

**Comparison of Attitudes toward
Science between Grade 9 and 10
Japanese Students by Using the PISA
Questions and Its Implications on
Science Teaching in Japan**

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Japanese students performed a relatively high achievement of scientific literacy in the cognitive test of 2006 PISA

Science scale						
	Mean score	S.E	Range of rank			
			OECD countries		All countries/economies	
			Upper Rank	Low er Rank	Upper Rank	Low er Rank
Finland	563	(2.0)	1	1	1	1
Hong Kong-China	542	(2.5)			2	2
Canada	534	(2.0)	2	3	3	6
Chinese Taipei	532	(3.6)			3	8
Estonia	531	(2.5)			3	8
Japan	531	(3.4)	2	5	3	9
New Zealand	530	(2.7)	2	5	3	9
Australia	527	(2.3)	4	7	5	10
Netherlands	525	(2.7)	4	7	6	11
Liechtenstein	522	(4.1)			6	14
Korea	522	(3.4)	5	9	7	13
Slovenia	519	(1.1)			10	13
Germany	516	(3.8)	7	13	10	19

Source: OECD PISA 2006 database, Figure 2.11c

But, levels of scale or indices in  aspects are very low compared to the OECD average

	<u>Students' self-beliefs</u>		Problematic aspect
	Index of self-efficacy in science [M=-0.53, SE=0.02]		Very low level
	Index of self-concept in science [M=-0.87, SE=0.02]		Low level compared to OECD average
	<u>Support for scientific enquiry</u>		
	Support for scientific enquiry scale [M=468, SE=2.3]		
	Index of general value of science [M=-0.18, SE=0.02]		
	Index of personal value of science [M=-0.23, SE=0.02]		
	<u>Interest in science</u>		
	Interest in scientific topics scale [M=512, SE=2.1]		
	Index of general interest in science [M=-0.13, SE=0.02]		
	Index of enjoyment of science [M=-0.26, SE=0.02]		
	Index of instrumental motivation to learn science [M=-0.43, SE=0.03]		
	Index of future-oriented motivation to learn science [M=-0.24, SE=0.02]		
	Index of science-related activities [M=-0.62, SE=0.02]		
	<u>Responsibility towards resources and environments</u>		
	Index of students' awareness of environmental issues [M=-0.13, SE=0.02]		
	Index of students' optimism regarding environmental issues [M=0.10, SE=0.02]		
	Index of students' responsibility for sustainable development [M=0.04 SE=0.02]		
	Index of students' level of concern for environmental issues [M=0.01, SE=0.01]		

The results gave strong impact to science education community, policy makers, media, and industrial community, because the results suggest that

- Japanese students tend not to believe themselves to be able to understand science,
- not to support for scientific enquiry,
- not to be interested in science not only in 10th grade but also in their future.

This situation is problematic to be improved.
However,

- It is not apparent when the problems occurred.
- Identifying the source of the problem is necessary to find the way for the improvement.
- There is a fundamental difficulty in PISA design to analyze the data of Japanese students in relation to school variables.

Japanese sample of PISA as representing the fifteen years old population is all 10th graders at the 1st grade level of upper-secondary school

