ARE THE COMPETENCIES OF SCIENCE TEACHERS AND SCIENTIFIC LITERACY OF SOCIETY ESSENTIAL FOR SUCCESS OF PHYSICS STUDENTS?

Jozefina Turlo
Institute of Physics, Torun, PL

Plan of presentation

I. Introduction

II. Summary of the results of international studies

1. TIMSS, PISA
2. International Physics Olympiads
3. First Step to Nobel Prize
4. ROSE

III. Factors influencing effectivenes of teaching

IV. Nuffield Report on Science Education in Europe: Critical Reflections

V. Research Physicists also have responsibilities in physics education

I. Introduction

1. The features of our time:

- globalisation,
- economy development based on knowledge,
- social transformations,
- dramatically accelerating progress in new technologies (including communication based on ICT). New jobs.

2. Implications for science educations:

- science for all not just for some (curricula and STL),
- science education for innovations (inquiry methods of teaching),
- teacher competencies and their enthusiasm as a background of success.

II. Summary of the results of international studies

1a. TIMSS

Trends in International Mathematics and Science Study

- Designed for fourth and eighth grades to address concerns about the quantity, quality, and content of instruction.
- For identification of progress or decline in student achievements.
- 50 countries from all over the world particiated in the years 1995 - 2007
- The best results were usually achieved by Singapore, Taiwan, Korea, Estonia, Japan, Hungary, Netherlands.

1b. PISA

Programme for International Student Assessment

•Finland, with an average of 563 score points, was the highest performing country on the PISA 2006 science scale.

•Six other high-scoring countries had mean scores of 530 to 542 points: Canada, Japan and New Zealand and the partner countries/economies Hong Kong-China, Taiwan and Estonia.

•Australia, the Netherlands, Korea, Germany, the United Kingdom, the Czech Republic, Switzerland, Austria, Belgium and Ireland, and the partner countries/economies Liechtenstein, Slovenia and Macao-China also scored above the OECD average of 500 score points.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT OECD

1b. PISA

- On average across OECD countries, 1.3% of 15-year-olds reached Level 6 of the PISA 2006 science scale, the highest proficiency level. These students could consistently identify, explain and apply scientific knowledge, and knowledge about science, in a variety of complex life situations.

- In New Zealand and Finland this figure was at least 3.9%, three times the OECD average. In the United Kingdom, Australia, Japan and Canada, as well as the partner countries/economies Liechtenstein, Slovenia and Hong Kong-China, between 2 and 3% reached Level 6.

- The number of students at Level 6 cannot be reliably predicted from a country's overall performance. Korea was among the highest-performing countries on the PISA science scale, with an average of 522 score points, while the United States performed below the OECD average, with a score of 489. Nevertheless, the United States and Korea had similar percentages of students at Level 6.

1b. PISA

•The number of students at very low proficiency is also an important indicator in terms of citizens' ability to participate fully in society and in the labour market. At Level 2, students start to demonstrate the science competencies that will enable them to participate actively in life situations related to science and technology. Across the OECD, on average 19.2% were classified as below Level 2, including 5.2% below Level 1.

•Males and females showed no difference in average science performance in the majority of countries, including 22 of the 30 OECD countries.
•However, similarities in average performance mask certain gender differences: In most countries, females were stronger in *identifying scientific issues (using academic knowledge),* while males were stronger at *explaining phenomena scientifically.*

•On average across OECD countries, around one-third of all variation in student performance (33%) was between schools, but this varied widely from one country to another.

1b. PISA

•In Finland less than 5% of the overall performance variation among OECD countries lay between schools and in Iceland and Norway it was still less than 10%. Other countries in which performance was not very closely related to the schools in which students were enrolled included Sweden, Poland, Spain, Denmark and Ireland as well as the partner countries Latvia and Estonia.

•Students' socio-economic differences accounted for a significant part of between school differences in some countries. This factor contributed most to between-school performance variation in the United States, the Czech Republic, Luxembourg, Belgium, the Slovak Republic, Germany, Greece and New Zealand, and the partner countries Bulgaria, Chile, Argentina and Uruguay.

•There is no relationship between the size of countries and the average performance of 15- year-olds in PISA. There is also no cross-country relationship between the proportion of foreign-born students in countries and the average performance of countries.

