The Science Education in Japan Its Strengths and Weaknesses

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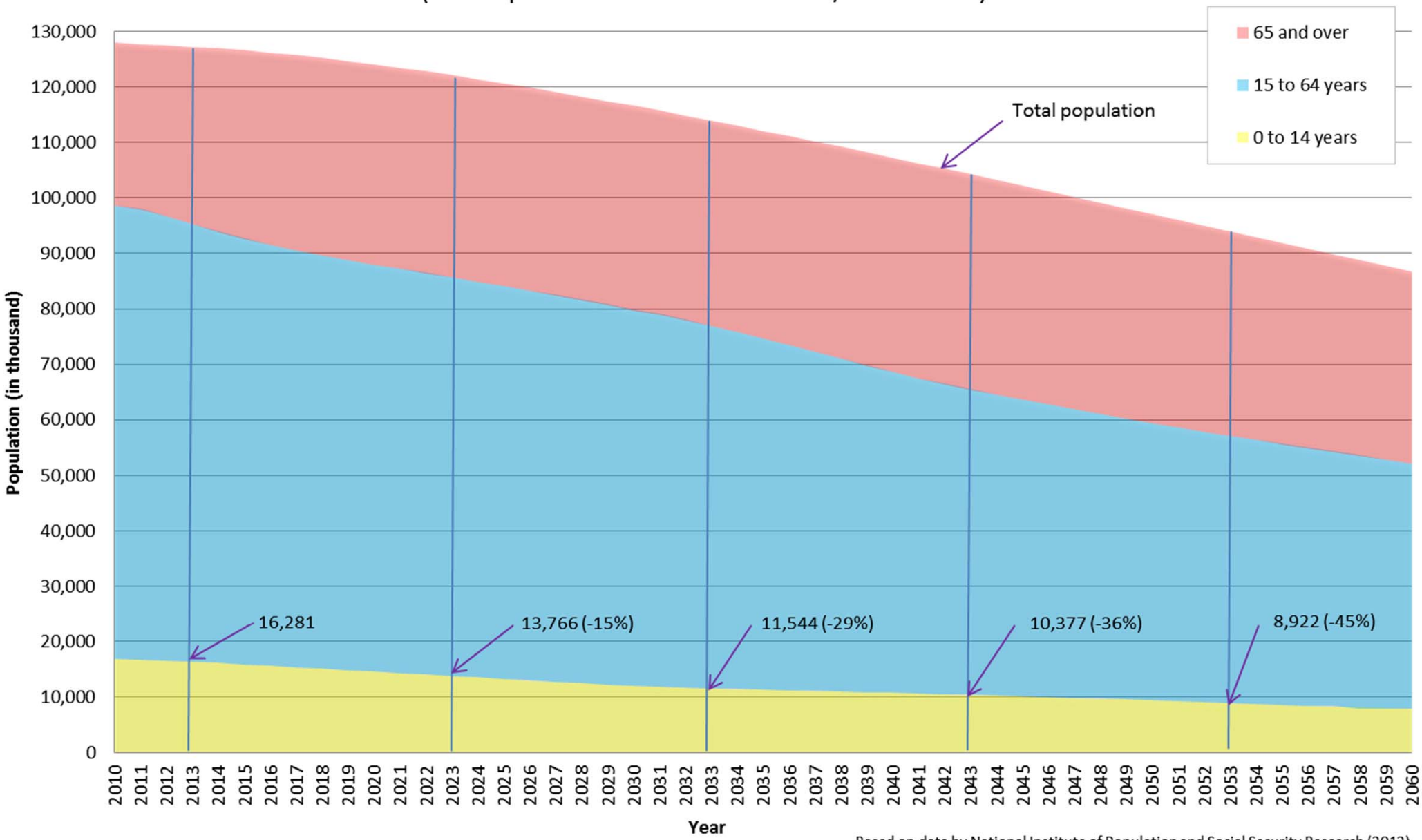
Contents

1. Backgrounds

- ***Centralized Education under national gov.***
  - ***Policy***: *Central Education Council*
  - ***Curriculum Standard***: *National Course of Study revised in about every decade*
  - ***Textbooks***: *nationally authorized, supplied for free of charge in compulsory education (grade 1-9)*
  - ***Tuition***: *public-free, private-partially (grade 1-12)*
  - ***Materials***: *partially subsidized (grade 1-12)*
  - ***Monitoring***: *National Assessment (6th & 9th grade), Curriculum Achievement Survey, TIMSS, PISA, etc.*
  - ***Teachers***: *educated at national certified university, permanent employment, salary-partially subsidized, board of education assign and change school*
- ***Learning & working population is rapidly decreasing***

Future change of population in Japan in three year bands

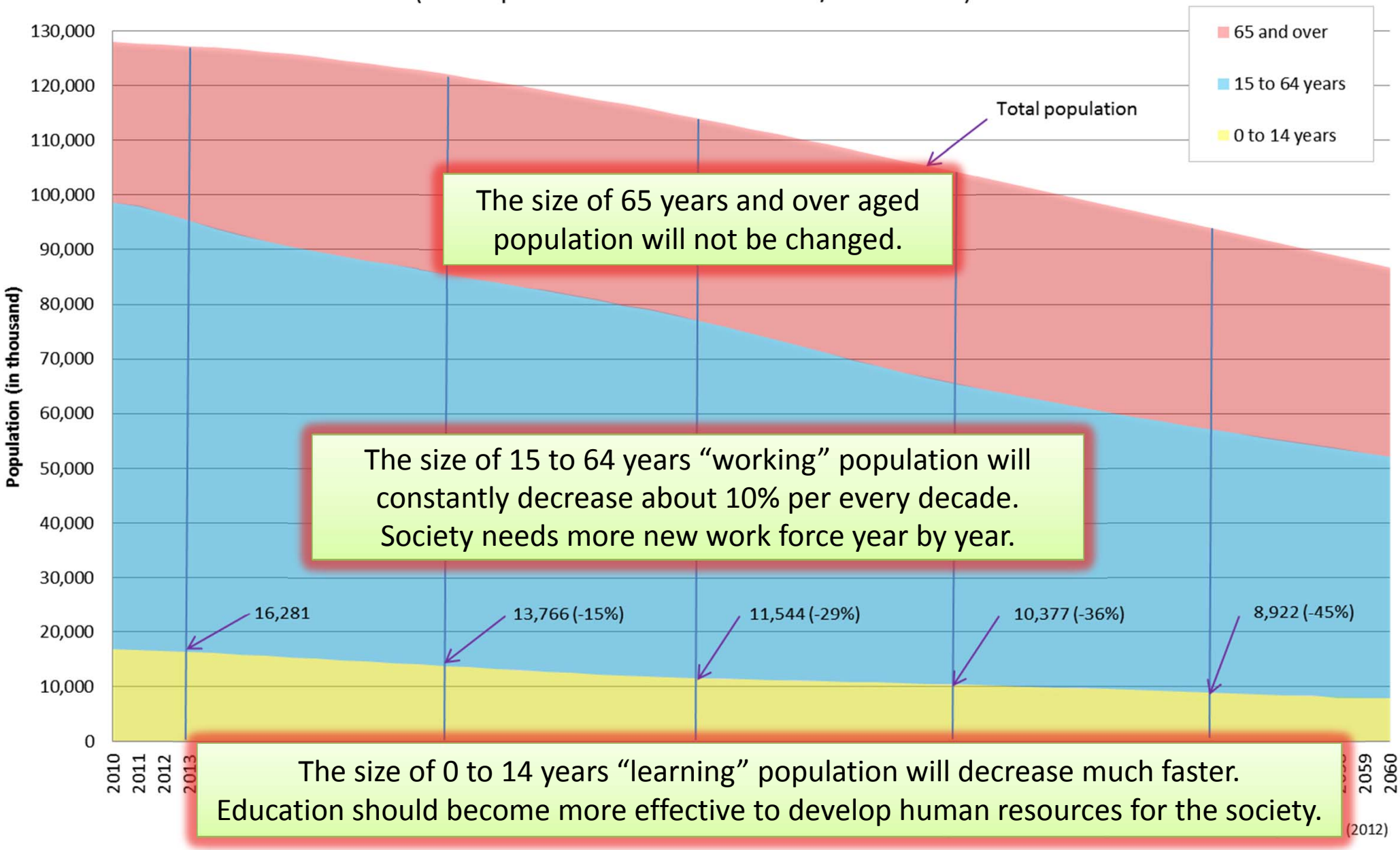
(Assumption of middle level of birth/death rates)



