TIMSS Advanced 2008

a research project

- An international comparative study in the final grade of upper secondary school:
  - mathematics (in Norway 3MX)
  - physics (in Norway 3FY)
- A trend study showing development over time
  - nationally
  - internationally

Elaborate quality insurance of translation, implementation, and participation

Institutt for lærerutdanning og skoleutvikling UiO

Abridged report 9 Dec. 2009 in Norwegian and English

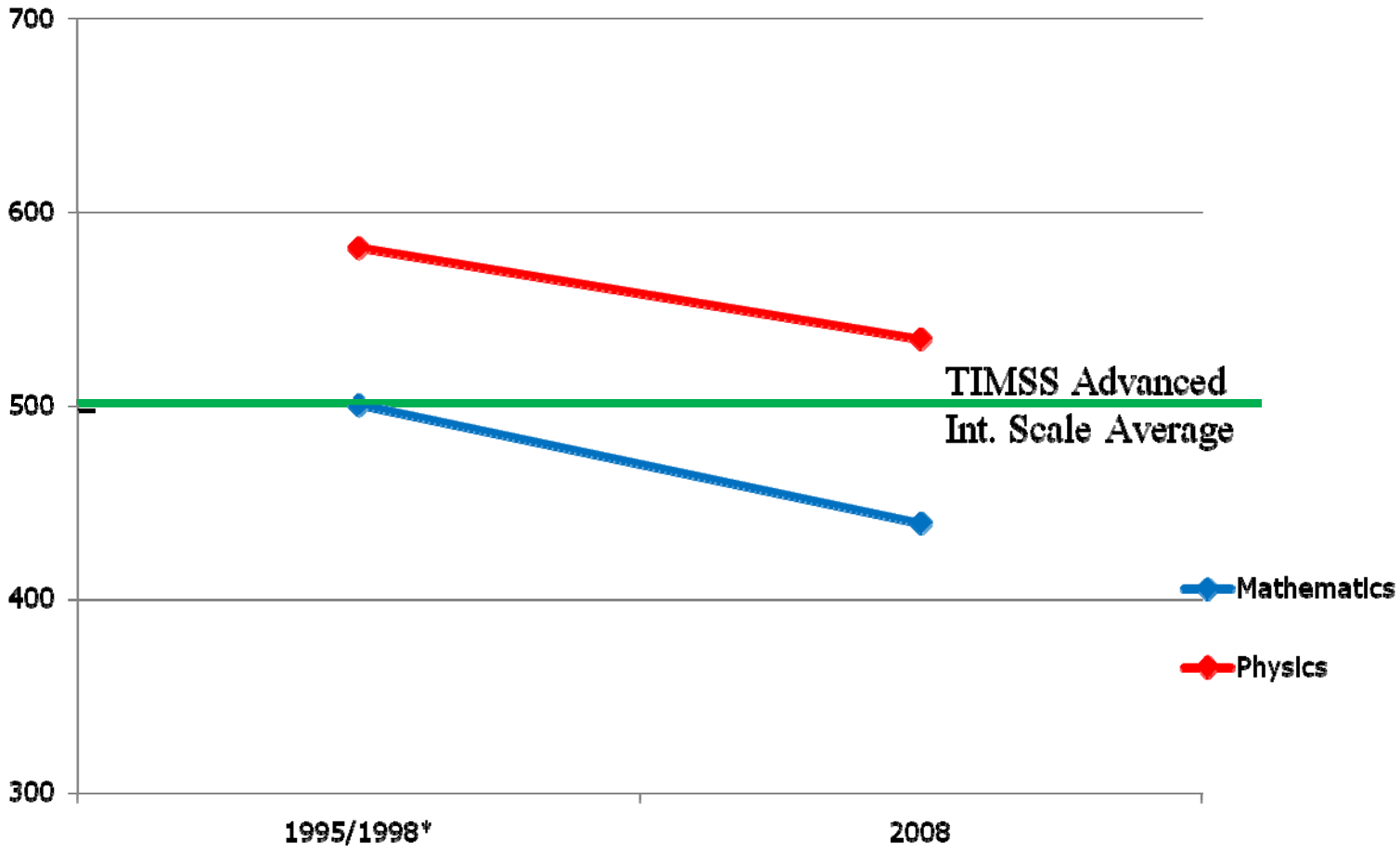
Chapter 1 Main findings and trends in TIMSS Advanced 2008

Chapter 2 Mathematics in TIMSS Advanced 2008
(Trends from 1998*)

Chapter 3 Physics in TIMSS Advanced 2008
(Trends from 1995)

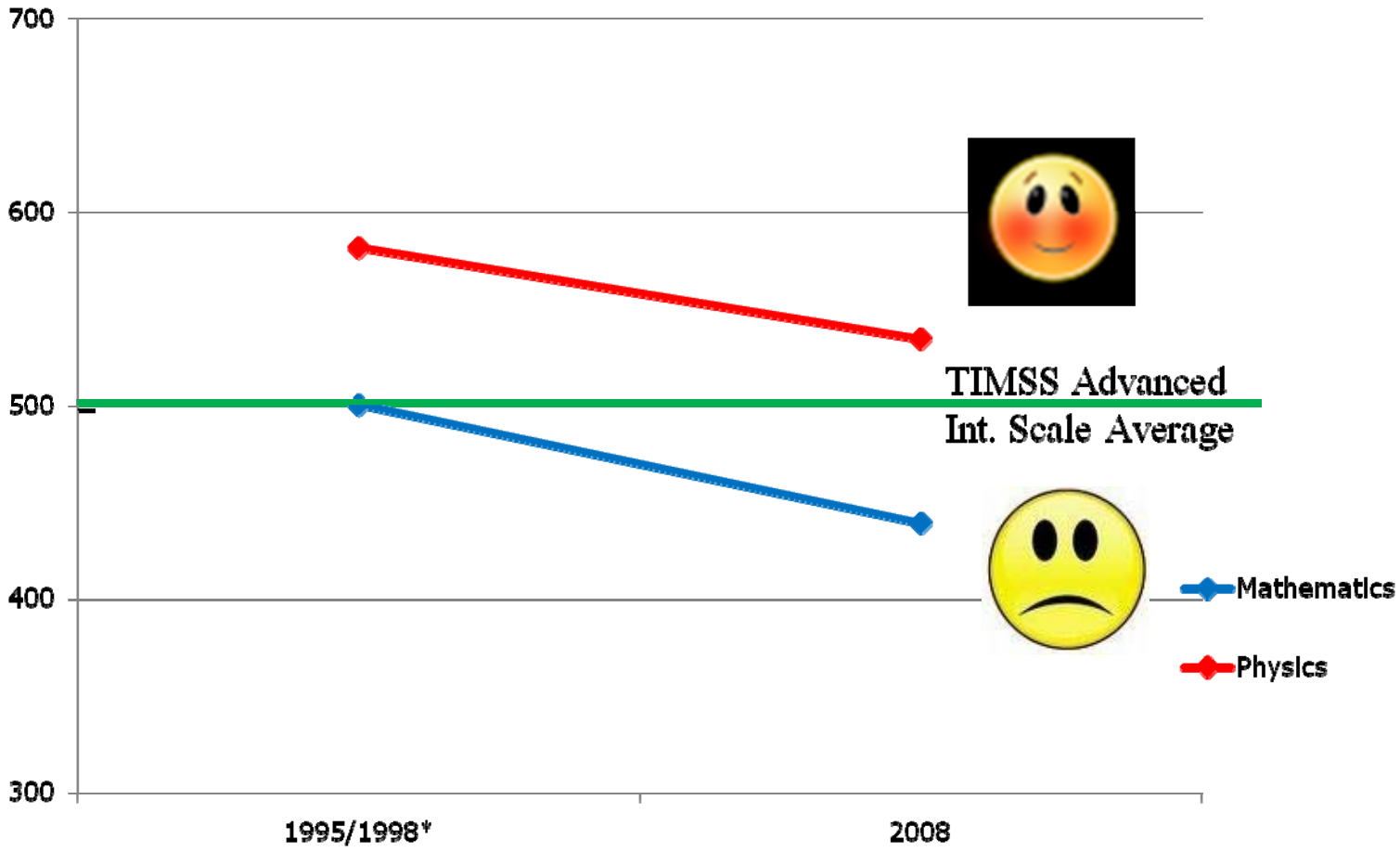
One step back

Advanced Mathematics and Physics



One step back

Advanced Mathematics and Physics



TIMSS Advanced 2008:

- ***A clear and pronounced decline in Norwegian students' performance in both Mathematics and Physics in the final grade of upper secondary school.***
- ***Performance is measured against a fixed international scale with average 500 and standard deviation 100, calculated on basis of results from 1995.***
- ***The decline in performance for the Norwegian students is about half a standard deviation in each subject. This pronounced decline coincides with the fact that the proportion of the age cohort choosing specialisation is decreasing in both subjects.***

Physics and Mathematics after the decline in TIMSS Advanced 2008

Physics:

Still a relatively good result in an international perspective (534 against the international scale average of 500). Boys perform significantly better than girls.

Mathematics:

Relatively weak in an international perspective (439 against the international scale average of 500). No significant difference between girls and boys.

