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Research Data

THREE DISTINCTIVE GROUPS AMONG JAPANESE STUDENTS IN TERMS OF THEIR SCHOOL SCIENCE PREFERENCE: FROM PRELIMINARY ANALYSIS OF JAPANESE DATA OF AN INTERNATIONAL SURVEY 'THE RELEVANCE OF SCIENCE EDUCATION' (ROSE)

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ABSTRACT

'The Relevance of Science Education' (ROSE) is an international survey project, whose aim is to provide insight into factors that relate to the relevance of the contents as well as the contexts of Science and Technology curricula, organized and managed by Svein Sjoberg and his team of University of Oslo. Its target population is 15 year-old students, who are supposed to be in the final stage of their compulsory education in respective countries. It focuses on students' emotions like interests, attitudes, values, future plans, perceptions of science, technology and/or environment as well as on their prior experiences, not on their achievement. At present, about 30 countries (mainly from Asian, African, European countries) are involved in the project. Comprehensive international comparative analysis has not yet begun, but national teams are permitted to begin to analyse respective countries' data set by themselves in advance. The present report proposes an analytical framework, by which students can be divided into three distinctive groups (Specific Priority Group, Other Priority Group, and Poor Priority Group) in terms of their 'School Science Preference,' and argues for its applicability and usability to obtain information on characteristics of respective groups' interests in learning topics and out-of-school experiences, in order to improve science teaching through preliminary analysis of ROSE data.

Keywords: School Science Preference, Relevance of Science Education (ROSE) Project, Japanese Students' Data Analysis

I. INTRODUCTION

Japan has received attention from science educators all over the world because of (1) its prosperity in scientific and technological innovations and economic development over several decades without losing its own cultural identity among Japanese people; and (2) students' rather high academic performance in international tests of scientific knowledge (e.g. IEA/TIMSS and OECD/PISA), despite having the lowest attitudes towards, and interests in, the scientific and technological enterprise. In Japan, education professionals as well as general public have serious concerns about youngsters' disinterests in learning activities in general and in science learning activities in particular. TIMSS-R results (Martin et al., 2000: NIER, 2001: NIER, 2002) triggered public debates in Japan.

Science educators seek to identify the factors that cause youngsters to dislike science and technology leading them to avoid learning science in schools. In order to get such information, international surveys on students' attitudes towards and interests in science and technology, as well as in their learning science in school settings, are needed. While a small set of items relevant to these points have been already involved in IEA/TIMSS, an extensive and intensive international survey has not yet been performed. However, now we have 'The Relevance of Science and Education' survey (ROSE), an international comparative research project organized at the University of Oslo. In contrast to IEA/TIMSS and OECD/PISA, ROSE has little financial support from international organizations or governmental agencies (one exception is the government of Norway), and volunteer researcher groups from all over the world have managed it. Because the ROSE project is currently collecting data from other countries, access to an international data set is not yet possible. Consequently our Japanese data can only be used for a preliminary analysis.

The primary aim of this report is (1) to develop an analytical framework, which can readily categorize Japanese students into several groups in terms of their preference of science, from the ROSE data, and (2) to show its applicability and usability for considering appropriate science teaching strategies for respective groups by using the items from ROSE instrument.

II. ROSE: AN INTERNATIONAL COMPARATIVE SURVEY

Sjoberg and Schreiner (2002) wrote: 'The ROSE project has the ambition to provide insight into factors that relate to the relevance of the contents as well as the contexts of S&T [science and technology] curricula. The outcome of the project will be empirical findings and theoretical perspectives that can provide a base for informed discussions on how to improve curricula and enhance the interest in S&T in a way that: respects cultural diversity and gender equity, promotes personal and social relevance, and empowers the learner for democratic participation and citizenship.' In the present research report, only a short outline of ROSE is described since its full description (not only ROSE instrument itself, but also information on Questionnaire Development Process, Methodological Considerations, and Instructions to Participants are available) is found elsewhere (Sjoberg and Schreiner, 2004).