Age Grade

18 12

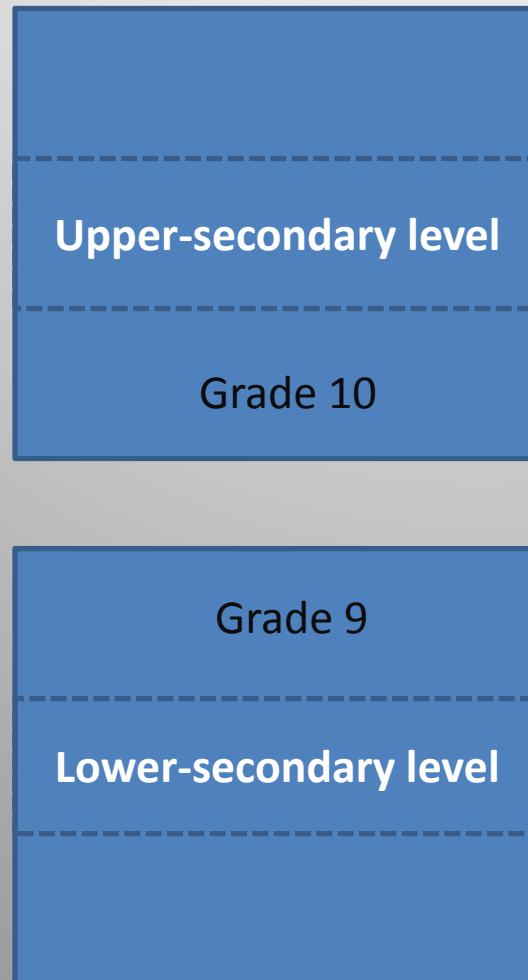
17 11

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14 8

13 7



PISA in July to 10th graders



3 months after entrance

Entrance in April

Graduation in March

Entrance Examination in Feb or March

Japanese sample of PISA as representing the fifteen years old population

Question

Are the problems of attitudes toward science found in PISA 2006 due to upper-secondary education or lower-secondary education?

Age

18

17

16

15

14

13

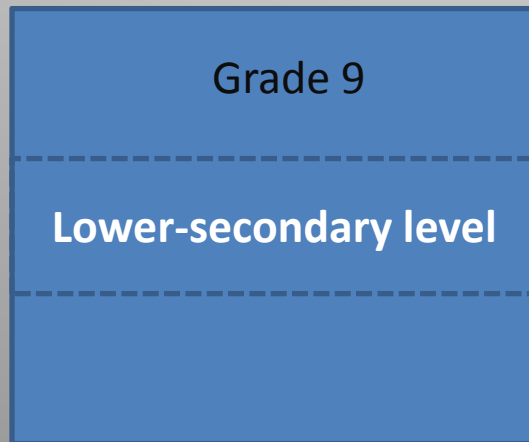
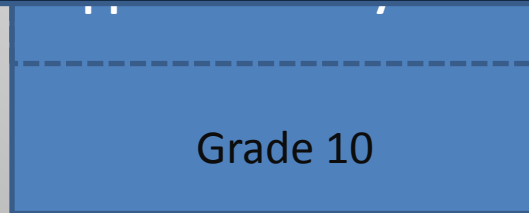
11

10

9

8

7



PISA in July to 10th graders



3 months after entrance

Entrance in April

Graduation in March

Entrance Examination in Feb or March

Japanese example of PISA assessment of the fifteen-year-old

There need additional data to 2006 PISA in order to explain whether the results of Japanese students' attitudes toward science are due to the influence of upper-secondary education or lower-secondary education or both.