Three curriculum levels

The intended curriculum
(system level)

- Documents and resources

The implemented curriculum
(school level)

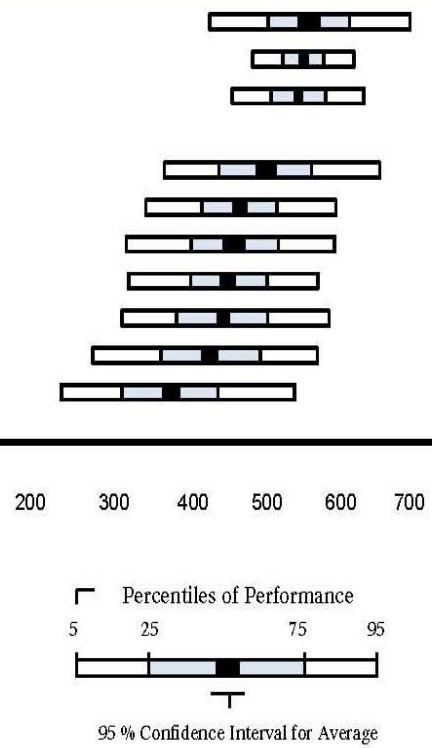
- Instruction and teachers

The achieved curriculum
(student level)

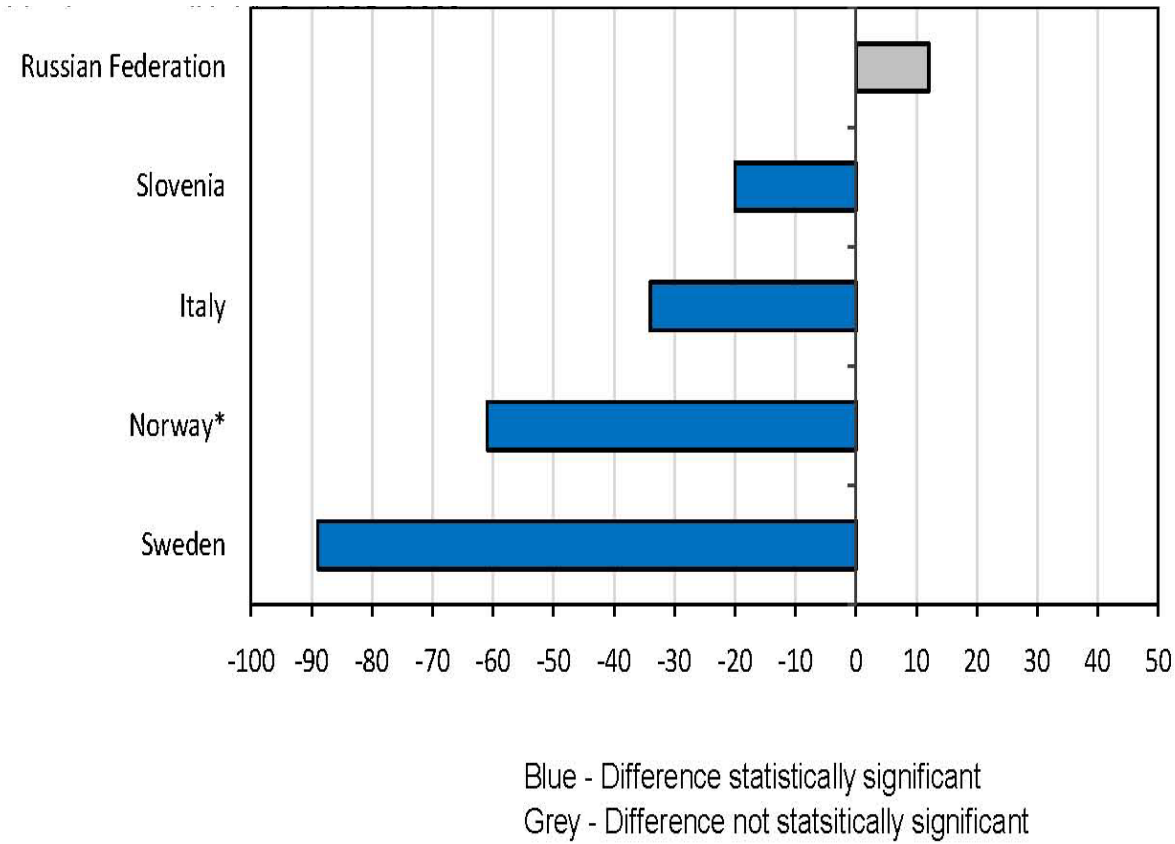
- Knowledge and skills

Main results in mathematics

Country	Coverage Index	Average Age	Years in School	Average Score	Achievement Distribution
Russian Federation	1,4	17,0	10 el. 11	561	
Netherlands	3,5	18,0	12	552	
Lebanon	5,9	17,9	12	545	
TIMSS Adv. Scale Average				**500**	
Iran, Islamic Rep. of	6,5	18,1	12	497	
Slovenia	40,5	18,8	12	457	
Italy	19,7	19,0	13	449	
Norway	**10,9**	**18,8**	**12**	**439**	
Armenia	4,3	17,7	10	433	
Sweden	12,8	18,8	12	412	
Philippines	0,7	16,4	10	355	



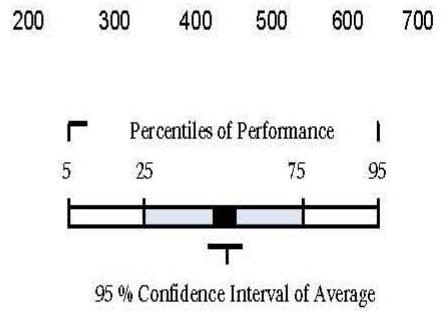
Changes in mathematics scores during the period 1995/1998* – 2008



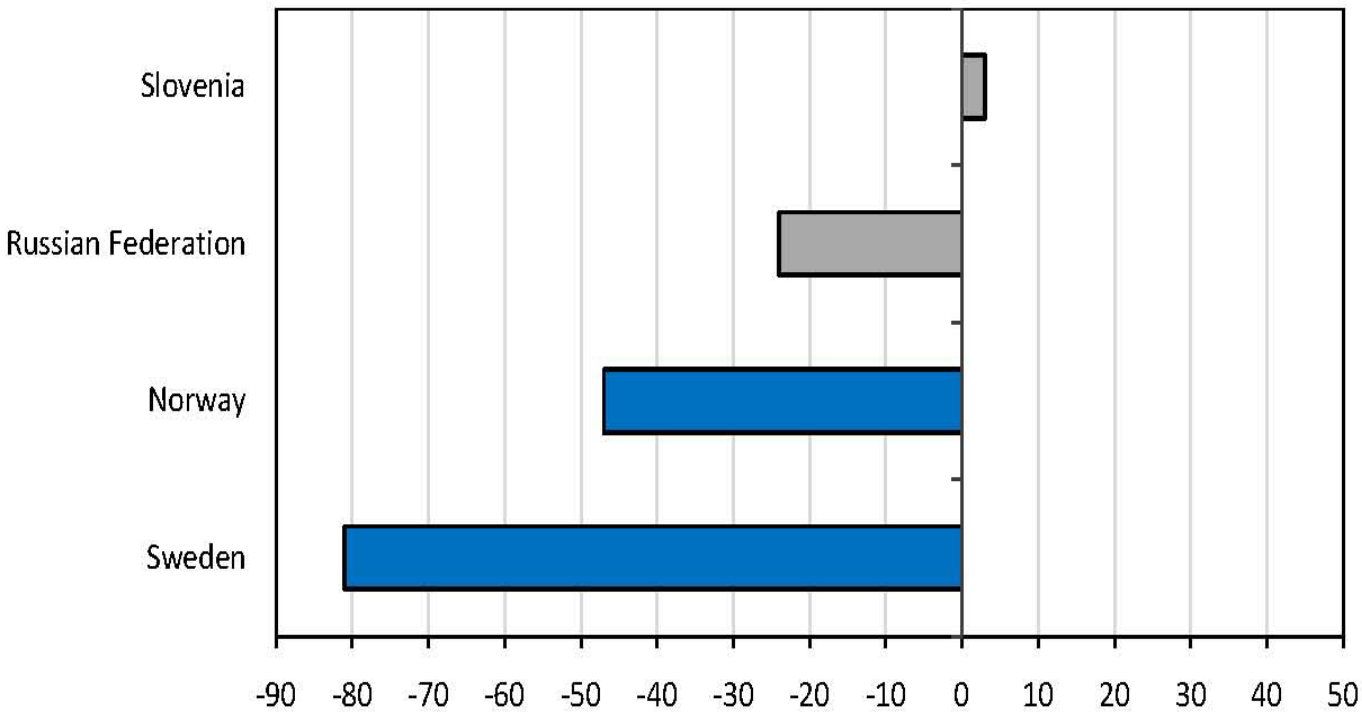
Agreeing with TIMSS results in lower grades