Based on data by National Institute of Population and Social Security Research (2012)

Future change of population in Japan in three year bands

(Assumption of middle level of birth/death rates)



The size of 65 years and over aged population will not be changed.

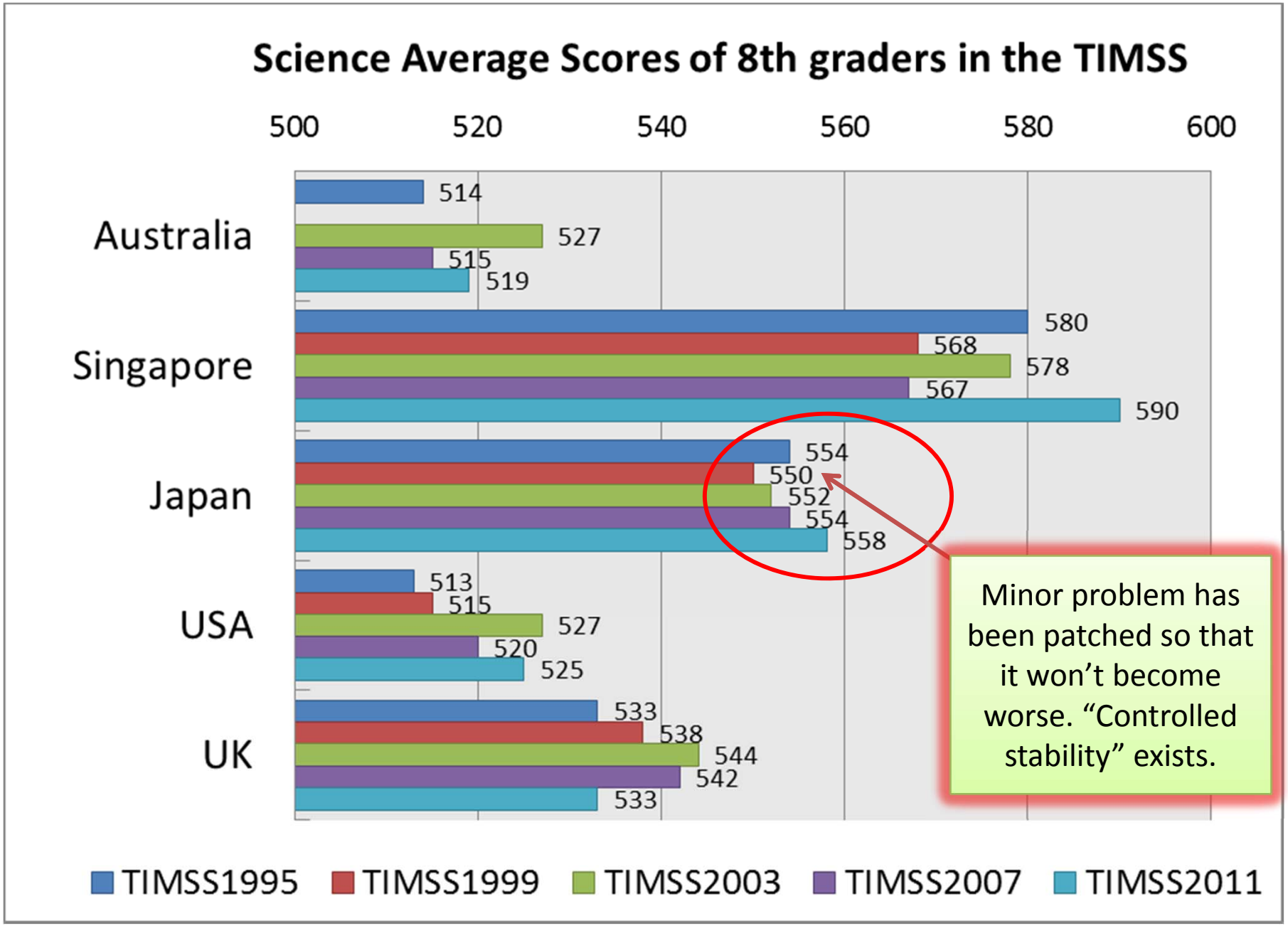
The size of 15 to 64 years "working" population will constantly decrease about 10% per every decade. Society needs more new work force year by year.

The size of 0 to 14 years "learning" population will decrease much faster. Education should become more effective to develop human resources for the society.

2. Strengths - Achievement

- *Base on the TIMSS (Trend of International Mathematics and Science Study), achievement level of 8th grade Science has been "consistently" at a high level since 1995 by 2011.*
- *Achievement level of 15 years' Scientific Literacy in PISA (OECD Programme for International Student Achievement) in 2006 was also at a high level.*
- *Students' socio-economic status does not strongly influence on their achievement.*
- *Adults sustain high level of skills in literacy, numeracy, and problem solving. (OECD PIACC - Programme for the International Assessment of Adult Competences)*