2. International Physics Olympiads

INTERNATIONAL PHYSICS OLYMPIADS (2005 - 2009)
1ST idea Czech Republic, Hungary and Poland (1965)

Year	Countries	Best scores (points)	Who?	Other Medals
2005	72	49,5	**Gabor Halasz, Hungary** **Ying – Hsuan Lin, Taiwan** + Singapore, China	46 Gold (G) – 45 p 26 Silver (S) 63 Bronze (B) 92 Honorable Mentions (HM)
2006	82	47,2	**Mailoa Jonathan Pradane,** Indonesia +China, Hungary, Singapore	37 G – 37 p 49 S 82 B 81 HM
2007	69	48,8	**Youngjoon Choi, South Korea** +China, Slovakia, Hungary, Russia	37 G – 44 p 46 S 51 B 31 HM
2008	82	44,6	**Longzhi Tan, China** +Taiwan, Romania, Chile	46 G – 33 p 47 S 78 B 87 HM
2009 **40th**	72	48,2	**Handuo Shi, China** **Yu-An Chen, China** +Korea, Poland	Lack of statistics

3. „First Step to Nobel Prize" competition

REMARKS ON "FIRST STEP TO NOBEL PRIZE"

Year	Countries	Number of Papers	A – Aworded papers	R – Honorable Mentions	Activity percent (%)
2005	1. Serbia	23	10	9	66,3
	2. Singapore	19	5	8	52,6
	3. Czech Rep.	18	2	11	44,4
	4. USA	48	13	12	43,8
	5. Latvia	30	3	11	32,2
	6. Israel	35	1	17	30,0
	7. Poland	53	5	12	25,3
	8. Belarus	26	0	8	23,4
	9. Russia	71	5	16	22,4
	10. Ukraine	128	11	20	20,5
2006	1. Serbia	27	10	9	56,5
	2. Czech Rep.	19	2	11	43,9
	3. USA	56	13	15	42,1
	4. Singapore	29	6	9	40,5
	5. Bulgaria	12	3	2	39,6
	6. Latvia	32	3	11	30,2
	7. Israel	36	7	17	29,9
	8. Croatia	29	2	6	26,7
	9. Indonesia	18	4	0	26,4
	10. Poland	57	5	12	23,5
2007	1. Serbia	27	10	9	56,5
	2. USA	60	13	17	41,9
	3. Singapore	29	6	9	40,5
	4. Bulgaria	12	3	2	39,0
	5. S. Korea	10	1	4	36,7
	6. Latvia	34	3	13	31,0
	7. Israel	40	1	19	29,9
	8. Croatia	29	2	6	26,0
	9. Poland	57	5	12	23,5
	10. Russia	87	7	6	23,2

% = (A+ R/2+C/4+I/3)/P *100%
where:
P – number of Papers received,
C – Contributed papers,
I – Instruments and devices.