Main results in physics

Country	Coverage Index	Average Age	Years in School	Average Score	Achievement Distribution
Netherlands	3,4	18,1	12	582	
Slovenia	7,5	18,7	12	535	
Norway	**6,8**	**18,8**	**12**	**534**	
Russian Federation	2,6	17,1	10 - 11	521	
TIMSS Adv. Scale Avg.				**500**	
Sweden	11,0	18,8	12	497	
Armenia	4,3	17,7	10	495	
Iran, Islam Rep. of	6,6	18,0	12	460	
Lebanon	5,9	17,9	12	444	
Italy	3,8	18,9	12	422	



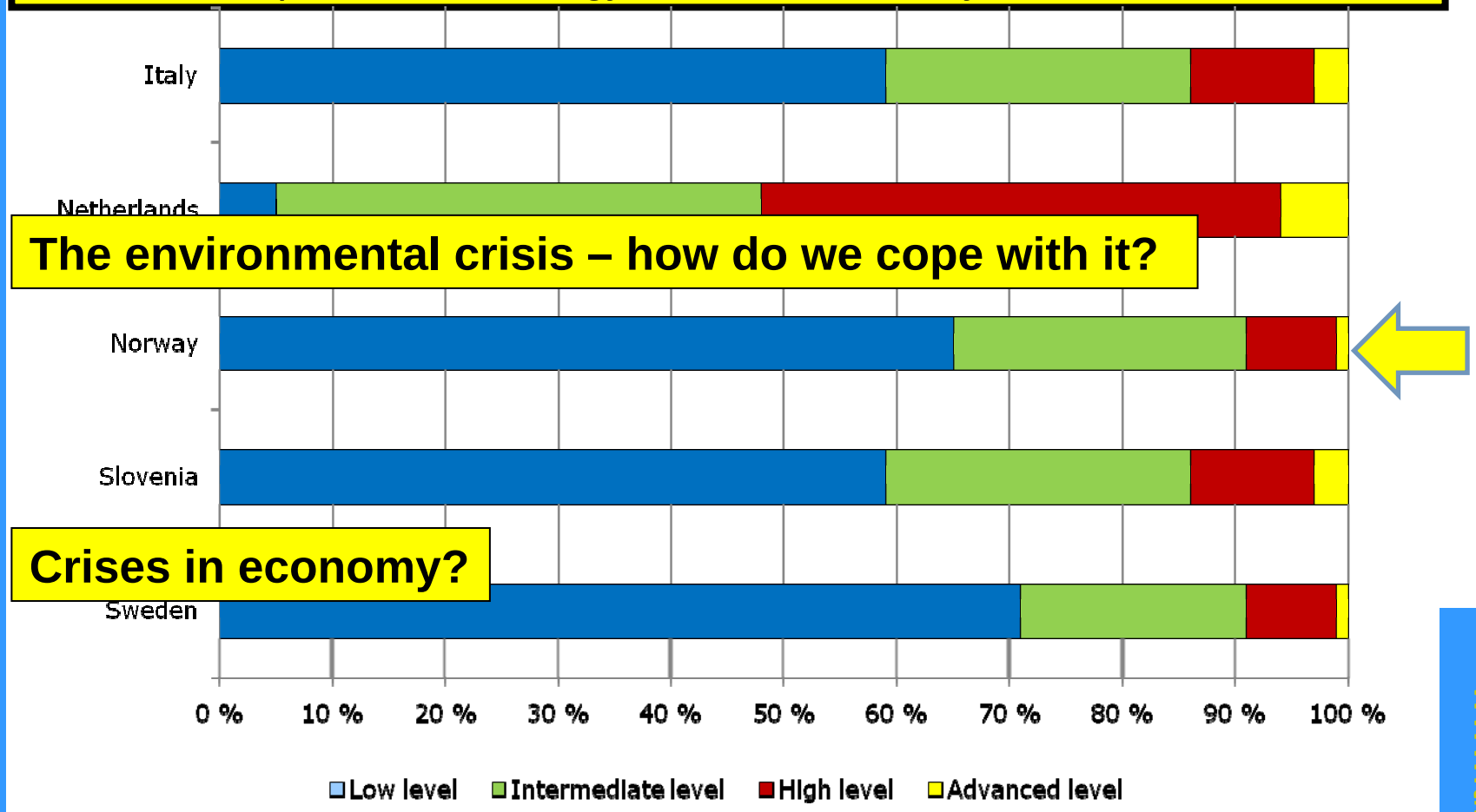
Changes in physics scores during the period 1995 – 2008



Blue - Difference statistically significant
Grey - Difference not statistically significant

Distribution of students across benchmark levels in mathematics

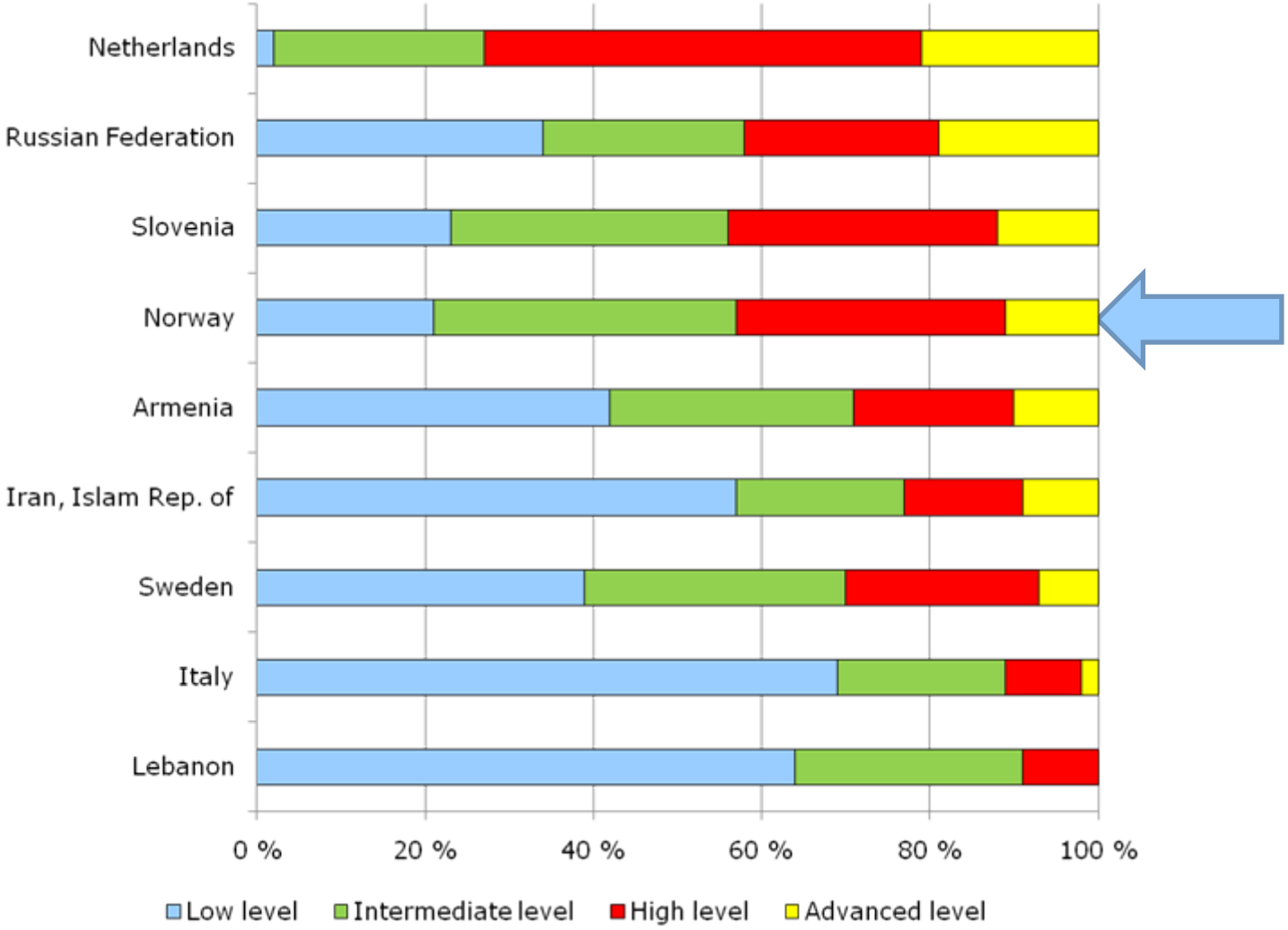
Agrees with TIMSS results in lower grades. What about talented students? The future experts in technology, science, economy, mathematics?