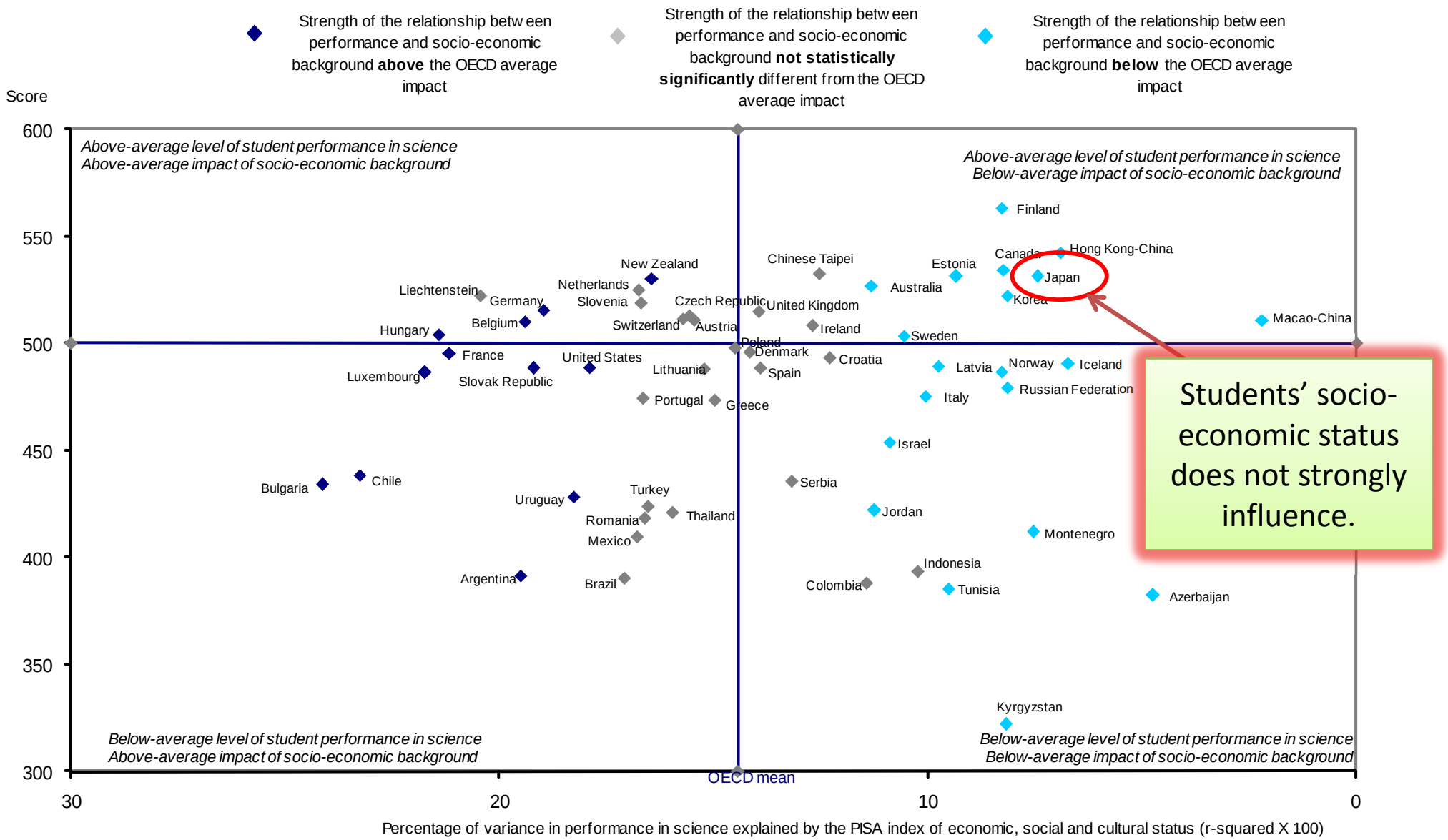
Science Scores in the past TIMSS (8th grade)



Achievement level of 15 years' Scientific Literacy in PISA2006 is above average and less socio-economic impact among OECD.

Performance in science and the impact of socio-economic background

Average performance of countries on the PISA science scale and the relationship between performance and the index of economic, social and cultural status



Students' socio-economic status does not strongly influence.

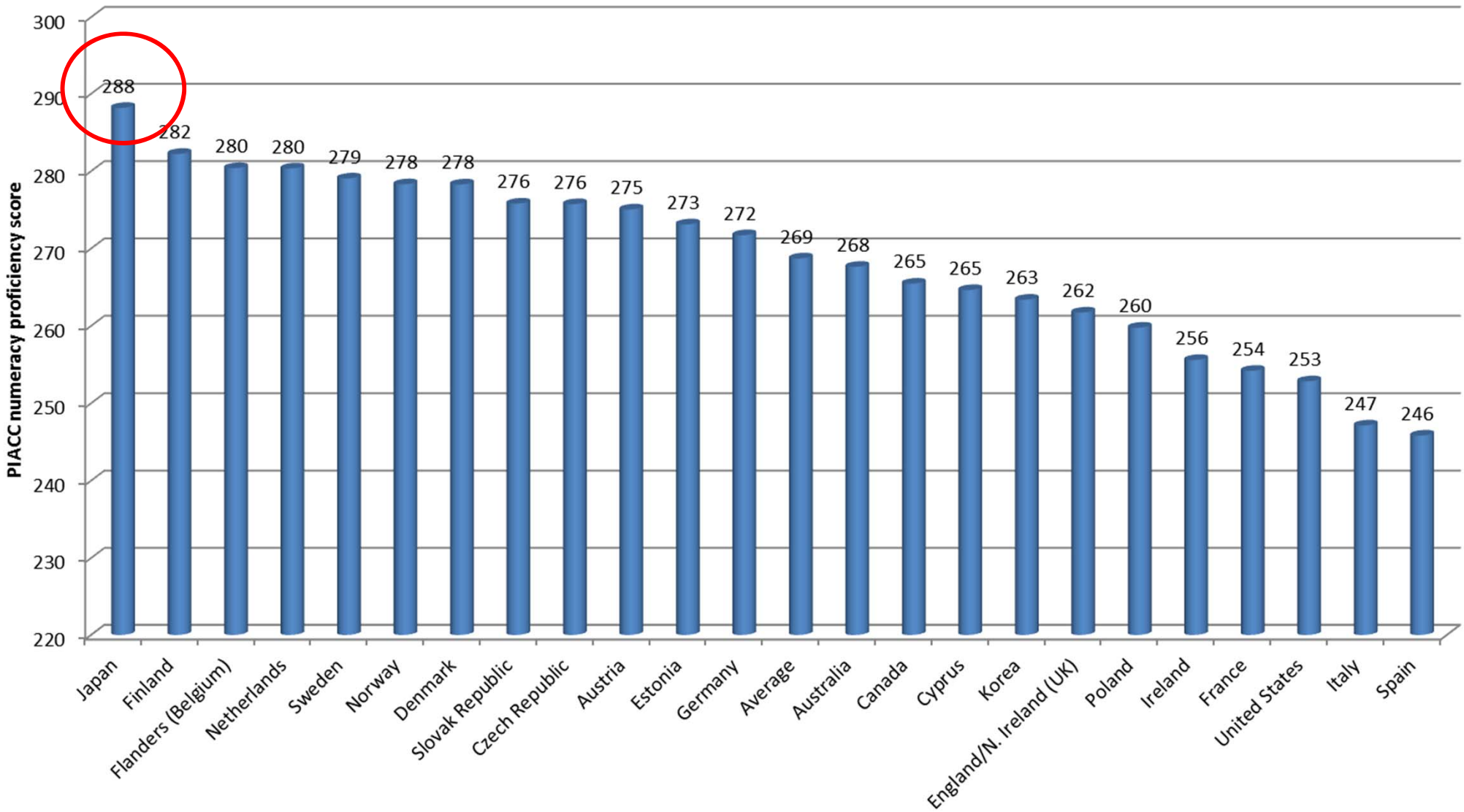
Note: OECD mean used in this figure is the arithmetic average of all OECD countries.

