Attitude Survey Regarding Science and Academic Records of Elementary Teacher Trainees in Japan

Mutsumi Nakai
Faculty of literature
Daito Bunka University

Minori Hashimoto
Faculty of social-human environmentology
Daito Bunka University

Kana Suematsu
A graduate school of education
the University of Tokyo

Tomoya Nakai
Center for Information
and Neural Networks, NICT

Kohji Terata
Faculty of economics
Daito Bunka University

Hisashi Aoki
Tokyo Gakugei University

Hiromitsu Masuda
Faculty of education
Gunma University

Norie Fujibayashi
Faculty of education
Niigata University

Atsushi Muta
Tokyo Polytechnic University

Hitoshi Nakai
Tsuru University

Abstract: *Many Japanese high schools offer unique curriculum in which student's study courses are divided into the humanities and the sciences. The students selected latter course learn small contents of science, but now occupy larger number of Japanese elementary school teachers than the before. Here we examined the students graduating from high school in the transition period between the old and new education guidelines. Our research clearly shows that university students training for elementary school teachers have similar "tendency to avoid practical experiments in science class". Under the next set of educational guidelines, incorporating "proactive and cooperative learning designed to identify and solve problems" with an emphasis on projects that involve both practical experiments and critical thinking, we expect changes in attitudes of the students at elementary school teacher training toward science and practical experiments.*
Keywords: *elementary school education, education history, Science*

1. Introduction: The Current Role of Science in Elementary School Teacher Training in Japan

Elementary education teaching licenses in Japan are in principle granted to trainees by the Board of Education after they have completed a university elementary teacher training course. The mandatory curriculum at university includes all nine subjects relevant to teaching: arithmetic, Japanese, science, social studies, music, arts and crafts, physical education, life studies, and homemaking, with the addition of moral education and English in 2019. Teachers must teach all these subjects at the elementary school.

Everyone has their own strengths and weaknesses. Teaching every subject is an unpleasant necessity for elementary school teachers. Until the end of the 20th century, however, it was normal for elementary school teachers to be able to cover all subjects within a matter of years after beginning work. In the last 10–20 years, the lack of skill displayed by young elementary school teachers in science has evidently grown (MEXT, 2011) [1] . Elementary school teachers show a tendency to learn well from each other. When the majority of teachers as a group are poor at science, this itself becomes an obstacle to learning from each other.

Japanese elementary and secondary (junior high school and high school) education is closely controlled according to the government's education guidelines decided by Ministry of education, culture, sports, science and technology, Japan (MEXT). These guidelines, called as Course of Study, are revised approximately every ten years, and the content of education is subject to close scrutiny. This means that the quality of learning content can be guaranteed to be roughly the same no matter where you go to school in Japan. The government released new Course of Studies in February 2017, and they are scheduled to come into full effect in elementary schools in 2020, junior high schools in 2021, and high schools in 2022. However, they are scheduled to come into preliminary effect in elementary and junior high schools from 2018.

Elementary and junior education is compulsory in Japan. While there are several companies that write textbooks for this period of compulsory education, the number of pages and prices are always the same. Every child in Japan gets these textbooks for free. Textbooks based on Course of Study demonstrate a significant amount of practical experiments in elementary school science education. Hashimoto *et al.* (2016)[2] reported over that 50% of students currently taking university entrance exams state that they did practical experiments several times a month while at elementary school. Much of this experimenting and practical training assist in supporting the high scientific literacy of Japanese schoolchildren. Children now engage in practical experiments as often as elementary school students up until middle school, when the percentage of high school students engaging in experiments at least one or twice a year falls to 23% (Hashimoto *et al.,* 2016)[2].

The current Course of Study, which was brought into effect in 2011 (for elementary schools) and 2012 (for junior high schools), increased the expanse of science that was covered compared with the preceding Course of Studies (previous Course of Studies). The new Course of Study accorded more space for practical experiments in science lessons and increased their number in compulsory education in elementary and junior high school. The results of the PISA (Program for International Student Assessment) survey, targeted at pupils who studied under Course of Study, indicated an improvement in scientific literacy score over the 2006 survey (OECD, 2007)[3]. The number of hours of teaching science increased in elementary and junior high schools, and the increase in the number of practical experiments may be the cause for this. Science lessons with room for practical experiments are critical for maintaining a high degree of scientific literacy.