The main focus of ROSE is not on students' achievement as was with like TIMSS or PISA, but on their personal experiences as well as on their: interests; attitudes; values; future plans; and perceptions of science, technology and/or the environment. The ROSE instrument was developed by a team in Norway in close collaboration with an international advisory group chaired by the principal investigator, Svein Sjoberg, University of Oslo, who has experience with another international survey study, 'Science and Scientists' (SAS) project (Sjoberg, 2000). The final version of the ROSE instrument (downloadable from the ROSE website, http://www.ils.uio.no/forskning/rose/documents/ROSE%20Quest.doc) consists of 250 items, most of which are divided into 7 item groups: 'My out-of-school experiences' (61 items), 'What I want to learn about' (108 items), 'My future job' (26 items), 'Me and the environment' (18 items), 'My science classes' (16 items), 'My opinions about science and technology' (16 items), and 'Myself as a scientist' (1 item). Except the free description response for the 'Myself as a scientist' item, all the items are responded on a 4-point Likert scale. However, each item group is not necessarily intended to relate to a priori theoretical construct, which may not be appropriate for the possible populations with socio-cultural diversity. ROSE Handbook (Sjoberg and Schreiner, 2002) reads: 'The ROSE study has an explorative character. ROSE aims at stimulating discussions about contents and contexts in science curriculum in diverse cultures. The project is more likely to generate hypothesis and theories than to confirm or reject a given hypothesis.' Thus, the choice of analytical framework is left to the researcher(s) who are responsible for the data set.

The target population is 15 year-old cohort, which is supposed to be the final stage of compulsory education in most countries. In order to obtain a representative sample, at least 25 schools should be selected from all over the respective country, and from each school only one class is involved in the survey. The total number of the sample in a country is expected to be more than 650 if possible. The original questionnaire is written in English and colleagues in participant countries should translate it into their respective language. But the format of the instrument, including its page structure, should be identical to the original English version. The country's data set (in either Excel or SPSS file), produced by the respective domestic research team, is sent to the principal investigator. In April 2004, the number of participant countries was 30 (see ROSE web site, http://www.ils.uio.no/forskning/rose/). These include both so-called 'developed countries' and 'developing countries' with extensive diversity in socio-cultural-economic settings.

III. ROSE SURVEY IN JAPAN

The researchers followed all procedures in the document 'ROSE Guidelines and Practicalities' (Sjoberg and Schreiner, 2002), which was approved by the ROSE international advisory group (13 members). The ROSE survey instrument was translated into Japanese by a Japanese team lead by the chief investigator (first author of this report). Two university students, whose major is science education, checked its readability and a revised final version was produced in a booklet format in December 2002. (The Japanese version is not included with this report due to page limitations, but it can be obtained from the authors upon request.) In the process of finalizing the Japanese version, we omitted an item asking for the number of books in the student's house because some parents and teachers felt that the socio-economic status of Japanese students should not be investigated. The omission of one item prevented unwanted trouble in administering the survey. We did not add any original Japanese items to the original survey.

According to the ROSE guidelines, 50 schools were selected randomly (using random numbers generated by a computer program) from among all 11203 lower secondary schools in Japan listed in the School Directory published by the Ministry of Education in 2002. This prospective sample of school comprised of; two private schools, one national school, and 47 municipal schools, reflecting the ratio of private, national and municipal schools among total schools in Japan. The chief investigator on the Japanese team sent formal letters of invitation to the principals of these 50 schools. The letter requested participation at the end of January 2003. Nineteen schools accepted the invitation. In Japan, the academic year begins on April 1 and ends on March 31. This means that the schools decided to try out the survey for the 9th graders, who were about to graduate from the school in mid-March. It was for this specific reason that the remaining 31 schools could not join the survey project. The Japanese sample (19 schools), thus, consisted of a total of 560 (268 girls, 291 boys, and one unknown) ninth graders, which was less than the minimum in the ROSE guidelines. In this specific point, the present sample should not be regarded as a representative of Japanese cohort but rather as one case study of Japanese students. A set of questionnaire booklets, plus a sheet of instructions for the teacher responsible for the administration of the survey, were sent by postal package in mid February to the 19 schools. The teacher administered all the survey instrument to the 9th graders of the same class of each school in March 2003.

