Article

Journal of International Students
Volume 15, Issue 1 (2025), pp. 169-188
ISSN: 2162-3104 (Print), 2166-3750 (Online)
jistudents.org

Scientific Concepts in Programs in Brazil and Japan for High School Students

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ABSTRACT

In this paper, we investigate how cultural, historical, and emotional factors influence scientific concepts in Brazil's Scientific Vocation Program (Provoc) and Japan's Sakura Science Program. It analyzes how Western and Eastern views of science might shape program goals through high school students' reports. Science education, history and sociology of science have been deployed to analyze documents from 2019 for both programs, and content analysis has been conducted with the assistance of ATLAS.ti software. The results indicate that different trends of the programs are important. While Provoc students' reports express the value of their practical experience leading to individual growth, either academic and/or professional, students' reports of Sakura Science tend to report more collective outcomes. Additionally, while Provoc's students are designated to have scientific initiation training, Sakura's students are selected to be trained in both scientific and technological innovation.

Keywords: Brazil, High School, Japan, Provoc-Fiocruz, Sakura Science, Science Education.

SCIENTIFIC CONCEPTS

Considering previous studies that identify cultural aspects of science concepts throughout history and their impact on the understanding of scientific and technological development (Watanabe, 1974; Matsumoto, 1999; Kawasaki, 1996, 1999, 2002; Sasaki, 2010), this paper proposes a comparative analysis of two high school science education programs: Brazil's Scientific Vocation Program from Polytechnic School Joaquim Venancio (Provoc-Fiocruz) and Japan's Sakura Science Program from Japan’s Science Technology Agency. This study aims to understand whether and how cultural, historical, and emotional factors help shape the understanding of the science concepts practiced in these educational programs. Specifically, the main interest lies in understanding how the experience in each program helps shape perceptions of science.

Because the notion of culture is understood as encompassing social rituals, language acquisition, emotions and history, the analysis uses science education, sociology and history of science, and content analysis approaches, which are supported by ATLAS.ti software for building analytical categories. The selection of Provoc-Fiocruz and Sakura Science for this comparative study is motivated by the interest in understanding the similarities and differences in science conceptions that guide activities within Western and Eastern cultural contexts. The literature on the history of science (Watanabe, 1970; Sasaki, 2010) and science education (Kawasaki, 1996, 1999, 2002, 2007) highlights that Western culture often separates science and technology, with science studying natural laws and technology intervening in nature, whereas Japanese culture views them as unified.

Both programs are considered strategic investments and align with government and educational policies aimed at addressing each country’s development and innovation needs.

CONTEXT IN BRAZILIAN AND JAPANESE SOCIETIES

Brazil and Japan are not comparable nations in terms of inequalities, and when the data are available, in 2022, the Brazilian Gini coefficient was 52.0, and the Japanese Gini coefficient in 2013 was 32.9 (Country Economy, n.d.). The Gini index, the most commonly used measure of inequality, reflects the fact that Brazil is a country divided between people living very well and those in poor conditions. Because conditions have changed over the last four years, Brazil has been rated between the 7th and 10th economy in the world, and Japan has occupied either the 4th or 5th position among global economies (Estadão, 2024; World Bank, 2021). In addition, Japan has experienced growth in inequality, as reported by Kitao and Yamada (2024).

Social and economic inequality in Brazil directly influences the priorities and focus of government-funded scientific research (Dantes, 2005; Birriel, 2023). While these factors shape research priorities, Brazil also conducts significant technological research, particularly in areas such as agriculture, renewable energy, and biotechnology, and research addresses social, environmental, economic and health issues (Birriel, 2023).

Because social inequalities are understood as barriers to sustainable development worldwide (United Nations Educational, Scientific and Cultural Organization - UNESCO, 2016), in the Brazilian context, recent academic training for young people in situations of social and economic vulnerability has been based on competencies aimed at increasing their employability in a labor market that has been precarious (Alves & Oliveira, 2020; Iamamoto, 2013). In fact, Brazil is seen as a country with many inequalities (Oxfam, 2022). In addition, social development is understood in terms of the interdependence among its social, ecological, economic, and cultural dimensions (UNESCO, 2016). Equally, scientific development can be seen as closely linked to all these variables and should interact positively with the environment and human health if a social world with justice is within the horizon.