Age

17

16

15

14

13

10

9

8

7

Grade 10

Grade 9

Lower-secondary level

PISA in July to 10th graders



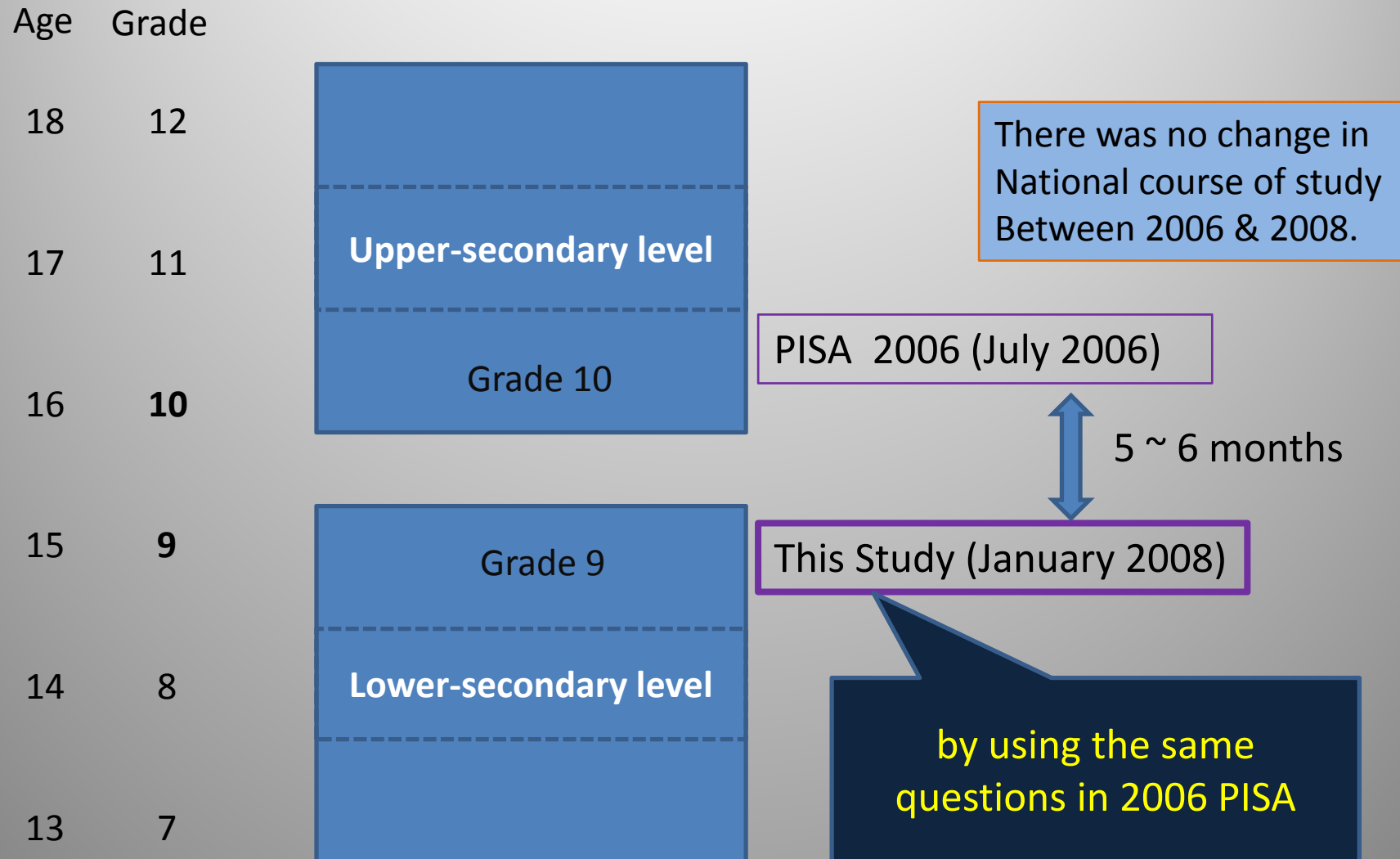
3 months after entrance

Entrance in April

Graduation in March

Entrance Examination in Feb or March

This study aims to analyze the origin of the problems of students' attitudes toward science by collecting students' data at grade 9 and comparing results between grades 9 & 10.



Comparison of results and interpretation

In January of 9th grade at lower-secondary education

If the result of this study was good

If the result of this study was low

If the result of this study was the same

lowered

further lowered

Problematic results in 2006 PISA

In July of 10th grade at upper-secondary education

problems should be occurring at upper-secondary level

problems should exist both at lower- and upper-secondary levels

problems should be occurred by the end of lower-secondary level and continued

Results

General interest in science

Country	Percentage of students reporting high or medium interest in								average
	A	B	C	D	E	F	G	H	
Mexico	84	72	74	75	76	74	65	66	73
Germany	77	62	59	56	57	54	49	42	56
France	75	60	60	65	51	50	48	38	56
Turkey			50	47	63	53	42	46	54
Luxembourg			58	55	49	61	45	41	54
Greece			53	53	57	48	40	47	54
Italy			46	44	48	62	49	42	54

- A) Human biology
- B) Topics in astronomy
- C) Topics in chemistry
- D) Topics in physics
- E) The biology of plants
- F) Ways scientists design experiments
- G) Topics in geology
- H) What is required for scientific explanations

Korea	62	52	42	31	45	24	42	28	41
Spain	59	43	36	35	41	43	34	29	40
Finland	66	48	45	41	33	24	31	26	39
Netherlands	63	36	38	40	39	30	28	27	38

