karimianzadeh and Rafiepour (2012). There are also some papers in English that focus on modelling and applications from the Iranian students point of view, such as Rafiepour et al. (2012), Rafiepour and Abdolahpour (2013) and Rafiepour and Stacey (2009). There have also been presentations at the annual Iranian Conference on Mathematics Education, including in 2012 papers by Abdolahpour, Rafiepour and Fadaie on the level of mathematical modelling competence of students and by Esmaili, Esmaili and Rafiepour on the effect of different types of problems on students' emotions.

In addition, many interested graduate students have produced papers based on modelling activities that they have conducted with school children and have presented them at mathematics education conferences in Iran. Almost all these graduate students are mathematics teachers and they work voluntarily with students providing extra-curricular activities in the Mathematics Houses across Iran. Their main purpose is to bridge the gap between school and real-life mathematics and to promote mathematical literacy.

Since 2004, the first 10 days of the eighth month of the Iranian (Jalali) calendar (22–31 October) have been named the "Mathematics Decade" by the Iranian Mathematics Society. During this time, all Mathematics Houses are actively involved in out-of-school activities to promote mathematical literacy. Many students, teachers and ordinary people visit the Mathematics Houses and other related organisations and get involved with mathematical activities. To give an example, in 2011 and 2012, the Kerman Mathematics House used some of the PISA released items (OECD 2006, 2013b) related to modelling and applications during Mathematics Decade. Students were actively engaged in doing mathematics and enjoying it. The main purpose of these modelling activities was preparing students for using their mathematical knowledge together with their daily experiences to solve real-world problems.

Another effect of PISA is that policy makers claim that it has influenced the direction of change in the new national mathematics textbooks. However, the reality of this claim has been questioned by Gooya (2013) and Hasanpour and Gooya (2013). Their view is that mathematical literacy and real-life activities are not promoted only by the inclusion of real objects and phenomena in textbooks, but "realistic mathematics education" situations must be created where students are involved in solving problems in genuine real-world contexts. This will include some modelling activities. The present contributors have examined the way in which the new mathematics textbooks for Grade 9 students might cultivate mathematical literacy (Rafiepour et al. 2012).

To sum up, school mathematics in Iran has been implicitly influenced by the PISA rationale via different genuine activities that are designed and carried out by some mathematics teachers and educators. Presenting this new direction for mathematics education has created new opportunities for young researchers as well as bringing some hope for the former generation to think more seriously about the feasibility of what Freudenthal preached a long time ago about 'Realistic Mathematics Education'. At the formal policy level, despite the claims, nothing much has yet been done to address the deeper issues of mathematical literacy.

Israel

About the Contributor

Dr. Hannah Perl works for the Ministry of Education in Israel. She served for many years as the highly-respected Chief Inspector for Mathematics in the Ministry of Education, where all major decisions about mathematics, including curriculum, testing, and teachers, were her responsibility. She is now the head of the science division in the pedagogical secretariat of the Ministry, which includes supervision of all science and mathematics education. She has undertaken various research projects including very interesting research with graphing calculators long before the use of technological tools was in the headlines.

The Influence of PISA on Mathematics Education in Israel

In Israel, mathematics has always been an obligatory part of the school curricula beginning in kindergarten and continuing throughout the 12 grades of the school system. One of the traditional arguments in support of this decision (among other important ones) has been that mathematics, because of its abstractness and special reasoning tools, is a universal means for describing the world around us and thus constitutes a necessary ingredient of every student's problem solving tools. It was believed that equipping students with these tools suffices to ensure that they would be able use them whenever necessary to solve problems in a variety of contexts.

Although the middle school and high school curriculum stated the importance of developing students' ability to decide when and how to use mathematical concepts, actual teaching practices in schools emphasised traditional mathematical skills and understanding and did not implement the developing of students' ability to apply their mathematical knowledge to solve authentic problems in a wide range of situations.