4. ROSE – The Relevance of Science Education

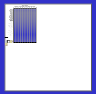
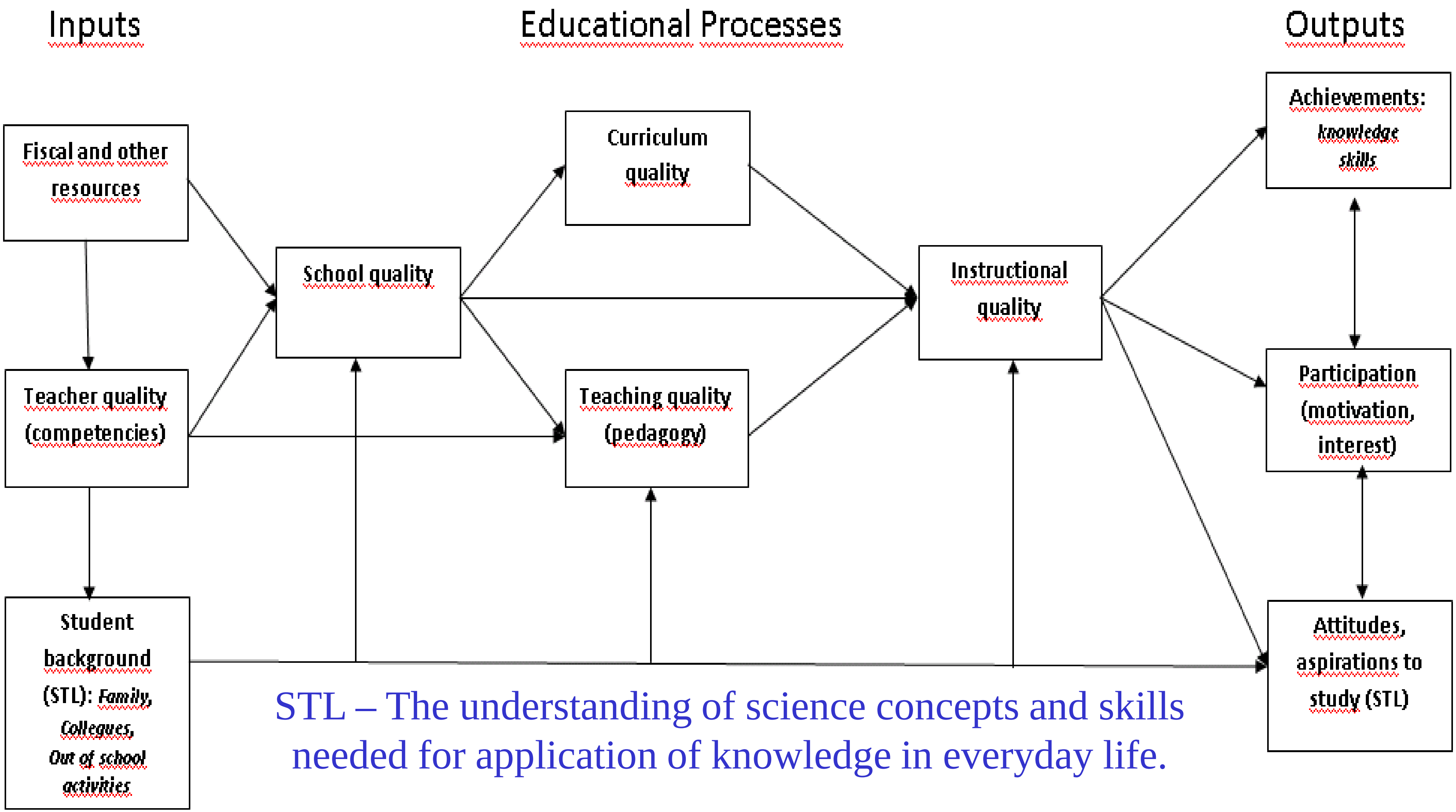


Fig 1: Data from the ROSE study showing students' responses to the question 'I like school science better than most other school subjects'. Percentage answering Agree plus Strongly agree. Male and female symbols.

III. Factors influencing effectivenes of teaching



STL – The understanding of science concepts and skills needed for application of knowledge in everyday life.

III. Factors influencing effectivenes of teaching

Teacher quality

Teacher competencies (placed in teacher training standards):

1. Subject knowledge
2. Subject application

   (pedagogy, methodology of teaching – learning)
3. Class management
4. Assessment (evaluation), recording of students' progress
5. Further professional development

   (for reflection and creativeness, being able to innovate: applying inquiry methods, ICT, foreign languages, work in collaboration, etc.)

IV. Nuffield Report on Science Education in Europe: Critical Reflections' 2008 by J. Osborne, J. Dillon

The Nuffield Foundation

The report message is clear.

There are shortcomings in curriculum, pedagogy, assessment and teacher quality, but the deeper problem is one of fundamental nature. School science education, has never provided a satisfactory education for the majority. Now the evidence is that it is failing in its original purpose, to provide a route into science for future scientists.

Taking these into account a special 19 Person Committee published the Report to the Nuffield Foundation on „Science Education in Europe: Critical Reflections" which consists of 7 important recommendations:

IV. Nuffield Report on Science Education in Europe: Critical Reflections by J. Osborne, J. Dillon

The Nuffield Foundation

Recommendation 1

The primary goal of science education across the EU should be to educate students both about the major explanations of the material world that science offers and about the way science works. Science courses whose basic aim is to provide a foundational education for future scientists and engineers should be optional.

Whilst science and technology are often seen as interesting to young people, such interest is not reflected in students' engagement with school science that fails to appeal to too many students. Girls, in particular, are less interested in school science and only a minority of girls select careers in physical science and engineering. The reasons for this state of affairs are complex but need to be addressed.