The Brazilian CNPq (National Council for Scientific and Technological Development) provides financial support for research across various fields of knowledge (Comissão de Pesquisa, n.d.). Recently, this agency launched funding announcements for three programs. The first program, the PIBITI (Institutional Program for Technological Development and Innovation Scholarships), provides 3,845 scholarships and aims to stimulate technological research and innovation among undergraduate students. The second one, the PIBIC (Institutional Program of Scientific Initiation Scholarships) program, offers 28,100 scholarships to support undergraduates in scientific research. Finally, the PIBIC-EM (Institutional Program for Scientific Initiation for High School Students) offers 5,602 scholarships and is designed to foster scientific initiation among high school students from public, military, and technical schools and recognized institutions (CNPq, 2024). Importantly, these government investments are not new for high school students in the country. Provoc have been receiving government scholarships for their students since 2010 (Oliveira & Bianchetti, 2018).

These programs highlight the focus difference between technological and scientific initiation: PIBITI aims to develop technological innovators at the undergraduate level, whereas PIBIC-EM and PIBIC seek to promote learning of the scientific method and techniques in scientific fields among high school and undergraduate students (CNPq, 2024). The number of scholarships for scientific initiation has been greater than that for PIBITI. For example, in 2024, the PIBITI selection process received 191 applications for 150 scholarships (Fundação Oswaldo Cruz - Fiocruz, 2024a), whereas the PIBIC process had 580 applications for 485 scholarships (Fiocruz, 2024b). These results emphasize greater investment in scientific initiation scholarships at the high school and undergraduate levels than in technological initiation.

Similarly, in Japan, the Japanese Ministry of Education is also worried that the population is more vulnerable. It also acknowledges that Japanese society has experienced an increase in temporary workers and changes in employment styles and conditions through the introduction of a results-oriented or performance-based remuneration system. Therefore, they emphasize the importance of developing individual vocational skills (Ministry of Education, Culture, Sports, Science and Technology - MEXT, 2008).

In the case of Japan, the Japanese government invests heavily in science and technology, with policies and funding directed at promoting technological advancements and industrial innovation that are internationally recognized and exported (Dore, 1986). For example, Japan is recognized for its scientific and technological production in fields such as life sciences, biotechnology, environmental sciences, information technology, and nanotechnology (Okada, Nakamura & Tohei, 2009).

Both the Brazilian National Common Curricular Base (Brazil, 2018) and the Japanese Basic Education Plan (MEXT, 2008) recognize that education should enable young people to develop independence, autonomy and cooperation with others. They advocate providing essential learning opportunities for everyone, ensuring lifelong learning and the acquisition of knowledge and skills necessary for both life and work.

Meis (2008) noted that young people in both developed and developing countries are increasingly required to have specialized scientific and technological training in the labor market. In this sense, developing countries have invested in initiatives for young people from their countries to study developed countries, which are more positively recognized for their knowledge production and extensive involvement in science and technology.

Despite the differences between Brazilian and Japanese societies, they face equal labor market demands for young people to become flexible individuals adapted to technologies arising from scientific development in increasingly competitive job markets with temporary and outsourced employment (Kalleberg, 2020). Anme and Mccall (2018) emphasize that to address or change any existing social issue, it is essential first to consider the cultural traditions and attitudes that perpetuate inequalities.

Therefore, it is necessary to understand what knowledge, skills, values, and attitudes have been shared in science education programs in Brazil and Japan and how they can contribute to empowering students by increasing their awareness of the material, economic, social, political, cultural, and ideological conditions that contribute to inequalities (Freire; Shor, 2005) and how they can intervene in these conditions through science and technology.

LITERATURE REVIEW

The Formative Process in Science Education Programs: Provoc-Fiocruz and Sakura Science

The Scientific Vocation Program (Provoc) was established at the Joaquim Venâncio Polytechnic School (EPSJV) in 1986 in Rio de Janeiro (Amâncio, Queiroz, & Amâncio Filho, 1999; Oliveira & Bazzo, 2016). This program offers science education activities related to the areas of natural sciences, biological sciences, health, humanities, and social sciences (Santos, 2021).

