Gender Disparities in Academic Performance and Motivation in STEM Subjects in Japan

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In Japan, the percentage of female students who elect to major in STEM (an acronym standing for Science, Technology, Engineering, and Mathematics) subjects when entering higher education is among the lowest of all OECD (Organisation for Economic Co-operation and Development) nations. In this article, in order to elucidate the factors that make girls less likely to select STEM courses, we use data from academic research on elementary and junior high school students to gain a chronological picture of gender disparities in academic performance and motivation in STEM subjects, and examine the interaction effects of gender, socioeconomic status, and achievement-oriented values that help to define students' levels of motivation.

As early as elementary school, the gender order of "girls preferring humanities, boys preferring sciences" is increasingly reflected in girls' levels of performance and motivation in math. Also, the correlation between socioeconomic status and academic motivation becomes evident earlier among girls than among boys, and by the third year of junior high school (age 14–15), achievement-oriented values emerge as a factor that strongly defines motivation in math. The above observations suggest that when women do choose an academic focus in the sciences, aspects other than academic performance and motivation strongly underpin their decisions.

I. Introduction

In recent decades, women's levels of education have risen dramatically, and today in most developed countries, girls make up more than 50% of students enrolling in undergraduate studies. In Japan, it was not until after World War II that the door to higher education opened for women, but women's rate of enrollment in higher education has shown a steady quantitative expansion, and as of the 2015 academic year the rate is above 50% of the 18-year-old population for both men and women. However, when narrowed down to four-year universities the enrollment rate among boys is still about 10% higher, and the disparity widens even further in graduate school. Japan is not only of the few developed nations where women's rate of undergraduate enrollment is lower than that of men, it also ranks lowest among OECD nations in terms of percentage of bachelor's, master's, and doctoral degree candidates who are female. And when we examine percentages of graduates by field of study, the gender gap becomes even more pronounced, e.g. the percentage of female graduates majoring in education, humanities, or social sciences stands at about 70%, whereas only about 30% of graduates majored in natural sciences. The low percentage of

female students majoring in STEM subjects such as natural sciences, engineering, and math is common throughout OECD nations, but it is particularly low in Japan, one of the lowest among OECD members.[1]

There is a very strong correlation between education and future participation in the labor market, and studies have shown higher incomes among sciences graduates than among humanities graduates (Urasaka et al. 2012). The gender disparity in higher education in Japan is among the widest in developed countries, as described above, but why does this gender gap exist in the first place? More specifically, why are there so few women majoring in the sciences? Perhaps the main cause is that girls tend to dislike STEM subjects and perform worse than boys in them, or perhaps there are factors other than performance leading to the disparity. In this article, we will examine the correlations between science subjects and gender empirically, using academic performance data on elementary and junior high school students.

The structure of this article is as follows: First, in Section II we present an overview of how gender and academic performance have been discussed thus far in the context of sociology of education and research on math and science education. In Section III, we employ academic performance data on elementary and junior high school students to gain an understanding of how academic performance on, motivation for, and attitudes toward school subjects change over time in the humanities and sciences respectively, and to clarify the contributing factors. Finally, the findings are summarized in Section IV.

II. Examination of Previous Studies and Enumeration of Issues

1. Selection of Educational Track, Academic Performance, and Gender

Throughout Japan's period of robust economic growth (roughly the mid-1950s to the mid-1970s), although Japanese women's rate of enrollment in higher education increased rapidly, it was viewed as in essence a "women-only track" (Amano 1986) due to the prevalence of women attending (usually two-year or occasionally three-year) junior colleges, or majoring in home economics or humanities. In the late 1990s the paradigm for women's higher education shifted from junior colleges to four-year universities, and it has been pointed out that the factors defining educational achievement have changed since then. That is to say, throughout the rapid economic growth period, the socioeconomic status from which girls originated was believed to exert a stronger impact on selection of academic track than it did for boys, but from the mid-1990s onward achievement-orientation (selecting an academic path or course of study based on academic performance) became more entrenched among girls as well as among boys (Ojima 2002; Shirakawa 2011). While there is still a tendency for gender-related factors, notably entrenched perceptions of gender roles,

[1] For these statistics we referenced the Ministry of Education, Culture, Sports, Science and Technology's Basic Survey Report on Schools 2015, the OECD White Paper on Gender (OECD ed. 2014), and *Education at a Glance 2015: OECD Indicators*, online edition.

to circumscribe girls' academic achievement, it can be said that the trend toward higher levels of education has caused achievement-orientation to become more pervasive among women as well.

Achievement-orientation becoming more pervasive means that, in effect, academic performance has come to exert a stronger influence on selection of educational track among girls as well as boys. However, as we will discuss below, there has not been sufficient debate on whether gender disparities exist in academic performance per se (Kawaguchi 2011).

