



A Comparative Study on Scientific Misconduct between Korean and Japanese Science Gifted Students

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ABSTRACT

The scientific integrity, perceptions of scientific misconduct, and students' needs in the research ethics education of Korean and Japanese gifted students were analyzed to address three questions. First, how well do students practice research ethics in their research? Second, how do students perceive scientists' misconduct? Third, do students want to learn research ethics and what aspects do they want to learn? Participants comprised 397 Korean and 370 Japanese science gifted high school students. Survey results showed that 48.92% of Korean students and 14.86% of Japanese students experienced scientific misconduct regarding their research. However, 90.61% of Korean students and 87.54% of Japanese students could identify these behaviors as scientific misconducts. Only 32.94% of Korean students and 19.63% of Japanese students expressed a desire to learn about research ethics concepts and practical issues during research. Although professing knowledge about scientific integrity, their scientific misconduct demonstrates a lack of authentic understanding. Thus, there is a need to accurately present students with the training they need.

Keywords: research ethics, science gifted student, science high school, scientific misconduct, super science high school

INTRODUCTION

After recent major research misconduct scandals by scientists in Korea and Japan, the scientific communities in both countries have initiated efforts for self-correction. In the 2000s, Korea faced a major scientific scandal in the cloning of human embryonic stem cells by Hwang Woo-suk, which raised alarms about research ethics and "research misconduct" in Korean society (Cyranoski, 2006; Gottweis & Triendl, 2006; Kakuk, 2009). After the controversy, progressive

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State of the literature

- Korea and Japan provide a school system with specialized focus on science gifted high school students, and they are facilitated by field professionals during research projects.
- Research ethics training for science gifted students is not currently a part of the scholastic curriculum in Korea as well as in Japan. Also, research on students' research ethics has been scarce.
- Guidelines share five similar definitions that are considered as research misconduct in Korea and Japan: fabrication, falsification, plagiarism, inappropriate authorship, and duplicating own publication.

Contribution of this paper to the literature

- Korean and Japanese gifted students had committed almost all the categories of research misconduct, namely, fabrication, falsification, plagiarism, inappropriate authorship, and self-plagiarism except duplication.
- Almost all the students from both countries who had committed these violations often perceived the same actions by scientists as scientific misconduct; this demonstrates a lack of true understanding.
- Only 1/3 of Korean and 1/5 of Japanese students were willing to learn research ethics. The desired contents described by students who were willing to receive research ethics training were very detailed and specific.

efforts were introduced in Korea to concretize research ethics regulations and to enforce stricter punishment for research misconduct committed by scientists and researchers (Korean Ministry of Education & National Research Foundation of Korea, 2015). Other efforts for self-correction include mandatory training on research ethics for scientists conducting government-sponsored research projects. Likewise, in Japan, the scandal of Haruko Obokata's research on stimulus-triggered acquisition of pluripotency (STAP) cells with its innovative results, which claimed that stem cells could be made to acquire pluripotency through stimulation with a weakly acidic medium, shocked the international community when the results were proven a fabrication (Asai, Okita, & Enzo, 2016; Normile & Vogel, 2014). Consequently, many researchers in scientific communities in Japan have increased their demands for self-correction efforts and measures (Macfarlane & Saitoh, 2008; Science Council of Japan, 2013).

Compared to the social attention and self-correction efforts regarding the misconduct by incumbent scientists, interest in the research misconduct of students who will be scientists appears lacking. For example, in one case of a famed Korean child prodigy, his recent paper was barred from publication on suspicion of plagiarism due to its extreme similarity with a paper authored by his advising professor (Vishniac, 2015). Because this was his first academic paper, many observers, both inside and outside the academic community, have raised concerns about his awareness of research ethics and misconduct. This incident demonstrates

the importance of teaching upcoming researchers about adhering to research ethics as a part of their training to become scientists.

Research ethics education for future scientists, however, is not carried out systematically, as compared with progressive efforts at the national level for the training of excellent high school students to become outstanding scientists in Korea and Japan. For their inherent talent and strong motivation to be a scientist, we can call them gifted students in the science field. They have learned research methods through authentic research activities; however, their learning of research ethics is implicit through the social values and productive atmosphere prevalent in each society, and their mentors' behaviors instead of an education program on systematic research ethics. We may expect these cultural and educational differences to widen the differences in the practice of students. Thus, by comparing the practice of students, we may be able to derive some implications regarding how research ethics is taught in each country.

Science gifted students, in their introduction to scientific research, are taught about ethical attitudes they must adopt when conducting research, while also learning to internalize different research methods. Therefore, early research experiences represent a crucial stage in determining the ethical integrity of future scientists. In order to plan the future direction of science education, there is a need to diagnose realistically the current research ethics status of students aspiring to become scientists. For this purpose, we examine high school students newly introduced to the practice of scientific research based on the following three aspects: (a) students' experiences with research misconduct in the course of their research practice; (b) students' perceptions of research misconduct if committed by scientists as perception linked to behavior; and (c) their demand for research ethics training—that is, whether they wish to receive such training, and what kind of content they hope will be included in such training.

LITERATURE REVIEW

Definition of Research Misconduct

The definitions of research misconduct as stated in Korea and Japan are as follows.

In Korea, the "Guideline for the Securing of Research Ethics" detailed the criteria and definitions of research misconduct as the following seven items (Ministry of Education, 2015). The first is fabrication, which means the act of creating, recording, or reporting nonexistent research results, research materials, or research sources. The second is falsification, that is, the act of intentionally tampering with research materials, equipment, or processes, or discretionally transforming or deleting research sources or materials to skew the research contents or results. The third is plagiarism, which means, the use of a third party's ideas or creations without adequate citation. The fourth is inappropriate authorship, such as not giving credit to a researcher who has contributed to the research results (or vice versa). The fifth is redundant publication, that is, the act of re-publishing one's previous research findings or a similar publication without adequate citation or permission. The sixth is the act of obstructing

investigations regarding research misconduct, and lastly, the seventh item comprises the miscellaneous acts that seriously deviate from conventionally tolerated practices in each academic field. In Japan, the Ministry of Education, Culture, Sports, Science & Technology (MEXT) has released guidelines regarding research misconduct after the Obokata scandal. These guidelines share five similar definitions of the above-mentioned acts that are considered as research misconduct in Korea: fabrication, falsification, plagiarism, inappropriate authorship, and duplicating own publication (Ministry of Education, Culture, Sports, Science & Technology, 2014).