Results

General interest in science

Country	Percentage of students reporting high or medium interest in								average
	A	B	C	D	E	F	G	H	
Mexico	84	72	74	75	76	74	65	66	73
Germany	77	52	59	56	57	54	49	42	56
France	75	57	60	65	51	50	48	38	56
Turkey	78	56	50	47	63	53	42	46	54
Luxembourg	75	49	58	55	49	61	45	41	54
Greece	78	55	53	53	57	48	40	47	54
Italy	74	65	46	44	48	62	49	42	54
Portugal	61	53	56	58	41	61	47	51	53
Canada	70	58	64	56	51	45	42	33	52
Japan at 9th grade	65	59	58	50	63	45	39	31	51
Austria	76	51	47	49	55	53	43	34	51
Belgium	73	53	52	52	49	50	42	36	51
United States	68	58	56	52	45	45	42	34	50
Poland	77	53	42	36	58	52	43	35	50
Switzerland	51	52	59	55	41	52	47	39	50
Norway	47	52	58	56	36	59	43	43	49
OECD average	68	53	50	49	47	46	41	36	49
United Kingdom	75	49	55	51	47	41	35	35	49
Slovak Republic	69	55	41	46	47	46	44	30	47
Czech Republic	69	57	40	47	40	54	37	35	47
Ireland	77	47	44	41	55	40	34	33	46
Hungary	72	59	36	41	44	43	40	37	46
New Zealand	66	50	55	49	44	38	36	30	46
Iceland	62	60	47	50	36	38	42	31	46
Sweden	61	53	50	48	37	44	35	35	45
Japan at 10th grade	65	55	48	40	58	34	33	25	45
Denmark	59	39	53	52	37	37	30	36	43
Australia	62	46	48	44	40	36	32	29	42
Korea	62	52	42	31	45	24	42	28	41
Spain	59	43	36	35	41	43	34	29	40
Finland	66	48	45	41	33	24	31	26	39
Netherlands	63	36	38	40	39	30	28	27	38

Results

General interest in science

Country	Percentage of students reporting high or medium interest in								average
	A	B	C	D	E	F	G	H	
Mexico	84	72	74	75	76	74	65	66	73
Germany	77	52	59	56	57	54	49	42	56
France	75	57	60	65	51	50	48	38	56

Level of “general interest in science” in Japanese 9th graders is higher than that in Japanese 10th graders in most of the topics.

The problem of losing “general interest in science” occurs at upper-secondary level.

Sweden	61	53	50	48	37	44	35	35	45
Japan at 10th grade	65	55	48	40	58	34	33	25	45
Denmark	59	39	53	52	37	37	30	36	43
Australia	62	46	48	44	40	36	32	29	42
Korea	62	52	42	31	45	24	42	28	41
Spain	59	43	36	35	41	43	34	29	40
Finland	66	48	45	41	33	24	31	26	39
Netherlands	63	36	38	40	39	30	28	27	38

Results

Instrumental motivation to learn science

Country	Percentage of students agreeing or strongly agreeing with the following statements					average
	A	B	C	D	E	
Mexico	85	86	85	79	82	84
Portugal	75	75	81	76	78	79
Turkey	80	80	73	69	79	75
United States	78	78	70	70	68	73
Canada	73	73	72	69	63	71
Poland	8	8	73	66	71	70
Italy			72	63	64	68
United Kingdom			71	65	54	67

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.

Results

Instrumental motivation to learn science

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

Results

Instrumental motivation to learn science

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	70	75

Japanese students at both grades are low compared to other OECD countries. Japanese 10th graders show further low percentages than 9th graders.

The problem of low “Instrumental motivation to learn science” exists both at lower- and upper-secondary levels.

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

Results

Self-efficacy in science

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	75	65	66	66	68	77	76	61	70
Portugal	75	75	72	71	76	61	66	57	69
United States	79	79	71	77	64	63	58	59	68
Canada	78	78	72	78	64	59	62	57	68
Slovak Republic	77	77	77	54	61	63	67	60	68
United Kingdom	69	69	69	77	67	60	61	52	67
Czech Rep.	64	64	64	67	60	71	57	57	67

- 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.