In the early 2000s in Japan, a debate over the pros and cons of a more relaxed education policy (known as *yutori kyoiku*) was accompanied by controversy over declining academic performance. This controversy was sparked by a publication with the sensational title *University Students Who Can't Do Fractions* (Okabe, Nishimura, and Tose 1999) which took a problematic view of the overall slump in Japanese children's academic performance. However, subsequent empirical studies by sociologists of education revealed that not only was children's academic performance declining across the board, there was a widening disparity in performance correlated with socioeconomic status, with particularly marked declines in performance among children of low socioeconomic status. For example, Kariya and Shimizu (2004) found that when the performance of children in 1989, when the relaxed education policy was introduced, was compared with that of their counterparts in 2001 when the policy was in effect, performance had fallen on average, but the decline was not uniformly distributed and among children of low socioeconomic status was particularly egregious. As there had previously been virtually no analyses of disparities in children's academic performance from a socioeconomic standpoint, this study had a tremendous impact. Thereafter, largely in the field of sociology of education, one study after another clarified the realities of performance disparities correlated with socioeconomic status, in other words the realities of factors like parents' or guardians' academic background, their income, and children's cultural environment impacting children's academic performance (Mimizuka 2013, etc.)

However, while there have been numerous studies on performance disparities correlated with socioeconomic status, the topic of gender, which is surely a social category just as important as socioeconomic status, has been almost completely overlooked in Japan. In Western countries, the superior academic performance of school-age girls compared to boys has been viewed as a problematic social issue, and the discourse tends to view academic performance issues as a boys' issue. This has at times been criticized as a mere social construct of a male-dominated society (Kimura 2010). By contrast, in Japan, while the annual Nationwide Survey on National Assessment of Academic Ability was reintroduced in 2007 after an approximately 60-year hiatus, in analyses of its outcomes a little attention has been given to gender disparities, and currently there is no evident concern with whether there is any such thing as gender disparity in academic performance in the first place.

The results of international academic performance assessments such as the Programme for International Student Assessment (PISA) and Trends in International Mathe-

matics and Science Study (TIMSS) point to girls' superior reading comprehension in Japan as in other countries. As for scores in math and science, while in most cases boys scored higher, the degree of statistical significance varies depending on the survey year, and no consistent trend can be identified. In any case, from an international vantage point Japan has maintained high performance levels among both boys and girls (National Institute for Educational Policy Research 2013a, 2013b, etc.)

Nonetheless, as described earlier, there remains a huge gender-based bias in terms of selection of majors at universities. If the mechanism of selection of academic track based on performance functions for girls as well as for boys, it would not be at all surprising to see nearly the same proportion of girls as boys select the sciences. However, when we examine students advancing to four-year universities as a whole, while certainly the trend toward achievement-orientation is becoming gradually more prevalent among both men and women, there is still a clear-cut gender order evident in the choice of sciences vs. humanities, and it follows that there must be factors other than academic performance affecting these decisions.

2. STEM Subjects and Gender

In studies on gender disparities with respect to STEM subjects, while the results of academic performance assessments are comparable, clear gender differences have been observed in terms of perceptions, with girls tending to have more negative attitudes than boys toward arithmetic, mathematics, and science. For example, Hojo (2015) employed TIMSS data and found a gender gap that widened between fourth grade of elementary school and the second year of junior high school with regard to confidence in and enjoyment of studying math, with girls tending to give more negative responses than boys to attitude-related questions. From these previous studies, we can infer that differences in attitudes and perceptions contribute more than discrepancies in test scores to the paucity of girls majoring in the sciences when advancing to university.

So, why is that girls tend to have more negative attitudes toward, and perceptions of, science subjects than boys? Based on information and insights from previous studies, we can enumerate the following three possible reasons.

One is that inherent gender bias lurks within the sciences themselves. As the production of scientific knowledge has historically been the task of men, this scientific knowledge can in itself be seen as male-centric. It has been pointed out that in biology, research findings on male organisms may be adopted as the standard, or researchers may project gender stereotypes on to animals and even plants (Muramatsu 1998; Ogawa 2001). Meanwhile, although cooking can certainly be seen as an applied science, it is classified as part of "home economics" courses teaching homemaking skills, and divorced from the sciences (Muramatsu 2004). In other words, the accepted body of scientific knowledge is in itself male-centric, and furthermore gender bias is at work in the organization of academic content into school subjects.

A second reason is the influence of people in the surrounding environment, particularly in the home. The parents of female university students majoring in the sciences are significantly more likely than parents of male university students majoring in the sciences, or university students of either sex majoring in the humanities, to be highly educated, with a significantly higher percentage of their fathers having studied the sciences themselves (Muramatsu 1996, 102). And it is not only family members and others in close proximity that exert an impact. Studies have shown that while the Internet is a new media platform, it has the effect of disseminating old gender stereotypes (Mendick and Moreau 2013). It is safe to say that the influence of family members, other people in the vicinity, and the media underlie the negative relationship of girls and STEM subjects.

Third, there is the issue of interactions among teachers and students, or students and their peers. According to a study analyzing video footage of second- and third-year junior high school science classes (Akai 1997), boys tended to play central roles, while girls tended to play auxiliary roles. It has been verified by a separate questionnaire survey (Muramatsu 2004) that boys more often than girls play key roles in handling equipment during experiments. Girls' passive attitudes towards and perceptions of STEM subjects are also progressively formed by these day-to-day interactions with teachers and with other students.

