GENDER ISSUES IN SCIENCE EDUCATION IN JAPAN

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ABSTRACT

The purpose of this study is to clarify gender differences in junior high school science students in Japan. In this paper, we describe gender imbalance in junior high school science education. As part 1 of the study, 222 junior high school students were surveyed with the use of a questionnaire about gender issues in science classes. Additionally, as part 2 of the study, twenty junior high school science teachers were interviewed about gender issues in science classes. The results of these two surveys showed gender inequities in junior high school science education in Japan. We should therefore deliberate on the strategies to be used in science education for gender equity.

Key words: Gender, Junior High School Students, Science Teachers, Japan

BACKGROUND

Japan used to be a traditional society in which the predominance of men over women was inherent. It was very hard for women even to enroll in science major courses at the university level. After World War II, the Educational Reform (The Fundamental Law of Education, 1947) made it possible for girls to enter universities with equal status. Men and women were given the same opportunity to enroll in any field at the tertiary education level. Following this, based on the confirmation of the Treaty of Abolition of Discrimination against Women in 1985, the Course of Study (revised in March, 1989) was epoch-making from the viewpoint of gender issues. At this time, homemaking courses were required of all students in senior high school, as well as, and in addition to this, all students were able to select both dance and martial sports (Judo and Kendo) for physical education at the secondary school level. As a result of this, the education system established gender equity in schools in Japan.

In recent years, the number of girls who select science major courses is gradually increasing. However this is still very low compared with the number of boys. Forty-two percent of males and 48.1% of females entered tertiary education after graduation from the senior high school level in 1998. However, females constitute only 12% of all students in science and engineering courses (The School Basic Survey, 1998).

The results of TIMSS (1995) showed that many female students in Japan are losing interest in science. Boys had significantly higher levels of science achievement than girls in both the 7th and 8th grades. Also, gender differences in the average of four-scale (Like a lot=4, Dislike a lot=1) that measures the
popularity of science is 0.5 (Boys : 2.8, Girls : 2.3) in Japan, and 0.1 (Boys : 2.9, Girls : 2.8) in the international average. Gender differences in Japan are the largest, and the four-stage average for girls is the lowest of all 21 countries.

Japanese society has maintained the preconception “female = non-science course, male = science course” as part of our social background. Moreover, a “Hidden Curriculum,” which promotes gender differences in education, has been in effect up until now. There are consequently disadvantages regarding gender issues in science education in Japan. Baker (1998), in reviewing the literature on equity issues in science education, provided an extensive summary of the research on gender equality in science education. She examines the status of women and minorities in science, especially within educational systems around the world. It is organized into the seven areas of (1) historical context, (2) the number of women and minorities in science, (3) the influence of schools, (4) the influence of the home, (5) socio-cultural barriers, (6) the nature of science, and (7) interventions. In most Western countries, science still is a male domain. When children in the USA, Australia, Ireland, Canada and Norway were asked to draw a scientist, they normally drew a man (Kahle & Meece 1994). This masculine image affects the kinds of decisions that girls and women make in relation to science.

In addition, some researches have shown gender differences in activities. Sadker & Sadker (1994) clarified that boys participated in class activities and discussions to a greater extent than girls. Also, Tobin (1988) said that females often had less access to science equipment and hands-on activities because males appropriated the equipment and relegated females to an observing role. The most studies on gender differences in science achievement favors male.

There are not only with some studies that clarify gender differences in science education, but also with various solutions for gender inequality that are being developed and practiced. Rennie (1998) reviewed the disadvantages and solutions for gender problems in “Four Perspectives on Gender and Science Education” as follows: (1) A remedial perspective, (2) A nondiscriminatory perspective, and the next perspectives regard the science curriculum itself as the source of the problem, (3) A gender inclusive or female friendly perspective, and (4) A socially critical perspective. There are concrete projects that support the science achievement of girls. Such as WISE (Woman into Science and Engineering) and GIST (Girls into Science and Technology) in England (Muramatsu, 1996), and WIEP (Women in Engineering Program) in the USA.