The returned responses were coded by two undergraduates independently under the supervision of the chief investigator. After finishing the respective coding, two resultant Excel files were compared to each other in order to check the consistency of the two sets of coding. A final approved version was used for a SPSS analysis. The free response item was not analyzed. In the present report, the complete extensive description of fundamental data (in the form of frequency distribution in each of 245 items) has been omitted due to page limitation.

IV. DEVELOPING AN ANALYTICAL FRAMEWORK

In previous survey results (e.g., TIMSS-R [Martin et al., 2000] and NIER's national survey on school curricula [2002]), we can see Japanese 8th or 9th graders' attitudes toward school science. TIMSS-R indicates that 55% of Japanese 8th graders like school science while the international average is 79%. The national survey on school curricula also indicates 55%

of Japanese 9th graders (64% of boys, and 46% of girls) like school science. These findings show students' 'absolute' preference of school science. Muramatsu et al. (2002) reported an interesting result that there is no difference in the ratios of 'dislikeness' among girls and boys when asked: 'Do you like school science?' But once they are asked, 'Please name your favorite school subjects as many as you like', school science is the fifth favorite subject among boys, while among girls, it is the seventh, out of a total of nine school subjects. These results suggest that the students' preference for school science can be viewed from at least two perspectives: 'absolute preference' and 'relative preference.' An important point to consider is that the two perspectives can be integrated into one variable that classifies students into several homogenous groups in terms of their preference for school science. If this type of classification be possible, and we can identify certain specific characteristics in terms of their interests in scientific topics or their out-of-school experiences, for example, among respective groups, such information could be appreciated by practicing science teachers, who are struggling with improving their daily science classes.

From this point of view, the item F2 ('School science is interesting') asks students their absolute preference for school science, while the item F5 ('I like school science better than most other subjects') does their relative preference for school science. Thus, we can construct a new variable of 'school science preference' by combining these two variables. Figure 1 shows this idea. Here, we can identify four distinct groups in terms of 'school science preference;' (1) ***Specific Priority Group*** showing positive attitudes toward school science from both absolute and relative preference perspectives, (2) ***Other Priority Group*** showing positive attitudes toward school science from an absolute preference perspective, but negative attitudes from a relative preference perspective, (3) ***Poor Priority Group*** showing negative attitudes from both absolute and relative perspectives, and lastly (4) ***Not-Positive Priority Group*** showing negative absolute preference but positive relative preference.

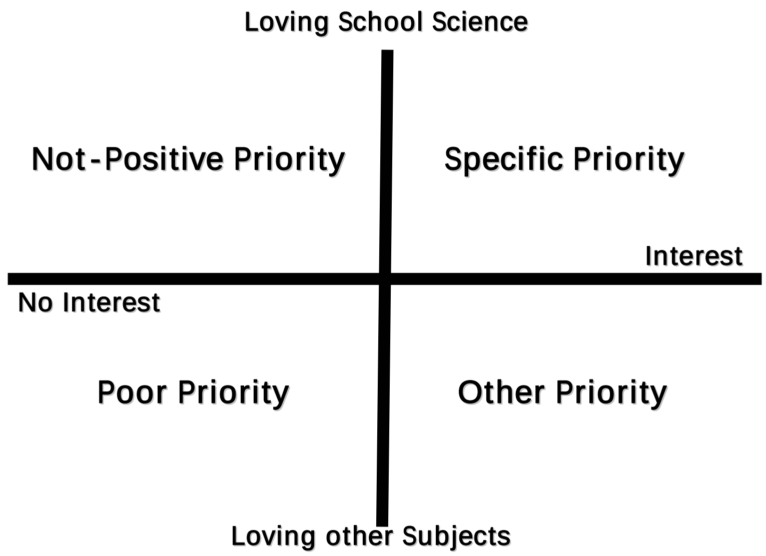

Figure 1: Framework for 'School Science Preference'