This program originated in Rio de Janeiro but currently includes several other Brazilian states encompassing Fiocruz units (Amazônia, Bahia, Brasília, Ceará, Minas Gerais, Mato Grosso do Sul, Pernambuco, Piaui, Rondônia and Salvador), which makes its importance even greater (EPSJV, n.d.).

The Brazilian Program has a multidisciplinary professional team working at the Basic Education Scientific Initiation Laboratory (Lic-Provoc). Its primary goals for high school science education students include stimulating interest in research, identifying students with an affinity for research, contributing to more informed career choices, enabling participation in research, promoting experiences in a research environment with theoretical and practical activities, contributing to the academic formation of students, and stimulating technical and scientific learning through practice (Fiocruz, 2024c, p.1).

Therefore, the objectives aim to stimulate students' interest in scientific activities, aligning these with each student's potential and interests. This is achieved on the basis of academic and professional experiences supervised by Fiocruz researchers, who act as volunteer advisors and guide students in science education activities, which may contribute to their more informed career choices by better understanding the impacts and role of science in society (Amâncio, Queiroz & Amâncio Filho, 1999; Oliveira & Bazzo, 2016).

The selection process for students to participate in the Provoc-Fiocruz Program depends on agreements with both public and private schools. In the early 2000s, the program also established agreements with Civil Society Organizations of Public Interest (OSCIPs), as mentioned by Ferreira (2010). These OSCIPs represent young people residing in and/or studying slums (Medeiros, Braga, Frutuoso & Filipecki, 2016).

Researchers who voluntarily advise these young people at Provoc-Fiocruz are committed to planning science education activities for an approximate one-year period, known as the Initiation Stage. Depending on the researcher's area of expertise and the area of interest assigned to the student, tasks may include fieldwork, computer work, questionnaires, theoretical studies, interviews, database management, lab work, and disease studies. Other activities involve educational materials, chemical process analysis, epidemiology, health history, and public policy research. Throughout this stage, students participate in preorganized activities, receiving instructions on biosafety and guidance to help them engage in science education activities (Medeiros, Braga, Frutuoso & Filipecki, 2016).

Additionally, students are encouraged to share their scientific work objectives and development through poster presentations as part of the scientific initiation event promoted by the Lic-Provoc coordination. For those students who choose to continue in the program, in the Advanced stage, a new research project must be developed with their advisors (Sousa, 2013).

The Sakura Science Program, organized by the Japan Science and Technology Agency (JST), was established in 2014 and has welcomed students and supervisors from various countries in Central Asia, East Asia, Southeast Asia, South Asia, the Pacific Islands, and Latin America, including Argentina, Brazil, Chile, Colombia, Mexico, and Peru (Japan – Asia Youth Exchange Program in

Science Promotion Office – Sakura Science, 2020). The program aims to support the development of potential talent that may contribute to innovations in scientific and technological development, promote continuous interaction between Japan and participating countries, advance the globalization of education and Japanese research institutions, and strengthen collaboration and cooperation between Japan and other regions (Sakura Science, 2020).

Since 2014, the Sakura Science Program has emphasized activities related to the exact sciences, natural sciences, and biological sciences, focusing on technology development for applications in health and environmental fields (Sakura Science, 2020).

The program invites high school students and their supervisors from various countries to participate in group-based scientific education activities over seven days and six nights. To participate in the Sakura Science Program, Brazilians must meet certain requirements, such as enrollment in a federal school with a technical course and being in their second, last or final semester, as well as maintaining above-average academic performance and a B1 level of English (Pereira & Kobayashi, 2020).

The activities involve students from different countries working together with the assistance of supervisors affiliated with their academic institutions. Participants engage in English-language classes, which may be taught by Nobel Prize-winning researchers; visit prestigious universities, research institutes, and embassies in Japan; interact with Japanese high school students; and participate in social and cultural experiences. They also have opportunities to present on cultural customs from their home countries (Sakura Science, 2020).

In fact, Sakura Science participants are international exchange students from diverse linguistic, cultural, and social backgrounds. The experience of studying abroad demands personal skills such as curiosity, courage, and patience (Sousa, 2015), which are essential to cultural understanding. This program highlights the advantages of student mobility and intercultural adaptation, offering international students opportunities to enhance their skills, expand their knowledge networks and adapt to diverse cultural norms and professional environments.