These references to gender inequality are similar to the situation in Japan. However, similar data has not been obtained so far in Japan. It is important to search for a common problem concerning gender issues, and to discuss prospective studies within the context of Japan. In this paper, we describe the disadvantages girls suffer in junior high school science education in Japan. We also discuss the strategies for achieving gender equity in science education.

**SURVEYS AND DATA COLLECTION**

**Part1 : Survey on Gender Differences in Junior High School Students**

**Purpose**

Part1 of the study discusses gender differences in junior high school science education. The respondents in this study are junior high school students.
Methods
We developed instruments for junior high school students through Research on Students’ Major Field Selection (Yoshida & Sugi, 2002) and teacher pre-interviews. First, we asked college students about major field selection. We clarified that gender difference in junior high school science education influenced the students’ ideas to select science/non-science courses in senior high school. Next, we asked a junior high school science teacher about gender differences in science education. This teacher pre-interview supports the results of first survey. It was gathered from this research that gender inequity in junior high school science education does exist. The questions used in the survey were designed to establish the following: “What type of gender difference exists in science education in junior high school?”, “What sort of ideas do the students have about science from a gender difference perspective?”, “What is the students’ individual attitude toward science from a gender difference perspective?”, “Why are students losing interest in science?” and “What creates gender differences between junior high school students?”. The items used in the questionnaire are as follows:
1. Students’ individual attitude toward science.
2. Grouping in science class.
3. Gender differences in affective orientation toward science class activities.
4. Gender role model in science-related jobs (Free writing).
The students responded by multiple choice and free responses.

Sample
A total of 222 junior high school students in Aichi, Japan, consisting of 111 females (7th grade 68, 8th grade 31, 9th grade 12) and 111 males (7th grade 70, 8th grade 29, 9th grade 12) were involved in the survey.

Part 2: Survey on Science Teachers’ Ideas about Gender Differences in Junior High Schools
Purpose
Part 2 of the study focused on science teachers’ ideas about gender differences for the purposes of comparison against the results obtained in Part 1 of the survey.

Method
Science teachers were interviewed on the following items in random order. Each interview took about 30 minutes.
1. Teacher’s background.
2. Gender differences in science classes.
3. Gender differences in the students’ liking of science class content.
4. Gender differences in the student’s achievement records in science.
5. Ways of teaching that consider gender differences in science classes.
6. Teachers’ opinions about the results of TIMSS (1995) indicating that “gender differences with regard to the liking of science are especially great in Japan”.

Sample
A total of 20 Junior high school science teachers in Aichi prefecture (10 female teachers, 10 male teachers)
RESULTS AND DISCUSSION

The results of the two surveys, the student questionnaires and the teacher interviews, showed similarities. We were able to make common conclusions for the two surveys. We also wanted to discuss how to improve gender equity through the results of part 1 and 2. We developed the following five perspectives for gender disadvantages in junior high school science education:

1) Students’ preparation for science learning.
2) Contents of science education (curriculum).
3) Science image.
4) Students’ consciousness about gender.
5) Social gender bias.

Students’ preparation for science learning

Items No.4 to No.7 in Table 1 show gender differences in liking the contents of science classes. These results indicate that boys like Physics and Earth Science more than girls, although on the other hand, girls like biology just as much as boys. Items No.8 to No.12 show gender differences in attitude in science classes. These results show that boys have a more positive attitude than girls toward laboratory work, and that girls have less opportunities to do hands-on activities while boys want to manipulate tools in laboratory work more than girls.

In the teacher interviews, science teachers said that girls avoid electrical circuits and insects, and girls have little experience with collecting insects and playing with electric toys. This indicates a large problem of gender difference before science learning commences. Boys and girls also have vastly different science-related experiences outside of school that contributes to the gender gap in science achievement (Sjoberg, 2002). Kobayashi (1980) shows that boys like more dynamic play than girls. Boys seemed to be more likely than girls to play with toys that encourage manipulation, construction, and movement.

This perspective reinforces the concept that girls are not sufficiently prepared for the learning of science. Therefore, teachers and educators should prepare supplemental teaching for girls to compensate for their fewer experiences in science.