The Japanese students were classified into these four groups. As indicated in Table 1, an interesting result was found in the cross-tabulation between F2 ('School science is interesting') and F5 ('I like school science better than most other subjects').

Table 1: Cross-Tabulation between F2 and F5 among Japanese Students.

Sex			F5: I like school science better than most other subjects: disagree	slightly disagree	slightly agree	agree	Total
Girl	F2. School science is interesting	disagree	34	3	0	0	37
		slightly disagree	46	26	5	1	78
		slightly agree	28	23	16	2	69
		agree	13	18	21	31	83
		Total	121	70	42	34	267
Boy		disagree	24	3	1	0	28
		slightly disagree	29	16	5	1	51
		slightly agree	25	44	19	2	90
		agree	5	18	42	48	113
		Total	83	81	67	51	282

Table 2: Classification of Japanese Students in terms of School Science Preference
(Total in Other priority includes one unknown student.)

	Specific Priority	Other Priority	Poor Priority	Non-Positive Priority	Total
Girls	70 26.2%	82 30.7%	109 40.8%	6 2.2%	267 100%
Boys	111 39.4%	92 32.6%	72 25.5%	7 2.5%	282 100%
Total	181 33.0%	174(5) 31.7%	181 33.0%	13 2.4%	549 100%

Table 2 indicates that Japanese 9th graders are classified into three major groups in terms of their ‘school science preference.’ ***Specific Priority Group*** consists of 181 students (70 girls and 111 boys) who ‘are interested in school science’ and ‘loves much more school science than other subjects.’ ***Other Priority Group*** consists of 175 students (82 girls, 92 boys and one unknown), who are also interested in school science but have much more favorite school subjects than school science. Also 181 students (109 girls and 72 boys) are in the ***Poor Priority Group***, who have few interests in school science and dislike school science. The remaining 13 students (6 girls and 7 boys), who have no interest in school science but love school science much more than any other subject, can be regarded as belonging to the ***Not-Positive Priority Group***. The probable reason of this group’s preference is, for example, that they are not interested in the contents of science, but they feel more fun in science classes because they can have chance to do hands-on experiments or handle apparatus than any other subjects’ classes. But since the number of students is so small, the category was excluded from the framework. This framework of classification of students can be helpful in analyzing their attributes relevant to science education.

From the viewpoint of science educators, the ***Other Priority Group*** is interesting. If we regard them as ‘school science lovers’ since they actually love school science in the absolute perspective, the total number of ‘school science lovers’ is greater. But if we consider them in terms of their relative perspective, the total number of them diminishes dramatically. The difference is so great as to make a significant impact on science educators’ debates concerning youngsters’ disinterests in science.

One fascinating question arises: What kind of specific characteristics does the ***Other Priority Group*** have in comparison with the other two groups? Do they have potential to become ***Specific Priority Group*** students if we can provide appropriate means to support them? What can science teachers do for making these students look back on science differently? In order to answer such questions, first we should try to find out specific characteristics of each of three groups in terms of their interests in scientific topics, their attitudes towards science and technology issues, and/or their out-of-school experiences.

In this preliminary report, we will restrict ourselves to present some examples alone, which may give us suggestions and implications to improve science teaching.