In contrast to the US, where only fabrication, falsification, and plagiarism are defined as forms of research misconduct (National Science Foundation, 2013), both Korea and Japan have more detailed regulations regarding research misconduct, with the former and latter stipulating seven and five acts of misconduct, respectively.

Science Gifted Education in Korea and Japan

Due to the differences in the educational philosophy between the two nations, the treatment toward the next generation of scientists differs (Frantz & McClarty, 2016; Sumida, 2013). According to Dai and Chen (2013), three paradigms are related to giftedness. First, the gifted child paradigm defines giftedness as high intellectual or creative capacity that endures throughout life and leads gifted students to experience the world in unique ways. Second, the talent development paradigm defines giftedness as a trait that can be developed. Gifted students are flexibly defined in this paradigm as those who demonstrate or have the potential to develop their talent in specific domains, and this potential may be sensitive to specific stages of talent development. Third, differentiation defines gifted students as individualistic, namely, advanced learners with unique needs; therefore, education should be individually matched to their strengths, weaknesses, and interests.

Korea has included the “gifted child” paradigm, whereas Japan has not included any paradigm of giftedness (Frantz & McClarty, 2016). In Japanese education or society, the word “giftedness” had not been used until recently due to a culture that emphasizes equality and equity (Sumida, 2013). Both nations, however, provide a school system with specialized focus on “science” even though they termed these schools differently based on their own paradigm of giftedness: Korea has “science high schools for the gifted,” while Japan has “super science high schools.”

Current Research Ethics Training for Gifted High School Students in Korea and Japan

Because research ethics training is not currently a part of the scholastic curriculum in Korea as well as in Japan, each school for the gifted is accorded autonomy in research ethics training. Therefore, a well-organized program is needed for the long term. To meet this demand, the Korean Foundation for the Advancement of Science and Creativity (KOFAC) conducts research ethics training sessions through school visitation. However, as

these are one-off sessions, they are not held on a regular basis. The Science Council of Japan has established committees on scientific misconduct, and the council has published its statements several times. In recent years, almost all higher institutions have mandated their researchers to receive training in research ethics before applying for research grants. However, research ethics programs that are designed for high school students in Japan may be scarce (Spratt, Mori, & Inoue, 2015).

METHODOLOGY

Participants

In this study, we examined students with experience of participating in research activities that are enrolled in Korean science high schools for the gifted (SHSs), in addition to Japanese students enrolled in super science high schools (SSHs). Surveys were administered to 400 Korean students in 4 SHSs, and 399 Japanese students in 4 SSHs. After discarding the incomplete responses, 397 responses from Korea and 370 responses from Japan were included in the final sample for analysis.

By “research activity,” we refer to the autonomous research activities conducted by students with facilitation by a scientist or instructor. In Korean SHSs and Japanese SSHs, students are facilitated by field professionals when they conduct their research projects. This mentoring program is called the “research and exploration (R&E) program” in Korea and “project exploration” in Japan. Because this study focuses on students who have had the experience of conducting their own research, there are differences in the number of students in each school year due to the institutional differences between the two countries. In Japan, students are given an introduction and overview of research during their first year, pursuing projects in their chosen subject in earnest only when they reach the second year. In contrast, because Korean students initiate their research projects in their first year, they experience about one research project per school year. Because of this, the share of students who have participated in one research project was 43.83% in Korea, but exceeded 90% in Japan.

In the matter of subject preference, physics was the most frequent subject in research projects conducted by students in both Korea and Japan. The most frequent subjects in Korea were, in descending order, physics, chemistry, other scientific fields, biology, and earth sciences. In Japan, they were physics, chemistry, biology, other scientific fields, and earth sciences. The participation rate in earth sciences projects was found to be very low among Japanese students. This reflects the Japanese situation in which most schools do not offer the subject “earth sciences” compared with the other three top scientific subjects, namely, physics, chemistry, and biology. For gender participation, there were more male students in both Korea and Japan, with shares of 87.90% and 61.89%, respectively. In particular, the ratio of males was even higher in Korea because of the high enrollment rate of males in SHSs.

Brief Descriptions of the Questionnaire

In this study, we investigated the student experiences and perceptions on the research misconduct regulations of Korea and Japan. The questionnaire largely comprised three sections. The first section focused on the scientific integrity of the participating gifted students, the second examined their perceptions on research ethics, and the third was concerned with the demand for research ethics training. The questionnaire was revised based on the study by Lee and Kim (2015).

The first and second sections categorized the forms of research misconduct that are defined in both Korea and Japan: fabrication, falsification, plagiarism, inappropriate authorship, and self-plagiarism. Duplicating own publication, one of the five forms of misconduct regulated in both countries, has been disregarded in this study in consideration of the fact that high school students are unlikely to have published prior papers. Nevertheless, we have included self-plagiarism, which also involves repeated use of one's own research findings, but on a smaller scale. Accordingly, in the first section, we asked the students whether they have experienced any form of research misconduct that corresponds to each category. In the second section, we asked whether the students would perceive actions corresponding to the same categories as misconduct if a scientist were to partake in them. In the third section, we asked the students whether they would like to receive research ethics training, and if so, what kind of specific content they would want included in the training. The summary of each questionnaire item for sections 1–3 is in Appendix A (Table A1, A2, and A3).

Survey Period and Methods

Surveys were conducted via web surveys from June 1 to October 1, 2015. In terms of facilitating data collection, because Korean students were more accustomed to web surveys whereas Japanese students were more familiar with paper-based surveys, we employed the survey methods that suit each respective group.

Data analysis

For Research Question 1, which focuses on students' experiences with research misconduct in the course of their research practice, we analyzed the instances of research misconduct experienced by students during their research activities. We analyzed the misconduct experience rate for all students and investigated microscopically, in terms of each category of misconduct, the number of research projects undertaken and the field of research.

As perception is linked to behavior, for Research Question 2 on students' perceptions of research misconduct if committed by scientists, we analyzed how students would perceive research misconduct by scientists, using the same categories of misconduct as in Research Question 1. These results were compared to the students' experiences with research misconduct.