The contents of science education (curriculum)

Items No.1 to No.3 in Table 1 show gender differences in attitude toward science. These results indicate that boys are interested in science, satisfied with science class, and that they want to study more in science class than girls.

In the teachers’ interviews, science teachers said that girls do not like to study science, and they are not interested in science and science experiments. The girls’ main concern is “How to become more beautiful? (Fashion and Makeup)”. On the other hand, the main concern of boys’ is “How to improve movement? (Plastic toy-model kits, radio-controlled cars, and sports)”. Therefore, girl’s interests tend to concentrate on “Changes in beautiful colors,” but not in “Changes in speed”.

This point might be similar to the “incongruousness” and “dis comfort” aspects brought up in Indigenous Science (Ogawa, 1998). It could be said that male concerns are suitable for science education, owing to the fact that science curriculum developers in Japan were almost all male until now. This
perspective highlights the disadvantage of the content of science being out of touch of girls' interests. Therefore, we should improve the science curriculum to encourage girls to recover an interest in science.

Table 1. Percentages Responding to “Agree” and “Disagree” and Sex Differences in Students' Individual Attitude Toward Science.

<table>
<thead>
<tr>
<th>Items</th>
<th>Girls</th>
<th>Boys</th>
<th>$\chi^2$</th>
<th>Significant difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) I am interested in science.</td>
<td>34%</td>
<td>37%</td>
<td>59%</td>
<td>20%</td>
</tr>
<tr>
<td>(2) I am satisfied with my science class.</td>
<td>14%</td>
<td>18%</td>
<td>27%</td>
<td>10%</td>
</tr>
<tr>
<td>(3) I want to learn more in science class.</td>
<td>23%</td>
<td>50%</td>
<td>37%</td>
<td>32%</td>
</tr>
<tr>
<td>(4) I like to study animals/plants in science class.</td>
<td>39%</td>
<td>29%</td>
<td>36%</td>
<td>29%</td>
</tr>
<tr>
<td>(5) I like to study solution/material changes and chemicals in science class.</td>
<td>37%</td>
<td>36%</td>
<td>45%</td>
<td>25%</td>
</tr>
<tr>
<td>(6) I like to study light/sound, electricity and mechanics in science class.</td>
<td>26%</td>
<td>50%</td>
<td>59%</td>
<td>19%</td>
</tr>
<tr>
<td>(7) I like to study the weather, the earth and space in science class.</td>
<td>21%</td>
<td>46%</td>
<td>37%</td>
<td>35%</td>
</tr>
<tr>
<td>(8) I like to do experiment in science class.</td>
<td>55%</td>
<td>22%</td>
<td>76%</td>
<td>10%</td>
</tr>
<tr>
<td>(9) I usually make my hypothesis for experiments in science class.</td>
<td>19%</td>
<td>60%</td>
<td>34%</td>
<td>33%</td>
</tr>
<tr>
<td>(10) I willingly do hands-on activities in science class.</td>
<td>26%</td>
<td>38%</td>
<td>46%</td>
<td>28%</td>
</tr>
<tr>
<td>(11) I prefer to note down the results of experiments than do hands-on activities.</td>
<td>28%</td>
<td>33%</td>
<td>17%</td>
<td>46%</td>
</tr>
<tr>
<td>(12) I sometimes play with experimental tools in science class.</td>
<td>24%</td>
<td>58%</td>
<td>37%</td>
<td>41%</td>
</tr>
<tr>
<td>(13) I think science is useful in daily life.</td>
<td>24%</td>
<td>44%</td>
<td>37%</td>
<td>23%</td>
</tr>
<tr>
<td>(14) I think science is useful for me in the future.</td>
<td>17%</td>
<td>53%</td>
<td>24%</td>
<td>35%</td>
</tr>
<tr>
<td>(15) I want to engage in a science-related job in the future.</td>
<td>4%</td>
<td>81%</td>
<td>17%</td>
<td>51%</td>
</tr>
<tr>
<td>(16) I like my science teachers.</td>
<td>17%</td>
<td>18%</td>
<td>34%</td>
<td>4%</td>
</tr>
</tbody>
</table>


Science image

Items No.13 to No.15 in Table1 show gender differences in ideas about the importance of science. These results indicate that there are more instances of boys than girls thinking that science is useful in their daily life and in the future. Eighty-one percents of girls do not want to engage in science-related jobs. Tables 2 and 3 show the student responses to free writing questions on science related jobs. Students identified more scientific jobs for males than females, and most students could not easily imagine scientific jobs for females.