The Brazilian Provoc-Fiocruz and the Sakura Science Program align with UNESCO's educational objectives for Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 17 (Partnerships for the Goals). Both programs emphasize practical research and the application of scientific theory, fostering critical thinking and problem-solving skills, which are central to UNESCO's goal of promoting sustainable development (SDG 4.7). The Sakura Science Program, through international student exchanges, also supports global partnerships and cultural exchanges, reinforcing SDG 17's focus on fostering global partnerships for knowledge sharing and collaborative innovation. Moreover, the Sakura Science Program's inclusion of cultural exchange aligns with UNESCO's objective of promoting respect for cultural diversity and global citizenship, further reinforcing SDG 4.7 (UNESCO, 2017).

Both the Provoc-Fiocruz and the Sakura Science Program also contribute to the promotion of lifelong learning, which is a key component of UNESCO's SDG 4 (Quality Education). These programs not only stimulate early interest in scientific research but also encourage the continuous development of skills that can be applied throughout one's career. By providing students with hands-on research experience and fostering critical thinking, both programs prepare participants for lifelong engagement with science. This aligns with UNESCO’s emphasis on lifelong learning, ensuring that students can continually build on their knowledge and competencies, adapt to new occupational conditions, and contribute to their fields of expertise long after their formal education ends (UNESCO, 2017). In this way, these programs aim to prepare their students to address complex global challenges.

Scientific environment

According to Mattedi and Spiess (2010), the production and dissemination of scientific knowledge are activities related to participation in a sociocultural community. The impact of integrating institutions within a scientific group can reflect the relationship between teaching-learning processes and a broader social context. Therefore, socialization processes are not limited to sharing technical competencies but also encompass ethical and normative commitments, exerting a mutual influence with the social context (Mattedi & Spiess, 2010).

Sociologist Merton (1968) defines the term "Science" as referring to a set of characteristic methods used to validate knowledge; a body of accumulated knowledge resulting from the application of these methods; a set of cultural values and practices that mediate activities considered scientific; or any combination of the aforementioned items. Moreover, science practices define the conditions for the entry and participation of its members, establishing standards of regulation and integration (Merton, 1968).

Mattedi and Spiess (2010) argue that the current perception of science is not limited to a solitary quest for understanding nature. Science involves investigations into not only the laws of nature but also the interactions among scientists themselves. This perspective aligns with the experiences of Brazilian participants in Provoc-Fiocruz and the Sakura Science Program. Through these interactions, students not only gain scientific knowledge but also develop essential skills for engaging in diverse academic and professional contexts, reflecting the social dimensions of scientific inquiry.

A study conducted with graduates of the Provoc programme, Silvestre, Braga, and Sousa (2008), concluded that there are significant benefits from this science education experience for career aspirations, such as personal development of the young, long-lasting social connections within the research environment, the professional contacts they establish, and the skills they acquire during their research activities. Moreover, many graduates of Provoc-Fiocruz either continue or plan their studies toward undergraduate courses. They acknowledge the importance of being socialized by sharing emotions such as interest and passion, as well as the skills and dispositions required for scientific practices that involve teamwork, understanding methodologies and experimental designs, and problem-solving in unexpected situations, which are essential for their academic choices and higher education formation (Sousa & Filipecki, 2009; Cabral Félix de Sousa, 2013; Medeiros, Braga, Frutuoso & Filipecki, 2016).

Sousa (2009) studied Provoc-Fiocruz graduates' trajectories, highlighting the significant role of mentors in guiding their scientific initiation activities. Many graduates who pursue scientific careers attributed their passion for science to the training they received during the program. Some went on to work as researchers and educators, continuing their involvement in science education. Additionally, some alumni now serve as advisors to new students in the program, further contributing to scientific learning (Medeiros, Braga, Frutuoso, & Filipecki, 2016).

Previous studies have shown that factors such as school learning experience and the quality of teaching can influence students' attitudes toward school science (Lyons, 2006; Tytler, 2014). Moreover, students tend to value science activities that involve hands-on experiences and the practical application of scientific concepts (Lyons, 2006). These attitudes toward science can also be shaped by experiences outside the formal environment, such as in nonformal science education settings. Attitudes toward science as a predisposition involve both cognitive and emotional components related to a specific object and reflect value systems constructed in various spaces, including family, school, and society in general (Vázquez & Manassero, 2001). Therefore, students in science education programs such as the Scientific Vocation Program and Sakura Science Program may gain new scientific knowledge that can influence their attitudes toward science.