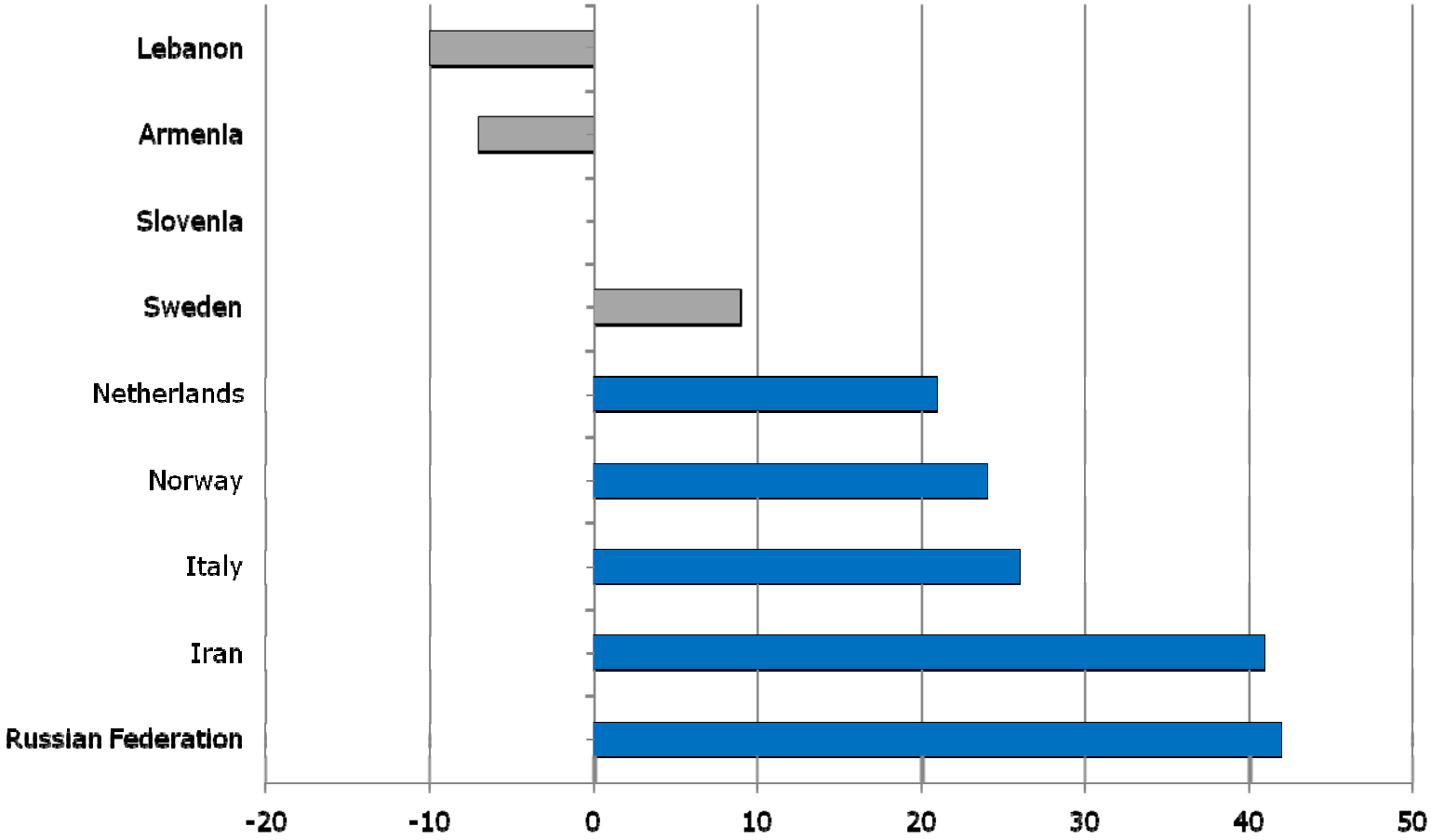
The environmental crisis – how do we cope with it?

Crises in economy?

Distribution across benchmark levels in physics



Differences between boys' and girls' average scores in physics.
Positive direction in favour of boys.
Grey colour means that the difference is not significant.

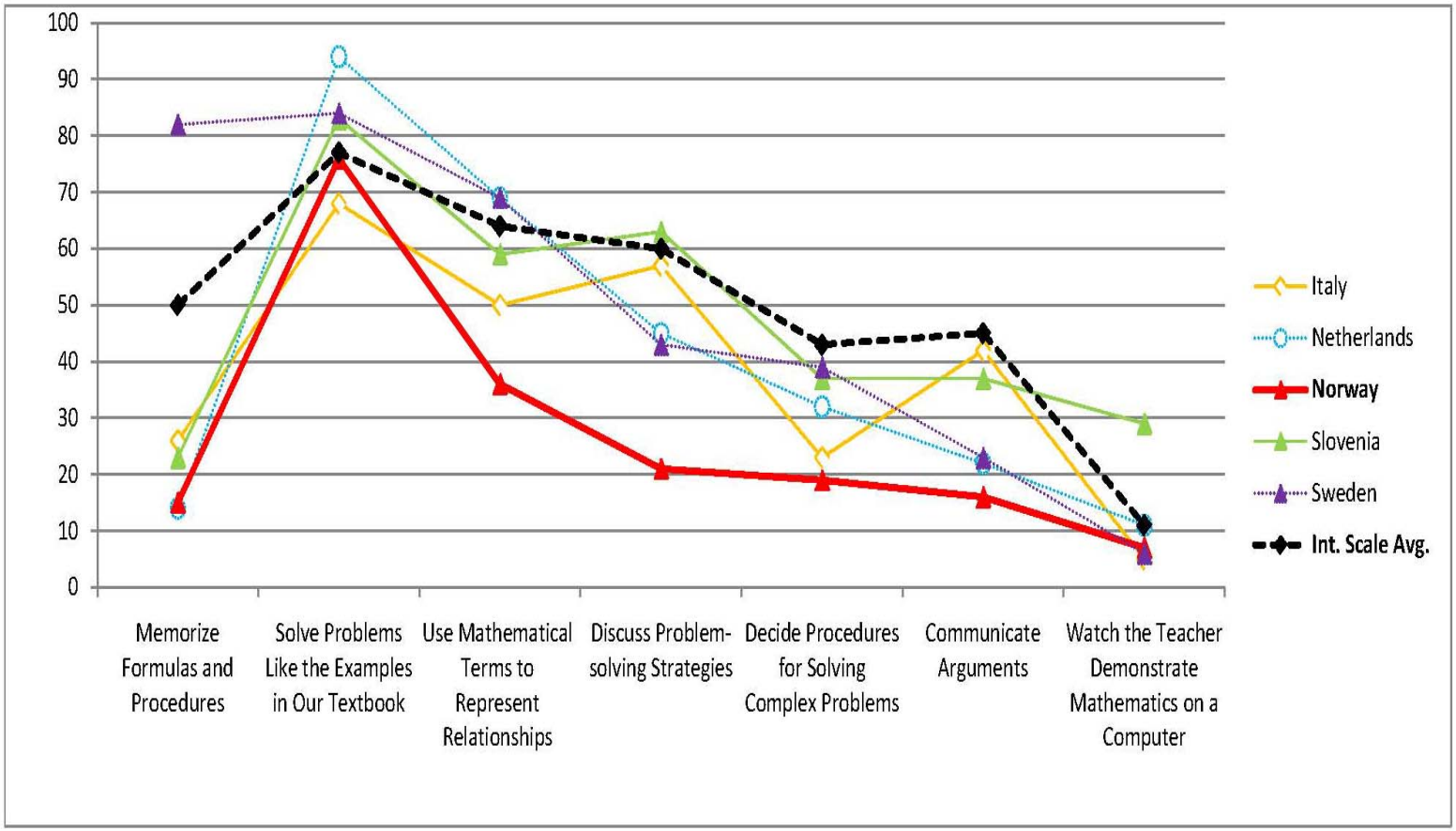


School level

Instruction and teachers in

TIMSS Advanced

Students reporting on how often various learning activities were used in mathematics lessons (half the lessons or more)

