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Why students' interest in science declined? On Focus Group of Japanese Undergraduate Students

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Abstract

Students' declining interest in science is internationally problematic, especially in developed countries. Despite efforts aimed at making science appealing to students, this problem persists. There is a shortage of studies that have applied fine-grained qualitative methods to examine how Japanese students' views have shifted toward a dislike of science. This qualitative study aimed at elucidating how and why undergraduate students in Japan experienced disliking science during their lives. A total of 22 freshman and sophomore students attending a Japanese public university described how their dislike of science came about within small focus group discussions (3–4 participants per group). Data sources comprised participants' interview data and written papers about life events associated with their attitudes toward science. A grounded theory approach was applied for coding the qualitative data. The analysis revealed 14 sub-categories under the following six categories: comprehension, hands-on activity, teacher and teaching, autonomy of learning, perceived relevance of science, and engagement. The study's findings demonstrated inter-relations among the sub-categories that influenced students' attitudes toward school science. The results emphasized the practical importance of hands-on activities for fostering students' understanding of abstract scientific concepts and the influence of teachers' personalities in shaping students' attitudes toward school science. The dynamics among these factors require further exploration to advance understanding of such complex attitudinal changes toward science.

Keywords: *Science Interest, Focus Group, Grounded Theory*

1. Introduction

Students' declining attitude towards school science in early adolescence have been a big issue in science education [1–3]. The TIMSS 2019 results reveal this continuing trend. Accordingly, in 2019, the percentage of Japanese students who 'do not like learning science' is 9% among 4th graders while 35% among 8th graders. Findings for other developed countries, including the United States, England, and Australia were similar [4].

Previous studies have shown that some factors such as gender, early experiences, and teaching quality affect students' attitudes toward school science [1,5,6]. Moreover, many interventions, such as summer camps and hands-on activities have been developed, all of which have demonstrably positive effects on students' attitudes [7]. Nevertheless, we are still facing a students' declining attitudes problem.

One of the possible reasons is that there is a shortage of studies that have examined detailed processes of swinging away from science. In fact, in Japan, no studies have applied a fine-grained qualitative method to examine how and why students' science interests shift to a dislike of science [8]. Some studies used qualitative methods [9-10], which focused on the emerging interest process and did not reveal the process toward disliking of science. A comprehensive examination of how students disliked science would be beneficial to tackle this problem. Therefore, this study sought to elucidate how undergraduate students came to dislike science in their life using a qualitative research method.

2. Methods

2.1 Participants

In July, 2020, 22 freshman and sophomore students (11 male and 11 female students) at a Japanese public university, who experienced disliking of science, participated in focus groups comprising three to four students. The participants represented all departments at the university, ranging from natural science disciplines to social sciences and humanities.

2.2 Data Collection

Before the focus group discussions took place, participants were asked to complete a pre-assignment (Fig. 1). Specifically, they were asked to plot attitudinal changes to school science during the course of

the four schooling phases (lower elementary, upper elementary, junior high, and high school) and to note any events that explained their attitudinal changes on a worksheet. Focus group discussions were subsequently conducted, during which the pre-assignment worksheets were used to facilitate participants' active engagement with each other, supplementing each other's memory gaps and stimulating their personal memories. All interviews were videotaped and analyzed.

2.3 Coding

A constructivist grounded theory approach [11] was applied, which included at least two coding steps: initial coding and focused coding. MAX QDA software was used for the coding process. An event mentioned by more than two participants when explaining their attitudinal change regarding school science constituted a sub-category. If only one participant mentioned an event, it was treated as an exception.

3. Results

The analysis generated six categories and 14 sub-categories that explained how they came to "dislike" science. Table 1 shows some illustrative quotes for some of the categories. The numbers in brackets after each sub-category name denotes the number of participants who mentioned it.

3.1 Comprehension

3.1.1 Increased memorization (12)

With ascending grades, the contents taught in science classes generally increase. Twelve students attributed their dislike of science to the need for increased memorization. In addition, the students increasingly tended to memorize contents without fully understanding them because they prioritized memorization in the limited time available, which did not facilitate the development of their understanding.

3.1.2 Content invisibility (5)

With ascending grades, the main activities in science classes entailed learning abstract concepts, such as force, energy, and electricity, rather than practical activities such as growing plants and craft making. These concepts, unlike the previously learned content are difficult to see or touch directly.

3.1.3 Mathematical operations (4)

The use of mathematical formulas and the need to perform calculations in science classes increases with advancing grades. Four students mentioned that these mathematical operations hindered their ability to follow science lessons.

3.1.4 Poor understanding (20)

Increased memorization, invisibility of content, and mathematical operations, along with decreased hands-on opportunities, disengagement from science learning (see 3.6.1). and poor teaching quality (see 3.3.1) contributed to a poor understanding of scientific content. Of the 22 participants, a substantial majority identified poor understanding as the cause of their dislike of school science.