Therefore, when seeking to understand the scientific community as a social institution, it is essential to observe its characteristics beyond productivity metrics. It is also necessary to consider the cultural aspects that permeate interpersonal relationships among its members, as these can play an important role in contextualizing the products of scientific activities and their repercussions in society.

Science Institutionalization in Brazil and Japan

Meis (2008) highlights that the first Brazilian institution officially representing interest in science was the National Museum in 1818. Founded to promote scientific studies in the natural sciences and conservation, various research areas, such as anthropology, zoology, botany, and paleontology, are currently presented.

Additionally, the author considers that the process of institutionalizing science in Brazil solidified in the 20th century, citing examples such as the Oswaldo Cruz Institute, founded in 1900, which gained international recognition for its sanitary campaigns against yellow fever and studies on tropical diseases such as Chagas disease; the University of São Paulo in 1920; and the Federal University of Rio de Janeiro in 1934 (Meis, 2008).

Meis (2008) explains that the context of the institutionalization of modern Science in Japan during the 19th century was driven by political interest in modernizing Japanese culture on the basis of the Western model. The University of Tokyo founded in 1877 and the Tokyo Academy of Sciences in 1879 were significant milestones in science institutionalization in Japan (Meis, 2008).

The term institution refers to the norms, rules, and regulations that guide scientists' behaviors, as well as organizational structures such as universities, laboratories, and research institutes, and the interactions between these organizations. From this perspective, science and technology are viewed not only as a set of results but also as a process subject to scientific investigation (Matsumoto, 1999).

Matsumoto (1999) noted that during the 19th century, known as the Meiji era, Japan undertook industrialization efforts based on science and technology, addressing the socioeconomic needs of that time. The cultural factors underlying scientific activities are expressed in people's modes of thought and behavior patterns, which are also determined according to the norms established in each society.

As an example, Sasaki (2010) noted that, in Japan, there was an adaptation of the Western notion of science, resulting in a scientific conception of science in the country, which associated science with technology, referencing the results of experimental sciences developed during the Second Industrial Revolution. These experimental sciences were appropriated in the production of technologies in Japan during the 19th century with the aim of modernizing Japanese society, referencing the Western model (Sasaki, 2010).

METHOD

As we aimed in this work to understand whether and how cultural, historical, and emotional aspects influence the science practiced in the educational programs of the two countries being evaluated, the thematic content analyzed reports from students participating in both programs, published in abstracts and reports issued in 2019, to identify the meanings of science adopted by students in their respective training programs. For Provoc-Fiocruz, the abstract book includes the program's goals, student experience reports, and summaries of their research projects. It also has 8 pages with some student reports from the Advanced Stage, identified by institutional affiliation and gender, and 64 cataloged pages with summaries of each student's research. These reports address the following question: “What was your experience completing Provoc?” (Braga, 2019, n.p.).

Regarding the Sakura Science Program, the reports present the program's goals, the number of participants from each affiliated institution and their respective countries, the activities performed by students, and their experiences during their training. The 2019 report of the Sakura Science Program, which consists of 17 cataloged pages, highlights the survey distributed by the program for students and supervisors participating in Sakura Science in 2019. Among the seven questions in this report, only questions Q3, Q4, Q6, and Q7 were selected for being open-ended: “Q1 What was your impression of Japan before participating in this program?”; “Q2 What is your impression of Japan after your visit?”; “Q3 Were you satisfied with the program?”; “Q4 Would you recommend receiving higher education in Japan to a friend?”; “Q5 Would you like to return to Japan?"; "Q6 For those who responded with either 'I would very much like to' or 'I would like to' in Q5, in what capacity would you like to return to Japan? Why? (Multiple answers allowed)"; "Q7 What did you learn in Japan?" (Sakura Science, 2020, pp. 16–17).

The study qualifies as descriptive, documentary, and qualitative (Gil, 2002). The content analysis approach is employed by the social scientist Minayo, which allows us to consider the possible meanings of the messages conveyed in documents on the basis of their cultural, social, and historical contexts (Minayo; Gomes; Deslandes, 2016).