Source: OECD PISA 2006 database, Table 4.4a

Comparison of average numeracy proficiency among adults

Mean numeracy proficiency scores of 16-65 year olds in PIACC

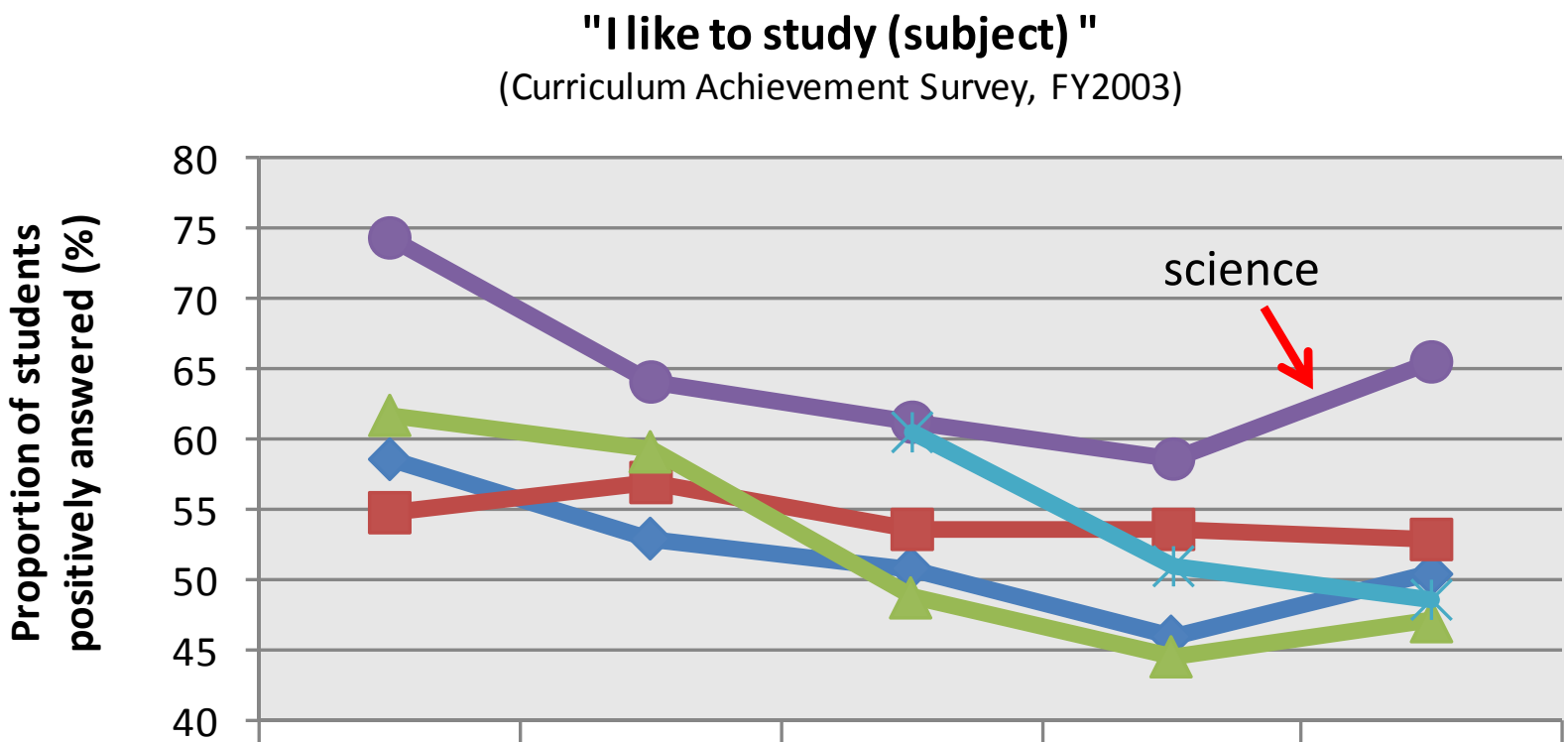
Based on Programme for the International Assessment of Adult Competences (OECD,2013)



3. Motivation to learn

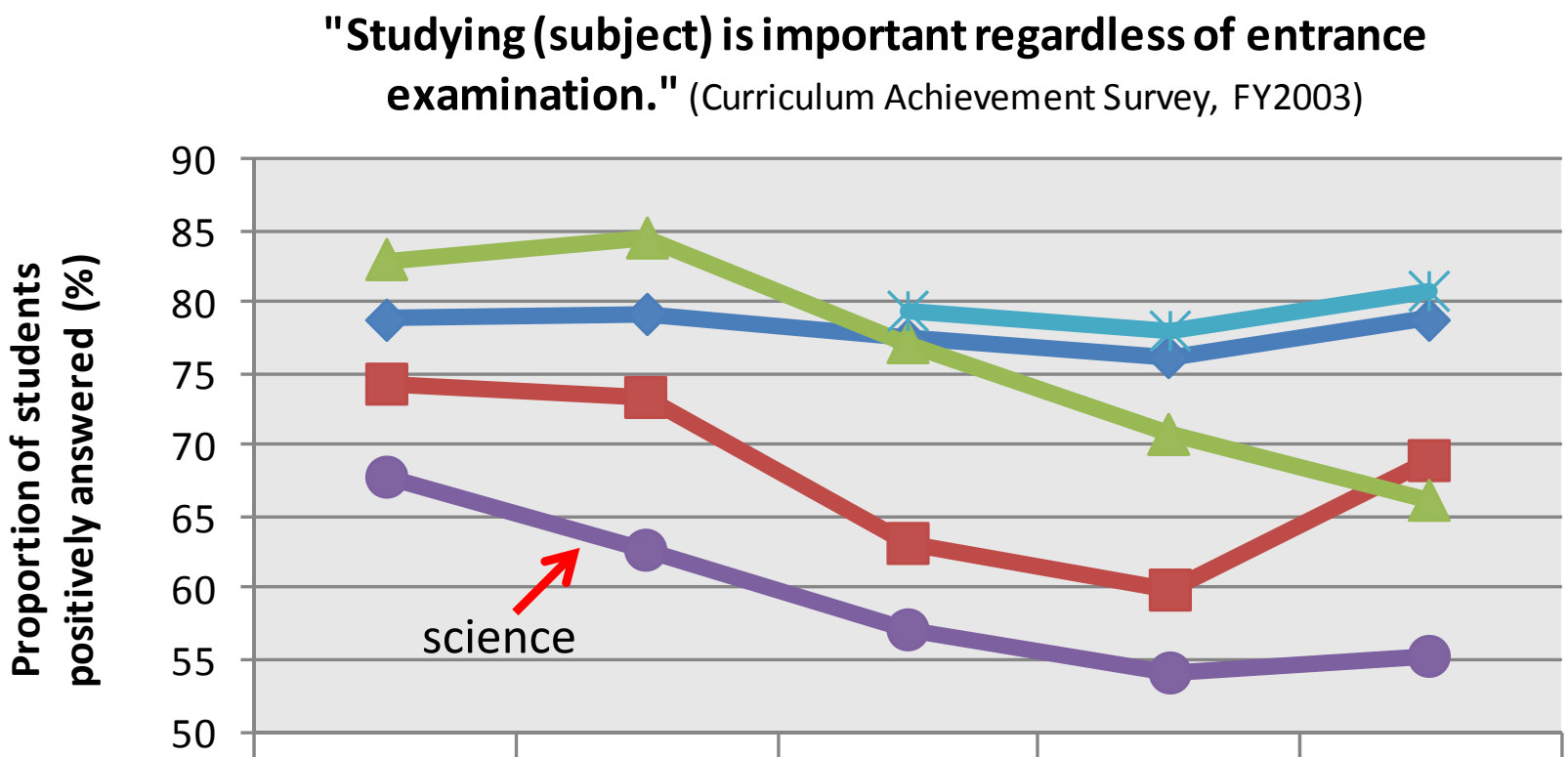
- *Science is liked by more Japanese students than other subjects, but*
- *studying science seems less important than studying other subjects.*
- *Level of "Instrumental Motivation to Learn Science" is low. Studying science seems useless.*
- *Level of students' "Self-efficacy in Science" is low. Using science seems difficult.*

Studying science is liked than other subjects



	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9
Japanese	59	53	51	46	50
Social Study	55	57	54	54	53
Mathematics	62	59	49	45	47
Science	74	64	61	59	65
English			61	51	49

Studying science is less important than other subjects



	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9
Japanese	79	79	77	76	79
Social Study	74	73	63	60	69
Mathematics	83	84	77	71	66
Science	68	63	57	54	55
English			79	78	81

Level of students' "*Instrumental Motivation to Learn Science*" is low at 9th grade and drops at 10th grade.