Against this backdrop, the obstacles to advancing to higher education in the sciences are much greater for girls than for boys. For this reason, as pointed out by Kawano (2009b), when boys do not have a clear picture of their future academic path they tend to choose the sciences without hesitation, while by contrast, for girls to go against the entrenched perception that "girls are geared toward the humanities" and leap into the world of the sciences requires a significant positive push in the form of advice, encouragement, or role models. It is a fact that female university students majoring in the sciences are more likely than their male counterparts to have proactive reasons for selecting their majors, such as "I like studying my field / conducting experiments," and a higher proportion of them responded that math had been their favorite subject in elementary and junior high school (Muramatsu 1996, 81).

3. Issues for Consideration

Thus far we have looked at an overview of previous studies in the fields of "academic track selection, academic performance, and gender" and "the sciences and gender." From this outline of existing findings, the following issues emerge with regard to gender and STEM subjects. First, studies on academic performance, particularly those conducted by educational sociologists in Japan, have frequently sought to clarify performance disparities correlated with socioeconomic status, but there has been very little discussion of gender disparities. These studies have given little consideration to the broad categorization of subjects into sciences and humanities, but it is particularly necessary to make this distinction when discussing performance disparities from a gender standpoint. Meanwhile, studies on the sciences and gender have verified the tendency for girls to dislike STEM subjects, and

have clarified the characteristics of female university students who do elect to major in them (Muramatsu 1996, 2004), but there has been virtually no discussion of which exerts a stronger influence, gender or the socioeconomic status that has generally been emphasized in the sociology of education, nor of whether these factors may interact with one another.

This article seeks to address these issues and fill gaps in existing research by analyzing academic performance data, keeping in mind the sciences vs. humanities subject breakdown and the influence of gender and socioeconomic status. In doing so, we will focus not only on academic performance, but also on differences in attitudes, perceptions and motivation towards STEM subjects, which have been shown to be important factors contributing to girls' selection of these subjects. In terms of specific analytical procedures, we will first of all examine levels of performance and motivation in each subject at the compulsory stages of education, and the transition of gender disparities in perceptions of these subjects, then seek to clarify the factors determining attitudes and motivation towards the sciences from the standpoint of interaction between gender and socioeconomic status.

In analyzing the determining factors, we would like to draw attention to the growth of achievement-orientation, which has often been highlighted in research on gender disparities in selection of academic track. This is because, as stated by Kajita (1981), the ongoing trend toward an achievement-oriented society is not uniform, but has an aspect of "attribute- or affiliation-based achievement-orientation." In an achievement-oriented society there are advantageous and disadvantageous attributes, and male gender is in the former category while female gender is in the latter. While men are able to adopt an achievement-oriented value system without being consciously aware of their male identity, their female counterparts cannot do so without experiencing conflicts between this value system and the accepted cultural values of women. This results in gender-based disparities in the degree of adaptation to achievement-orientation, and means that distribution of resources is uneven.

Thus far, studies on gender disparities in educational achievement have discussed the growth of achievement-orientation, as academic performance has come to play an increasing role in determining selection of academic track. However, achievement-oriented values are themselves a factor affecting academic performance and motivation, and it seems likely that built-in gender disparities are lurking within these values. Further, it seems likely that this acts as an obstacle to girls' electing to study STEM subjects. If choosing the path of the sciences means hurling oneself into a highly masculine and male-dominated world, it means women must have an even higher level of adaptability to the achievement-oriented value system than their male counterparts.

III. Analysis

1. Overview of Data

The target of this analysis is data from an academic assessment (Criterion Referenced Test [CRT] by Toshobunkasha Co.) of all children attending elementary and junior high

schools in one Japanese city, and from a questionnaire on their daily lives. This assessment was conducted every May from 2005 to 2012 by the city's Board of Education, and as the authors of this article had been involved in analysis, etc. of its results, we were able to obtain permission to utilize the data. This article employs two sets of data. The first combines data for one group of students over four years, from when they were in third grade in the 2007 academic year to when they were in sixth grade in the 2010 academic year, so as to examine changes over time within the framework of elementary school. The second data set tracks another group over the three years of junior high school from 2006 to 2008. There is no overlap between the students in data sets 1 and 2. As the city's academic assessments cover different grade levels in different academic years, it was the use of two sets of data that made it possible to track students in a group over four years of elementary and three years of junior high school, and this article employs two data sets to track changes in academic performance, attitudes and perceptions of school subjects over these two periods.

To provide some background on the city where the survey was conducted, it is a part of Keihanshin metropolitan area and has one of the highest population densities in Japan. Historically speaking, it developed as an industrial city, and even today it has a relatively low percentage of white-collar workers compared to neighboring cities. In addition, the percentage of students attending standard, full-time high schools (which are not part of compulsory education in Japan, but are attended by the overwhelming majority of students in this age group) and advancing to four-year universities is somewhat lower than the national average. We would like to note in advance that the insights gleaned from this data analysis have limitations in that they are based on data from a specific region with the characteristics described above. Next, we will outline the variables used in this article.

(1) Performance: For elementary school children the assessment of academic performance covered two subjects, Japanese and math, for third and fourth graders, and added science and social studies for fifth and sixth graders for a total of four subjects. For junior high school students it covered five subjects, including English. For the purposes of this article, math is treated as a science subject and Japanese as a humanities subject, in line with the findings of previous studies showing gender differences in perceptions of math (Muramatsu 1996) when selecting an academic path in the sciences.