The documented reports were coded via ATLAS.ti 24, which is a qualitative data analysis software designed to support thematic content analysis (Walter & Bach, 2015). Bardin (2011) noted that content thematic analysis, which considers one or more themes or items of significance within a predefined coding unit, allows for the selection of a phrase as a coding unit. Following Lincoln and Guba's (1985) framework for establishing the rigor of qualitative research, the strategy of triangulation was adopted. Triangulation means "cross-checking of data and interpretations through the use of multiple data sources" (Lincoln & Guba, 1985, p. 109). This was applied by incorporating multiple sources of data, including abstracts and reports from the Sakura Science Program and Provoc-Fiocruz, along with data from different contexts of Brazil and Japan.

Nevertheless, to address concerns about validation, a detailed and thorough analysis of the available data was conducted. This involved rounds of reading, coding, and recording to ensure that the categories and themes that emerged were consistent and reflected the underlying patterns in the data (Walter & Bach, 2015).

RESULTS

The abstract book Provoc-Fiocruz from 2019 provides a comprehensive view of the students' experiences and perceptions of the program. The reports were categorized into three main themes: meanings of science, authenticity, and interpersonal relationships.

"Meanings of Science": This term is related to students' reports on what they learned and how they evaluate what they learned about scientific knowledge and products. Additionally, these reports mention the implications of scientific knowledge, highlighting its role in society modernization and development;

"Authenticity": In this category, there are reports about the students' experience in science education programs that influence their personal dispositions, such as autonomy, responsibility, punctuality, commitment, achievement, satisfaction or dissatisfaction, regarding opportunities to study what they like, passion for, love, curiosity, and/or interest in learning and how they evaluate this experience;

Finally, "Interpersonal Relationships" contains reports about students' experience mediated by relationships of friendship, affection, trust, and respect with others, allowing students to become familiar with the program and/or receive help and support in carrying out scientific activities.

Figure 1 shows a table and summary of the findings from the 2019 abstract book of the Scientific Vocation Program.

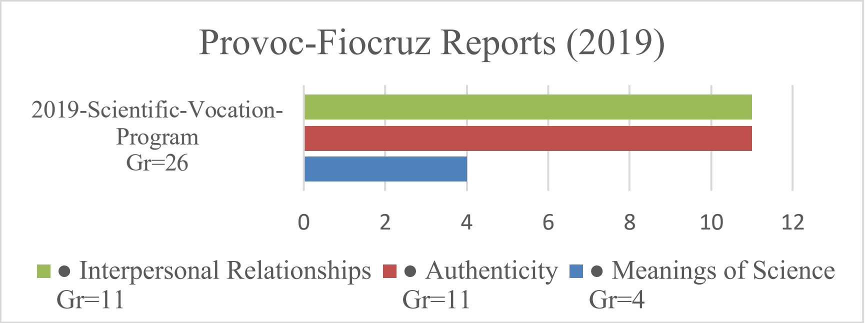

Figure 1: Categories in Provoc-Fiocruz Documents

The abstract book contains 8 pages with a total of 15 students' reports from the Advanced Stage. These reports respond to the issue "The experience upon completing Provoc" (Braga, 2019, n.p.). The document also includes 64 cataloged pages with summaries of each student's research. These reports, written by 11 female students and 4 male students, consist of brief experience reports that may be composed of one or more sentences. From these reports, 4 units of text were categorized as meaning of science, 11 units of text as authenticity, and 11 units of text as interpersonal relationships.

Meanings of Science

- Students reported that their experiences broadened their science understanding. For example, one student enjoyed learning about the humanities and social sciences and reevaluated gender expectations and talent as prerequisites for engaging in science. Another example is from a student from the Maré community and a state public school, who became aware that science extends beyond biomedicine and biology, recognizing its presence in everyday life.

Authenticity

- Students reported that scientific initiation experiences fostered autonomy and responsibility. For example, one student mentioned having experienced a change for better both in his or her scientific work and personal life, having found the process of creating summaries, posters, and presentations both challenging and rewarding. Nevertheless, another student described initial difficulties in adapting to the unpredictable routine but viewed the experience as an opportunity for personal growth, maturity, and increased independence.