The results of international surveys and assessments such as TIMSS and PISA have underscored the fact that the ability to identify and apply mathematics when it is needed does not develop by itself, even in mathematically oriented students, and has to be taught explicitly to both mathematically strong students and those who are not mathematically inclined. Thus mathematics education policy makers and curriculum developers in Israel were challenged to re-examine the mathematics curricula (Grades 7–12) and to rethink it in terms of the content, skills, processes and contexts that have the potential to bring our students to achieve mathematical literacy as defined by PISA.

There was a debate regarding the role of mathematical literacy in teaching mathematics to all students. It became necessary to answer the questions "What mathematics should be taught?", "To whom?" and "How?" The utilitarian approach was important but not acceptable as the main or only organising theme of the curriculum. Other traditional considerations that were considered equally important were teaching mathematics for intellectual pleasure, noticing the aesthetics of mathematics and appreciating it as an important cultural achievement of mankind, understanding abstract structures, solving pure mathematical problems, and developing high order thinking skills. The Mathematics Professional Advising Committee to the Ministry of Education revised the middle school curriculum taking all these aspects into consideration.

In middle schools (Grades 7–9) mathematical literacy has become a part of the new curriculum for all students. Curriculum developers and textbook writers have broadened their traditional approach to school mathematics and realised that it is possible to find meaningful, interesting and authentic applications that are mathematically challenging for different grade levels and students' capabilities. Formal mathematics competency was not abandoned but reduced in size and relegated to the higher grade levels. It was also understood that in order for students to effectively deal with these new tasks, teaching practices must change and learners will have to be taught in new ways that, hopefully, will raise the learning and teaching standards and also support intellectual enjoyment for all. Resources were made available to implement these changes. They included the design of new teaching and learning materials, teacher professional development and the appointment of school instructors to assist teachers in the classrooms.

In high school (Grades 9–12) a new mathematics curriculum is currently under development. Mathematical literacy will be taught to all students but in different ways at different levels depending on students' mathematical abilities and inclinations. Students who are not mathematically inclined will focus on mathematical literacy with higher mathematics content so that they will be able to autonomously engage a wide range of real-life mathematical and basic statistical situations. For mathematically oriented students the concept of mathematical literacy will be broadened to include not only real-life situations but tasks that are more complex and abstract and which integrate a larger range of topics (including applications to other scientific disciplines), the reading of advanced mathematical texts and use of higher level mathematics concepts and competencies. Levels of performance will be in accordance to the six levels defined in the proficiency scale descriptions of the PISA Framework.

All mathematics curricula will incorporate use of twenty first century technology both in learning and assessment. Details of the curriculum changes in the middle school can be found (in Hebrew) on Israel's Ministry of Education website: http://cms.education.gov.il/EducationCMS/Units/Mazkirut_Pedagogit/Matematika/ChativatBeinayim/.

Korea

About the Contributor

Kyungmee Park is a professor at Hongik University in Korea, teaching pre-service teachers. She was a member of the PISA Mathematics Expert Group from 1998 to 2004, and worked as a researcher at the Korean Institute of Curriculum and Evaluation, responsible for PISA 2000 in Korea. She is involved in mathematics curriculum and textbook development, writes mathematical columns in several daily newspapers, and has contributed to the popularisation of mathematics for the general public.

Impact on Mathematics Curriculum

The impact of PISA on mathematics education in Korea can be discussed in the two aspects of curriculum and textbooks. The Korean Institute of Curriculum and Evaluation (KICE), which is responsible for the development of mathematics curriculum in Korea, was heavily influenced by OECD's DeSeCo project (Rychen and Salganik 2003). DeSeCo is an abbreviation of 'Definition and Selection of Key Competencies'. Over 3 years, KICE attempted to similarly identify key competencies for Koreans of the future (KICE 2009). As a result, ten core competencies were identified: creativity, problem solving, communication skills, information processing, interpersonal relations, self-management, basic learning skills (literacy), citizenship, global awareness and vocational development. These competencies suggested directions for constructing national curriculum. However, the new mathematics curriculum of Korea announced in 2011 did not explicitly mention these key competencies. Instead, it emphasised the processes of doing mathematics. The mathematics curriculum states:

> Crucial capabilities required for members of a complex, specialised, and pluralistic future society are believed to be fostered by learning and practising mathematical processes, including mathematical problem solving, communication, and reasoning. (Ministry of Education, Science, and Technology 2011, p. 2)

In fact, problem solving, communication, and reasoning had already been mentioned in the previous mathematics curriculum, but the 2011 curriculum put more emphasis on them and intends to implement these three mathematical processes in the content. This emphasis can be interpreted as an influence of OECD DeSeCo and PISA. In particular, the mathematical processes are part of the mathematical competencies presented in the PISA 2009 Mathematics Framework (OECD 2010a).

Impact on Textbooks

The 2011 national mathematics curriculum emphasises contextual learning from which students can grasp mathematical concepts and make connections with their everyday lives. Thus the new textbooks developed for this curriculum include more real-life contexts. In addition, a 'story-telling textbook' was introduced as a prototype for mathematics textbooks. Story-telling mathematics textbooks have already been developed and are being used in Grades 1 and 2 from 2013. In the middle school and high school, the story-telling approach has been recommended to be adopted for textbooks and sample chapters have been prepared.

Here is an example. The chapter on "Measuring Length" in Grade 2 is called "The emperor's new clothes" (MEST 2013). The plot for the story is to make clothes for the King to wear on his birthday. Students play the role of the king and tailors, and they come to see the necessity of having standard units for measurement because otherwise the measurements vary from one tailor to another. Students naturally acquire the concept of standardised units through problem solving in this fairy tale. By learning mathematics through story-telling textbooks, students are expected to understand a concept in conjunction with a story that provides a practical impetus for and application of the concept. In the meantime, mathematical processes such as problem solving, communication, and reasoning are naturally embedded in each chapter (Kwon 2013).

Figure 15.6 shows three pages from the chapter "Measuring Length". On page 134, two tailors measure the length of the arms of King by using their palms. The male tailor on the left says "two palms" and female tailor says "three palms". Here, students are expected to think about the problems caused by these arbitrary body units to measure length. On page 137, students measure objects in the classroom using various body units. Before the metric system, body units such as feet were prevalent. Through this activity, students indirectly experience the historical development of measuring units. On page 150, the king and the tailors agree to introduce

Fig. 15.6 Sample pages from story-telling textbook (MEST 2013) (Reproduced with permission)

the centimetre to measure length as a standard unit. Students are expected to appreciate this uniform unit, which can be used in any place without confusion.

The PISA assessment takes a broad approach to measuring knowledge, skills and attitudes, moving beyond the school-based approach towards the use of knowledge in everyday tasks and challenges. Thus, despite often using fantasy settings, the story-telling textbooks are putting into practice the context-oriented nature of the OECD PISA philosophy.

Singapore

About the Contributor

Professor Berinderjeet Kaur is a professor of mathematics education and Head of the Centre for International Comparative Studies at the National Institute of Education in Singapore. Since 1995, she has been involved in the secondary analysis of TIMSS data for Singapore and other countries. She was the mathematics consultant to TIMSS 2011 and is presently a member of the Mathematics Expert Group for PISA 2015.

Affirmation of Mastery and Directions

Singapore participates in international studies to benchmark itself internationally and to learn from best practices of other education systems. Singapore has participated in TIMSS since 1995 for both Grades 4 and 8. The results of every administration of TIMSS for Singapore have affirmed that students have mastery of content knowledge according to international standards. In addition they are highly proficient in the application of their knowledge and in reasoning with their mathematics.

Although the first administration of PISA was in 2000, Singapore did not participate in PISA until 2009. As Singapore is a small country with only about 170 secondary schools, support must be obtained from all the schools as such international benchmarking studies require the participation of at least 150 schools.