V. METHOD OF DATA ANALYSIS

In the present preliminary study, the data were analyzed item by item through three dimensional cross-tabulation of frequency distribution (sex (girl, boy) ×group (Specific, Other, Poor) ×response category (4 point Likert scale)) utilizing a SPSS package. Chi-square analysis with residual analysis was administered in each of the items. The residual analysis (for example, see Everitt (1977)) was used to identify outlier and/or influential observation not fitting the overall trend shown by the remaining data. It goes without saying that it gives useful information on the cases of overall chi-square analysis showing significant differences ($p<0.05$), but even if chi-square value shows marginally significant difference level ($0.05<p<0.10$), the observations with adjusted standardized residuals (which are approximate to Z scores) beyond ±1.96 suggest their possibility to be outlier. The information is very helpful to decipher characteristics of respective groups.

VI. APPLICATION OF THE FRAMEWORK: EXAMPLES

Purpose of the present report is to show a limited number of examples, which suggest applicability and usability of the three-group-framework with gender difference when deliberating appropriate teaching strategies for respective groups. Among the ROSE instruments, the item sets, 'What I want to learn about' (A, C and E: total 105 items), and 'My out-of-school experiences' (H: 61 items) are directly relevant to the issue, how to improve science teaching. Thus, special emphasis should be laid on showing examples of application of the framework to these items.

On the item sets 'What I want to learn about,' in general, Specific Priority Group is apt to respond more positively, and Poor Priority Group more negatively while Other Priority Group is apt to responds in between. Table 3 shows a typical pattern of the responses of each group to the items of 'What I want to learn about.'

Table 3: How the Eye Can See Light and Colors (Girls, x2=21.197, df=6, p<0.01: Boys, x2=30.883, df=6, p<0.01)

Sex	A36. How the eye can see light and colors						
	Group		not interested	a little interested	interested	very interested	Total
Girl	Poor	Frequency	34	42	22	11	109
		Adjusted Residual	3.1	1.6	-2.1	-2.8	
	Specific	Frequency	11	16	25	17	69
		Adjusted Residual	-1.4	-2	2	1.7	
	Other	Frequency	12	28	23	19	82
		Adjusted Residual	-1.9	0.2	0.3	1.4	
	Total	Frequency	57	86	70	47	260
Boy	Poor	Frequency	27	31	9	5	72
		Adjusted Residual	3.3	1.1	-3.1	-1.7	
	Specific	Frequency	17	32	39	23	111
		Adjusted Residual	-2.6	-2.4	2.7	3.3	
	Other	Frequency	20	40	25	7	92
		Adjusted Residual	-0.4	1.5	0.2	-1.8	
	Total	Frequency	64	103	73	35	275

Table 4: How Mobile Phones Can Send and Receive Messages (Girls; x2=4.524, df=6, NS: Boys; x2=24.098, df=6, p<0.01)

Sex	C6. How mobile phones can send and receive messages						
	Group		not interested	a little interested	interested	very interested	Total
Girl	Poor	Frequency	15	30	36	28	109
		Adjusted Residual	-0.6	1.7	-0.4	-0.7	
	Specific	Frequency	12	10	27	21	70
		Adjusted Residual	0.5	-1.9	0.8	0.4	
	Other	Frequency	13	18	27	24	82
		Adjusted Residual	0.2	-0.1	-0.4	0.3	
	Total	Frequency	40	58	90	73	261
Boy	Poor	Frequency	22	21	12	16	71
		Adjusted Residual	3.9	1.1	-2	-2.3	
	Specific	Frequency	8	25	30	46	109
		Adjusted Residual	-3.2	-0.5	0.6	2.5	
	Other	Frequency	14	21	28	29	92
		Adjusted Residual	-0.3	-0.5	1.3	-0.5	
	Total	Frequency	44	67	70	91	272

Table 5: The Possible Radiation Dangers of Mobile Phones and Computers (Girls; x2=7.856, df=6, NS: Boys; x2=28.531, df=6, p<0.01)