Elementary school lessons with a rich element of practical experiments occur today owing to the ceaseless efforts undertaken by Japan’s elementary teachers. However, the number of elementary teachers who are not enough skillfully at practical experiments is increasing. This led MEXT to disseminate guidelines about experiments to all elementary school teachers (MEXT, 2011)[1]. Moreover, the currently used elementary school textbooks include instructions that help elementary school teachers not familiar with laboratory equipment. For example, changing the gasoline in the spirit lamp in the miniature version of the tabletop stoves used at home, which are a frequent cause of accidents. What is the reason for MEXT to act in this way? Why are the elementary school teachers teaching science worse than other subjects? Why are they not so familiar with scientific experiments?

Many Japanese high schools offer a unique curriculum divided into the humanities and the sciences. This categorization is derived from the division in Japanese university entrance examinations. Most high school students choose which course to take in their first and second years at high school. Students who choose the humanities mostly stop taking science and mathematics lessons and do not engage in experiments during their time at high school. Essentially, it is largely the students in the course of the sciences who take lessons with experiments in high school. This division into two extremes expanded across high schools in 2003, when the previous Course of Studies were in place, as the result of an effort to make elective courses more widespread and efficient in response to the reduced number of hours spent in school. High school students hoping to be part of an elementary teacher training university choose to take the so-called humanities courses. Because of the paucity of science and mathematics lessons in this course, many elementary school teachers now have poor skills in science and mathematics. Their lack of experience with practical experiments has resulted in a lack of skill.

In the beginning of the 2000s, “most elementary school teachers felt that they were poor at science but were obliged to make an effort to be able to teach it. Nakai (2008) [4] showed that many trainees training to become elementary school teachers “were not good at science experiments, but only needed the help of a leader to be able to teach them.” Even when elementary teacher trainees were bad at science, they did not dislike studying it and performing experiments. However, the manner in which elementary teacher trainees think has changed in recent years.

The education records of students graduating from high school between 2013 and 2015 reflect the transition period between the old and new Course of Study. High school students graduating between 2013 and 2014 studied under the old Course of Studies, while high school students graduating in 2015 studied under the current Course of Study. However, a small part of this cohort was educated under the next set of Course of Study in advance, depending on their school. These students were the subjects of this survey; they were examined in terms of their academic records (the lessons they took up in high school, whether they engaged in practical experiments) and their awareness about science to determine whether the manner in which elementary teacher trainees think has genuinely changed and whether a link exists with their academic records. The survey in this study includes many questions, and they have not yet been completely analyzed; this article serves to report an overview of the study’s findings.

2. Survey Method

The survey was taken by elementary teacher trainees at three national, one public, and one private university; these trainees, who had mainly graduated high school between 2013 and 2015, were administered a questionnaire paper and a problem evaluation paper to test their scientific literacy with respect to the junior high school level. The same survey was administered to a group studying science and technology at university to serve as a comparative study (41 participants). There were 710 valid responses from elementary teacher trainees. Of these, 477 responses were from trainees who had attended high school under the old Course of Studies, and 191 were from trainees who had attended high school under the current Course of Studies. 42 participants did not give the year of graduation.

The survey obtained basic information about sex, upbringing, and living environment of the trainees and then asked them about the science- and mathematics-related subjects they took in high school and the subjects on which they were examined. The survey also asked the trainees about their experiences involving nature during their childhood (up until the age of 10) and the amount of practical experimental experience they had in elementary, junior high, and high school. Further, it was determined whether they liked or disliked science. Trainees who disliked science were asked how much and why they disliked it.

The problem evaluation paper took problems from The International Association for the Evaluation of Educational Achievement's (IEA) Trends in International Mathematics and Science Study :TIMSS 2011 (IEA, 2013)[5]. The problems included areas where elementary teacher trainees have been empirically found weak. In 2014, before the survey, a similar preliminary problem evaluation paper was administered to trainees at two universities in the context of the full survey. The findings from which were used to curate the problems that were investigated.

In Japan, science is taught as one subject by a single teacher in both elementary and junior high school, whereas in high school, it is normally divided and taught as separate subjects: physics, chemistry, biology, and earth sciences, among others. This survey is therefore also separated into different fields of discussion. Problems requiring knowledge about biology had a high rate of accurate responses in the preliminary survey; thus, the questions were modified to integrated ecosystem problems considered to be difficult for trainees. There were a total of ten questions: three multiple choice questions concerning atoms and molecules for chemistry, two questions about the ecosystem and environment, one question about the law of inertia for physics, one question on topographical maps (in a half-essay form), two questions on the planetary system for earth sciences, and one essay question on heat in physics. The inclusion of the concept of molecules for chemistry is linked to the concept of particles introduced to elementary schools under the current Course of Study. The problems in the survey are provided below in abbreviated form.

