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The Essential Elements of Japan Super Science High School Projects: A Case Study of Shizuoka Prefecture

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Abstract.

To support the enhancement of science and technology, the Japanese government established the Super Science High School in 2002. However, there is a lack of information about this school for international scholars. We addressed this problem by observing and working with SSH in Shizuoka Prefecture and understanding their intended school models. The context of Shizuoka prefecture is interesting because it is well-known for its high-technology manufacturing company. Our “bottom-up” approach was mainly based on observation, in contrasts with other studies using a literature-based method to define SSH schools. We identified four elements that represent the common goals and strategies employed by SSH: Independence scientific research, Scientific English, courses related to STEM, and international collaboration. This framework offers a clear picture of what exactly SSH schools are. Findings suggest that SSH identity is rooted in pedagogy, school culture, and rigorous instruction, especially in science and technology, including support from scientists and researchers from the surrounding universities as invited speakers, teacher assistance, and opportunities to conduct research in university-level laboratories.

Keywords: essential elements, Japan Super Science High School, Projects, Case Study

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1. INTRODUCTION

The movement in education to enhance student skills to adapt to 21st-century challenges has gained dramatic momentum over the past decade. The importance of human resources in science, technology, engineering, and mathematics (STEM) is increasingly recognized in Japan [1, 2] and other countries worldwide [3]. The movement varies from classroom adaptation on a small scale to school adaptation on a large scale. Although there is no equivalent term for 'STEM' in Japanese [4], Japan government recently introduced the terminology of Society 5.0. A human-centred society that balances economic advancement with the resolution of social problems that highly integrates cyberspace and physical space [5]. As one of the countries that is well-known as a high-tech country, Japan faces a challenge in improving its young generation toward science and technology enhancement [6]. The students with a strong interest in science and technology are then categorized as gifted students [7] who need special treatment to enhance their appeal and contribute to an increase in the number of students pursuing science careers [7] and enhance innovation for the future. Compared to abundant research related to a STEM school, especially in western countries [9–11], the study and Super Science High School (SSH) in Japan is rarely found.

Super science high school (SSH) fosters "dreams for science" and a "heart to enjoy science" [10]. SSH is an upper secondary school that prioritizes science, technology, art, and mathematics and, in so doing, receives the SSH designation awarded by the Japanese Ministry of Education, Culture, Sports, Science, and Technology [7]. Students of SSH are expected to be advanced researchers, so they can have opportunities to enhance their problem-solving skills that drives toward innovation. Many SSH students carry out scientific research, not only ordinary subjects (Math, Biology, Physics). They present their results to students, teachers, and professors in other schools. Every year, many local meetings occur in each region, and the national meeting is held every summer.

Schools could be applied to this program by the MEXT and selected through the process to become an SSH [10]. The details of the SSH application will be processed through the Board of Education of each prefecture and city, the administrative department of private schools, or the administrative department of national and public university-affiliated schools. After the selection process, the Japan Science and Technology Agency (JST) will provide the necessary support for promoting activities in schools designated by MEXT. The JST supports SSH activities by purchasing goods, paying

for training and instructor fees, planning and managing presentations, and providing information on behalf of the school [9].

This study addresses the question, what specific components are present in these schools? we examine how SSH themselves articulate what they are and how this may (or may not) align with the national push for improved science, technology, engineering, and math education. Understanding the intended models and specific model components of functioning inclusive STEM schools allows us to examine the implementation of strategies and how that implementation relates to outcomes and develop a comprehensive theoretical framework of SSH, which we present here. This framework can inform future research and suggest a widely applicable model that will provide policymakers and practitioners with common ground for discussion and collaboration.

2. RESEARCH METHOD

This research describes the findings of the Super Science High School keywords in various publications and examined four SSH in Shizuoka Prefecture area. We sought to derive a theoretical model for SSH by employing a "component approach" [10] to identify and clearly describe the critical components from articles, documents, and observations, identify commonalities, and synthesize them into vital conceptual elements.

2.1. Sample

Sample schools reside in Shizuoka prefecture Japan, consisting of four schools (Table 1). The research team worked closely with SSH policy leaders to select, and recruit participant schools, the implementation, and its relation to support the implementation of STEAM education.

TABLE 1: SSH in Shizuoka Prefecture.

School Name	Based on Prefectural Government	Based on City Government
Shimizu Higashi High School	x	
Hamamatsu Technical High School	x	
Shizuoka City High School		x
Shizuoka Kita High School	x	

2.2. Data collection

Our data collection strategy is based on the guide that researchers should derive information about the essential components of a program from (a) the program developers through written materials produced mainly by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Japan and (b) observation in the SSH schools. We reviewed these documents before the observations and interviews to understand each of the schools and provide context for the observations and interviews themselves [11].

3. RESULTS AND DISCUSSION

3.1. Essential Elements of SSH

Independence scientific research is one activity conducted by a group of students by doing their original research with support from teachers and teachers' assistance. This activity brings opportunities for students to develop their problem-solving skills and critical thinking skills. Former studies also support that projects could elaborate on student engagement [12] and critical thinking [13]. To strengthen the research, collaboration with universities' laboratories opens opportunities for students to do their research further—this opportunity for students to interact with professional scientists. A deeper understanding through interaction with a scientist will strengthen students' interest in STEAM-related careers [14, 15].

Scientific English communication is another essential element that is strongly observed in SSH. While their research is ongoing, scientific communication is also enhanced by the Science teacher, English teacher, and English teaching assistants. On our observations, teacher assistants are recruited from master's and Ph.D. candidates in STEAM-related areas from the nearest universities in Shizuoka City, such as Shizuoka University and the University of Shizuoka. Each group of students has the opportunity to learn how to explain their scientific ideas in an English presentation. Students design their research poster and PowerPoint slides as a summary of their research, as shown in Figure 1. From that research, the student then has opportunities to visit overseas universities and present their research in front of high school students in a foreign country. This opportunity is connecting all of the research and scientific activities became a memorable and encouraging moment for the students.

(a) (b)

Figure 1: Students independence research.

3.2. How SSH Supports the National Movement Toward Society 5.0 and the Global Trend of STEM Education

To support Society 5.0, the enhancement of science and technology in SSH is suitable for nurturing students' skills to develop innovation. The ideas of integration in the STEM education movement in Asia countries face challenges related to the fixed curriculum in most Asia countries [16, 17]. In Japan, these challenges could be addressed by forming a school for students with gifted talents in science. Although at some point, the perspective that only talented students will have these opportunities is not entirely in line with the idea of inclusivity in STEM education [18]. Although the number and quality of SSH are increasing (218 schools in 2020), compared to all the senior high schools in Japan (4874 schools), this number is insufficient.

4. CONCLUSION

SSH is an upper secondary school that prioritizes science, technology, art, and mathematics that nurture scientific research. The common goals and strategies employed by SSH: Scientific research, Science in English, courses related to STEAM, and international collaboration. This framework offers a clear picture of what exactly SSH schools are. Findings suggest that SSH identity is rooted in pedagogy, school culture, and rigorous instruction, especially in science and technology, including support from scientists and researchers from the surrounding universities as invited speakers and teacher assistance.

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