Results

Self-efficacy in science

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	43	54	61
Belgium	67	73	67	64	51	58	57	52	61
Spain	73	61	62	59	55	54	61	56	60
Luxembourg	78	71	57	65	57	58	49	44	60
Austria	78	73	53	61	63	55	58	36	60
Italy	77	70	63	64	57	46	56	46	60
Greece	67	67	52	56	61	57	59	42	58
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

Results

Self-efficacy in science

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

Percentages of Japanese students at both grades are low or at the lowest level among OECD countries.

The problem of low level of “self-efficacy in science” has occurred by the end of lower-secondary level and continues to upper-secondary level.

Italy	77	70	65	64	57	48	58	48	60
Greece	67	67	52	56	61	57	59	42	58
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

Results

Self-efficacy in science

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

Japanese education by grade 10 fails to teach students necessary scientific knowledge and skills to become citizens.

For example, scientific explanations of antibiotics, vaccination, bacteria and viruses are not taught for all students in Japan, but every citizen may need to understand these in their life.

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

Results

Responsibility for sustainable development

Country	Percentage of students agreeing or strongly agreeing with the following statements							average
	A	B	C	D	E	F	G	
Portugal	98	98	98	92	93	90	90	94
Turkey		95	96	90	89	92	94	93
Korea		96	97	94	92	85	86	93
Spain		97	94	84	88	88	81	90
Mexico		96	92	91	80	89	83	89
Poland		5	90	88	89	79	85	89
Hungary			95	86	82	77	85	88

- A) Industries should be required to prove that they safely dispose of dangerous waste materials.
- B) I am in favour of having laws that protect the habitats of endangered species.
- C) It is important to carry out regular checks on the emissions from cars as a condition of their use.
- D) To reduce waste, the use of plastic packaging should be kept to a minimum.
- E) Electricity should be produced from renewable sources as much as possible, even if this increases the cost.
- F) It disturbs me when energy is wasted through the unnecessary use of electrical appliances.
- G) I am in favour of having laws that regulate factory emissions even if this would increase the price of products.

Netherlands	92	90	88	75	65	51	53	73
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Results

Responsibility for sustainable development

Country	Percentage of students agreeing or strongly agreeing with the following statements							average
	A	B	C	D	E	F	G	
Portugal	98	98	98	92	93	90	90	94
Turkey	93	95	96	90	89	92	94	93
Korea	97	96	97	94	92	85	86	93
Spain	96	97	94	84	88	88	81	90
Mexico	94	96	92	91	80	89	83	89
Poland	93	95	90	88	89	79	85	89
Hungary	94	94	95	86	82	77	85	88
France	94	95	95	85	77	87	77	87
Greece	91	90	97	85	79	82	76	86
Italy	95	96	96	80	81	84	68	86
Japan at 9th grade	90	93	86	91	88	77	76	86
Japan at 10th grade	88	92	89	90	88	73	71	84
Belgium	94	91	94	86	74	76	68	83
Canada	93	93	93	86	82	69	66	83
OECD average	92	92	91	82	79	69	69	82
Ireland	94	93	92	92	84	60	61	82
Luxembourg	89	91	91	85	75	72	63	81
Switzerland	92	92	93	82	74	69	62	81
Finland	91	91	93	81	79	59	71	81
Denmark	92	92	81	82	79	54	75	79
Australia	92	93	90	88	78	62	52	79
Austria	92	91	87	81	69	63	69	79
Slovak Republic	94	83	91	73	81	72	56	78
United Kingdom	90	89	92	82	82	58	56	78
United States	88	90	89	77	75	63	56	77
New Zealand	90	92	90	83	75	58	49	77
Germany	91	91	89	80	66	64	53	76
Norway	88	88	83	74	72	53	73	76
Czech Republic	93	93	93	64	71	52	63	75
Iceland	89	91	86	73	77	45	65	75
Sweden	92	86	86	63	72	52	69	74
Netherlands	92	90	88	75	65	51	53	73

Results

Responsibility for sustainable development

Country	Percentage of students agreeing or strongly agreeing with the following statements							average
	A	B	C	D	E	F	G	
Portugal	98	98	98	92	93	90	90	94
Turkey	93	95	96	90	89	92	94	93
Korea	97	96	97	94	92	85	86	93

Percentages of Japanese students at both grades are relatively high among the OECD countries.