Interpersonal relationships

- Student reports underscore the value of supportive interactions with lab members and advisors, influencing students' academic and career aspirations. In terms of illustration, one student valued supportive and patient interactions with laboratory members, which facilitated their learning. Furthermore, another student reported that their experience with researchers opened new possibilities for academic and professional development.

Figure 2 shows a table and summary of the findings from the 2019 report of the Sakura Science Program.

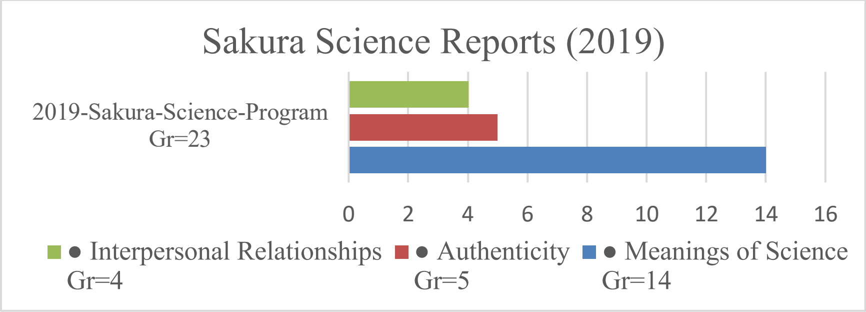

Figure 2: Categories in the Sakura Science Documents

A total of 33 student reports were analyzed in relation to questions Q3, Q4, Q6, and Q7, as they provide insights into their experiences and learning during the Sakura Science Program. Among the 33 reports analyzed, 10 reports were not considered for categorization because their content was not related to the research aims. These entries consist of brief experience narratives, sometimes composed of just one or a few sentences. From these reports, 14 units of text were categorized under "Meanings of Science", 5 under "Authenticity", and 4 under "Interpersonal Relationships."

Meanings of Science

- The students' reports highlighted the program's impact on their perspectives on science and technology. For example, a student from the Philippines noted that the Sakura Science Program broadened her or his perspective on these fields and recognized their usefulness for their country's development. Moreover, a Brazilian student expressed that this experience enhanced her or his interest in science and technology and deepened her appreciation for Japan.

Authenticity

- Student reports highlighted personal perspectives regarding science education experiences. For example, a student from Taiwan expresses dissatisfaction with the time allocated for visiting scientific initiation spaces, feeling that it was insufficient to assimilate new knowledge, customs, and expectations. Additionally, a student from India highlights the importance of questioning within the scientific process.

Interpersonal relationships

- Students' reports emphasized positive interactions, with some noting the kindness and support received from Japanese people during their experience. A student from Papua Nova Guiné highlights kindness and care in interactions with participants who accompanied them during the program formative process. Additionally, a student from Indonesia views punctuality and respect for others as positive social and cultural traits within Japanese society.

With respect to internationalization, until now, the Provoc has received very few international students, few of whom have been due to the individual initiative of a researcher who had collaborated with Europe and, owing to families, who had just migrated to Brazil. Nevertheless, the Provoc can play an important role in leading to cultural awareness, since students take part in different social worlds (Sousa, 2023). On the other hand, the Sakura Science Program is full of internationalization experiences, which tend to provide critical thinking and cultural awareness, which are crucial for thriving in diverse environments and effectively navigating complex global issues. Importantly, the Sakura Science Program in Brazil searches for students from Federal Institutes (IFs), which are educational institutions that provide professional and academic education along with technical training, offering courses in various fields, including technology and health sciences. These institutes encompass higher, basic, and professional education (Brasil, 2008). For example, a female student experience in the 2023 Sakura Science High School Program illustrates the impact of international exchange programs on academic and personal development. Her journey included hands-on activities such as DNA extraction at the Kazusa DNA Research Institute and learning about fuel cells at AIST, along with interactions with Japanese students and participation in Kendo. Nevertheless, a male experience in the 2023 Sakura Science Exchange Program highlights the importance of student mobility and intercultural adaptation. Traveling from Brazil to Japan, he engaged with peers from diverse backgrounds, such as Taiwan, Nepal, and Sri Lanka, enhancing his cross-cultural skills.

DISCUSSION

Despite the difficulty in comparing both Brazil and Japan as nations so diverse, both the Provoc-Fiocruz and Sakura Science programs reveal similarities in their students' reports regarding how these science education experiences influenced their perceptions of science. The students reported that these programs deepened their interests, passions, and knowledge in various fields and provided insights into potential career paths in scientific investigations.