(2) Motivation: We evaluated the survey targets with the criterion of "interest, motivation, and attitude" that is employed in the CRT survey. The CRT evaluates students on each subject from four or five criteria, of which "interest, motivation, and attitude" (hereinafter referred to as "motivation") is one. For example, for the survey of third-year junior high school Japanese, there is an item headed "Choose the statement that best expresses your feelings about reading," with four choices ranging from "I read books in a wide range of fields so as to develop my own independent ideas," to "I think reading books is a waste of time." For third-year junior high school math, there are items like "Choose the statement that best expresses your feelings about factorization" and

"Choose the statement that best expresses your feelings about quadratic equations."[2] Approximately seven items are listed for each subject, relating to already-learned material, with responses assigned numerical values resulting total scores out of 100.

(3) Socioeconomic status: The data used for this article does not include survey items directly related to the socioeconomic status of the children, such as their parents' academic background or occupation. For this reason we employed an alternative indicator of socioeconomic status, inspired by the concept of cultural capital (Bourdieu and Passeron 1991)" and making reference to Kariya and Shimizu (2004). In specific terms, this indicator separated respondents into three groups, i.e. "high" "middle" and "low" cultural, social, and economic status, based on total score of maximum 21 obtained by totaling responses (each assigned a numerical value of 0 to 3) to seven statements about people in their households: "They watch news programs," "They look things up in reference books or dictionaries," "They ask me about what's going on at school," "They take part in school or community activities," "They read me picture books when I was little," "They have taken me to a museum at least once," and "They use computers at home." Responses from third-year junior high school students were subjected to analysis,[3] with an alpha coefficient of 0.699.

(4) Achievement-oriented values: This was quantified by assigning values of 0 to 3 to responses to the statements, "What I study now will be useful in the future," "In our society, the more effort you make, the more you will be recognized," "Graduating from a prestigious school enables you to do what you want to do in the future," and "People who have studied hard are able to lead happy lives," for a maximum total score of 12. Responses from second- and third-year junior high school students were subjected to analysis, with alpha coefficients of 0.637 and 0.623 respectively.

2. How Do Performance and Motivation in Each Subject Change over Time?

First, let us examine the gender disparities in academic performance and motivation for third- through sixth-graders, in Japanese and math respectively (Table 1). In terms of performance, while girls have consistently higher scores in Japanese, in math there is no clearly verifiable gender disparity except for slightly superior scores for girls in fifth grade. Meanwhile, with regard to motivation, girls are similarly above boys in Japanese, but in

[2] For example, with regard to quadratic equations, the four options were "I would like to solve a lot of problems using quadratic equations," "I do not mind studying quadratic equations as long as they are not too difficult," "Quadratic equations are difficult, but I would like to study them from now so I can understand them," and "I do not want to study quadratic equations because they are too difficult."

[3] The reason for employing third-year junior high school students' responses when preparing the socioeconomic status variables was that higher grade levels are thought to be correlated with more accurate responses. Also, because it is difficult to envision socioeconomic status changing significantly in a single year, third-year responses were used when plotting second-year academic performance and motivation as dependent variables as well.

Table 1. Gender Disparities in Performance and Motivation in Japanese and Math, by Grade Level: Elementary School

	Japanese							Math						
	Academic performance			Motivation			N	Academic performance			Motivation			N
	Average	Disparity	SD	Average	Disparity	SD		Average	Disparity	SD	Average	Disparity	SD	
3rd grade														
Boys	70.1	5.4 ***	16.496	67.8	5.8 ***	16.866	2012	80.3	-0.7	14.189	80.7	0.5	19.508	2014
Girls	75.5		15.047	73.6		15.875	1956	79.6		14.396	81.2		17.731	1959
4th grade														
Boys	71.0	4.8 ***	15.307	68.0	5.4 ***	18.283	2009	78.7	0.5	17.993	72.2	2.3 ***	21.627	2010
Girls	75.8		13.896	73.4		17.227	1961	79.2		15.946	74.5		19.668	1962
5th grade														
Boys	74.3	6.3 ***	17.377	68.5	2.4 ***	17.352	1969	72.7	1.3 *	18.952	73.7	1.7 *	23.886	1971
Girls	80.6		14.180	70.9		15.912	1944	74.0		16.627	75.4		21.153	1948
6th grade														
Boys	70.2	6.2 ***	17.414	70.8	4.2 ***	18.432	1944	65.5	-0.3	20.072	77.1	-1.3 +	23.983	1941
Girls	76.4		14.890	75.0		16.640	1933	65.2		17.854	75.8		23.107	1926

Note: On this table "Disparity" refers to gender disparity in each subject.
T-test. ***p<.001 **p<.01 *p<.05 +p<.1