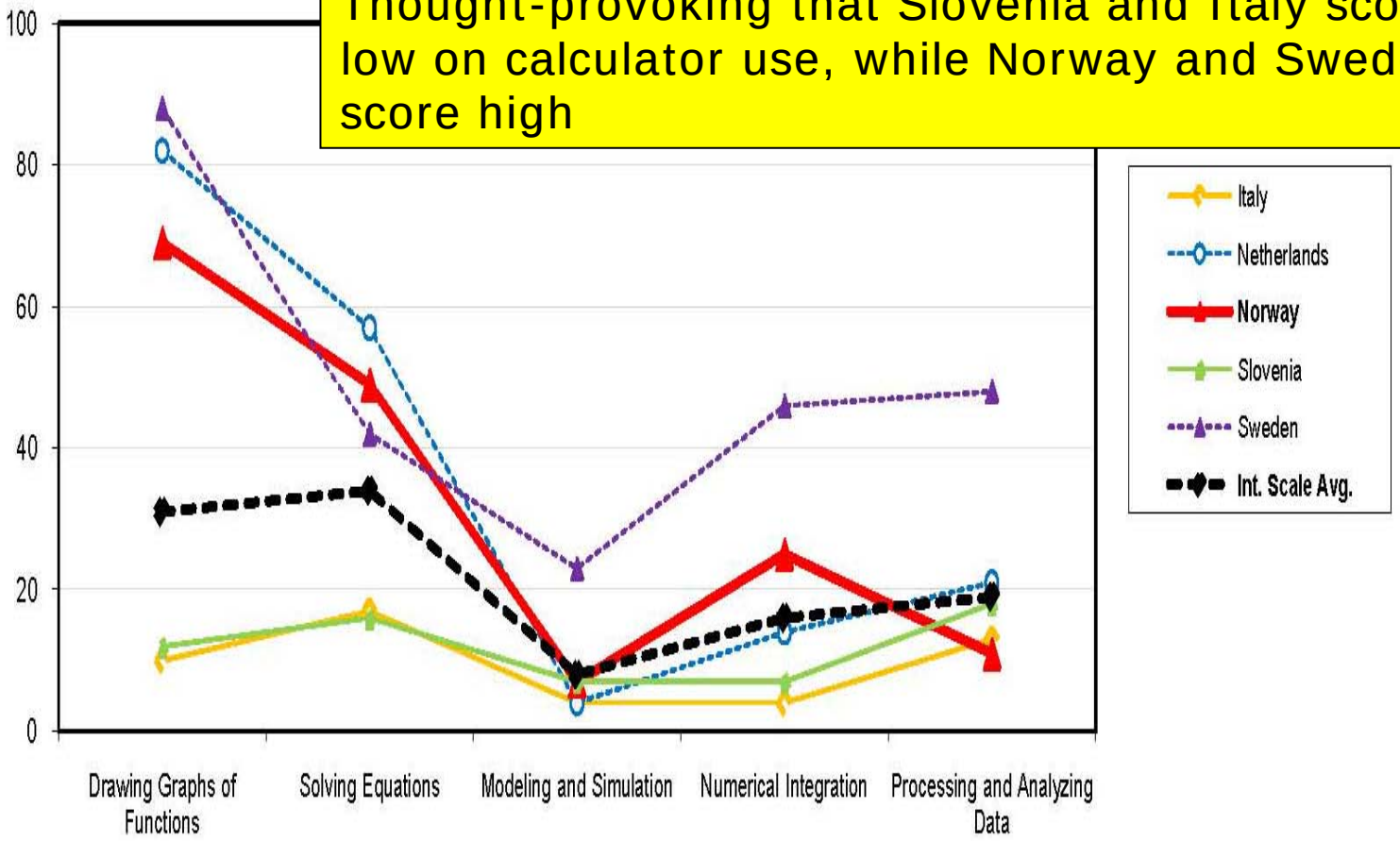


Agrees with TIMSS results in lower grades

Agrees with teachers' reports on learning activities

Teachers reporting on how often students use calculators in various ways in mathematics lessons (half the lessons or more)

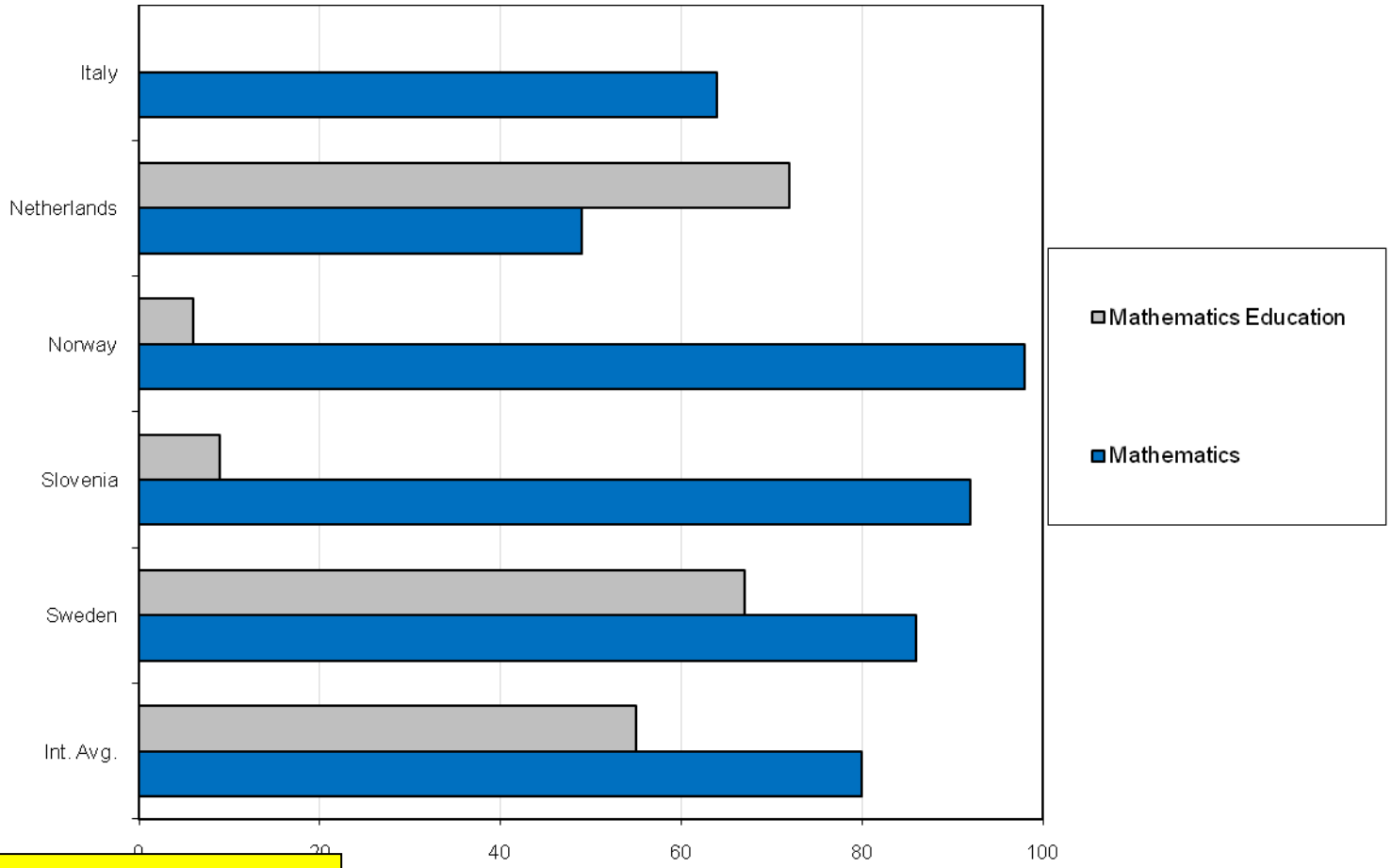
Thought-provoking that Slovenia and Italy score low on calculator use, while Norway and Sweden score high



Factors related to instruction

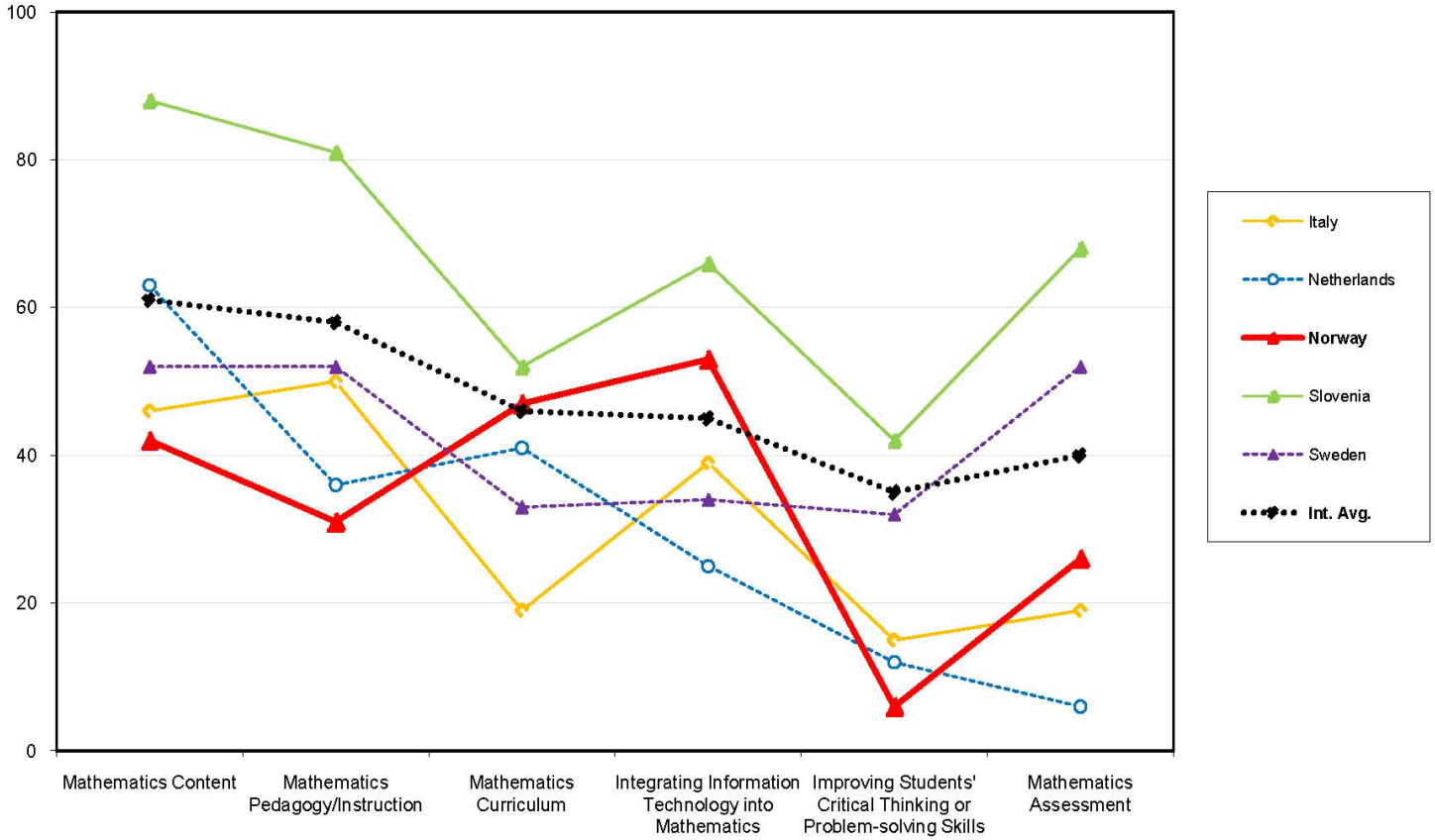
- Results in TIMSS and TIMSS Advanced point out that practice and automation of skills in mathematics are less applied in Norway than in most countries.
- Learning activities like arguments and discussion of solutions and strategies seem to be less used in 3MX in Norway than in corresponding courses in other countries.
- Norwegian students in 3MX and 3FY work much individually with problems.
- Much calculator use in Norwegian schools.