Result of PISA2006 student questions on "Instrumental Motivation to Learn Science"

A) I study school science because I know it is useful for me.
B) Making an effort in my school science subject(s) is worth it because this will help me in the work I want to do later on.
C) Studying my school science subject(s) is worthwhile for me because what I learn will improve my career prospects.
D) I will learn many things in my school science subject(s) that will help me get a job.
E) What I learn in my school science subject(s) is important for me because I need this for what I want to study later on.

Country	Percentage of students agreeing or strongly agreeing with the following statements					average
	A	B	C	D	E	
Mexico	86	86	85	79	82	84
Portugal	84	75	81	76	78	79
Turkey	73	80	73	69	79	75
United States	77	78	70	70	68	73
Canada	75	73	72	69	63	71
Poland	73	68	73	66	71	70
Italy	76	66	72	63	64	68
United Kingdom	75	71	71	65	54	67
New Zealand	71	69	68	66	56	66
Ireland	73	67	68	67	54	66
Greece	70	65	63	58	61	63
Australia	69	66	64	62	55	63
Spain	66	66	63	62	54	62
Iceland	65	62	60	57	64	62
Denmark	67	64	61	54	60	61
OECD average	**67**	**63**	**61**	**56**	**56**	**60**
Hungary	66	69	53	53	55	59
Sweden	62	62	63	52	55	59
France	67	59	61	48	52	57
Germany	66	58	55	50	48	55
Norway	60	56	59	48	53	55
Luxembourg	61	57	54	49	48	54
Slovak Republic	62	55	56	52	43	54
Belgium	57	56	55	48	48	53
Netherlands	62	54	56	44	46	52
Czech Republic	62	50	49	47	52	52
Finland	63	53	51	48	43	52
Korea	55	57	52	46	45	51
Switzerland	60	54	49	41	44	50
Japan at 9th grade	**51**	**51**	**47**	**43**	**48**	**48**
Austria	55	44	47	38	36	44
Japan at 10th grade	**42**	**47**	**41**	**39**	**42**	**42**

Studying science seems useless for Japanese students.

Level of students' "*Self-efficacy in Science*" is low both at 9th and 10th grades.

Result of PISA2006 student questions on "Self-efficacy in Science"

Questions:
A) Explain why earthquakes occur more frequently in some areas than in others.
B) Recognise science question that underlies a newspaper report on a health issue.
C) Interpret the scientific information provided on the labelling of food items.
D) Predict how changes to an environment will affect the survival of certain species.
E) Identify the science question associated with the disposal of garbage.
F) Describe the role of antibiotics in the treatment of disease.
G) Identify the better of two explanations for the formation of acid rain.
H) Discuss how new evidence can lead you to change your understanding about the possibility of life on Mars.

Country	Percentage of students who believe they can perform the following tasks either easily or with a bit of effort								average
	A	B	C	D	E	F	G	H	
Poland	76	76	82	71	62	72	71	59	71
Norway	78	65	66	66	68	77	76	61	70
Portugal	75	75	72	71	76	61	66	57	69
United States	76	79	71	77	64	63	58	59	68
Canada	76	78	72	78	64	59	62	57	68
Slovak Republic	76	83	77	54	61	63	67	60	68
United Kingdom	75	79	69	77	67	60	61	52	67
Czech Republic	81	81	61	67	60	71	57	57	67
Iceland	79	72	74	72	58	63	55	59	67
Mexico	74	78	62	67	77	57	62	55	66
Australia	78	78	68	75	61	59	54	55	66
Netherlands	82	78	60	62	60	66	65	53	66
Germany	83	78	61	69	62	64	64	44	66
Turkey	73	76	72	65	64	61	57	51	65
Finland	83	77	68	56	63	53	48	64	64
OECD average	**76**	**73**	**64**	**64**	**62**	**59**	**58**	**51**	**63**
Ireland	81	68	64	63	69	55	64	41	63
Sweden	80	67	65	67	58	53	58	54	63
New Zealand	78	73	64	68	58	58	48	50	62
Denmark	78	77	70	59	54	42	49	62	62
Hungary	70	72	66	49	74	63	62	35	61
France	79	65	67	59	52	70			
Belgium	67	73	67	64	51	58			
Spain	73	61	62	59	55	54			
Luxembourg	78	71	57	65	57	58			
Austria	78	73	53	61	63	55			
Italy	77	70	63	64	57	46			
Greece	67	67	52	56	61	57			
Switzerland	77	69	55	62	54	52	45	41	57
Korea	72	68	47	53	65	55	56	39	57
Japan at 9th grade	**65**	**62**	**43**	**66**	**66**	**34**	**47**	**32**	**52**
Japan at 10th grade	**62**	**64**	**44**	**58**	**61**	**33**	**43**	**26**	**49**

Using science seems difficult for Japanese students.