For Research Question 3 on students' demands for research ethics training and the content they hope will be included in such training, we calculated the total ratio of students who expressed the wish to receive research ethics training, as well as the ratios for students in each school year. Students provided free-form responses to the open questions regarding topics they thought should be included in the research ethics training. These were coded by the type of response. The responses were coded independently by three researchers, after which the results of the coding were verified for concordance.

RESULTS

Status of the Research Ethics Integrity of Science Gifted Students in Conducting Research

We counted the number of students who reported instances of violating the nine items in the five categories of research misconduct. By calculating the ratio of students who have reported having committed any one of the acts of misconduct at least once, we found that the ratio was 48.92% for Korean students and 14.86% for Japanese students. Overall, Korean students had a higher rate of experiencing misconduct than did Japanese students.

In **Figure 1**, data falsification was reported as the most common sub-category of research misconduct experienced by the students. This may be attributed to the ease of data falsification compared to falsification of experiment processes. In addition, because it is easier to predict the outcome of experiments through calculating data, students could have been tempted to tamper with the data if the experiment results differ from what they had expected.

Regarding plagiarism, instances of word plagiarism were found to be more prevalent than the plagiarism of ideas, with word plagiarism being ranked second in Japan and third in Korea. This may be due to advances in search technology, which has made it easier to access and download published research papers. It appears that this is not limited to the case of gifted students, but is part of a larger worldwide phenomenon of cyber-plagiarism prevalent among university students.

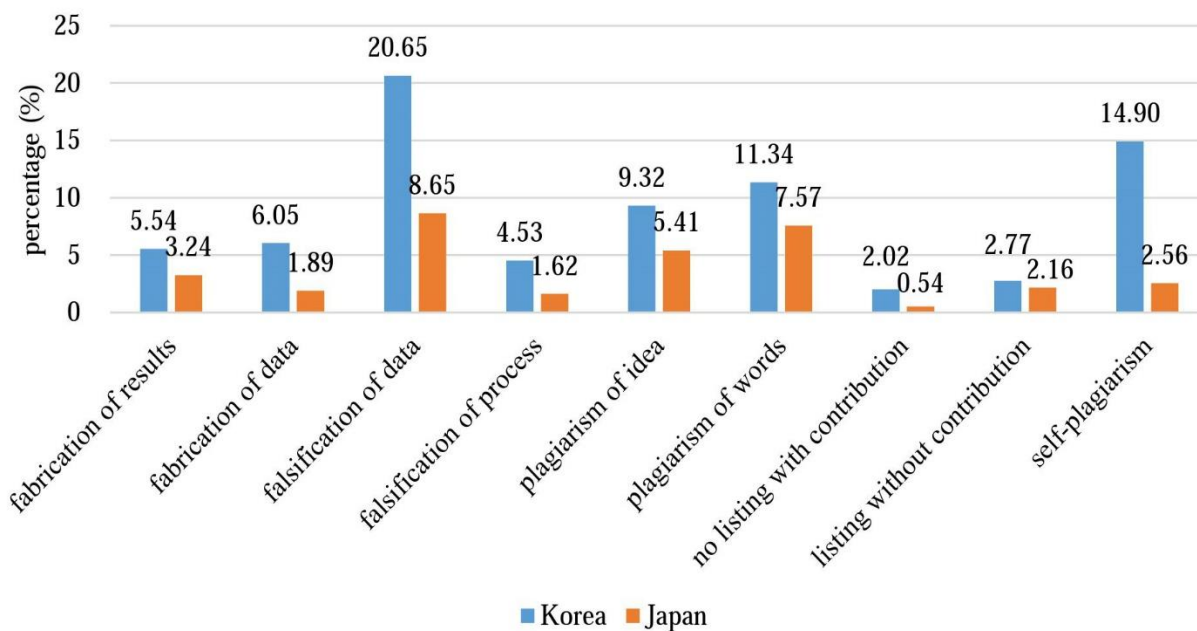


Figure 1. Categories of research misconduct experienced by the students

Next, we examined the misconduct experience rate among students by the number of research projects undertaken (see **Figure 2**). In Korean students, the misconduct experience rate steadily rose as they gained experience in conducting more research projects. In contrast, the misconduct experience rate among Japanese students was not linearly proportional to the number of projects they had conducted. While the misconduct rate rose as they conducted one to two research projects, Japanese students who conducted at least three projects reported the lowest misconduct rate.

The linear growth of the misconduct rate in Korean students, in line with the number of projects undertaken, means that the number of students who commit research misconduct increases with the number of research projects. Thus, more than half of the third-year students were found to have committed research misconduct.