Sex	E14. The possible radiation dangers of mobile phones and computers						
	Group		not interested	a little interested	interested	very interested	Total
Girl	Poor	Frequency	21	29	41	18	109
		Adjusted Residual	1.3	0.6	0.8	-2.6	
	Specific	Frequency	8	15	24	22	69
		Adjusted Residual	-1.1	-0.7	0	1.6	
	Other	Frequency	12	20	25	24	81
		Adjusted Residual	-0.3	0	-0.9	1.2	
	Total	Frequency	41	64	90	64	259
Boy	Poor	Frequency	28	14	11	18	71
		Adjusted Residual	4.4	-0.7	-2.6	-0.7	
	Specific	Frequency	14	26	29	41	110
		Adjusted Residual	-2.8	0.3	-0.3	2.6	
	Other	Frequency	16	22	35	19	92
		Adjusted Residual	-1.1	0.3	2.8	-2.1	
	Total	Frequency	58	62	75	78	273

However, there are exceptions. Interesting exceptions are found in the responses to the items, ‘C6. How mobile phones can send and receive messages’ (Table 4) and ‘E14. The possible radiation dangers of mobile phones and computers’ (Table 5). In both cases, no significant differences of distribution pattern are found among three groups in girls while significant differences are found in boys. Even girls in the Poor Priority Group show interests to these items to the extent that girls in the Specific Priority Group and in the Other Priority Group do. Generally, girls are believed to be not so much interested in science and technology, but in these items, they clearly show their interests. Why? The key to resolve the problem can be found in the responses to the items, H44 and H45, which are involved in the item set, ‘H. My out-of-school experiences.’ Tables 6 and 7 indicate the responses. Girls in the Poor Priority Group are heavier users of mobile phones than the boys in any other groups

(Table 6). And they also enjoyed SMS (text message on mobile phone) much more, while no significant differences among boys in the three groups were found (Table 7). These results suggest that girls in the Poor Priority Group, believed to be the least interesting to science and technology in general, show distinct interest to the mechanism of how mobile phones can send and receive messages or to the possible harm of mobile phones to human body, which are quite scientific topics relevant to their daily ways of life, because they realize that they are heavily dependent upon the mobile phone system in their daily life. Thus, ‘mobile phone system’ can serve as a ‘trigger’ or ‘breakthrough’ to make girls in the Poor Priority Groups (and other two groups, too) look back to science classes. Science teachers can try to develop learning activities on mobile phones especially for the girls in the Poor Priority Group if they take the findings seriously.

Table 6: Used a Mobile Phone (Girls, x2=10.785, df=6, p=0.095: Boys, x2=4.356, df=6, NS)

Sex	H44. Used a mobile phone						
	Group		never	few	less often	often	Total
Girl	Poor	Frequency	4	7	11	87	109
		Adjusted Residual	-1	-1	-2.2	2.9	
	Specific	Frequency	6	8	12	44	70
		Adjusted Residual	1.4	1.1	-0.3	-1.6	
	Other	Frequency	4	7	19	52	82
		Adjusted Residual	-0.2	0	2.1	-1.6	
	Total	Frequency	14	22	42	183	261
Boy	Poor	Frequency	9	14	12	36	71
		Adjusted Residual	-0.7	0.1	-0.8	1.1	
	Specific	Frequency	15	25	21	48	109
		Adjusted Residual	-0.5	1.2	-0.3	-0.3	
	Other	Frequency	17	14	22	39	92
		Adjusted Residual	1.1	-1.3	1.1	-0.7	
	Total	Frequency	41	53	55	123	272

Table 7: Sent or Received an SMS (Girls; x2=12.296, df=6, p=0.056: Boys, x2=8.172, df=6, NS)