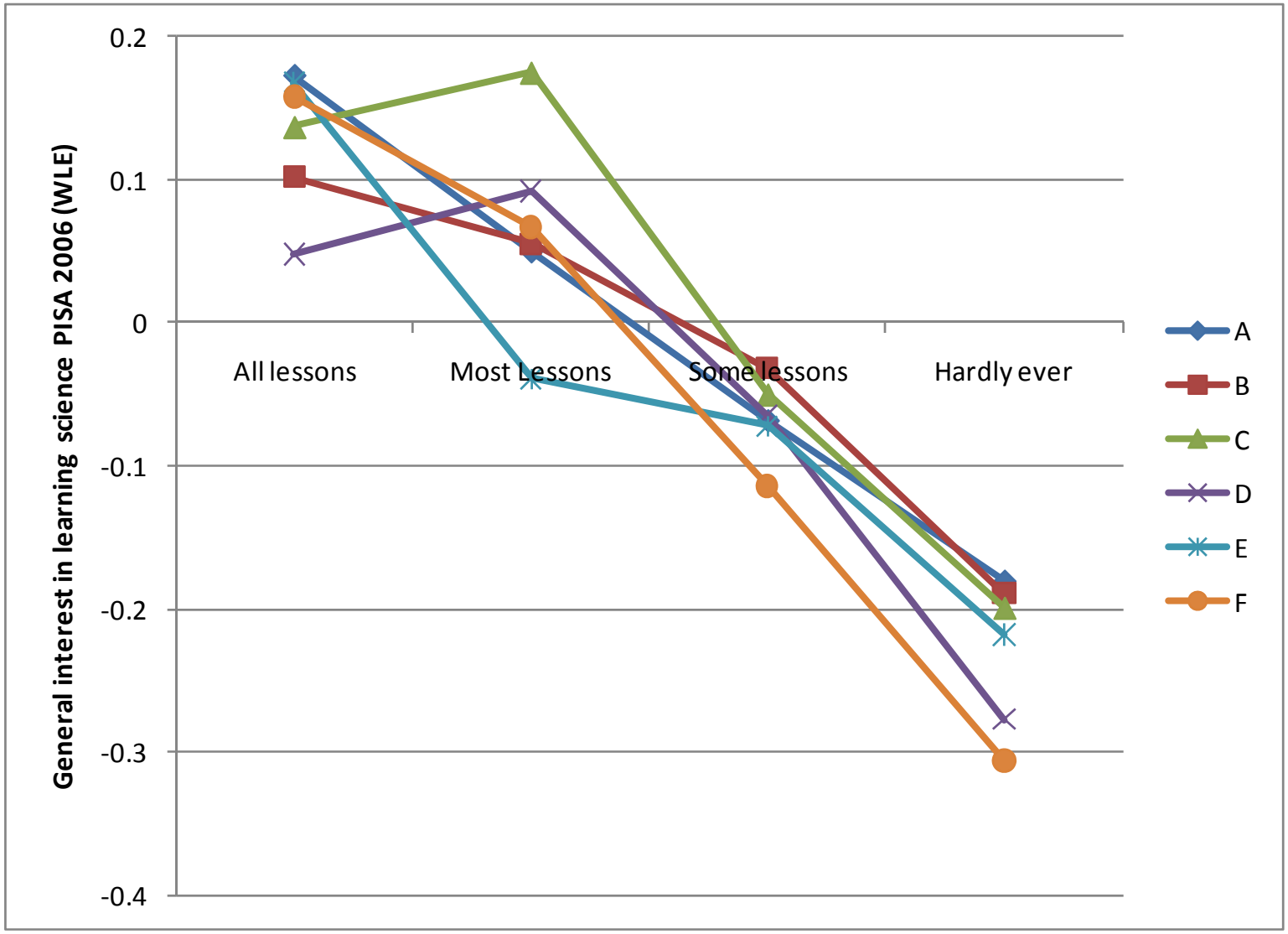
4. Teaching

- *"Inquiry Based Science Teaching" enhances students' "General Interest in Learning Science", however, "Inquiry Based Science Teaching" mostly disappears from the upper secondary education.*
- *Science lesson is rarely taught in connected with "real life".*
- *Teaching science becomes more teacher-centered in upper secondary education.*
- *Lack of lesson time is the most difficult obstacle for high-school teachers to teach inquiry based science, but much time is used for preparation for entrance examination*

"Inquiry Based Science Teaching" enhances students' "General Interest in Learning Science"

Result of PISA2006 student questions on "Inquiry Based Science Teaching"

Questions:
A) Students are required to design how a <school science> question could be investigated in the laboratory
B) Students are allowed to design their own experiments
C) Students are given the chance to choose their own investigations
D) Students are asked to do an investigation to test out their own ideas
E) Students spend time in the laboratory doing practical experiments
F) Students are asked to draw conclusions from an experiment they have conducted



"Inquiry Based Science Teaching" mostly disappears from the upper secondary education

Result of PISA2006 student questions on "Inquiry Based Science Teaching"

Questions:
A) Students are required to design how a <school science> question could be investigated in the laboratory
B) Students are allowed to design their own experiments
C) Students are given the chance to choose their own investigations
D) Students are asked to do an investigation to test out their own ideas
E) Students spend time in the laboratory doing practical experiments
F) Students are asked to draw conclusions from an experiment they have conducted

Country	Percentage of students answered "In all lessons" or "In most lessons" with the following statements						average
	A	B	C	D	E	F	
Turkey	27	42	45	42	28	53	39
Mexico	34	34	34	47	35	60	37
United States	45	30	28	38	45	69	35
Portugal	25	28	28	36	13	53	29
Greece	26	23	33	33	20	53	29
Japan at 9th grade	**22**	**17**	**15**	**47**	**32**	**52**	**25**
Canada	33	18	18	29	28	66	25
Denmark	51	13	11	14	61	63	22
Australia	28	16	16	26	25	65	21
United Kingdom	36	14	12	23	27	67	21
Switzerland	22	18	17	23	23	61	20
OECD average	**22**	**17**	**16**	**23**	**22**	**51**	**19**
France	23	17	16	22	23	68	19
Italy	16	16	20	24	17	36	19
New Zealand	26	14	12	22	23	58	19
Poland	14	16	16	28	8	59	18
Germany	25	14	16	19	22	65	18
Sweden	21	19	13	18	28	61	18
Luxembourg	19	16	16	20	19	49	18
Norway	26	13	13	16	24	49	17
Slovak Republic	13	18	16	21	12	37	17
Netherlands	26	13	12	17	30	51	17
Austria	20	12	14	18	16	38	16
Ireland	23	10	13	17	35	62	16
Spain	14	13	12	20	8	48	15
Korea	13	13	12	13	9	26	13
Czech Republic	10	13	8	18	9	37	12
Japan at 10th grade	**9**	**9**	**8**	**22**	**10**	**26**	**12**
Belgium	11	12	12	14	12	49	12
Hungary	8	12	10	17	9	34	12
Iceland	15	9	6	12	7	26	10
Finland	10	5	7	14	22	55	9

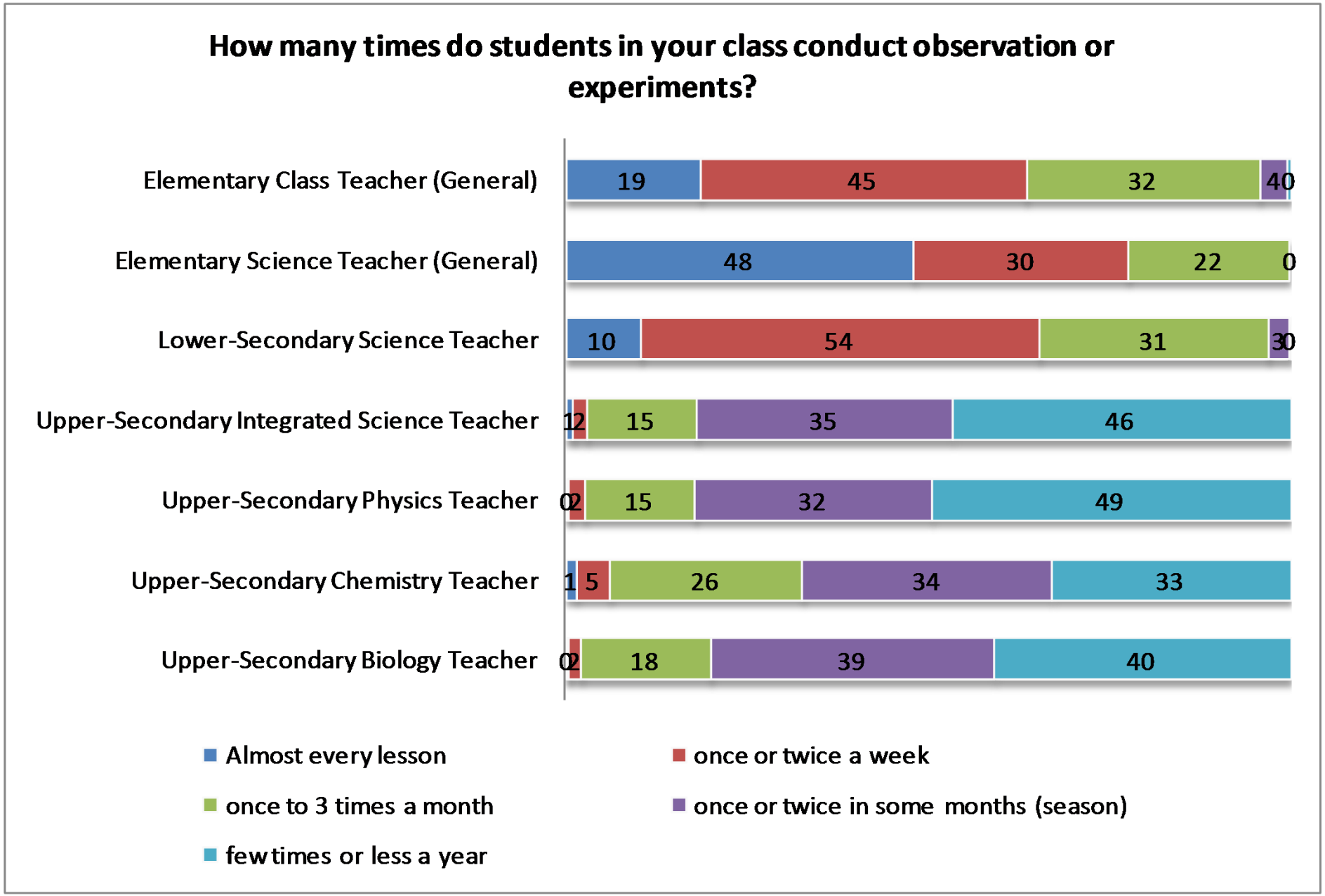
Science lesson is rarely taught in connected with "real life"