The results of PISA 2009 Mathematics showed that Singapore was ranked second to Shanghai. The positive outcome affirmed that 15-year-olds in Singapore were able to apply reason and transfer their knowledge of mathematics in new, unfamiliar contexts, and demonstrate the ability to think critically and solve real-life problems. This outcome has affirmed that the systemic adoption of the "Thinking Schools, Learning Nation" vision (Goh 1997) for all schools in Singapore has had the desired and valued impact where students are acquiring the knowledge and skills necessary for the workplace.

Irrespective of the results in TIMSS and PISA, the mathematics school curriculum is revised every 6 years. The revision is guided by global developments, the needs of and feedback from stakeholders (including teachers and school leaders), as well as developments in the teaching, learning and assessment of mathematics. This allows the curriculum and resulting classroom practices and assessment modes to be revised periodically so that they remain relevant for students and for the economy.

Spain

About the Contributors

Luis Rico, José Luis Lupiáñez and Rosa M. Caraballo all work at the University of Granada in Spain. Dr Rico has been Professor of Didactics of Mathematics at the University since 1992, where he leads the Research Group on Didactics of Mathematics. He was member of the Mathematics Expert Group for PISA 2003. His main subjects of research are the design and development of mathematics curriculum, quality of mathematics training programs and quality indicators for mathematics education. In 2012 he was awarded the Social Sciences Research Prize "Ibn-Al-Khatib", by the Government of Andalusia. Dr Jose Luis Lupiáñez is a lecturer at the Mathematics Education Department of the University of Granada (Spain) where he teaches prospective primary and secondary teachers. His research focuses on teachers' learning processes, mathematics teacher training, mathematical competences and learning expectations. Rosa M. Caraballo, a Puerto Rican research student at the University of Granada, completed a master's dissertation on Spanish National Assessment tests in 2010, which are based on the PISA Mathematics Framework. Her doctoral dissertation is on mathematical tasks to assess mathematical literacy.

Mathematical Competency and the Spanish Curriculum

In 2006 the Spanish Education Fundamental Act (LOE, its Spanish acronym) was first passed and it remains in force. The Act proposed an evolution of the educational orientation in Spain and improvements to be followed in the succeeding years. The LOE responds, first, to the social changes of recent decades and to the demands of Spanish citizens for a general and democratic education. Second, it attends to the trend towards high quality education, which is acclaimed by the countries of the European Union in their agreements since the late twentieth century (Ministerio de Educación y Ciencia 2006).

As a definite and innovative tool, the Act introduced the concept of competency at all educational levels in the curriculum taking an inherently wide general conception. The Act defines curriculum as "the set of objectives, key competencies, pedagogic methods and assessment criteria outlined for each one of the subject areas the law regulates" (Ministerio de Educación y Ciencia 2006, p. 17166).

The LOE was grounded on the concept of lifelong learning. Education is perceived as an ongoing and dynamic learning process of progressive qualification.

> Everyone should have the opportunity to learn throughout life, in and out of the educational system in order to acquire, update, add to and expand his or her competencies, knowledge, abilities, aptitudes and skills for personal and professional development. (p. 17166)

Following the LOE provisions, the education system aims to provide students with the knowledge and skills necessary to perform effectively in the society of which they are part, in mathematics as well as in other subjects. Key competencies set these expectations for learning and training based on the DeSeCo (OECD 2005) and the Eurydice Projects (Unidad Europea de Eurydice 2002).

The Spanish curriculum does not use *mathematical literacy*; instead it uses the (parallel) term *mathematical competency*. The reason for this change of name is discussed in Chap. 1 of the present volume. Mathematical competency is considered to be one of the main basic learning expectations of the whole Spanish educational system. It should be understood as similar to mathematical literacy as defined by PISA Mathematics Frameworks for 2003 and 2012 (OECD 2003, 2013a), and the associated ideas of Niss (2002).

Diagnostic Assessments

On lifelong learning and basic competencies development, the LOE stipulates that diagnostic assessments of key competencies will be carried out at the end of the fourth course of primary education and the second year of compulsory secondary education (Ministerio de Educación y Ciencia 2006). They are preliminary and complementary to the PISA assessment; it is expected they will provide useful information to establish the progress of key competencies, especially the mathematics one as the law regulates.