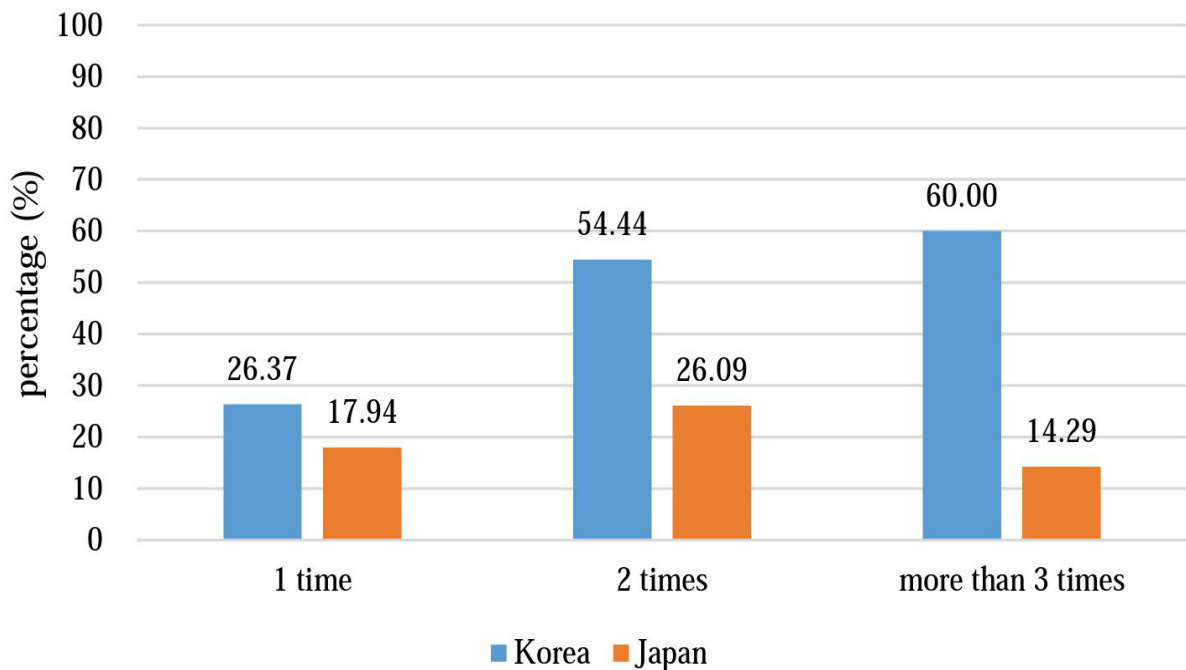


Figure 2. The misconduct experience rate among students by the number of research projects undertaken

However, this simple count of research misconduct occurrences did not consider cases where a single student experiences multiple forms of misconduct. Accordingly, there is a need to consider the number of violations committed by each student. This is because a minority of students may account for the majority of the misconduct. In view of this, we calculated the weighted means (M) by the number of research projects undertaken.

We found differences between the misconduct experience rate among students by the number of research projects undertaken and the weighted means by the number of research projects undertaken for Korean and Japanese students. That is, while the number of violations grew with the number of projects undertaken in the case of Korean students (up to twice but not more than thrice), there was a linear decrease in the number of violations with more projects undertaken in the case of Japanese students (see [Figure 3](#)).

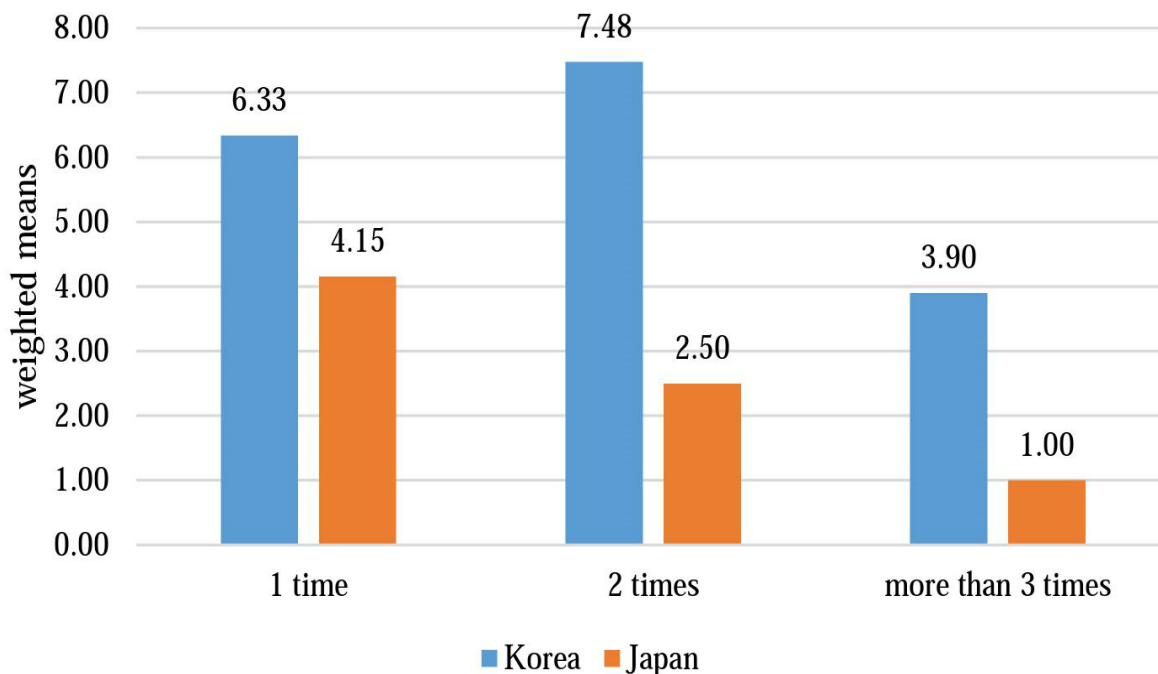


Figure 3. Violations with more projects undertaken

It is possible to hypothesize that certain forms of research ethics violations may be more prevalent in certain fields of study, due to the characteristics of each field. Thus, we analyzed the misconduct experience rate of students across the fields of study. Looking at the violation rate by the field of study in Korean and Japanese students, no statistically significant differences across fields were found in either country. This suggests that the characteristics of each field of study did not substantially affect the research misconduct acts of students.

Perception of Scientific Misconduct of Science Gifted Students

In the previous section, we examined the misconduct experience rate of students while conducting their own research. There is the possibility that these results may be due to an insufficient understanding of research ethics. Thus, in this section, we examined how students would perceive the same category of violations if committed by a scientist.

In **Figure 4**, across all categories, students perceived the actions of a hypothetical scientist to be in violation of research ethics. For all categories, nearly 90% (in some cases, more than 90%) of Korean students responded that the scientist's actions constituted research misconduct. Likewise, more than 80% of Japanese students responded similarly for all categories (see **Figure 5**). One form of misconduct that was perceived relatively less as a violation by students from both countries was data fabrication. Both Japanese and Korean students, 85.68% and 85.95%, respectively, responded that inappropriate authorship listing amounted to misconduct: The rates were somewhat lower compared to other categories.