Result of PISA2006 student questions on "Science Lessons taught in Connected with Real Life"

A) The students are asked to apply a <school science> concept to everyday problems
B) The teacher explains how a <school science> idea can be applied to a number of different phenomena
C) The teacher uses <school science> to help students understand the world outside school
D) The teacher clearly explains the relevance of <broad science> concepts to our lives
E) The teacher uses examples of technological application to show how <school science> is relevant to society

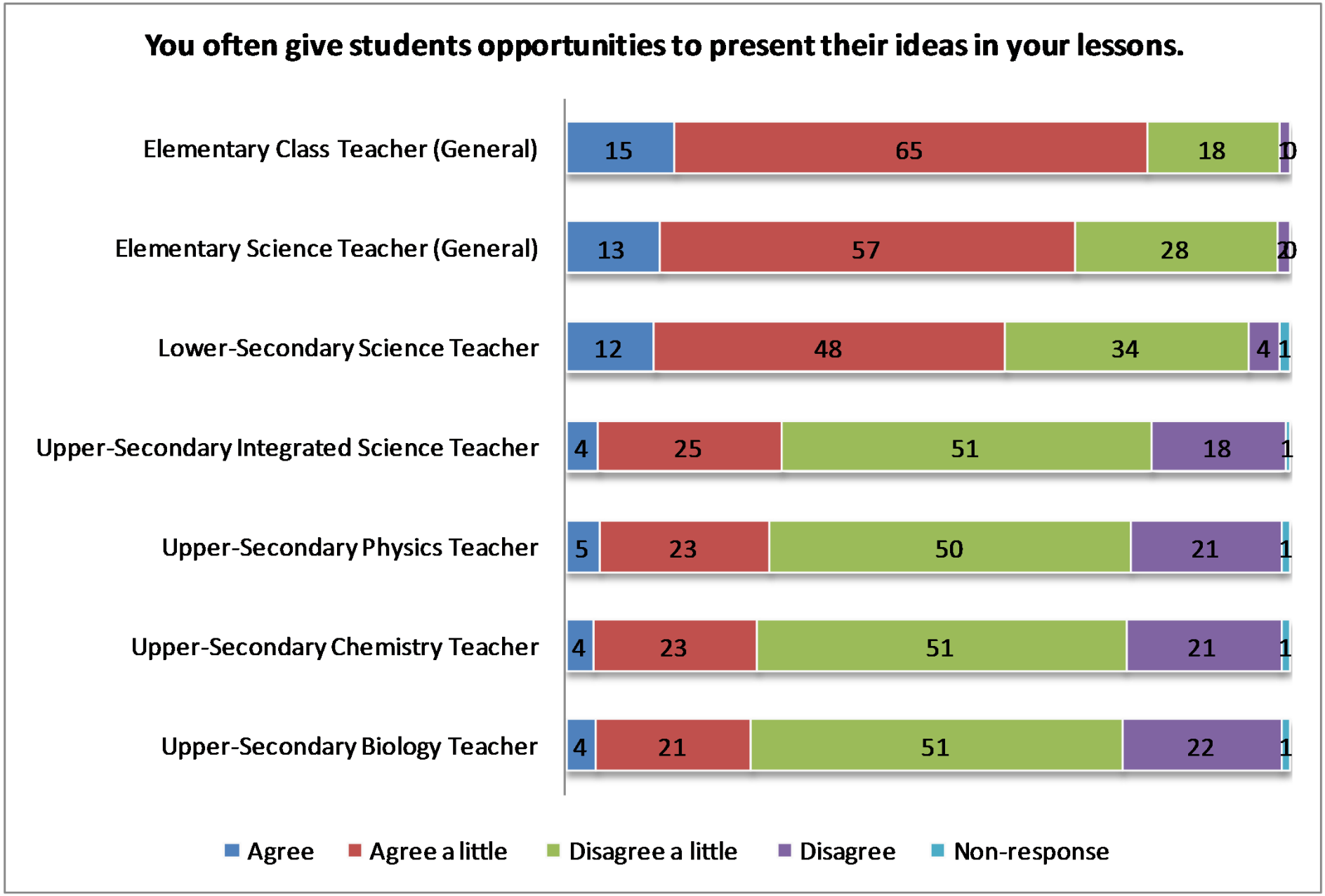
Country	Percentage of students answered "In all lessons" or "In most lessons" with the following statements					average
	A	B	C	D	E	
United States	50	68	58	57	50	57
Canada	50	72	53	58	49	56
Greece	40	63	54	60	48	53
Mexico	43	67	45	57	51	53
Portugal	38	61	53	60	49	52
Australia	39	66	49	55	41	50
New Zealand	38	66	48	51	37	48
Denmark	36	73	45	44	37	47
Switzerland	30	65	45	49	41	46
Turkey	39	56	42	46	45	46
Poland	32	69	34	48	39	45
United Kingdom	33	59	40	45	33	42
Ireland	26	61	45	47	30	42
France	32	65	37	43	32	42
OECD average	**30**	**59**	**38**	**46**	**34**	**41**
Iceland	23	67	36	49	29	41
Hungary	20	61	43	49	28	40
Sweden	28	62	34	41	32	39
Italy	27	50	36	48	32	39
Spain	24	56	30	47	36	39
Austria	21	56	38	44	33	38
Germany	25	57	38	39	31	38
Belgium	26	61	33	38	32	38
Norway	25	56	37	42	28	38
Luxembourg	21	55	34	41	30	36
Finland	25	61	31	41	20	36
Slovak Republic	21	45	29	54	26	35
Czech Republic	23	51	27	43	33	35
Netherlands	26	51	25	42	25	34
Japan at 9th grade	**22**	**45**	**25**	**36**	**30**	**32**
Korea	21	59	18	35	25	32
Japan at 10th grade	**11**	**26**	**12**	**19**	**16**	**17**

Science teaching at elementary schools depends most on observation and experiments