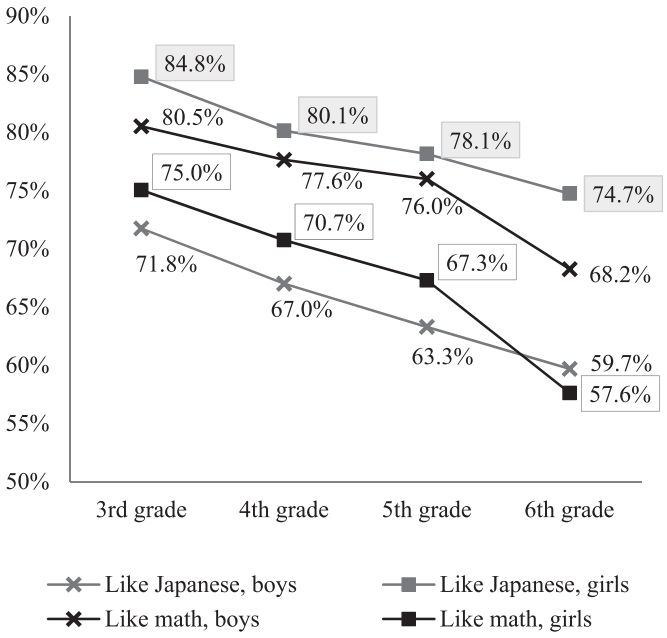

Figure 1**.** Change over Time in Preferences for Subjects: Elementary School

math, while girls rate slightly higher in fourth and fifth grade but there is a reversal in sixth grade, with boys showing slightly stronger motivation.

Now, let us look changes in students' preferences for subjects. Figure 1 shows the percentages of students who like (total of "I like it" and "It's OK" responses) and dislike the two subjects, and we can see two starkly contrasting patterns, with girls and boys consistently preferring Japanese and math respectively over the four years starting in third grade.

The percentages of both girls and boys responding that they like each subject decline over the years, but between fifth and sixth grade there is a sharp drop in percentages of both girls and boys who say they like math, which is somewhat more pronounced among girls. Over these four years of elementary school, although there is no dramatic gender disparity in math scores, and girls maintain levels of motivation similar to those of boys, the growth of the tendency to dislike math is stronger among girls.

Next, let us look changes over the three years of junior high school. Table 2 shows academic performance in Japanese and math respectively. With regard to Japanese, as in elementary school, girls have consistently higher scores than boys over the three years. In math, while there is no gender disparity in scores during the first year, during the second and third years boys score slightly higher.

Meanwhile, in terms of motivation, in Japanese girls' motivation is above that of boys during the first and second years, but the significant difference disappears in the third year. In math, the slight gender disparity at the first-year stage grows wider during the second year, with girls' motivation being clearly lower.

Table 2. Gender Disparities in Performance and Motivation in Japanese and Math, by Grade Level: Junior High School

	Japanese							Math						
	Academic performance			Motivation			N	Academic performance			Motivation			N
	Average	Disparity	SD	Average	Disparity	SD		Average	Disparity	SD	Average	Disparity	SD	
1st year														
Boys	69.2	4.8 ***	16.178	60.9	3.0 ***	18.297	1670	62.5	-0.5	20.157	62.3	-1.5 +	19.135	1674
Girls	73.9		14.786	63.9		16.375	1552	62.0		17.957	60.8		18.731	1553
2nd year														
Boys	60.7	6.6 ***	17.022	57.2	2.5 **	20.299	1498	53.3	-2.2 **	19.924	58.6	-5.0 ***	21.197	1504
Girls	67.3		16.013	59.7		19.391	1400	51.1		17.938	53.6		21.229	1403
3rd year														
Boys	67.7	4.7 ***	16.651	57.5	1.1	18.605	1433	53.1	-1.7 *	20.658	55.0	-3.4 ***	23.672	1437
Girls	72.4		14.189	58.6		18.369	1350	51.4		17.837	51.6		22.926	1356

Note: On this table "Disparity" refers to gender disparity in each subject.
T-test. ***p<.001 **p<.01 *p<.05 +p<.1

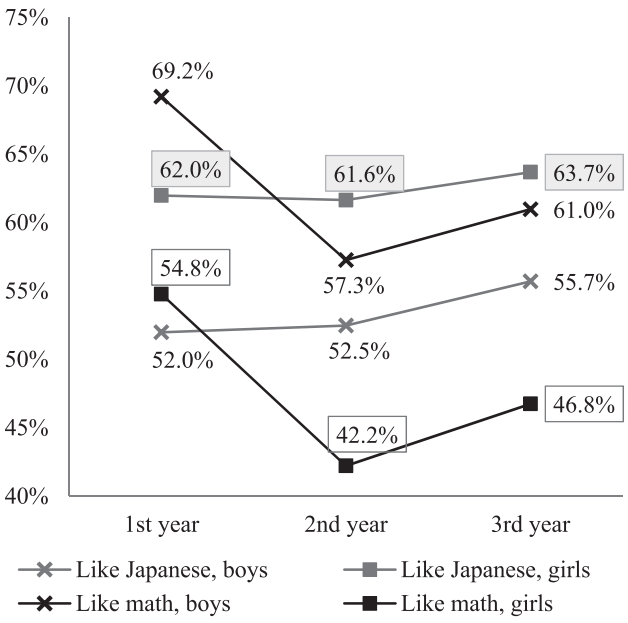

Figure 2**.** Change over Time in Perceptions of Subjects: Junior High School

Figure 2 shows the percentages of students who like and dislike the two subjects. While the structural pattern of girls preferring Japanese and boys preferring math remains unchanged from elementary school, the percentages of both boys and girls who like Japanese stays relatively stable throughout junior high school, the percentage who like math hits bottom in the second year before rising somewhat in the third year. At the same time, the tendency of girls to distance themselves from math, clearly apparent in the first year of junior high, continues thereafter. There is a clear-cut gender disparity, and by the third year, while 61% of boys say they like math, the corresponding percentage of girls has fallen below half at 46.8%.