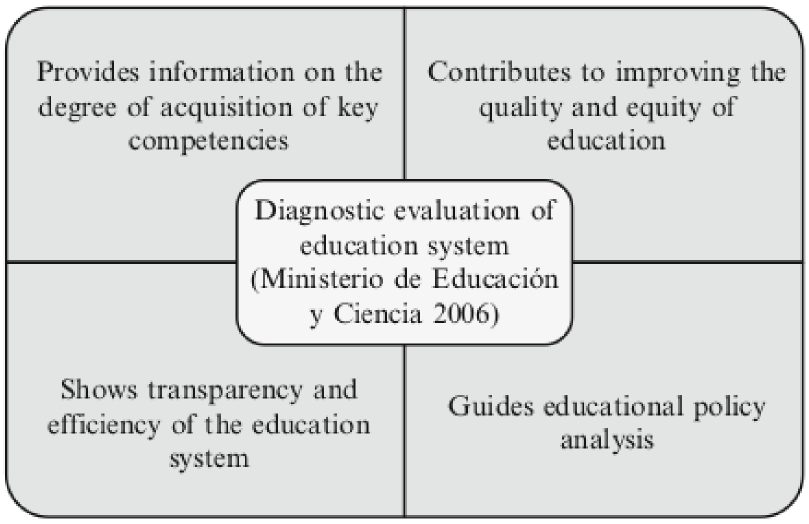

Fig. 15.7 Main goals of diagnostic evaluations of the Spanish education system

It is important to stress that the objective of these assessments is not to determine whether, and to what degree, the intended curriculum has been implemented. Rather, it aims to know the students' ability to apply their acquired learning when facing tasks that require them to cope with real-life situations. In addition, changes in the curriculum and key competencies introduced by the LOE, allocate priority to learning expectations. Figure 15.7 summarises the main goals of the general assessments.

Competencies and Mathematical Literacy Assessment

For mathematics in particular, diagnostic evaluations serve as training for the mathematical literacy evaluation that will take place at the end of the compulsory period through PISA. Here we can establish links between mathematical competency development and mathematical literacy at the end of compulsory education.

In order to assess mathematics competency, diagnostic assessments consider three dimensions: (1) the situations and contexts in which the competency is applied, (2) the processes that enable the student to apply the acquired knowledge to the contexts, and (3) the curricular content embedded in the full range of students' knowledge and skills. Of these three dimensions, the description of the contexts and processes are shared with the PISA Framework, whilst the content is described in terms of traditional curriculum areas rather than the *overarching ideas* of the PISA 2003 Framework (and the content categories of PISA 2012 Framework).

The link between PISA assessments and quality indicators for the Spanish education system is based on the notion of competency as a central concept (Rico 2011). There is a quality indicator (R2.2) for the second year of secondary school that is measured by the overall results achieved in the mathematical competency in the general diagnostic evaluation described above. The indicator for age 15 in mathematics (R3.2) is determined by the results of the international PISA study. Because it is included in the Education Quality Indicators, together with the national and regional diagnostic tests (Instituto de Evaluación 2011), the PISA assessment is very important in the Spanish educational system.

PISA Results

Spain has participated in all five PISA assessments that have been conducted so far. Table 15.1 presents the number of participating Spanish students and their average score in the four PISA assessments from 2000 to 2009, in the three main key competencies. The OECD average score was initially set at 500 with a standard deviation of 100. All of the average scores for Spain are below the OECD average, including the score (484) for PISA 2012. With a standard deviation of 100, approximately two thirds of students across the OECD score between 400 and 600. The number of students tested has been increasing in successive PISA administrations because of a desire to obtain reliable estimates of the performance of regional communities within Spain.