The reason earth sciences (which could also be partially thought of as social geography) are represented to such a great extent is not because questions from this subject area are included in PISA and TIMSS but because the widespread introduction of multiple choice in both the previous Course of Study and the Course of Study before that in Japan has led to only 5% of high school students choosing to study earth sciences and geography; further, this has resulted in a drop in the rate of accurate responses to questions in these subjects in the 2014 preliminary survey.

Calculations were made using IBM's SPSS software.

Table 1 The contents of the problem evaluation paper

	Questions	Choices	Subjects
Question 1 (Q1)	What happens to the molecules of a liquid when it cools?	(1) their velocity decreases [correct answer]	Chemistry
		(2) their velocity increases	
		(3) they decrease in number	
		(4) their size decreases	
Question 2 (Q2)	What happens to the atoms of a can when it is crushed flat?	(1) they are broken	Chemistry
		(2) they are flattened	
		(3) they stay the same [correct answer]	
		(4) they become different atoms	
Question 3 (Q3)	On organisms creating organic matter	(1) they create nutrients using energy from the sun [correct answer]	Biology
		(2) they absorb energy from parasites	
		(3) they gain energy by eating plants	
		(4) they break down dead organisms	
Question 4 (Q4)	Which of the following things change when a liquid turns into gas?	(1) density: changes [correct answer]	Chemistry
		(2) mass: does not change	
		(3) volume: changes	
		(4) size of molecules: does not change	
		(5) velocity of molecules: changes	
Question 5 (Q5)	Considering a person jumping out of a plane with a parachute, when is the gravitation force acting on them? [Multiple choice was allowed. Correct answer: (1), (2), (3), and (4)]	(1) on the plane before the person has jumped out	Physics
		(2) immediately before they open the parachute after jumping out of the plane	
		(3) when they have descended with the parachute	
		(4) After they hit the ground	
Question 6 (Q6)	Read the topography of an island. Illustrate the position of a river. Find the top of a mountain, half-essay question.		Earth sciences & geography
Question 7 (Q7)	What is the difference between satellites and planets in the solar system?	(1) all can sustain life	Earth sciences
		(2) everything has an atmosphere, apart from satellites	
		(3) planets rotate around the sun, while satellites rotate around planets [correct answer]	
		(4) planets are always larger than satellites	
Question 8 (Q8)	What are the positions of the sun, moon and planet during a lunar eclipse?		Earth sciences
Question 9 (Q9)	What has been the reason for the sharp fall in the number of herbivorous animals?	(1) global warming	Biology
		(2) lack of predators	
		(3) shrinking ozone layer	
		(4) forest fires [correct answer]	
Question 10 (Q10)	State the difference between heat and temperature (essay)		Physics

3. Survey Results

3.1 Results of the Questionnaire Paper

Results are shown in Tables 2-8 and Figure 1.

Table 2 indicates the science subjects taken in high school according to the educational record of previous or current Course of Study.

Table 2 shows the subjects taken by elementary teacher trainees in high school.

The results show chemistry and biology as common choices for science.

Table 2 Educational Records of Surveyed Elementary Teacher Trainees

		Math I and II	Math III	Basic Physics	Basic Chemistry	Basic Biology	Basic Earth Sciences
Previous educational guidelines	No. of trainees	465	171	59	91	96	34
Total (477)	Proportion (%)	97.50%	35.80%	12.40%	19.10%	20.10%	7.10%
Current educational guidelines	No. of trainees	184	25	104	165	180	77
Total (191)	Proportion(%)	96.30%	13.10%	54.50%	86.40%	94.20%	40.30%
		Physics	Chemistry	Biology	Earth Sciences	Integrated Science A	Integrated Science B
Previous educational guidelines	No. of trainees	191	291	297	51	194	98
Total (477)	Proportion(%)	40.00%	61.00%	62.30%	10.70%	40.70%	20.50%
Current educational guidelines	No. of trainees	20	40	45	9	3	0
Total (191)	Proportion(%)	10.50%	20.90%	23.60%	4.70%	1.60%	0

Table 3 shows the percentages of trainees' childhood environments (up to the age of 10), with responses of "commercial area," "residential area," "industrial area," "coastal area," "agricultural/dairy farming area," "upland valley/mountain area," and "no response." Note that multiple answer was allowed in this data. A high percentage of respondents were raised in residential areas.