As the data for elementary school and junior high school are for two different groups of children, this is not a rigorous comparison, but we believe it is possible to make the following points. First, at the elementary school stage, while there is no clear, objectively observable gender disparity in performance or motivation with regard to math, a clear picture is gained of many girls' strong distaste for it, which in junior high school comes to be reflected in girls' performance and motivation as well. Also, compared to boys, girls exhibit a significantly stronger preference for Japanese as opposed to math, and their affinity for Japanese and, conversely, avoidance of math is a more clearly defined pattern than the opposite tendency which holds true for boys.

Table 3. Average Scores for "Achievement-Oriented Values"

Junior high school	Average	Disparity	SD	N
3rd year				
Boys	7.6	-0.9 ***	2.744	1296
Girls	6.7		2.578	1206
2nd year				
Boys	7.5	-0.9 ***	2.678	1301
Girls	6.6		2.585	1214

T-test. ***p<.001 **p<.01 *p<.05 +p<.1

3. Factors Determining Motivation toward STEM Subjects: Focus on Socioeconomic Status and Achievement-Oriented Values

Thus far, we have examined how the gender disparity in academic performance and motivation changes over time during elementary and junior high school. Now, let us inquire into whether the factors determining academic performance and motivation differ between girls and boys. This section explores the question with a focus on the second and third years of junior high school, when the gender disparities in performance and motivation are particularly pronounced.

Here, in considering gender disparities in determining factors, we will look at two described earlier in Section II, "socioeconomic status" and "achievement-oriented values." As for the reasons for focusing on these two particular factors, first of all, academic performance disparities correlated with socioeconomic status have been extremely strongly emphasized in educational sociology research, but it is possible that the degree of correlation between performance and socioeconomic status differs depending on gender (Kataoka 2001). Meanwhile, the focus on "achievement-oriented values" is due to the fact that while the growth of achievement-orientation has been recognized, with academic performance playing a larger role in girls' selection of academic track, it is possible that academic performance and motivation may in turn be determined by the degree of strength or weakness of achievement-oriented values. For girls in particular, who are likely to have less affinity for achievement-orientation than boys, the strength or weakness of these values is thought to be an important determining factor.

To examine these issues, in this section we perform a multiple regression analysis, but first let us verify the gender disparities in achievement-oriented values. Unfortunately, questions related to achievement-oriented values are not included in the survey at the junior high school first-year stage, so comparisons can only be made for the second and third years. Table 3 shows the average scores for achievement-oriented values among second- and third-year students, and we can see that in both years, there is a discrepancy of around 0.9 points. As expected, boys' affinity for achievement-orientation is stronger than that of girls.

So, do the factors determining academic performance and motivation in fact differ

Table 4. Descriptive Statistics on Variables

	N	Minimum	Maximum	Average	SD
Motivation in Japanese (junior high, 3rd year)	2540	0.000	100.000	58.430	19.946
Motivation in math (junior high, 3rd year)	2542	0.000	100.000	56.400	21.514
Motivation in Japanese (junior high, 2nd year)	2524	0.000	100.000	58.090	18.531
Motivation in math (junior high, 2nd year)	2533	0.000	100.000	53.590	23.399
Girls' dummy	2564	0.000	1.000	0.482	0.500
Aspiration to advance to university dummy (junior high, 3rd year)	2564	0.000	1.000	0.367	0.482
Aspiration to advance to university dummy (junior high, 2nd year)	2564	0.000	1.000	0.314	0.464
private preparatory school attendance dummy (junior high, 3rd year)	2510	0.000	1.000	0.534	0.499
private preparatory school attendance dummy (junior high, 2nd year)	2469	0.000	1.000	0.445	0.497
High socioeconomic status dummy	2464	0.000	1.000	0.329	0.470
Low socioeconomic status dummy	2464	0.000	1.000	0.326	0.469
Achievement-oriented values (junior high, 3rd year)	2502	-2.643	1.799	0.000	1.000
Achievement-oriented values (junior high, 2nd year)	2515	-2.653	1.835	0.000	1.000

depending on gender? To ascertain the difference in degree of impact of socioeconomic status and achievement-oriented values on academic performance and motivation depending on gender, we conducted a multiple regression analysis with academic performance and motivation as dependent variables, and gender, socioeconomic status, achievement-oriented values, and the interaction among them as independent variables. To prevent the effects of the above-mentioned independent variables from becoming excessive, we controlled for these effects with dummies for private preparatory school attendance (attendees = 1, non-attendees = 0) and university aspiration (aspiring to attend university or graduate school = 1, other = 0), both factors seen as strongly affecting academic performance and motivation. Descriptive statistics on the variables used are shown in Table 4.