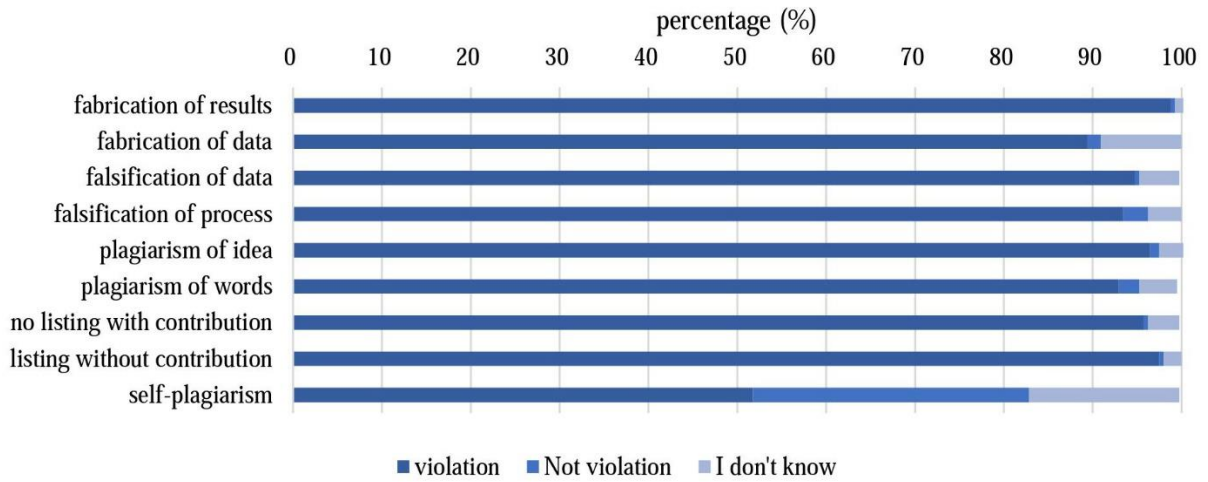


Figure 4. Across all categories, Korean students perceived the actions of a hypothetical scientist to be in violation of research ethics

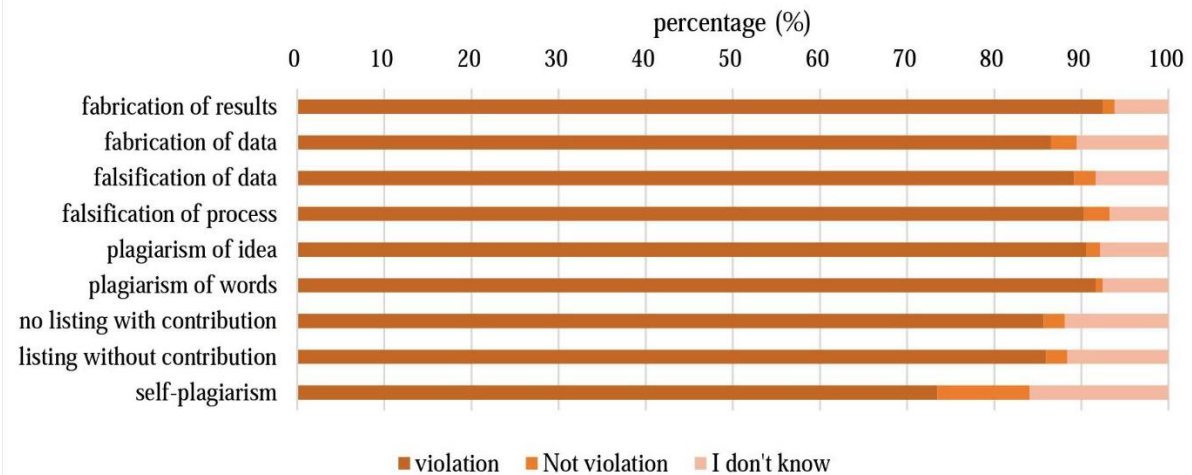


Figure 5. Across all categories, Japanese students perceived the actions of a hypothetical scientist to be in violation of research ethics

To examine the relation between students’ perceptions of research misconduct by scientists and their own experiences of misconduct—that is, to establish the connection between what they knew and how they acted—we compared the misconduct experiences and their perception of each category of misconduct (see [Figure 6](#)). We found that students frequently committed violations despite knowing that the acts constituted research misconduct. Thus, while they had high moral sensitivity about the misdeeds of others, they were inconsistent concerning their own actions.

Self-plagiarism—the second most frequent violation found among Korean students—was the least frequently perceived to be wrong if committed by a scientist. The most frequent response regarding self-plagiarism was that students were uncertain as to whether it was

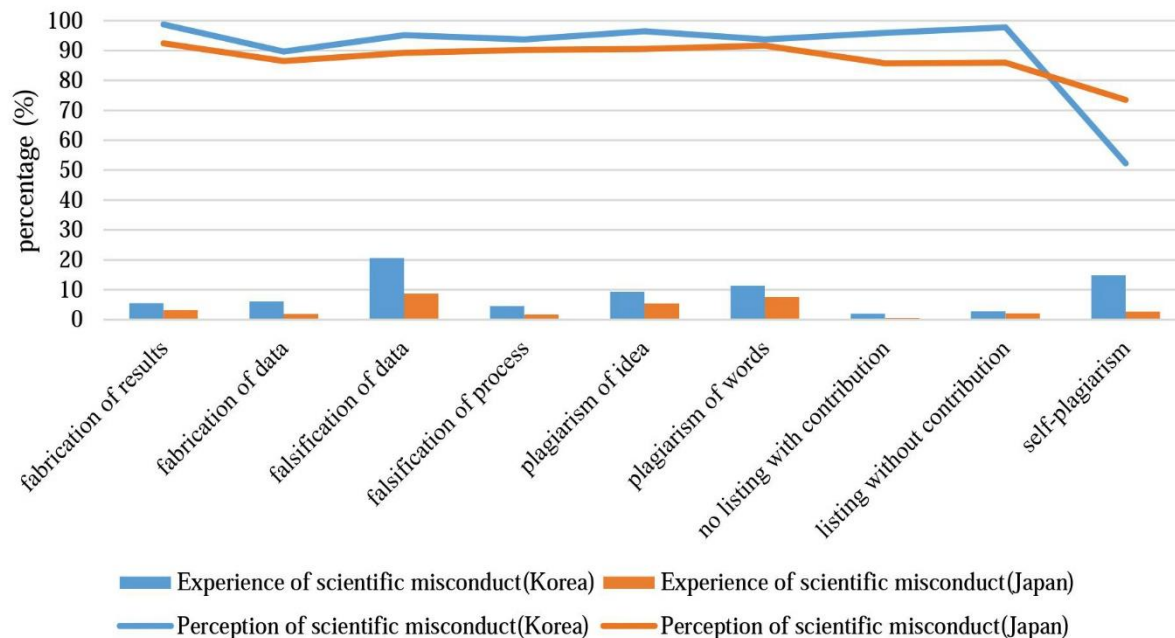


Figure 6. The misconduct experiences and their perception of each category of misconduct

wrong or right. Thus, it appears that students are unaware about the acceptability of self-plagiarism, leading Korean students to commit it. Consequently, self-plagiarism is the second-most frequent violation. According to Perry’s matrix (2011), self-plagiarism is accidental infringement because of the students’ poor understanding and non-adherence to the rules.