Sex	H45. Sent or received an SMS (text message on mobile phone)						
	Group		never	few	less often	often	Total
Girl	Poor	Frequency	10	4	10	85	109
		Adjusted Residual	-1.8	-1	-1	2.6	
	Specific	Frequency	16	3	7	44	70
		Adjusted Residual	2.6	-0.5	-0.5	-1.4	
	Other	Frequency	10	7	13	52	82
		Adjusted Residual	-0.5	1.5	1.5	-1.4	
	Total	Frequency	36	14	30	181	261
Boy	Poor	Frequency	23	6	7	35	71
		Adjusted Residual	0.2	-0.7	-0.6	0.7	
	Specific	Frequency	32	18	11	48	109
		Adjusted Residual	-0.7	2.6	-0.7	-0.5	
	Other	Frequency	31	5	14	42	92
		Adjusted Residual	0.5	-2	1.3	-0.1	
	Total	Frequency	86	29	32	125	272

It is difficult to summarize the Japanese students' out-of-school experiences briefly. However, several characteristics are found. For example, few Japanese students have experiences in nomadic ways of life which are still popular in certain areas in the world (for example, H6, H7, H10 and H11, see Table 8), because such daily ways of life are rare in contemporary Japan. However, the number of families who spend their holidays in a country-side or farm land is not so small. Students from such families are readily expected to have experiences in the activities relevant to originally nomadic ways of life. While there are no significant differences in the response pattern among three groups in H6, H10, and H11 in both girls (H6: x2=3.652, df=6, NS; H10: x2=6.176, df=6, NS; H11: x2=1.630, df=6, NS) and boys (H6: x2=9.250, df=6, NS; H10: x2=11.803, df=6, NS; H11: x2=10.007, df=6,NS), significant differences in the response patterns of H7 among three groups in both girls (x2=16.499, df=6, p<0.05) and boys (x2=15.250, df=6, p<0.05) are found as shown in Table 9. Both girls and boys of the Specific Priority Group have the richest experiences in 'caring animals on a farm' while girls and boys of the Poor Priority Group have the poorest experiences. The results imply that while Japanese students as a whole have few experiences of nomadic ways of life in general, the Specific Priority Group students have still more direct experiences 'on a farm' condition than any other groups. This fact suggests a possible relationship between their direct experiences in a field and their positive attitudes toward science.

Table 8: Experiences in items relevant to nomadic ways of life (% of students)

Items	Never	Few	Less Often	Often
H6: watched (not on TV) an animal being born	60.7	14.0	12.2	13.1
H7: cared for animals on a farm	58.6	20.0	13.1	8.3
H10: milked animals like cows, sheep or goats	67.7	10.9	14.1	7.3
H11: made daily products like yoghurt, butter, cheese or ghee	57.0	14.6	18.2	10.2

Table 9: Cared for Animals on a Farm (Girls, x2=16.499, df=6, p<0.05: Boys, x2=15.250, df=6, p<0.05)

Sex	H7. Cared for Animals on a Farm						
	Group		never	few	less often	often	Total
Girl	Poor	Frequency	65	27	13	3	108
		Adjusted Residual	1.0	1.4	-1.0	-2.7	
	Specific	Frequency	36	14	8	12	70
		Adjusted Residual	-1.0	-0.2	-0.9	3.2	
	Other	Frequency	45	13	17	6	81
		Adjusted Residual	-0.2	-1.3	1.9	-0.3	
	Total	Frequency	146	54	38	21	259
Boy	Poor	Frequency	53	9	4	3	69
		Adjusted Residual	3.1	-1.6	-1.6	-1.5	
	Specific	Frequency	58	24	11	15	108
		Adjusted Residual	-2.1	1.0	-0.3	2.5	
	Other	Frequency	53	19	14	5	91
		Adjusted Residual	-0.7	0.4	1.7	-1.3	
	Total	Frequency	164	52	29	23	268

Another example is that there found significant differences of three groups in experiences of science museums (Table 10) and science books (Table 11). The Specific Priority Group has rich experiences in 'H9: visited a science centre or science museum' and the Poor Priority Group has the least experiences (Girls: x2=29.880, df=6, p<0.01; Boys: x2=35.184, df=6, p<0.01). Similarly, the Specific Priority Group 'H12: read(s) about nature or science in books or magazines' very much, while the Poor Priority Group read(s) few books or magazines (Girls: x2=51.149, df=6, p<0.01; Boys: x2=57.743, df=6, p<0.01).