Table 5 shows the results of an analysis with academic motivation as the dependent

Table 5. Factors Determining Academic Motivation (Multiple Regression Analysis)

	Junior high school, 2nd year				Junior high school, 3rd year			
	Japanese		Math		Japanese		Math	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
(Constant)	54.498 ***		54.235 ***		54.602 ***		50.332 ***	
Aspiration to advance to university dummy	2.344	0.055 **	4.381	0.095 ***	5.454	0.143 ***	6.619	0.137 ***
private preparatory school attendance dummy	-0.238	-0.006	3.643	0.084 ***	-1.597	-0.043 *	2.040	0.044 *
Girls' dummy	6.970	0.175 ***	-0.143	-0.003	3.706	0.100 **	0.512	0.010
High socioeconomic status dummy	5.243	0.123 ***	2.756	0.060 +	6.084	0.155 ***	2.992	0.060 +
Low socioeconomic status dummy	-0.714	-0.017	-0.935	-0.020	-3.212	-0.081 **	-2.215	-0.044
Achievement-oriented values	3.761	0.189 ***	4.413	0.205 ***	2.212	0.119 ***	4.439	0.189 ***
High socioeconomic status dummy × Girls' dummy	-4.888	-0.088 *	-3.267	-0.054	-1.100	-0.022	-2.719	-0.042
Low socioeconomic status dummy × Girls' dummy	-5.552	-0.098 **	-5.709	-0.093 **	-2.585	-0.050	-2.007	-0.031
Achievement-oriented values × Girls' dummy	0.393	0.013	1.069	0.033	-0.167	-0.006	2.255	0.064 *
R^2	0.078		0.118		0.108		0.121	
Adjusted R^2	0.074		0.115		0.105		0.118	
F-test of regression	p=0.000		p=0.000		p=0.000		p=0.000	
N	2319		2319		2378		2378	

***p<.001 **p<.01 *p<.05 +p<.1

variable, broken down by grade and by subject.[4] We also carried out an analysis with performance as the dependent variable, but there was no particular impact from the interaction of gender, socioeconomic status of origin, and achievement-oriented values, so its results are omitted due to space limitations.

First, turning our attention to the girls' dummy variables, they do not show a significant, consistent effect on math, but its effect is significant with regard to Japanese. The results show that female students are more motivated than their male counterparts in Japanese, conforming to the preceding section's analysis finding clearer gender disparities in motivation in Japanese than in math.

We will interpret socioeconomic status and achievement-oriented values in light of their relationship to the interaction effects. As for socioeconomic status, its interaction with the girls' dummy variables tends to have a significant effect on both Japanese and math together in the second year of junior high school. Notably, as is evident if we examine "low" socioeconomic status paired with the girls' dummy variables, low socioeconomic status does not have a significant impact for boys, but for girls there is a significant negative correlation with academic motivation. Conversely, with high socioeconomic status, especially with regard to Japanese there is a significant positive correlation for boys, but for girls, high socioeconomic status scarcely has any impact.[5]

On the other hand, in the third year of junior high, the effects of socioeconomic status and the interaction of girls' dummy variables are no longer significant. Examining the change in the regression coefficient, we find the magnitude and absolute value of the main effect of socioeconomic status has become larger, while the absolute value of the interaction of the girls' dummy variables is smaller. In other words, in the third year of junior high, the effect of socioeconomic status for boys has become as significant as it is for girls. Previous studies have shown that a slump midway through junior high school (i.e. in the second year) is particularly common among students whose parents/guardians have little cultural capital (Sudo 2013, 164). Given these findings, although the dependent variable in the previous studies was comprehension of lesson content rather than academic motivation, the results of our analysis are interesting in that they similarly suggest that even with the same low socioeconomic status, girls are prone to fall into a "midway slump" earlier than boys.

[4] When inputting data for the multiple regression analysis, achievement-oriented values were standardized. Also, inputting interactive factors heightens the probability of problems with multicollinearity arising, but the VIF (variance inflation factor) is not greater than 5, and the effects of the independent variables input for this article remained stable even when the analysis model was changed somewhat.

[5] However, with regard to Japanese, it must be noted that even if high socioeconomic status has a strong effect for boys, the independent effect of gender is strong enough to surpass it. For example, when estimated from the standardizing coefficient for second-year junior high school Japanese, the value of the girls' dummy is 0.175, while that of the main effect of high socioeconomic status (that is, the effect of high socioeconomic status among boys) is 0.123, and academic motivation among boys of high socioeconomic status is still lower than that of girls of middle socioeconomic status.