On the other hand, in the case of data falsification – the most frequent violation among students – we tracked the students who responded as having partaken in falsifying data to ascertain how they perceived the same action when committed by a scientist. We found that 100% of both Korean and Japanese students perceived the act as misconduct. Thus, we found that the students who committed data falsification in the course of their research did so despite their awareness of its wrongfulness. Data falsification constitutes cheating in Perry’s (2011) matrix, because students who committed such ethical violations were presumed to possess mature understanding of the subject.

Demand for Research Ethics Training and Student Requested Contents

We found that both Korean and Japanese students reported high rates of misconduct while pursuing their research, despite knowing that such actions are wrong. Accordingly, in this section, we examined whether students perceive the need to receive research ethics training, and if so, the content they would want included in the training.

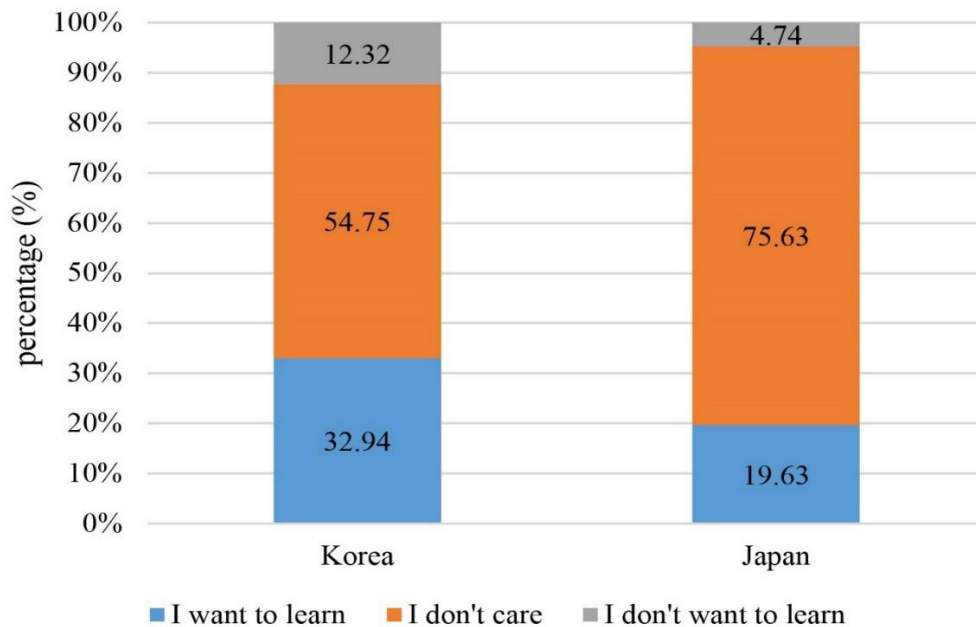


Figure 7. The question of students' perceived need for ethics training

In **Figure 7**, to address the question of students' perceived need for ethics training, 32% of Korean students responded in the affirmative, whereas a relatively lower percentage was seen in Japanese students (19%, affirmative). While the ratio of Korean students who reported having experienced research misconduct was roughly similar to the ratio of those who responded that they would like to receive research ethics training, the majority of Japanese students (75.63%) expressed indifference about receiving such training. While the ratio of indifferent responses was higher than the ratio of positive or negative responses in Korean students as well, the ratio was lower than that for Japanese students. We may consider two interpretations of the indifferent responses of Japanese students regarding research ethics. First, they may not feel the need because they are already well aware of the matter. Second, they may feel that it would not be very meaningful even if they were to learn about research ethics. If the former reason holds, we could not explain the high rate of experienced misconduct. If the latter reason holds, this implies that the content of the research ethics training must be improved to instill its importance and for students to feel the need for ethical conduct.

Next, we examined the relationship between the students' experience of misconduct and their acceptance of research ethics training, where 11.28% of the Korean students who had experienced misconduct responded that they would like to receive research ethics training. In Japanese students, the ratio was 2.90%, a rate even lower than the ratio among students with no experience of misconduct.

Concerning the demand for research ethics training, it tended to increase in progression with the students' grade advancement for Korean students, whereas Japanese