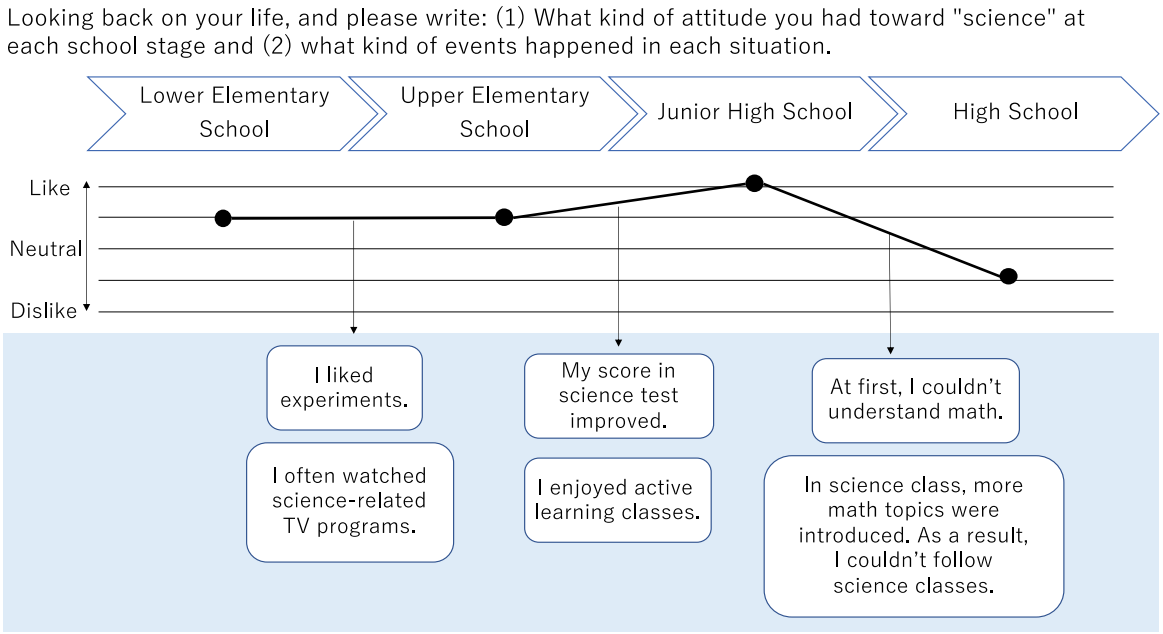

Fig. 1. Quotes (translated from Japanese) in a Student's Worksheet

Table 1. Some Categories, Sub-categories, and Illustrative Quotes

Category Sub-category	Illustrative quote
Comprehension	
Poor Understanding	"At first, I couldn't understand the equation ma = F in physics at all. I got stuck there. I couldn't visualize it at all. Even if I drew it in a diagram, I couldn't understand it."
Increased Memorization	"There was so much to memorize in inorganic chemistry that I gave up trying to remember it, and because chemistry is a subject where everything is connected, my understanding of the theory part went down, and I didn't even know where to restart."
Hands-on Activity	
Decreased hands-on opportunities	"The number of experiments was reduced, and it became more difficult to understand the concepts and content, even though high school students were doing things that were more invisible and difficult to imagine."
Teacher and Teaching	
Negative perceptions of teachers' personalities	"I asked a lot of questions, but I was rebuffed. So I had a negative feeling toward my teacher, and I didn't want to study anymore."
Autonomy of learning	
Studying for the entrance exam	"I felt as if science had become nothing more than a subject for [passing] entrance exams."
Perceived relevance	
Relevance to life	"I didn't think I would get into science course at all, and I wasn't interested in science at all."
Engagement	
Disengagement	"I didn't like him/her, so I didn't even want to ask about it."

3.1.5 Poor test scores and grades (11)
Tests reveals the level of their understanding. When students' scores were below the class average or when they compared their scores with those in other subjects, or with their past scores in the same subject, they recognized their science ability were poor. Eleven participants mentioned this factor.

3.2 Hands-on activity

3.2.1 Decreased hands-on chances (9)
Decreased opportunities to engage in hands-on activity (e.g., observations and experiments) negatively influenced attitudes toward school science both directly and indirectly. Indirectly, it deprived learners of opportunities to understand abstract science concepts. Nine participants mentioned this factor.

3.2.2 Independent research (2)
Elementary school students in Japan are commonly assigned homework during the summer vacation called independent research. Two participants mentioned that one of the reasons why they disliked school science was the requirement of conducting independent research.