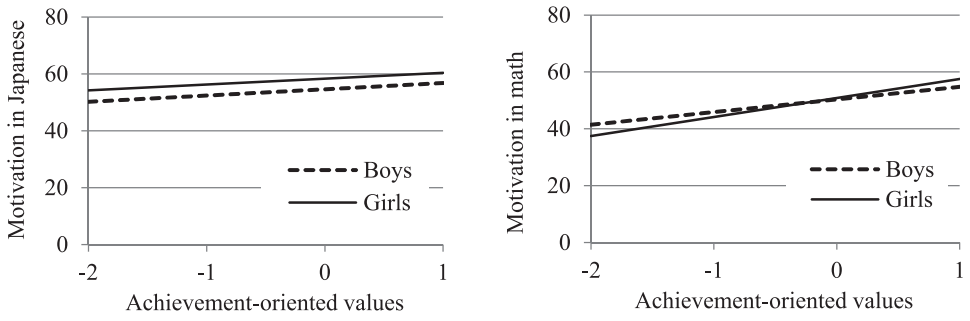

Figure 3. Gender Disparities in Correlation between Motivation and Achievement-Orientation

Now let us turn our attention to achievement-oriented values, the primary effect of which is a consistent positive impact on academic motivation. That is, the stronger a student's achievement-oriented values are, the higher his or her academic motivation is observed to be. This is a common-sense correlation and is hardly surprising. Here, however, it is in junior high school third-year math that this correlation is particularly notable. In third-year math, achievement-oriented values paired with the girls' dummy variables have a significant positive effect. In other words, achievement-oriented values have a significant effect on academic motivation in math for boys as well, but the effect is even greater among girls. For Japanese, however, no such gender disparity in effect was observed. It follows that more significant effects of achievement-oriented values on academic motivation among girls, compared to boys, can be considered a trend specific to STEM subjects.[6]

We prepared Figure 3 to enable easier visualization of these effects. This figure illustrates, on the basis of the values in Table 5, the impact of achievement-oriented values on motivation in Japanese and math, by gender, in the third year of junior high school. It is evident that girls' motivation is consistently higher in Japanese regardless of the degree of achievement-orientation, and there is little or no gender disparity in this regard. In math, however, there is a gender disparity, with achievement-orientation impacting motivation significantly more among girls. In other words, among girls more than boys, achievement-orientation plays a powerful role in determining degree of motivation of math. Kawano (2009b, 21) notes that "it has been pointed out that girls are unlikely to select the sciences unless propelled by strong academic motivation and good academic performance, in other words they will not choose this path simply because they 'like' STEM subjects," but given the above analysis findings, the reality is that for girls motivation toward STEM subjects, in and of itself, is strongly defined by achievement-oriented values.

To summarize the analysis in this section, with regard to academic motivation in math,

[6] We also performed a similar analysis with the dependent variable of response to the question "Do you like math / Japanese class?" (with four options, "I like it very much," "It's OK," "I don't like it very much," and "I dislike it"), and obtained similar results.

the interactive effects of gender and socioeconomic status are manifest in the second year of junior high school, but disappear during the third year and are replaced by the significant interactive effect of gender and achievement-oriented values. On the other hand, this interactive effect was not significant with regard to performance. In Japan, the high school entrance examinations taken during winter of the third year of junior high school are a crucial turning point, shaping the subsequent course of young people's academic careers. Given that this survey was conducted in the spring of the third year (over half a year prior to the entrance examinations), it is conceivable that the effects of these factors on performance will grow stronger during the period between spring and the high school entrance examinations. In any case, the above analysis results show that during the third year of junior high, an important turning point in academic careers, individual students' levels of achievement-oriented values are a more important determining factor for girls than for boys, and suggest that in STEM subjects, achievement-oriented values among girls are a key contributor to gender disparities.

IV. Conclusion

In this article, we have been discussing gender disparities in performance and motivation in Japanese and math respectively, based on an analysis of academic assessments of elementary and junior high school students. We found that during both elementary and junior high school, academic performance and motivation were consistently higher among girls, meaning that Japanese can be called a clearly gender-affected subject. Meanwhile, with regard to math, at the elementary school level there is virtually no gender disparity in academic performance and motivation, but at the junior high school level girls' performance and motivation both fall below those of boys. The gender order of "girls preferring humanities, boys preferring sciences," formed early on in elementary school and visible in children's stated affinities for the respective subjects, is gradually reinforced with each passing school year, and eventually comes to be reflected in academic performance and motivation.

Also, with regard to the interactive effects of gender and socioeconomic status as factors defining academic motivation, in both Japanese and math, low socioeconomic status is correlated with lower motivation, but this correlation becomes manifest at different times, during the second year of junior high school among girls and the third year among boys. In other words, the influence of socioeconomic status on academic motivation appears earlier among girls.

In addition, among female third-year junior high school students, the strength of achievement-oriented values emerges as a powerful determinant of degree of motivation in math. Being achievement-oriented is correlated with stronger academic motivation among both boys and girls, but especially among girls and especially in math, the degree of affinity with an achievement-oriented value system is highly influential. In other words, we have observed a phenomenon in which adaptability to an achievement-oriented value system

translates to degree of motivation in STEM subjects, and this phenomenon is more conspicuous among girls. This suggests that in girls' selection of academic careers in the sciences, factors other than academic performance and motivation alone are strongly at work.

We are left with a picture of numerous, repeated, and reinforced hurdles that women must overcome in order to pursue a career path in the sciences, not only in terms of academic performance but also motivation in the STEM subjects, the underlying effects of socioeconomic status, and affinity for an achievement-oriented value system. What Kajita (1981, 81) pointed out more than 30 years ago still holds true today: female students must choose between aligning themselves with the prevailing "culture of women," and internalizing a largely male-dominated "achievement-oriented value system," and the path of the sciences remains effectively closed to many women in our society.

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