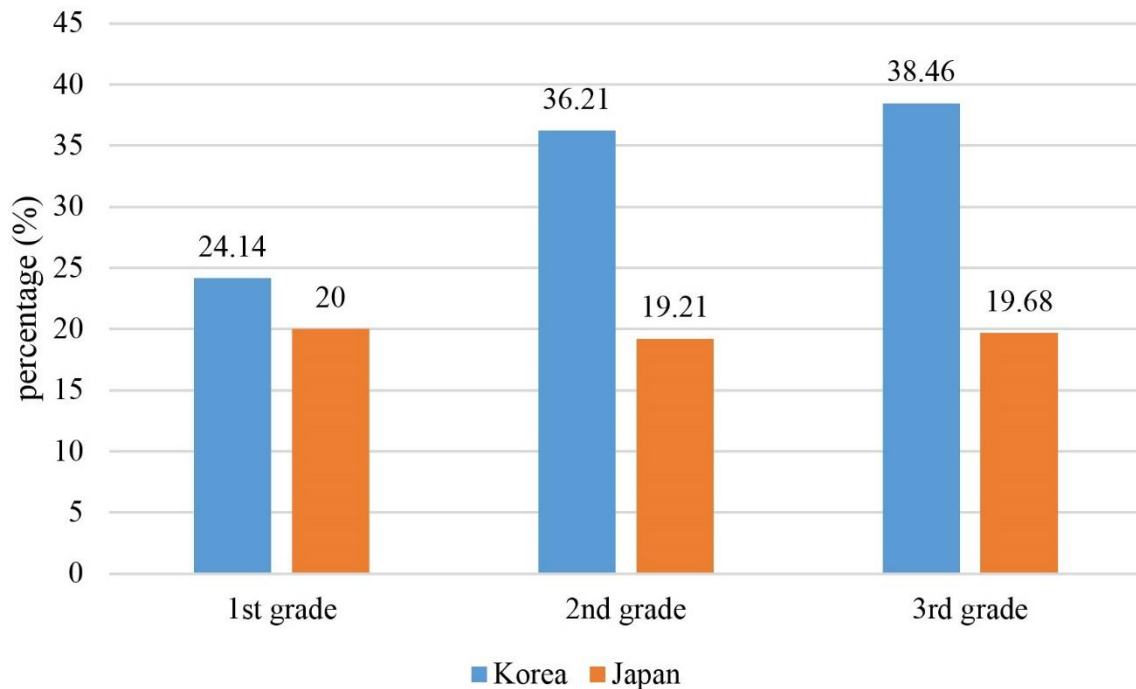


Figure 8. The demand for research ethics training in progression with the students’ grade advancement

students expressed roughly the same level of demand regardless of grade: This is similar to the findings on students’ misconduct experiences against the number of projects undertaken. In the case of Korean students, we may consider two reasons why the demand for ethics training increased with the grade. First, because research experience grows proportionally with the grade, students may want to resolve some of the difficulties or questions they had encountered through training. Second, we may also interpret that this is due to the differences in the opportunity to receive research ethics training, despite the recent increasing provision of such training (see [Figure 8](#)).

We asked students about the content they would like learn if they were to receive research ethics training. Mostly, students who expressed willingness to receive research ethics training also gave their responses regarding the desired content. A total of 18.39% of Korean students and 16.49% of Japanese students responded. We grouped similar responses from the open-format responses into several categories. The following presents the results from their responses (see [Figure 9](#) and [10](#)).

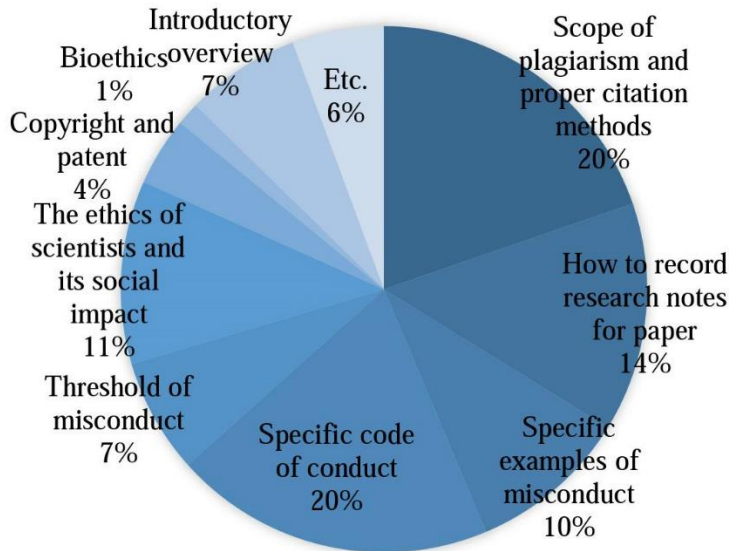


Figure 9. The content of research ethics training demanded by the Korean students

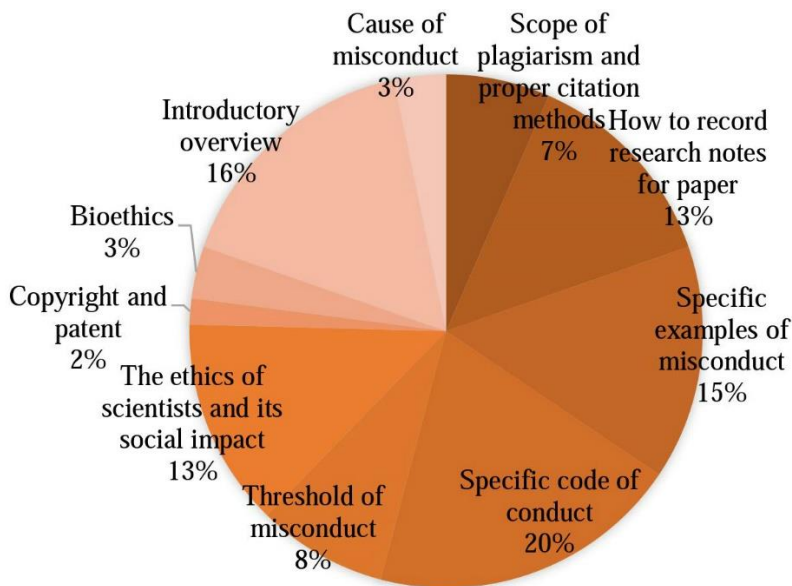


Figure 10. The content of research ethics training demanded by the Japanese students

In both countries, the most frequent response was “specific code of conduct.” Items, such as the scope of plagiarism, proper citing methods, and good writing practices, were all categorized into a specific code of conduct because these aspects deal with specific and practical issues in conducting research. More than half of the Korean and Japanese students responded that they would like to learn more about practical matters concerning conducting research while observing research ethics.

In addition, 16.39% of the Japanese students responded that they would like an introductory overview of research ethics. This type of demand may arise because research ethics was not in the curriculum content.

DISCUSSION

We surveyed science gifted high school students in Korea and Japan—the future scientists—about research misconduct based on their experiences in pursuing research. Results show that students had experienced all the categories of research misconduct in the present study, and often perceived such actions to be wrong. However, the ratio of students willing to learn research ethics was low. We consider these findings in more detail below.

First, for science gifted students, conducting research experiments constitutes authentic research and represents their earliest experience in research. In addition, their research is a learning process under the guidance of a mentor; however, at least 48.92% of Korean students and at least 14.86% of Japanese students reported having committed research misconduct even as they were learning how to conduct research. Because these responses were self-reported, we may deduce that the actual number of students who have experienced misconduct is even higher.