IV. Nuffield Report on Science Education in Europe: Critical Reflections

Let's exemplify the interest in science for boys and girls.

Boys	Girls
Explosive chemicals How it feels to be weightless in space How the atom bomb functions; Biological and chemical weapons and what they do to the human body; Black holes, supernovae and other spectacular objects in outer space.	Why we dream when we are sleeping and what the dreams might mean Cancer – what we know and how we can treat it How to perform first aid and use basic medical equipment; How to exercise the body to keep fit and strong; Sexually transmitted diseases and how to be protected against them

The top 5 items boys would like to learn about in science and the top 5 for girls.

IV. Nuffield Report on Science Education in Europe: Critical Reflections

Recommendation 2

More attempts at innovative curricula and ways of organising the teaching of science that address the issue of low student motivation are required. These innovations need to be evaluated. In particular, a physical science curriculum that specifically focuses on developing an understanding of science in contexts that are known to interest girls should be developed and trialled within the European Union.

Recommendation 3

EU countries need to invest in improving the human and physical resources available to schools for informing students, both about careers *in* science – where the emphasis should be on why working in science is an important cultural and humanitarian activity – and careers *from* science where the emphasis should be on the extensive range of potential careers that the study of science affords.

IV. Nuffield Report on Science Education in Europe: Critical Reflections

Student engagement or interest in science is largely formed by the age of 14. This situation has implications both for the formal curriculum and for opportunities to engage with science outside the classroom.

Recommendation 4

EU countries should ensure that:

- teachers of science of the highest quality are provided for students in primary and lower secondary school;
- the emphasis in science education before 14 should be on engaging students with science and scientific phenomena. Evidence suggests that this is best achieved through opportunities for extended investigative work and 'hands-on' experimentation and not through a stress on the acquisition of canonical concepts.

IV. Nuffield Report on Science Education in Europe: Critical Reflections

Recommendation 5

Developing and extending the ways in which science is taught is essential for improving student engagement. Transforming good teaching practice across the EU is a long-term project and will require significant and sustained investment in continuous professional development.

Recommendation 6

EU governments should invest significantly in research and development work on assessment in science education. The aim should be to develop items and methods that assess the skills, knowledge and competencies expected of a scientifically literate citizen (STL).

Recommendation 7

Good quality teachers, with up-to-date knowledge and skills, are the foundation of any system of formal science education. Systems to ensure the recruitment, retention and continuous professional training of such individuals must be a policy priority in Europe.

V. Research Physicists also have responsibilities in physics education

ORIGINAL AND FASCINATING LESSONS OF MARIA SKŁODOWSKA - CURIE AROUSING INTEREST IN SCIENCE

You have to be persistent
and believe that you are able
to do something well...
Maria Skłodowska-Curie

1903 – Nobel Prize in physics for discovery of polonium and radium

1911 – Nobel Prize in chemistry for exhalation of radium as a pure chemical element.

V. Research Physicists also have responsibilities in physics education

MARIA SKLODOWSKA – CURIE AS PHYSICS TEACHER of A CLASS OF 12 year old STUDENTS

1907 – creation the Society of Scientists for Experimental Teaching.

Teachers:
Maria Sklodowska-Curie - physics,
Jean Perrin - chemistry,
Pierre Langevin - mathematics,
Henri Mouton - science,
Henrietta Perrin - French, history,
Alice Chavannes - English, German, geography,
Jean Magrou - drawing.

The air inside of dried pig blister.

V. Research Physicists also have responsibilities in physics education

FEATURES OF ACTIVE TEACHING METHODS

- Not verbal teaching,
- learning from nature and demonstration of exciting science hands-on experiments with the use of low-cost materials, explained by great scientists,
- activity of students by doing individual investigations,
- lively discussion (brainstorming) with the use of simple and understandable language,
- acquiring valuable social skills through personal examples of teacher genius: hard-working, persistence, honesty, sensitivity for needs of others, etc.

If you think that education is not important

or too expensive you didn't try ignorance yet…

Chinese proverb

„Train today for a job of tomorrow".

USA also working to improve its science education:

President Barack Obama advertised a new campaign: "Educate to Innovate"

Thank You for your attention!