Percentage of the mathematics teachers reporting that they have specialisation in mathematics and/or mathematics education



Does **NOT** agree with TIMSS results in lower grades

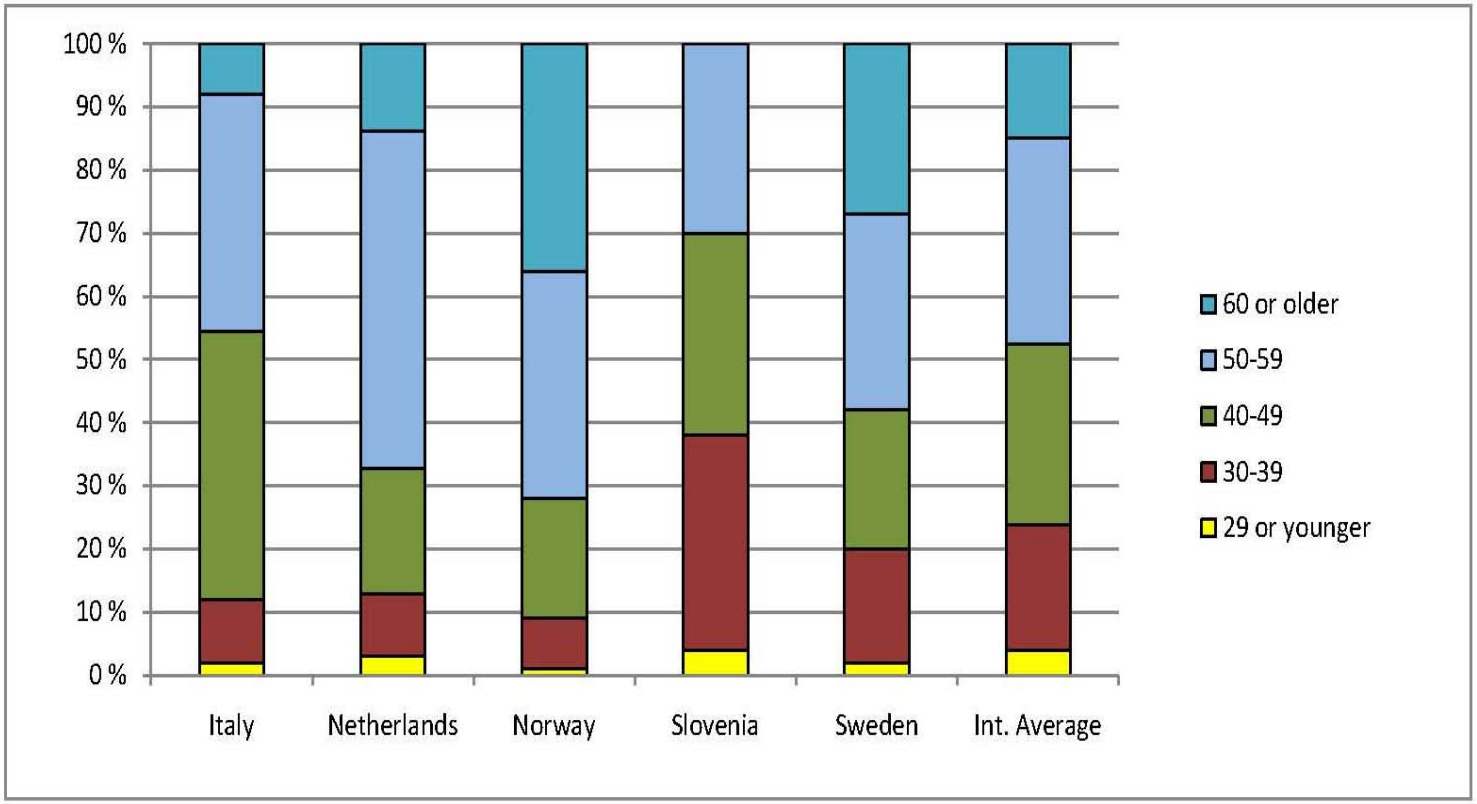
Percentage of mathematics teachers reporting that they have participated in professional development in various areas during the last two years



Agrees with TIMSS results in lower grades

Percentages of 3MX teachers distributed across age groups

Recruitment to the teaching profession!!!



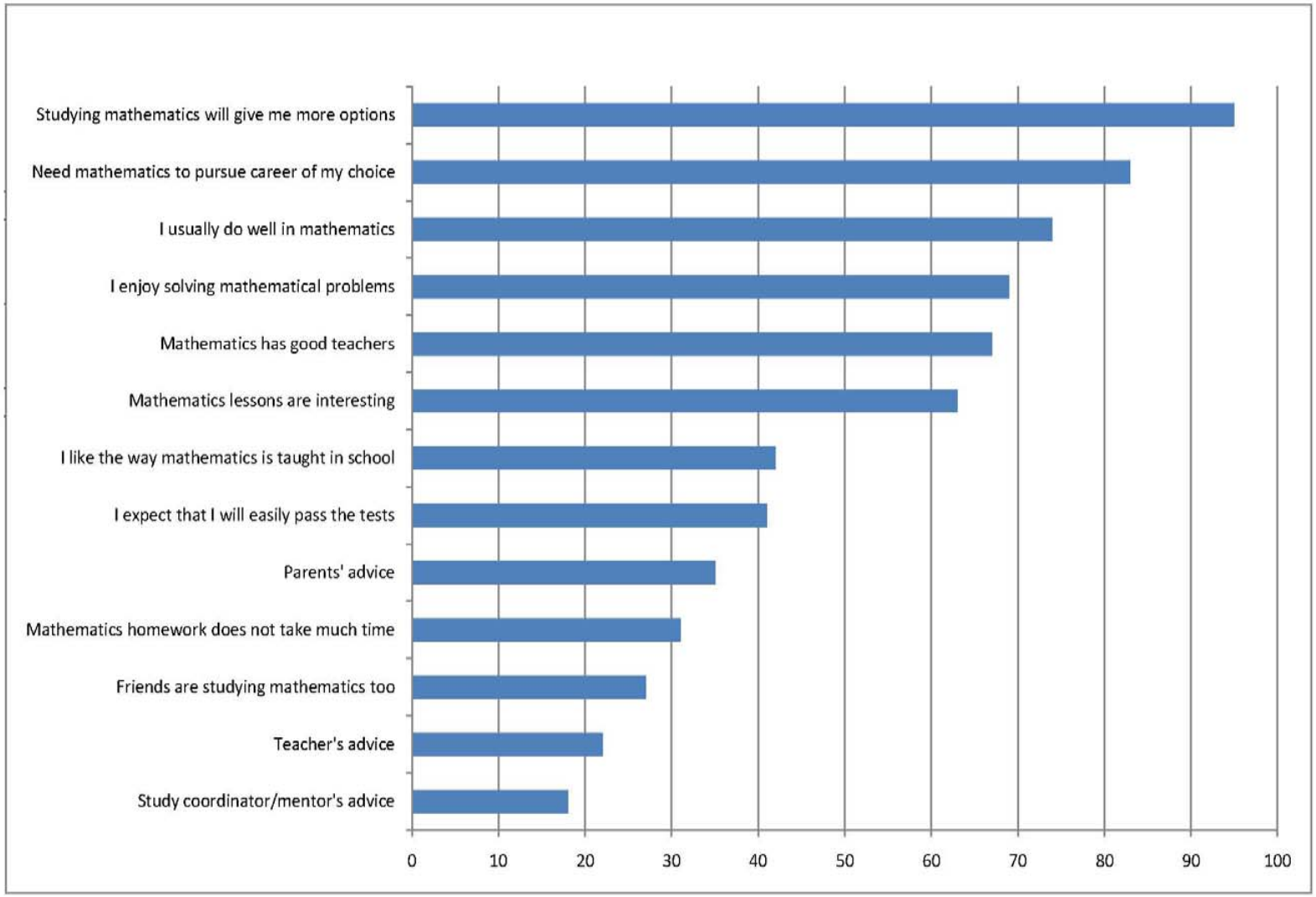
Well educated, experienced teachers, but with high age.
Applies to physics as well.