The poor performance of Spanish students in recent international comparative assessments, including PISA, has created widespread public concern. As a response, deep curriculum reforms were requested. In recent years, the results have systematically generated a major media debate that has often placed political blame on the incumbent government and emphasised the more negative aspects (Aunión 2007; Díaz and Suárez 2010). Notwithstanding, critical analysis that highlights achievements in addition to detecting deficiencies has been also carried out. Moreover, outcomes have been analysed from a constructive point of view (Recio 2010). As stressed by Rico:

> You have to understand and explain why Spanish results in PISA assessments are not satisfactory and therefore, channel the discussion towards the adoption of radical, urgent and appropriate measures to improve the curriculum and teacher training in mathematics. (Rico 2011 p. 10)

Recently, the Spanish Federation of Teachers of Mathematics organised a meeting aimed to study the design, organisation and impact of national and

Table 15.1 Number of participating Spanish students and their average scores in PISA assessments

Year	Average score			
	Number of students	Reading	Mathematics	Science
2000	6,214	493	476	491
2003	18,000	481	485	487
2006	20,000	461	480	488
2009	26,000	481	483	488

international assessments in Spanish mathematics education. They found that poor coordination of the various professional and government sectors involved in this process have great impact on the teaching and learning of mathematics.

Final Remarks

The impact of PISA has affected the foundation and organisation of the compulsory mathematics curriculum in Spain. The results of the evaluations raise questions about the quality of the system and show weak approaches to incorporating core competencies in school practice. Social concern is evident and the interest of parents and teachers to adopt corrective measures is strong. As in other countries, there has been no questioning of the learning model established by PISA.

There are favourable conditions for improving the institutional assessment system, involving both the general public and professional sectors. We must remember that PISA does not evaluate students or teachers; PISA provides indicators on the quality of the system. Everything is ready to improve the level of Spanish mathematics education.

United States of America

About the Contributor

Solomon 'Sol' Garfunkel is an American mathematician who has dedicated his career to mathematics education. Since 1980, he has been the executive director of the Consortium for Mathematics and Its Applications (COMAP), an award winning non-profit organisation that creates learning environments where mathematics is used to investigate and model real issues in our world. One acclaimed product is "For All Practical Purposes: An Introduction to Contemporary Mathematics", a television series and now textbook. Dr Garfunkel was a member of the PISA 2012 Mathematics Expert Group. In 2009, he was awarded the Glenn Gilbert National Leadership Award from the National Council of Supervisors of Mathematics.

An American Reminisces on PISA

First, to put this reminiscence in context, I should state that I was a 'math warrior', from what I regard as the losing side of the 'math wars' that raged in the United States especially during the 1990s and continue to some extent today. For readers unfamiliar with these issues, Schoenfeld (2004) provides a history of the debate and

Harwell et al. (2009) is one reference discussing the hotly contested differences over approaches to mathematics curriculum and teaching.

My background in mathematics education is in curriculum reform. I have been involved in the creation of literally hundreds of modules, textbooks, and one comprehensive 4-year secondary school curriculum. All of these exemplify the importance and centrality of mathematical applications and modelling. They are about teaching mathematics through its contemporary use. And they are in the spirit of the 1989 NCTM standards. Without rehashing the issues of the 'math wars', it is fair to say that the approach of the 1989 NCTM standards has now been supplanted in the U.S.A. by the new Common Core State Standards in Mathematics (CCSSM 2010). While applications and modelling get a nod in these standards, they are certainly not as central as arithmetic and algebraic fluency and the exposition of mathematical structure. I have been an outspoken critic of the CCSSM, although I am working with a number of organisations to make standards implementation go as smoothly as possible—for our students' sake. One such group is *Achieve* (www.achieve.org), a non-profit organisation set up to provide technical assistance and research capacity to U.S. states on educational reform, especially standards, assessments, curriculum and accountability systems. I have consulted for *Achieve* on a number of projects. I am usually seen to be on the philosophical 'left', balancing off other consultants who occupy space on the philosophical 'right'.