Table 3 The percentages of trainees' childhood environments (until the age of 10).

	Commercial area	Residential area	Industrial area	Coastal area	Agricultural/daily farming area	Upland valley /mountain area	No response
No. of trainees	22	485	14	53	118	113	37
Proportion(%)	3.10%	68.30%	2%	7.50%	16.60%	15.90%	5.20%

Figure 1 indicates the percentages of the expanse of nature in the area where the trainees lived until the age of 10, with responses of "hardly any," "not much," "some," "lots," and "no response." The results show that most respondents were raised in environments with a fair expanse of nature.

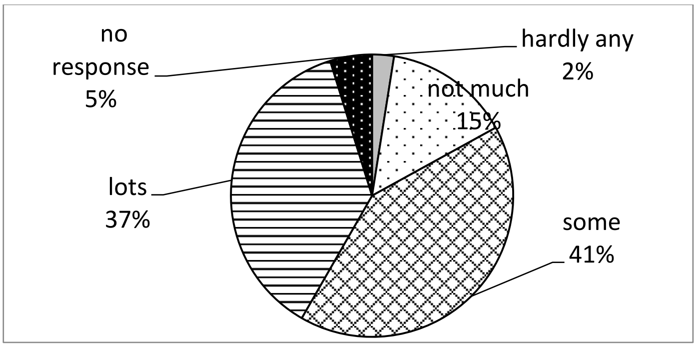

Figure 1 The percentages of the expanse of nature in the area where the trainees lived until the age of 10.

Table 4 shows the percentages (%) of elementary teacher trainees identifying on the side of either the sciences or the humanities, with responses of “the sciences,” “more science than humanities,” “more humanities than science,” “the humanities,” “I really don’t know,” and “no response.” The results show a high percentage of trainees identifying either with “the humanities” or “more humanities than science.”

Table 4 The percentages (%) of elementary teacher trainees identifying on the side of either the sciences or the humanities

	The sciences	More science than humanities	More humanities than science	The humanities	I really don’t know	No response
No. of trainees (total 710)	94	106	137	281	62	30
Proportion (%)	13. 2	14. 9	19. 3	39. 6	8. 7	4. 2

Table 5 shows the results of the proportion of trainees who liked or disliked each subject within the elementary, junior high, and high school curricula. Responses are divided into “strongly liked,” “liked,” “neither,” “disliked,” “strongly disliked,” “did not take,” and “other.” The results show a high percentage of trainees either “disliked” or “strongly disliked” subjects involving quantities like physics and chemistry.

Table 5 The results of the proportion of trainees who liked or disliked each subject within the elementary, junior high, and high school curricula

	Strongly liked	Liked	Neither	Disliked	Strongly disliked	Did not take	Other
Physics of high school	3.70%	12.80%	15.10%	19.40%	12.40%	29.40%	7.20%
Chemistry of high school	8.70%	20%	20.40%	22.10%	12%	10.10%	6.60%
Biology of high school	8.60%	28.60%	27.90%	13.20%	5.50%	9.40%	6.80%
Earth science of high school	3.10%	11.00%	15.50%	7.50%	3.00%	50.60%	9.40%
Science of Junior high school	19.90%	32.30%	26.60%	12.50%	3.80%		4.90%
Science of Elementary school	27.90%	35.50%	24.60%	5.60%	1.40%		4.90%

Trainees who responded by selecting “disliked” or “strongly disliked” for science subjects were asked when and why they came to dislike them (Table 6). The answers of “preschool period” and no answers were excluded from this table. The results show that a high percentage came to dislike the science subjects in either middle or high school. No distinct correlation was discovered for liking or disliking science between the extent to which the trainees experienced nature until the age of 10 and the frequency with which they did experiments or wrote reports in elementary, junior high, and high school. Considering all the science subjects offered at high schools, the percentage of trainees who said they “disliked” or “strongly disliked” biology was low, while the percentages for chemistry and physics were high. Many trainees did not take earth sciences. The choice of “Experimental observation is difficult”, “I don’t like physics and chemistry experiments”, “I’m bad at manual work”, and “I dislike observing nature” are related to experimental activity. The total number of "dislike" in those experimental activity was 88 point, which is reaching to the same level as "Because I dislike math and arithmetic" or "I dislike the scientific thought process".