These two factors seem to be close relationship with their school science preference.

Table 10: Visited a ScienceCentre or Science Museum (Girls: x2=29.880, df=6, p<0.01; Boys: x2=35.184, df=6, p<0.01)

Sex	H9: visited a science centre or science museum							
	Group		never	few	less often	often	Total
Girl	Poor	Frequency	18	38	37	13	106
		Adjusted Residual	2.0	3.4	-1.4	-3.4	
	Specific	Frequency	5	10	26	28	69
		Adjusted Residual	-1.4	-2.3	-0.5	4.1	
	Other	Frequency	8	16	40	18	82
		Adjusted Residual	-0.8	-1.4	1.9	-0.3	
	Total	Frequency	31	64	103	59	257
Boy	Poor	Frequency	21	21	19	10	71
		Adjusted Residual	4.7	0.3	-1.7	-2.2	
	Specific	Frequency	7	26	37	39	109
		Adjusted Residual	-2.7	-1.3	-0.3	3.9	
	Other	Frequency	8	29	39	15	91
		Adjusted Residual	-1.5	1.0	1.9	-2.0	
	Total	Frequency	36	76	95	64	271

Table 11: Read about Nature or Science in Books or Magazines (Girls: x2=51.149, df=6, p<0.01; Boys: x2=57.743, df=6, p<0.01).

Sex	H12. read about nature or science in books or magazines						
	Group		never	few	less often	often	Total
Girl	Poor	Frequency	48	35	20	6	109
		Adjusted Residual	5.0	0.2	-2.1	-3.9	
	Specific	Frequency	6	18	20	25	69
		Adjusted Residual	-4.1	-1.1	0.9	5.4	
	Other	Frequency	18	29	25	10	82
		Adjusted Residual	-1.4	0.9	1.4	-1.1	
	Total	Frequency	72	82	65	41	260
Boy	Poor	Frequency	31	24	9	7	71
		Adjusted Residual	5.3	1.2	-3.1	-3.2	
	Specific	Frequency	11	19	36	43	109
		Adjusted Residual	-3.7	-3.3	2.0	4.9	
	Other	Frequency	16	34	27	15	92
		Adjusted Residual	-1.1	2.3	0.8	-2.1	
	Total	Frequency	58	77	72	65	272

VII. WAY FORWARD

The three-group-framework is proposed by using the new variable ‘School Science Preference’ constructed from the Japanese ROSE data of items, F2 and F5. Though it is a rather simple construct, it seems to serve as a useful tool to decipher differential perspectives of Japanese students’ interests in scientific topics, attitudes toward school science and/or out-of-school experiences. Discussion on how to cope with students’ negative attitudes toward school science or learning science has not yet been so extensively developed or differentiated into several groups (except gender) in terms of their preference toward science or school science. However, once we can identify three distinct groups in terms of their ‘School Science Preference’ and their respective characteristics on motivations towards school science, then we can deliberate appropriate teaching strategies, teaching topics and materials for respective groups, just as shown in the example on girls in the Poor Priority Group (topics relevant to mobile phones) .

The framework is likely to be promising in international comparative studies of ROSE in the future. Do we identify four (or three?) groups of students in any country? What are the relative ratios among the groups in respective countries? What kinds of characteristics does each group have in terms of their attitudes toward science or science classes? How do students differentiate into such groups? Can school innovations or interventions turn students classified as the ‘Other’ and ‘Poor’ group students into ‘Specific’ group students? It is our hope to conduct an international joint analysis from this point of view.

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