Students recognized that their experiences in these programs exposed them to different notions of science than they had before joining them. They also shared a common acknowledgment that practical experiences offered by both programs made scientific concepts and theories more comprehensible, engaging, and relevant to daily life. In fact, Scheid (2019) argues that participation in collective activities, such as those in science education programs, is crucial for challenging and transforming preexisting notions of science, such as the common perception of science as linear, immutable, and capable of achieving absolute knowledge.

Specifically, in the case of the Sakura Science Program, students value the cultural knowledge gained during scientific activities as important for broadening their perspectives on the role of science and technology. This emphasis on culture is also reflected in Ren and Wang's (2022) research with students from two Chinese universities, which analyzed their perceptions of internationalization and reported that students who frequently interact with people from diverse backgrounds are more likely to view internationalization as an opportunity to learn from others and enhance their ability to analyze global issues.

Penman, Malik, Chu, Kett, Hampton, Thomacos, Ebrahimi-Zanjani, Zhong and McKenzie (2021), who evaluated a program designed to help international health profession students adapt to university life in Australia, corroborated the importance of interpersonal relationships in this formative process. The study revealed that creating a safe, supportive, and interactive environment was essential for participants, enabling them to build confidence, embrace new experiences, and develop their skills effectively.

In this sense, it seems that students from both Provoc-Fiocruz and Sakura Science have narratives expressing knowledge and recollections after the experience. The subjective experience of remembering information considered emotionally significant contributes to making it more important, serving as a reference point for decision-making in new or uncertain situations (Brosch, Scherer, Grandjean & Sander, 2013).

Most Provoc-Fiocruz students mentioned that science and scientific activities were primarily learned theoretically in school, noting that practical experience with laboratory instruments and observations of researchers' practices exceeded their expectations compared with school-based learning. In contrast, Sakura Science students had expectations of engaging in science and technology activities, with the added advantage of participating in or observing these activities under the supervision of Nobel laureates.

On the one hand, Provoc-Fiocruz students emphasized science education activities as representing a body of knowledge and practices that foster personal qualities such as responsibility, maturity, punctuality, and commitment, which are important for their future academic and professional choices after high school (Sousa, 2013). In general, Provoc-Fiocruz students view these activities as crucial for developing skills and competencies that assist in career choices and scientific engagement. On the other hand, student reports from Sakura Science tend to highlight the role of scientific education activities by demonstrating their awareness of the integration of science and technology in societal technological and industrial development.

While Provoc-Fiocruz emphasized the importance of science education in providing access to knowledge through practical research experiences, focusing on the individual aspect of learning to do science and its impact on students' academic and professional trajectories, Sakura Science's goals, which highlight supporting young individuals with potential for scientific and technological innovation, societal conventions may emphasize the collective dimension over the individual dimension. In fact, a study on science classes in three Brazilian and three Japanese schools revealed that experimental activities in Brazilian schools occur less frequently than those in Japanese schools (Leite & Bonamino, 2021). Additionally, only 12.5% of elementary schools and 48% of high schools have science laboratories (Brasil, 2020).

CONCLUSION

This study reveals that both Brazilian and Japanese science nonformal education programs offer diverse opportunities for students to engage in scientific activities, reflecting a range of academic, cultural, and social experiences that shape their expectations and attitudes toward science education and its practitioners.

Both the Provoc-Fiocruz and the Sakura Science Program play pivotal roles in shaping students' scientific knowledge, personal development, and intercultural understanding. The students' reports highlight how these programs provide enriching experiences that expand students' understanding of science, foster deeper reflections, and alter initial perceptions of the field. The integration of personal interests and curiosity into the learning process enhances students' engagement with science.

Key findings emphasize the importance of interpersonal relationships in these educational settings. Aspects such as curiosity, kindness, and teamwork emerged as significant factors contributing to students' science education experiences. These relationships not only support learning but also help students navigate challenges. Overall, this research highlights the value of science and intercultural education in broadening students' perspectives on science and social differences.

Acknowledgment

To prepare this manuscript, we did not utilize artificial intelligence (AI) tools for content creation. This article does not incorporate content generated by artificial intelligence (AI) tools.

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