Japanese grade 9 and 10 students have developed their responsible attitude toward environment and resources through their school education.

Norway	88	88	83	74	72	53	73	76
Czech Republic	93	93	93	64	71	52	63	75
Iceland	89	91	86	73	77	45	65	75
Sweden	92	86	86	63	72	52	69	74
Netherlands	92	90	88	75	65	51	53	73

Consideration

- Country of high achievement does not mean also the success in fostering the attitude toward science, especially interest in science.
- Both raising achievement and fostering interest should be important goal of science education.
- In order to improve interest in science, it should be understood why it decreases at upper-secondary level.

Question

Why students' interest in science declines at upper-secondary level?

Possible explanations

- Pressure for high achievement may restrain interest in further learning. Students are deprived the room to develop their interest in and enjoyment of science.
- Science lessons are not interested for students compared to lessons at lower-secondary level.

Further Results: Science lessons are not interested *Inquiry based science teaching*

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	30	28	28	38	45	69	35
Portugal	28	28	28	36	13	53	29
Greece	23	33	33	33	20	53	29

- 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

Further Results: Science lessons are not interested

Inquiry based science teaching

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

Further Results: Science lessons are not interested *Inquiry based science teaching*

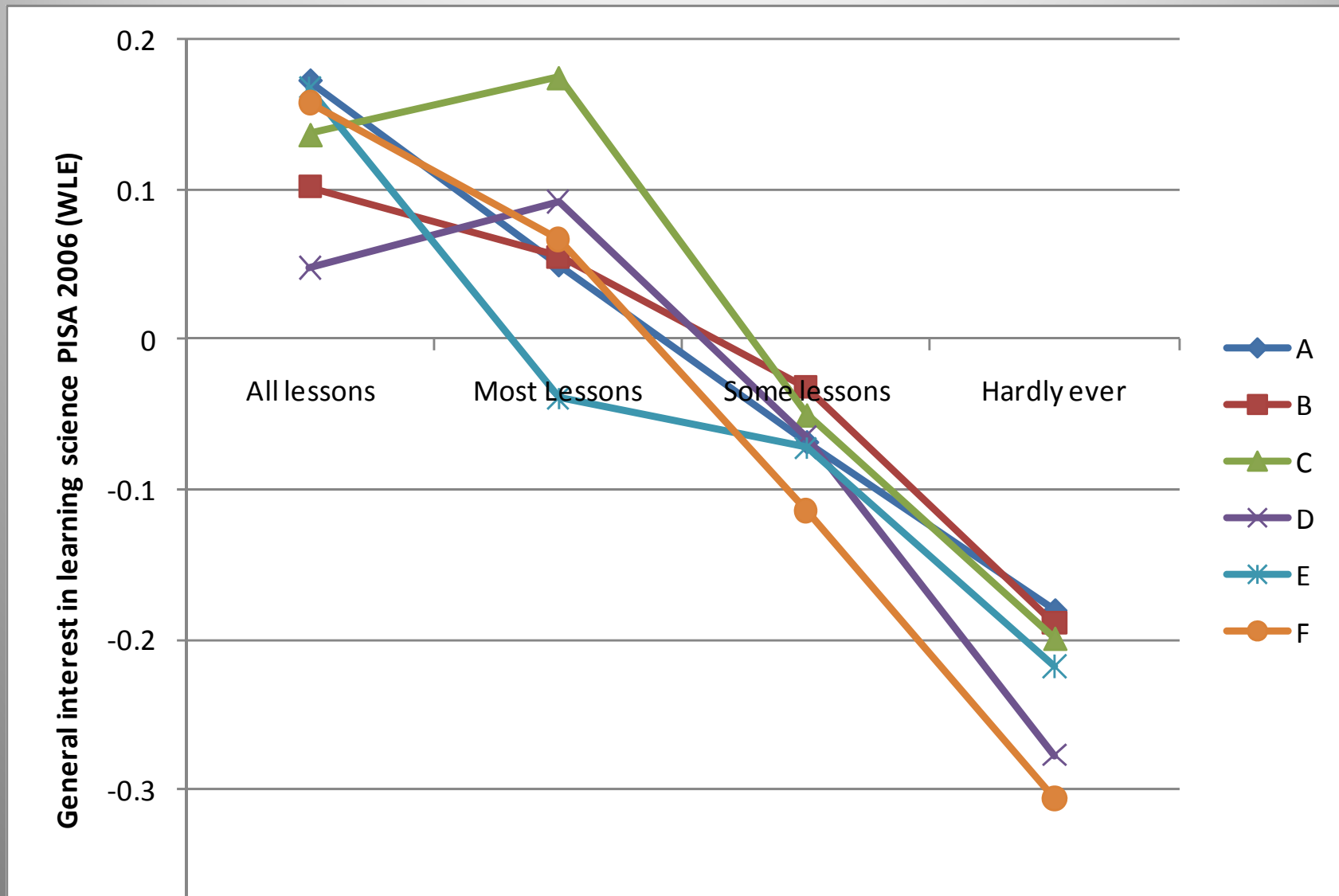
Country	Percentage of students answered "In all lessons" or "In most lessons" with the following statements						average
	A	B	C	D	E	F	
Turkey	27	42	45	42	28	53	39
Mexico	34	34	34	47	35	60	37
United States	45	30	28	38	45	69	35