Now, I have kept up with PISA and the work of the Mathematics Expert Group (MEG) through personal friends and colleagues since 2003. As a consequence I was aware that PISA had come in for some criticism from some members of the mathematics research community for not being 'mathematical' enough. This criticism by and large came from conservative 'math warriors', and clearly the OECD's PISA Secretariat was sensitive to their comments. *Achieve* was brought in to assist the international contractors with the preparation of the Framework for mathematical literacy for 2012, as well as conducting an international consultation on the earlier and proposed frameworks and external validation of the alignment of the final item pool to the agreed framework and the presence of explicit mathematics. Moreover, the newly constituted MEG for 2012 included three U.S. members. This high representation of one country was unprecedented and certainly left the impression that the OECD felt the need for stronger U.S. involvement.

It is worth noting that this U.S. interest in PISA is a relatively new phenomenon. In 2003 I all but begged the National Science Foundation (NSF) to look at disaggregated PISA data to investigate whether students who had gone through the comprehensive reform curricula funded by NSF had significantly different results from other students. These curricula had been aligned directly to the NCTM Standards and thus were geared to improving mathematical literacy. NSF showed no interest at the time. Mostly this was because PISA was not on the U.S. radar in the way that TIMSS was.

However, when the 2003 PISA survey results were announced, the situation changed. Critics of the reform movement and the NCTM Standards were quick to use the mediocre U.S. results as 'proof' that those standards and the curricula that were designed to embody them were a failure. And therein lay an unintended consequence. Up to that point, as I indicated, PISA was far from a U.S. household name. In fact, it had pretty much been dismissed by the right because it measured mathematical literacy, which was in their eyes not as important as mathematical skills. Much more credibility was given to comparisons in curriculum-based assessments, i.e. assessments that are designed around systematic testing of specific mathematical topics taught in schools. But in emphasising the poor results on the PISA survey, PISA itself became emphasised and its importance in the U.S.A. grew from there.

Between 2003 and 2012 we have seen the rise of a new reform movement in the U.S.A. culminating in the CCSSM. And therefore, to some extent the shoe is now on the other foot. When the PISA 2003 results were announced it was clearly unfair to blame the poor U.S. results on the reform curricula at that time, mainly because they had not achieved significant market penetration above the elementary school level. At this time it would be foolish to blame any poor results in the 2012 survey on the policies of the current U.S. administration. But such logic seldom rules in political debates. I think it is safe to predict that any poor results in PISA 2012 will be blamed not on policies of the prior administration but unfairly on the current U.S. government, and possibly on CCSSM despite its very recent implementation.

Given the new-found importance of PISA results in the U.S.A., I believe that there was a move to make PISA a more curriculum-based assessment. The minutes of the first meeting of the 2012 MEG highlight directions from the PISA Secretariat to make the mathematics involved in solving PISA tasks explicit, that authentic tasks were desirable but that these contexts should not constrain the level of mathematical competencies assessed, and that task difficulty should be driven by the mathematics involved and not the complexity of the task context. I believe that the inclusion of three MEG members from the U.S.A. and the involvement of *Achieve* were meant to be steps to move PISA mathematics in accordance with those directions. That a final product evidently acceptable to all stakeholders was achieved is a testament to the MEG members, old and new, to the intellectual leadership of ACER, and to *Achieve* as well.

I found the first meeting of the MEG somewhat tense. But with each subsequent meeting, the MEG came closer and closer to consensus. At our final meeting in Heidelberg in October 2012, MEG member after MEG member spoke to the integrity of the process and the intellectual achievement of the 2012 Mathematics Framework. Given the diversity of the membership and the politically charged atmosphere in which we began, this was no mean feat. I think that it is fair to say that all members believe in and appreciate the importance of promoting mathematical literacy, in the sense of the new Framework definition, throughout the world. We understand that PISA is not a horse race, no matter how the results may be viewed or used. With the change of international contractor for PISA 2015 leading to the exit of ACER from the field and the increased involvement of organisations whose core businesses often involve the commercial publication of textbooks, it is our sincere hope that the essential spirit of PISA can be maintained as it was with the 2012 MEG.

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