Recruitment to mathematics and science

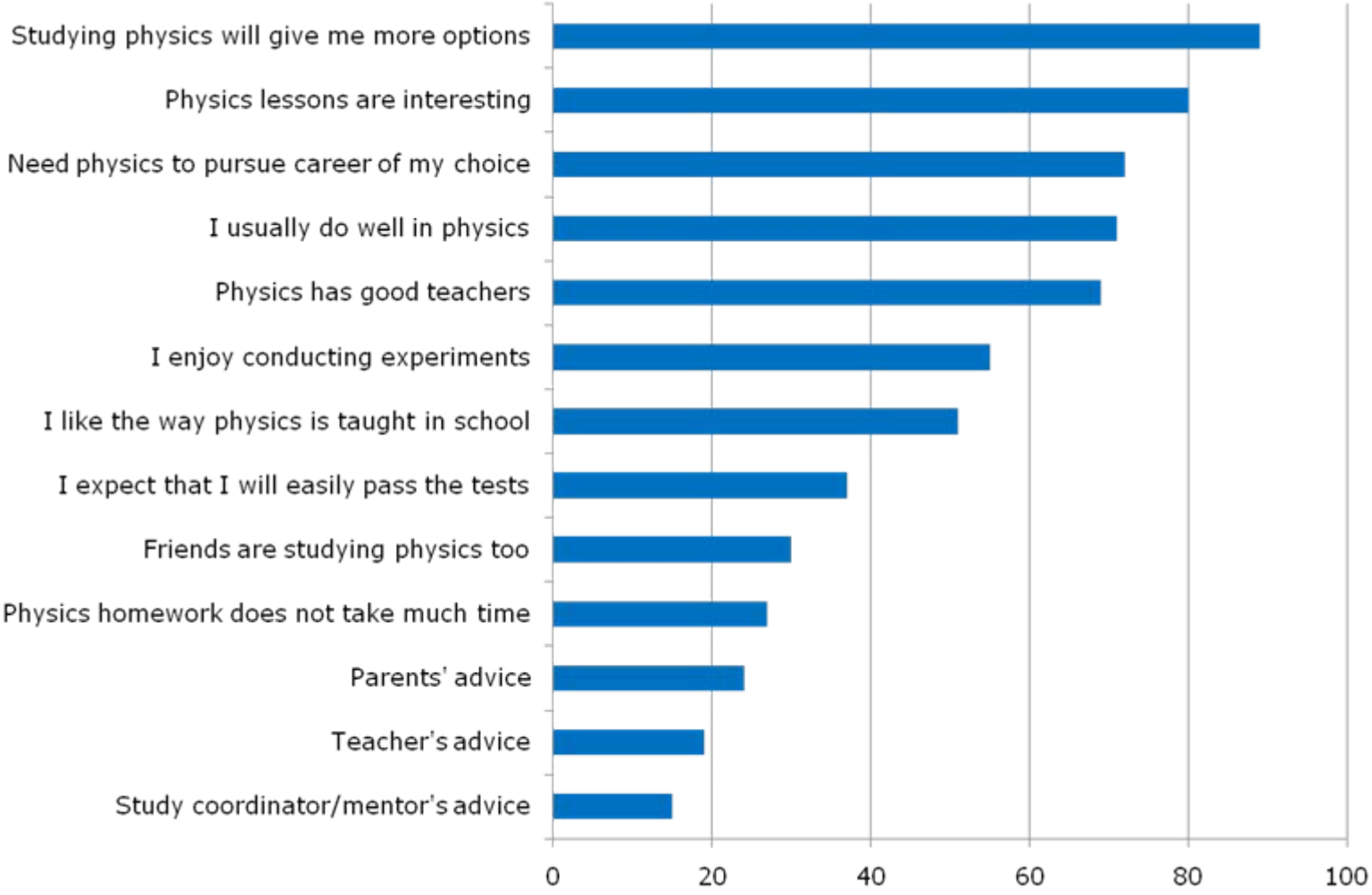
3MX and 3FY students'

- reasons for choosing to specialise in mathematics and physics
- plans for further studies

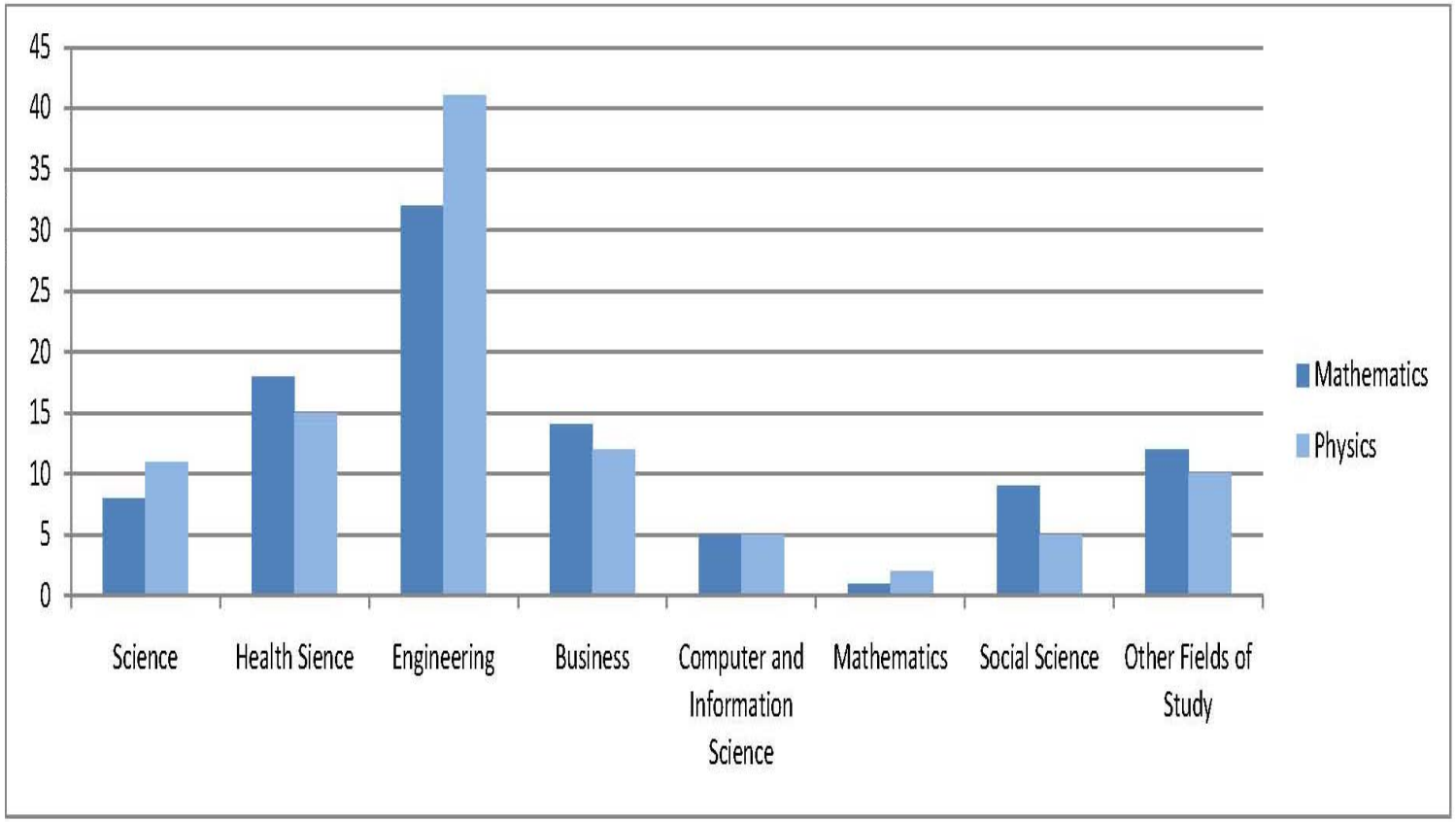
Percentage of students reporting that various reasons were ”Very important” or ”Important” for them to choose 3MX



Percentage of students reporting that various reasons were ”Very important” or ”Important” for them to choose 3FY