Table 6 shows the number of respondents choosing different reasons for why they came to dislike science subjects. Based on the assumption that the quantity and quality of experiments and observations in one's educational history would be important for the taste toward science, we employed many items on experiments and observations. There were twelve possible options given for beginning to dislike science, with multiple answers allowed. Only eight of the responses, those with more than five answers, are shown. Commonly chosen answers included "because I dislike math and arithmetic," "I dislike the scientific thought process," "I don't like physics and chemistry experiments," "I dislike observing nature," "problems with the teacher," "I'm bad at manual work," "experimental observation is difficult," "I dislike thinking about why something is important during experimental observations," and "there is one specific subject I dislike in science." Trainees who said that there was one specific subject that they disliked provided the name of the subject; most chose chemistry and physics.

Table 6 Trainees who responded by selecting "disliked" or "strongly disliked" for science subjects were asked when and why they came to dislike them

When they came to "dislike"		Because I dislike math and arith-metic	I dislike the scien-tific thought process	I don't like physics and chemist-ry exper-iments	I dislike observ-ing nature	Problems with the teacher	I'm bad at manual work	Exper-imental obser-vation is difficult	There is one specific subject I dislike in science
Total no of "dislike"		111	93	35	8	44	14	31	50
Elementary school	No	25	20	12	2	6	5	7	3
	%	23%	22%	34%	25%	14%	36%	23%	6%
Junior high school	No	43	38	9	4	15	6	12	16
	%	39%	34%	26%	50%	34%	43%	39%	32%
Senior high school	No	35	32	11	2	18	3	8	25
	%	32%	29%	31%	25%	41%	21%	26%	50%

Table 7 indicates the different subjects taken in high school, and the percentage of trainees who thought each of these subjects is important. English was overwhelmingly seen as important and science less so. A comparison of Table 5 and Table 7 demonstrates that even trainees who thought science subjects are important did not necessarily like them.

Table 7 The different subjects taken in high school, and the percentage of trainees who thought each of these subjects is important

	No. of trainees						
Subject	Total No	Very important	Important	Not so important	Not important at all	Did not take	No response
Japanese language	710	188	352	117	15		38
History and geography	710	132	380	150	10	3	35
Citizen	710	261	312	53	5	41	38
Mathematics	710	79	272	264	59	-	36
Physics	710	46	125	252	66	173	48
Chemistry	710	55	195	282	68	67	43
Biology	710	60	248	264	40	54	44
Earth science	710	31	114	195	35	279	56
English	710	399	241	27	7	1	35

3.2 Results of the Problem Evaluation Paper

The accurate response rates for the questions asked are provided in Table 8. The questions appear as follows: “molecules of a cooled liquid” for Q1, “molecules of a can” for Q2, “organic matter generation of an organism” for Q3, “changes in a substance from vaporization” for Q4, “gravitational force” for Q5, “topographical map” for Q6, “satellites and planets” for Q7, “lunar eclipse” for Q8, “cause for an animal’s extinction” for Q9, and “heat and temperature” for Q10.

Table 8 Correct Answer Rates of Questions

Question No.	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Correct answer rate (%)	75.90%	77.00%	59.90%	74.60%	81.80%	55.10%	79.90%

Questions 1, 2, and 4 were chemistry problems and had a high accurate response rate of at least 80%. The biology problems focused on ecological issues and questioned the relationship with the environment; further, they had low accurate response rates in the decile 50–60%. The accurate response rate for earth sciences questions was approximately 80% for Q7 (which is a question of basic knowledge), approximately 60% for Q 8 (which involved choosing a logical explanation), and between 50–70% for Q 6 (half-essay question). In particular, the percentage of trainees who accurately showed the route of the river was in the 50% decile. The accurate response rate for physics questions was high, at approximately 80%, for Q 5 (basic knowledge) but extremely low, at the 10% mark, for Q 10 (essay question).

4. Discussion

While this article only reports on the study findings, it reveals the impact of previous and current Course of Study. The necessity of exposing young people to a broad culture and the necessity of a general education have been revisited in the current Course of Study. As a result, there have been revisions to the Course of Studies for many compulsory subjects, including science. The trainees educated under the current Course of Study and those educated under the previous Course of Study have had roughly the same experience of taking mathematics in high school, but trainees educated under the current Course of Study have taken more science classes (Table 2).