There are big differences in the percentages of each teaching pattern between students at grade 9 and 10.

Japanese 10th graders have less opportunity to conduct scientific investigation and to do science experiment than 9th graders do.

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

Further Results: Science lessons are not interested
Students reporting “In all lessons” or “In most lessons” are more interested than students reporting “Some lessons” or “Hardly ever”.



Further Results: Science lessons are not interested *Inquiry based science teaching*

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

Although students are interested in inquiry based learning, science teaching at grade 10 does not orient it.

This suggests an approach to improve the problematic situation of students' interest in science at upper-secondary level.

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

Consideration

- Japanese students are not instrumentally motivated to learn science both at grade 9 & 10.
- Instrumental motivation is important for course selection, career choice and performance. (Wigfield and Eccles 1992; Wigfield et al. 1998)
- Students can learn, because it is valuable.

Question

How science lessons are taught in connected with real life?

Further Results: Science lessons are not valuable *Purpose to learn science*

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		63	54	60	48	53
Mexico		67	45	57	51	53
Port		61	53	60	49	52

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

Further Results: Science lessons are not valuable

Purpose to learn science

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

Further Results: Science lessons are not valuable *Purpose to learn science*

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

Most of Japanese students may not be able to understand the purpose of learning science because of lacking connection with real life.

Japanese science education both in lower- and upper-secondary schools should teach science with the value for students to learn.

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

Conclusion

- (1) Japanese students are losing their interest in science at grade 10
- (2) the level of motivation to learn science at grade 9 is low and further lowered at grade 10
- (3) the level of self-efficacy in learning science is low both at grade 9 and 10
- (4) responsible attitude toward environment and resources is well developed by grade 10.

Conclusion

The difference of science teaching styles between lower- and upper-secondary schools can explain why Japanese students in PISA showed quite low level of attitudes toward science.

- Students are interested in inquiry based learning, while science teaching at upper-secondary level does not orient it.
- Science taught both at lower- and upper-secondary levels does not seem valuable for students to learn, and lacks contents necessary scientific knowledge and skills to become citizens.

What is happening in Japan after 2006 PISA?

- New *national course of study* increased the lesson hours for science, and put emphasis on fostering attitudes toward science.
- *Textbooks* will be improved in quantitatively and qualitatively.
- Additional *budget* for doing science experiments for all schools at primary and secondary levels was made by national government.
- There are *assistants* (technicians) available for primary schools to do experiments in science.
- There are super science high schools (SSH) as the *model of science and math teaching* for other school teachers at upper-secondary level.

Thank you for your listening.

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