In the teacher interviews, teachers said that girls have negative images toward science. The general feeling about images of science includes “Scientific studies require time before results are achieved”, “Abstract”, and “It is difficult to understand the technical terms in science”. In addition to this, science-related jobs have a negative image for girls that evokes the 3K syndrome: kitsui, kitanai, and kiken (3 D’s: difficult, dirty, and dangerous).

In one of the typical studies regarding stereotypes, Mead & Metraux (1957) first analyzed the gender stereotyping of science by asking children to describe scientists. Recently, Sumida (2001) asked children to draw pictures of scientists in Japan. The result indicated that the image of a scientist is mostly a male chemist.

This perspective shows the idea that the images of science and science-related jobs are advantageous for only a single gender. These factors are influenced by the history and the social structure of Japan. Therefore, we should present “Women active in science areas” as role models to both girls and boys in order to eliminate these poor images.

Table 2. Number of Students’ Responses to the Free Writing Questions on Science Related Jobs as Women’s Jobs.

<table>
<thead>
<tr>
<th>Girl’s responses (N=10)</th>
<th>Boy’s responses (N=2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacist (2), Nurse (2), Weather forecaster (2), Veterinary surgeon (2), Scientist, Astronomical observer.</td>
<td>Pharmacist, Weather forecaster, Scientist. (Total 10 jobs)</td>
</tr>
<tr>
<td>(Total 3 jobs)</td>
<td>(Total 3 jobs)</td>
</tr>
</tbody>
</table>

Table 3. Number of Students’ Responses to the Free Writing Questions on Science Related Jobs as Mens’ Jobs.

<table>
<thead>
<tr>
<th>Girl’s responses (N=38)</th>
<th>Boy’s responses (N=47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science teacher (13), Scientist (7), Teacher (6), Medical doctor (6), Researcher (3), Electrician (2), Pharmacist (2), Doctor, Professor, Fossil excavator (Archaeologist), Veterinary surgeon, Inventor, Architect, Explorer, others (5). (Total 51 jobs)</td>
<td>Teacher (20), Medical doctor (12), Science teacher (6), Scientist (10), Weather forecaster (4), Astronaut (6), Doctor (2), Electrician (2), Professor (2), Fossil excavator (Archaeologist), Scholar, Animal researcher, Design engineer, others (5). (Total 72 jobs)</td>
</tr>
</tbody>
</table>

Students’ consciousness about gender

We asked students “Do you think more boys or more girls would be involved in the following activities in science class?” Figure1 shows the gender differences in affective orientation in science classes. In science classes, gender roles show that “Boys manipulate experimental tools” and “Girls
clean up the laboratory and maintain records". Also, "Girls are passive in science class" is one of the responses discovered from the teacher interviews. It is therefore apparent that boys are usually more active in science classes than girls. On the other hand, girls seem more serious in their approach to laboratory work, are more active in writing down results, and tend to ensure that laboratory instruments are kept in order. Female and male students' attitudes toward science classes are ruled by "femininity" and "masculinity."

Table 4 shows the students' concerns with regard to organizing group activities into single/same sex groups. The table shows that 73% of students want to do group activities with the same sex in item No.1, and 73% of students do not want to work in mixed sex groups in item No.2. This shows that many students prefer to be grouped with the same gender. However, only one class in the sample classes uses single gender grouping. This result shows that a lot of students are disagreeable/dissatisfied in mixed gender groups. Therefore, it is thought that there are many students who feel a sense of unpleasantness in laboratories. Not only girls but also boys want to do laboratory work in single gender groups. This data proves that "Peer collaboration was exclusively same sex in science fair (Adamson, et al, 1998)."