When Nakai (2008)[4] conducted a similar survey on elementary teacher trainees eight years ago, many of them felt that although they “were not good at science experiments, they only needed the help of a leader to be able to teach them.” In comparison, the feelings of the trainees surveyed in this study were different. There were a relatively large number of responses given by elementary teacher trainees who dislike science: “I dislike the scientific thought process,” “experimental observations are difficult,” and “I dislike thinking about why something is important in experimental observations.” The participants in both the 2008 survey and those in this study were first- or second-year elementary teacher trainees. However, it is impossible to state in a generalized manner that the feelings of trainees have changed because the nature of responses revealed in Nakai (2008) [4] are different from those found in this study. The results of Nakai (2008) [4] reflect the strong feelings of elementary teacher trainees, which stated that even though “they were poor at science, they were obliged to make the effort to be able to teach it.” The trainees in this survey, however, displayed “a tendency to avoid practical experiments in science out of a dislike for the subject.” The students in Nakai

(2008)[4] went through elementary school at the end of the 20th century. Elementary school teachers at the time were skilled at practical experiments. Hence, the participants in the survey conducted by Nakai (2008)[4] were part of a generation that engaged in plenty of practical experiments during their time at elementary school. The trainees in our study were taught in elementary school by teachers who were unskilled at science and had a poor understanding about experiments. 44 participants answering the question "why did you come to dislike science" in the paper questionnaire with the response "because of my teacher." However, such teachers are not limited to elementary school. Identifying the history behind the creation of this "tendency to avoid practical experiments in science" and the type of support required to resolve it are matters for future consideration.

It should be noted that chemistry, which had a high accurate response rate in evaluating problems, also had a high rate of participation at high school. High school education affects scientific literacy of the student for the future. The fact that the participation rate for biology in high school was higher than that for chemistry, but the performance in the problem evaluations was lower because the problems posed were integrated questions about ecosystems. Integrated problems about ecosystems are part of the subject matter of Integrated Science B under the previous Course of Study, which has a fairly low participation rate. Under the current Course of Study, this subject area is not taken as seriously as under the previous Course of Study. The fact that the performance was low for earth sciences questions apart from the general knowledge question could be because many students do not take the subject.

Nakai *et al*. (2015) report some of the results of the preliminary survey for this study. Question 6 (topographical maps) had a low accurate response rate, nearly 50%, in Nakai *et al.*, regardless of whether the student concentrated on sciences or humanities. In the full survey, the performance for the essay part of the question and the insertion of the river route was in the 50% decile. Under the previous Course of Study, this problem (map reading) was excluded from the social studies mandatory curricula in both elementary and junior high school. However, map reading was reintroduced into the junior high school social studies under the current Course of Study. Nakai *et al*. (2016)[6] conducted a simple survey at a school including a similar map-reading problem and found that the accuracy reached 80%. This again reaffirmed the impact that changes in the educational curriculum (based on the Course of Study) have on the students. Since the current Course of Study have come into effect, the participation rate for earth sciences has increased. The next set of Course of Study is predicted to further increase the participation rate in subjects that include topographical maps, when integrated geography becomes a compulsory subject in high school social studies.

The essay problems (Q 6 and Q10) on problem evaluation and problems requiring well-thought-out judgment (such as Q 3 and Q9) had a low accurate response rate in the survey this time. However, the next set of Course of Study will incorporate "proactive and cooperative learning designed to identify and solve problems" (active learning) with an emphasis on projects that involve both practical experiments and critical thinking and is predicted to improve the accurate response rate of essay problems and problems requiring well-thought-out judgment.

The results of TIMSS for Japan show that both elementary school (fourth-year) students and junior high school (second-year) students slipped in the international rankings between 2000 and 2010. It also revealed few positive responses to the following questions: "science is fun," "I'm good at science," "studying science helps me in my daily life," and "I need to get good results in science to get the job I want in the future." The trainees who participated in this survey are roughly of the same generation as the students who were the subject of the TIMSS 2007 junior high school and TIMSS 2003 elementary school studies (IEA, 2008[7]; IEA,2004[8]). If one considers the TIMSS 2015 points (IEA, 2016) [9] from the homepage of the study of the National Institute for Educational Policy Research (NIER, 2016) [10], it is revealed that this generation was in elementary school when Japan's TIMSS results for science began dropping and were in junior high school when TIMSS results for science began rising again after having dropped sharply. Moreover, the participants in this survey who responded positively to the TIMSS statements "science is fun," "I'm good at science," and "studying science helps me in my daily life" are part of the generation with the lowest positive response rate out of four TIMSS surveys (2003, 2007, 2011, and 2015 (IEA, 2004[8],2008[7], 2013[5], 2016[9] ; NIER, 2016[10]).