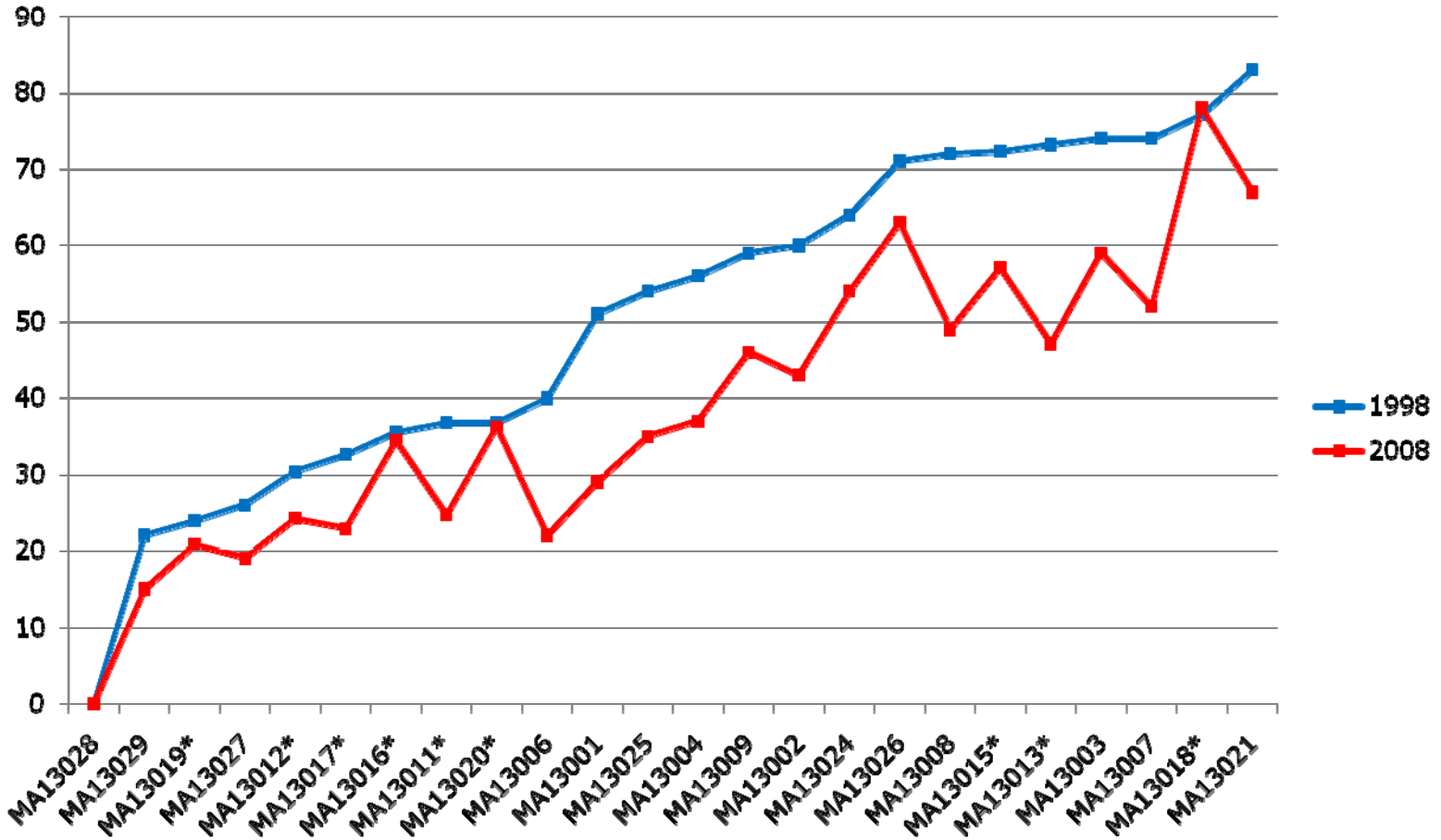


Percentages of students reporting on aspirations for further studies

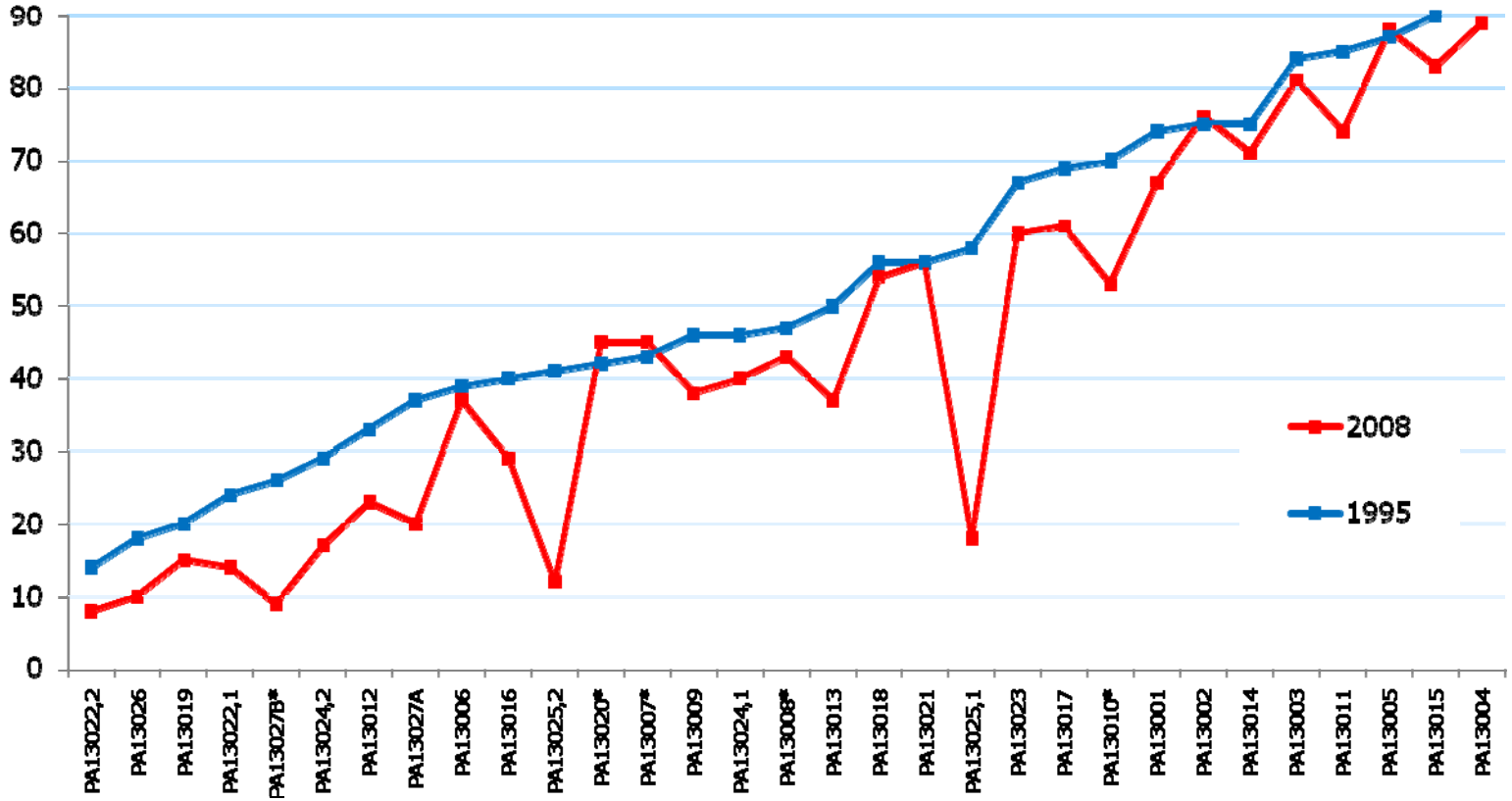


Drop-out from studies is often caused by weak entrance knowledge in mathematics

Percentage of Norwegian 3MX students who answered correctly on identical problems in 1998 and 2008



Percentage of Norwegian 3FY students who answered correctly on identical problems in 1995 and 2008



Item on differentiation

The derivative with respect to x of $\frac{4}{\sqrt{3x-4}}$ is

Ⓐ $12\sqrt{3x-4}$

Ⓑ $\frac{4}{\sqrt{3}}$

Ⓒ $\frac{-2}{(3x-4)^{\frac{3}{2}}}$

Ⓓ $\frac{-6}{(3x-4)^{\frac{3}{2}}}$

Ⓔ $6\sqrt{3x-4}$

	Norway		Slovenia	Sweden	Netherlands	Italy	INT
	1998	2008					
A	13	19	5	10	8	7	9
B	9	15	9	22	4	7	10
C	21	21	26	27	19	21	21
D*	40	22	36	27	55	42	44
E	9	10	13	8	10	9	8
No response	7	10	10	4	3	13	7

Possible reasons for the decline?

- The decline in performance in both mathematics and physics seems to be related to lack of basic competences in mathematics.
- Mathematics is both a subject in its own right, and a tool for other subjects.
- Results from TIMSS Advanced in mathematics and physics point to students not mastering basic skills in mathematics.
- This regards skills in arithmetic, in algebra, and in the basics of calculus.

Basic mathematical skills (a concept with progression)

- In primary school, the multiplication table and basic number calculations
- In lower se[illegible]y school, also skills in algebra, like manipulati[illegible]h symbols and equations
- In upper secondary sc[illegible]lso skills in differentiation, limits and [illegible]ulation with more complex algebraic expressio[illegible]
- In university, also calculations with complex numbers and matrices

Maintenance of skills

Measures at system level: curricula, exams, frames

- New curriculum (K06)
- Exams
  - Two parts (with/without aids)
  - Testing topics from lower levels?
- Testing
  - Basic arithmetical skills
  - What about basic mathematical skills (algebra, differentiation,...)??

What other measures/initiatives are needed?

Thanks for your attention!

We turned the trend of decline in TIMSS in lower grades from 2003 to 2007.
Now we must turn the trend in upper secondary as well!!

It is an [illegible] educating our future experts:

- with sufficient [illegible]ence

- in sufficient numbers

Environmental crisis?
Economical crisis?