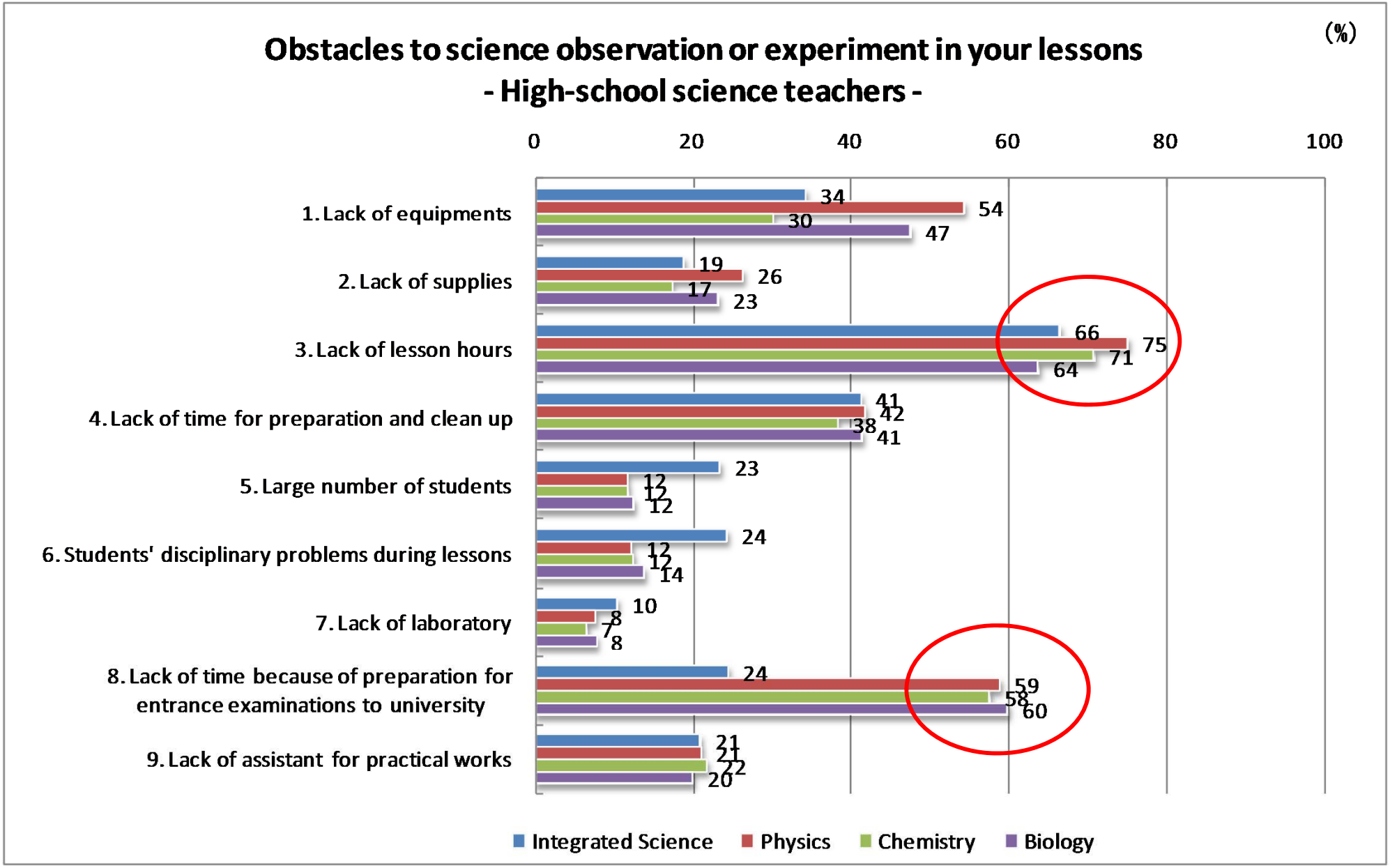
Based on JST & NIER (2009)

Teaching science becomes "teacher-centered" in upper secondary education



Based on JST & NIER (2009)

Lack of lesson hours is the most difficult obstacle for high-school teachers to teach inquiry based science

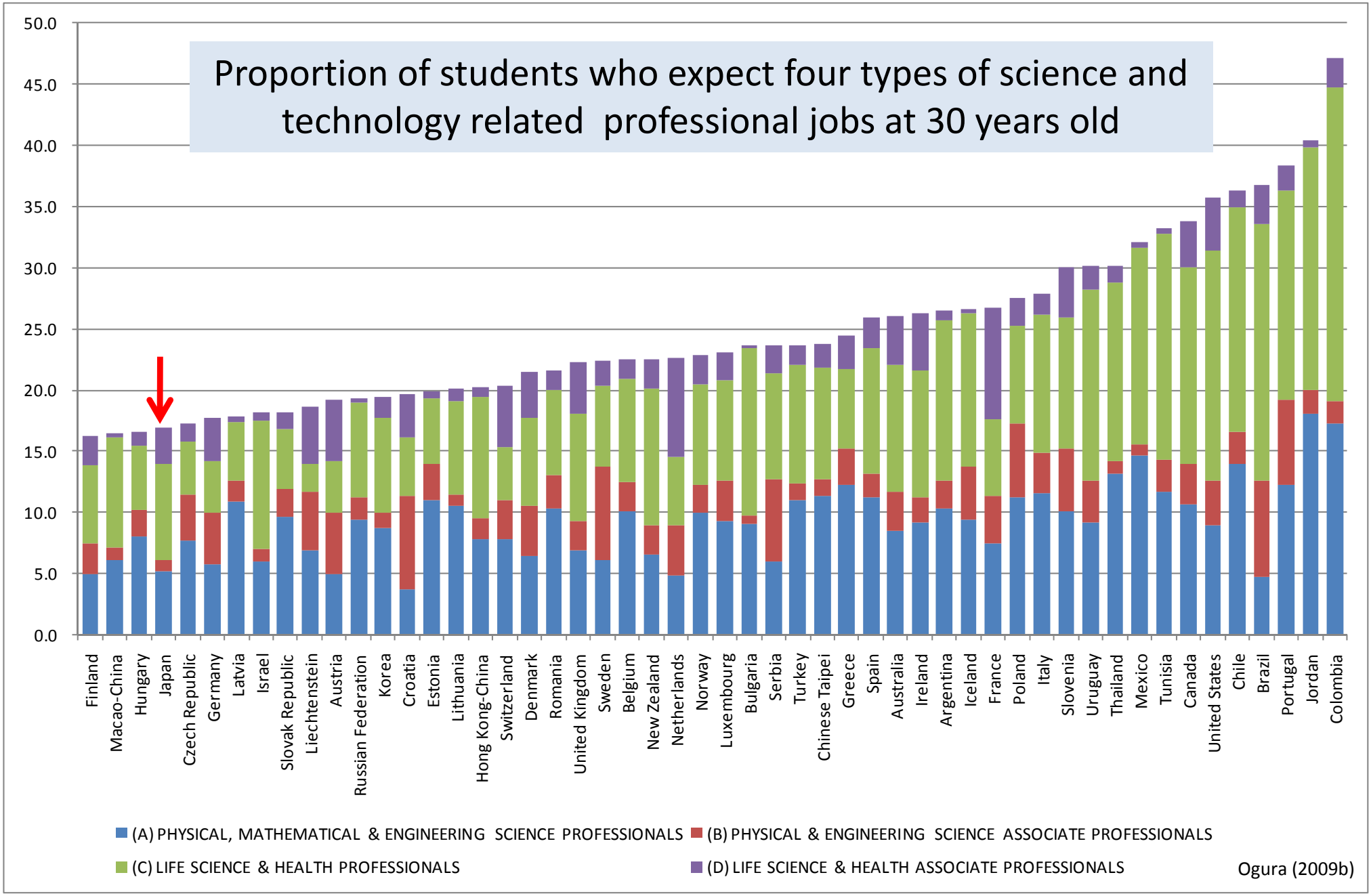


JST & NIER (2009)

5. STEM education

- *Relatively small percentage of Japanese students expect science and technology related professional jobs.*
- *In spite of various measures to facilitate STEM education, Grade 10 situation in 2011 has not changed since 2006.*

Japan develops less proportion of students who expect science and technology related professional jobs



Ogura (2009b)

Grade 10 situation in 2011 has not changed since 2006