3.3 Teacher and teaching

3.3.1 Poor teaching quality (3)
Poor teaching quality led to negative attitudes toward school science in two ways. In the first, poor teaching quality led to poor understanding, which in turn led to a negative attitude toward school science. The second pathway was via formation of a negative attitude toward the teacher, which in turn led to a negative attitude toward school science.

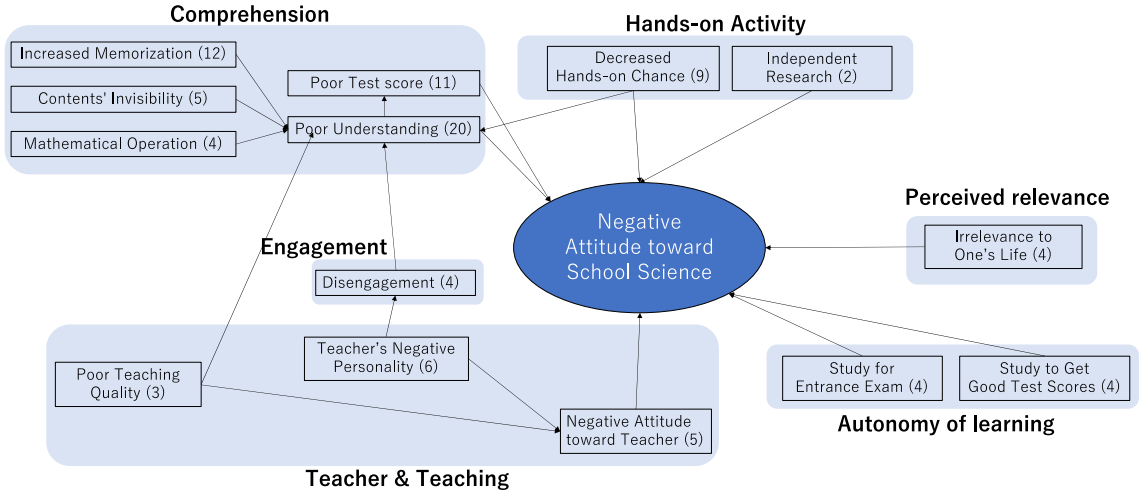

Figure 2. Relationships between Category and Sub-category
Note. The numbers in brackets denotes the number of participants who mentioned each sub-category.

3.3.2 Teachers' unfavorable personalities (6)
Teachers' unfavorable personalities induced negative attitudes toward school science in two ways. The first way entailed discouraging students' active engagement in learning science, which constrained their understanding. The second way entailed the transference of a student's dislike of an individual science teacher to the science subject that they taught.
3.3.3. Negative perceptions of teachers (5)
The above points show that the development of students' negative perceptions of teachers is brought about by poor teaching quality and teachers' negative personalities. The difference is that while the "Poor teaching quality" simply refers to teaching methods, the "Negative perceptions of teachers" refers to teacher's personality.

3.4 Autonomy of learning

3.4.1 Studying for entrance exams (4)
The first sub-category was related to entrance exams. Before they recognize that science is a preparation subject for entrance exam, they could enjoy science classes. However, after they recognized that science is a subject for entrance exam, their learning will come to be forced beyond their own will of studying.
3.4.2 Studying to attain good test scores (4)
The second sub-category was related to tests. Even though they initially started their science learning with their own intellectual curiosity, they came to worry about evaluations and test scores after they recognized science is an important subject for their future.

3.5 Perceived relevance

3.5.1 Irrelevance of class content to students' lives (4)
Four students mentioned that their negative attitudes toward school science developed when they began to perceive school science as being irrelevant to their lives.

3.6 Engagement

3.6.1 Disengagement from science learning (4)
There are many reasons for disengagement from learning science, such as being busy with club activities and illness. During the focus group discussions, students mentioned that teachers' negative personality caused them to disengage.

3.7 Dynamic interrelations among factors

Fig. 2 illustrates the interrelationships among the above-described sub-categories. When at least one student mentioned the causal link between the two sub-categories, we drew an arrow. It reveals that there were five categories (except for Engagement) that directly influenced negative attitudes toward

school science. In addition, some sub-categories also indirectly influenced negative attitudes toward school science. For example, the decrease in hands-on opportunities directly fostered negative attitudes toward school science and also indirectly reduced understanding, which led to negative attitudes.

4. Discussion

While the findings of this study are consistent with Self-Determination Theory [12], the influence and relevance of hands-on activities appears to be unique to science education. However, the negative impact of independent research on students' attitudes contrasts with the finding of a previous study that open inquiry positively influences interest in science [13]. This study's findings emphasized the practical importance of hands-on activities for students' understanding of abstract science concepts and of teachers' personalities in shaping students' attitudes toward school science. The dynamics among factors require further exploration to grasp complex attitudinal changes toward school science.

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