Analyzing the specifics of the misconduct experienced by students, we found two concrete characteristics. Data falsification and word-for-word plagiarism represented the most frequent types of misconduct experienced by students in both countries. The significance of this fact is that these types of misconduct are easy to commit. With the ease of data falsification compared to fabrication, as well as of the present education setting in the digital age, cyberplagiarism has become widespread. Because these students are still beginners working on simple research projects, it is important that they receive guidance to promote ethical practices during this stage of their career.

Second, Korean students were found to have violated research ethics more than Japanese students did across all the categories of research misconduct. Furthermore, they committed more violations as they gained more research experience. Educators in Korea must consider the reasons for such phenomenon from multiple angles and enact improvements. For example, in terms of educational philosophy and goals, the following difference may be one of the contributing factors. In Japan, students are allowed sufficient time to develop and further investigate their research if the existing data do not fit their hypothesis or assumptions, by treating the initial data as important. On the other hand, Korea places a greater emphasis on results rather than processes. Another contributing factor may be the different extent to which each society takes seriously the basic premise of refraining from misconduct. We may also consider the system that prevails in the research community. For scientists, output is crucial for professional success. Due to the characteristics of the profession, where the sentiment of “publish or perish” prevails, researchers may be more easily tempted to commit misconduct (D'Angelo, 2012; Van Dalen & Henkens, 2012). Thus, since a competition-based system leads to wrongful temptations even in researchers who are well aware of the harm in

violating research ethics, students who have yet to form fully their sense of ethics must not be asked to produce undue output or be placed under excessive competition. Finally, there is a need to monitor how teachers perceive research ethics. This is because students' sense of research ethics may be reflective of the teachers' inability due to lack of knowledge of the topic, or failure on the part of the teacher to recognize or emphasize its importance, reinforced by the belief that there is no need to teach about research ethics, choosing instead to trust the conscience of the student.

However, we found that the students frequently responded that they did not want to learn about research ethics. Therefore, why do students in both Korea and Japan show a lower level of willingness to learn about research ethics in schools? A possible reason may have been derived from their perception that such training is ineffectual; hence, they may see such training as an additional burden or extra work. According to the results of interviews with science teachers, however, we have to recognize and credit few schools in Korea and Japan with their effective provision of such training programs. Thus, there is a need to accurately present students with the training they need. The desired contents described by students who were willing to receive research ethics training were very detailed and specific. Thus, the training provided should meet the students' demands for specific instruction. As each education institution is autonomous in providing such training, implementing needs analysis prior to a course design as well as after course implementation is crucial. Teaching research ethics during repeated actual research situations (Mabrouk, 2013) may be one alternative method of doing this.

CONCLUSION

One of the most effective ways to prevent research misconduct by scientists is to provide comprehensive training on ethics and misconduct to upcoming researchers and future scientists. In the course of conducting their research, a large proportion of science gifted students in both Korea and Japan were found to have committed research misconduct. As a result of examining how students perceived matters of research ethics and comparing this result to instances of their actual experiences in misconduct, we found that students only had superficial knowledge, rather than "true understanding" of research ethics. While science gifted students were aware of the acts that constitute as research misconduct, they were often found to be unable to follow through with their moral practice in actual research situations. Thus, this reveals that science gifted students possess a certain level of theoretical knowledge (theōria or logos) but were lacking in the ability to apply this in practice (praxis). In keeping with the integrated perspective, which states that true understanding must be accompanied by practice, there is a need to provide students with an integrated education, which ranges from theoretical guidance to an internalized sense of ethics. In addition, science teachers who work at Science High Schools and Super Science High schools should be given opportunities to learn research ethics, both in theory and practice, in pre- and in-service teacher training programs.

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APPENDICES

Appendix A

Table A1. Summary of Questionnaire Section 1—Gifted Students' Scientific Integrity In Conducting Research: Have I Ever Committed Any of the Following Acts?

No.	Category	Description
1-1	Fabrication	While preparing a report (or paper), I fabricated data rather than conducting an actual experiment, due to insufficient data/information.
1-2		I over-reported the number of times experiments were run.
1-3	Falsification	I tampered with data to fit the results, or deleted data that did not align with results.
1-4		I misleadingly described how the research was actually conducted in a report.
1-5	Plagiarism	I used another person's research idea or data without citing it.
1-6		I copied, verbatim, texts from another person's report, paper, or web page without citing it.
1-7	Inappropriate author listing	I omitted the name of a person who participated in the planning, execution, outcome, or examination of my research from the list of authors of a report or paper.
1-8		I included the name of a person who did not participate in the planning, execution, outcome, or examination of my research in the list of authors of a report or paper.
1-9	Self-plagiarism	I copied, verbatim, texts from a previous report or paper by myself without citing it.

Table A2. Summary of Questionnaire Section 2—Perception of Scientific Misconduct: Do Any of the Following Acts Constitute Research Misconduct If Committed by a Scientist?

No.	Category	Description
2-1	Fabrication	While preparing a report (or paper), a scientist fabricates data to fit the results rather than conducting an actual experiment, due to insufficient data/information.

2-2		Once a scientist runs a successful experiment, he/she can write a paper without repeating the experiment to verify the results.
2-3	Falsification	A scientist tampers with data to fit the results, or deletes data that did not align with the expected results.
2-4		A scientist writes a paper with a conclusion that does not correspond to the experiment that was actually run.
2-5	Plagiarism	A scientist uses another person's research idea or data without citing it or obtaining permission.
2-6		A scientist copies, verbatim, texts from another person's report or paper without citing it.
2-7	Inappropriate author listing	A scientist omits the name of a person who participated in the planning, execution, outcome, or examination of the research from the list of authors of a report or paper.
2-8		A scientist includes the name of a person (such as a teacher or friend) who did not participate in the planning, execution, outcome, or examination of the research in the list of authors of a report or paper.
2-9	Self-plagiarism	A scientist copies, verbatim, texts from a previous report or paper by himself/herself.

Table A3. Summary of Questionnaire Section 3: Demand for Research Ethics Training and Requested Contents

No.	Category	Description
3-1	Demand for Research Ethics Training and	Demand for Research Ethics Training
3-2	requested contents	Requested contents of research ethics training

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