This perspective shows the problem of student's (adolescent) attitude toward gender. Therefore, we should improve the gender roles in science classes through gender-free education to show that "femininity/masculinity is unimportant in the science class," as equal participation is needed.

Figure 1. Percentages Responding "More Boys" or "More Girls" on Affective Orientation in Science Class.
Table 4. Number and Percentages by Item of Students’ Concerns Regarding Group Activities in Single Sex/Same Sex Groups, by Actual Grouping.

<table>
<thead>
<tr>
<th>Items</th>
<th>Actual group organization</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixed gender</td>
<td>Single gender</td>
</tr>
<tr>
<td></td>
<td>N=193 (6 classes)</td>
<td>N=22 (1 class)</td>
</tr>
<tr>
<td>(1) Do you want to do group activities with same sex groups?</td>
<td>Yes</td>
<td>138 (72%)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>55 (28%)</td>
</tr>
<tr>
<td>(2) Do you want to do group activities with mixed sex groups?</td>
<td>Yes</td>
<td>54 (28%)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>139 (72%)</td>
</tr>
</tbody>
</table>

Social gender bias

In the teacher interviews, teachers said that high school teachers and parents do not encourage female students to enter science courses. Teachers and parents suggest, “Boys should enter science courses if they have no other ambitions”. It was also discovered that male teachers pay more attention to boys than girls (more boys were asked questions and admonished by the teachers). This statement shows that gender discrimination still exists in reality. Girls are not expected by science teachers and parents to have science-related jobs or to enroll in science courses.

Item No.16 in Table 1 shows the biggest gender difference in that only 17% of girls like their science teachers. Therefore, girls feel hesitant to enroll in science courses. This perspective shows inequity through science teachers’ and parents’ gender bias. We should therefore eradicate teachers’ gender bias through teacher education, and improve the ratio of female science teachers in junior high schools. At the moment, 80% of science teachers in junior high schools are male (TIMSS, 1995).

CONCLUSION

The results of two surveys showed that gender inequity exists in junior high school science education in Japan. We have listed five issues relating to the disadvantages of girls, as follows:
1) Girls are not prepared to learn science.
2) The contents of science curricula do not match girls’ interests.
3) The images of science and science-related jobs are advantageous for boys.
4) Girls and boys’ concepts about gender make girls perform passive roles as women in science classes.
5) Girls are not expected by social context (e.g., teachers, parents, and friends) to enroll in science courses or pursue science-related jobs.

The reasons why female students are losing interest in science and science learning are very complicated. It is very hard to solve these problems. While the above five issues relating to disadvantages are not enough to explain the reason for gender differences in science education, they seem to be efficient at stimulating discussions regarding the strategies to be established in science education with an aim for gender equity.

We need much more studies and discussions on how to improve science education against gender
inequity. It is an unfortunate problem that most of the science teachers seemed indifferent to gender equity, although they felt that gender differences exist in science classes. Moreover, from different interpretations of the words “Gender” and “Equity,” such as “Gender sensitive means Gender free” and “Equity Education means Giving the same chance for all students,” many teachers showed resistance to admitting that gender differences exist. The same problem is identified in teacher education (Haggerty, 1995; McGinnis & Pearsall, 1998), and it is referred to in the symposium in the National Association for Research in Science Teaching meeting in Chicago in 1997 as “Resistance to Promote Gender Equity” (Rennie, 1998). It is therefore necessary to think about strategies defining the meaning and the merit of gender studies. In addition to this, even if there are teachers who attach importance to gender differences, they do not know how to improve their science classes.

Programs and investigations are recommended in order for teachers to produce more scientifically literate citizens in the future. We should develop science curricula and methods in science teaching to establish “Science for all, not only males but also females”. We contend that the study of these strategies is needed in science education in Japan.

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WIEP (Women in Engineering Program).

WISE (Woman into Science and Engineering).


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