The low percentage of students expressing positive attitudes on science subjects compared to the international average has been a long-standing problem in Japan's science education. While considering this problem, under the current Course of Study, science textbooks for high schools have begun to include sections dedicated to career education. Moreover, now the educational curriculum for trainee teachers also emphasizes career education. According to the TIMSS 2015 data (NIER, 2016)[10], the percentage of positive respondents to the previously discussed attitude survey on science is on an upward trend and is closing the gap with the international average. Trainees at elementary school teacher training universities with "a tendency to avoid practical experiments in science out of a dislike for the subject" are also expected to show improvement in the future.

5. Conclusions

Teacher trainees at elementary school teacher training universities mostly study without science. When those students were in high school, they received education under a curriculum with little science or mathematics and now have "a tendency to avoid practical experiments in science out of a dislike for the subject." However, Course of Studies have a significant impact on education in the classroom. Students who are studying the curriculum under the next set of Course of Study, which is set to introduce "proactive and cooperative learning designed to identify and solve problems," will most probably show changes in attitudes toward science and practical experiments.

This is only a first-stage report and multiple matters remain to be discussed before the analysis, which should encompass course records and attitudes toward science, course records and accurate response rates in problem evaluation, and findings from the concurrent TALIS study, among other aspects. These will be analyzed as quickly as possible to assist in the training of future teachers.

Acknowledgements

I would like to thank Daito Bunka University for a grant that made it possible to complete this study. Dr. Kenji Matsubara, Prof. Masamichi Ueno, Prof. Hisako Hirai and Dr. Mieko Uchiyama gave insightful comments and suggestions. We are deeply grateful to them.

References

[1] MEXT(Ministry of education, culture, sports, science and technology, Japan) , *Elementary school science experiment observation guidelines.* 213p. (2011), URL: http://www.mext.go.jp /a_menu/shotou/new-cs/senseiouen/1304651.htm. (15 / 6 / 2017)

[2] Hashimoto, M. *et al.*, A research on the relationship between students' experience of science education and their attitude toward science: a case in teacher Training colleges. *Journal of center for teacher development and educational research, Daito Bunka Univerdity*, No.1, pp. 107-110 .(2016)

[3] OECD (Organisation for Economic Co-operation and Development) PISA 2006 Results. (2007),URL:http://www.oecd.org/edu/school/programmeforinternationalstudentassessmentpi sa/pisa2 006results.htm. (15 / 6 / 2017)

[4] Nakai, M., Problems related to modern education. *Geoscience Education and Science Movement,* No.57 (*Chigakukyouku to kagakuunndo, in Japanese*), pp.9-15. (2008)

[5] IEA, *TIMSS 2011 international database.* Trustees of Boston College (2013) , URL: https:// timssandpirls. bc. edu/timss2011/international-database.html. (15 / 6 / 2017)

[6] Nakai, M., *et al*., Contemporary Problem of middle and high school teacher training as seen from the curriculum of university. *The bulletin of educational research*, No.6, pp.117-130 .(2015)

[7] IEA, *TIMSS 2007 International Science Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades*, Trustees of Boston College (2008), URL: https://timss.bc.edu/TIMSS2007/sciencereport.html . (15 / 6 / 2017)

[8] IEA, *TIMSS 2003 International Science Report: Findings from IEA's trends in international mathematics and science study at the fourth and eighth grades.* TIMSS & PIRLS International Study Center, Boston College. Trustees of Boston College (2004) URL : https://timss.bc.edu/ timss2003i/mathD.html. (15 / 6 / 2017)

[9] IEA, *TIMSS 2015 International science report* (2016), URL: http://timss2015.org/timss-2015/science/student-achievement/0. (15 / 6 / 2017)

[10] NIER, *Changing Results in Trends in International Mathematics and Science Study [TIMSS 2015]* (2016), URL: http://www.nier.go.jp/timss/ (15 / 6 / 2017)