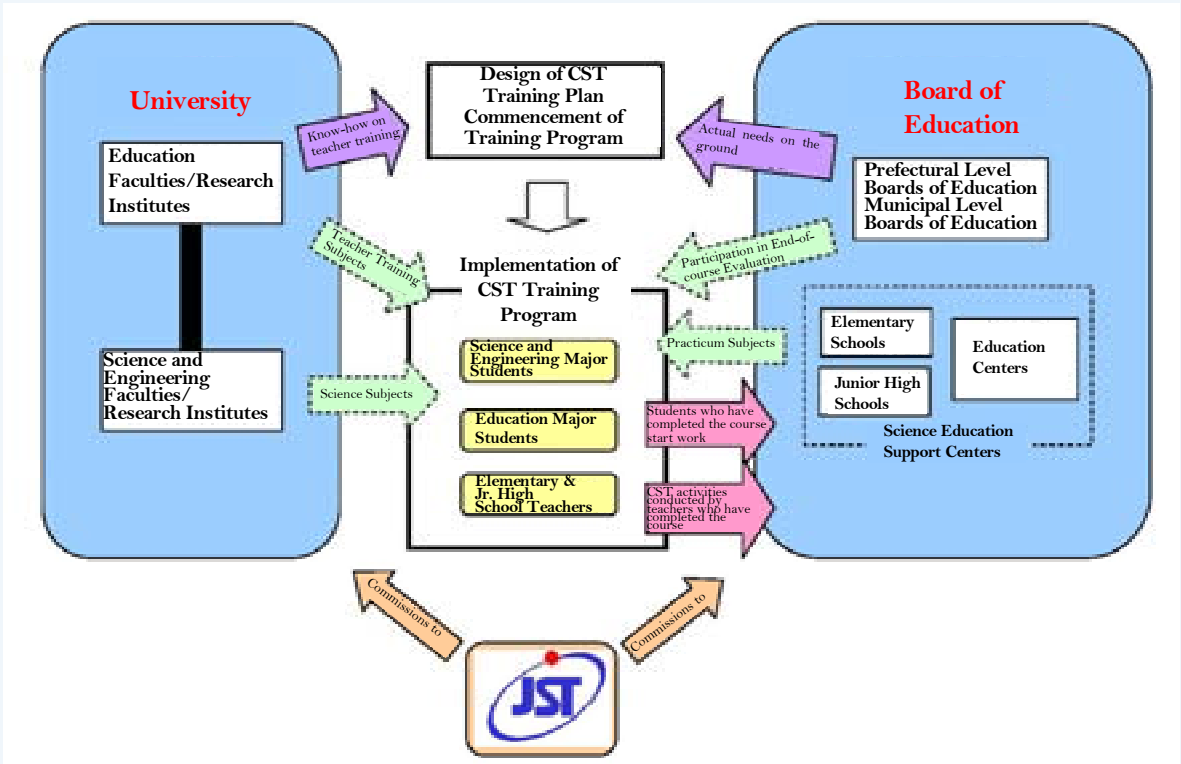
Figure 1-2-14/An Example of the Project "Establishing Training Centers for Core Science Teachers" (Ochanomizu University)

-The Science and Education Center of Ochanomizu University embarked on the project from 2009 with the Tokyo Metropolitan Board of Education.

-Participants in the training course (approximately 1 year) learn how to teach science and independent research, develop materials, implement teacher training, and communication skills. Participants who pass the final exams will be certified as Core Science Teachers (CST).

-It certified 32 teachers and post-graduate students in Tokyo as CSTs in 2009. Twenty eight elementary school teachers with CSTs held science teacher workshops and trained a total of 1460 elementary school teachers in various cities and wards in Tokyo by Nov 2010.

(Flow of the Project "Establishing Training Centers for Core Science Teachers")



Source: Created by MEXT based on materials from Ochanomizu University and the Japan Science and Technology Agency

In addition, the following efforts are promoted to improve the science education environment.

-Assistance for maintenance of science education equipment expenses, etc in public and private primary, junior high and senior high schools (MEXT)

Under the Act for Promotion of Science Education, to subsidize necessary items such as equipment and devices for observations and experiments (1/2 subsidy)

-Development of science materials and utilization support (the Japan Science and Technology Agency)

To develop digital contents for science learning, and provide them to schools through the digital media such as the Internet

(4) Cooperation with Society to Improve S&T Literacy

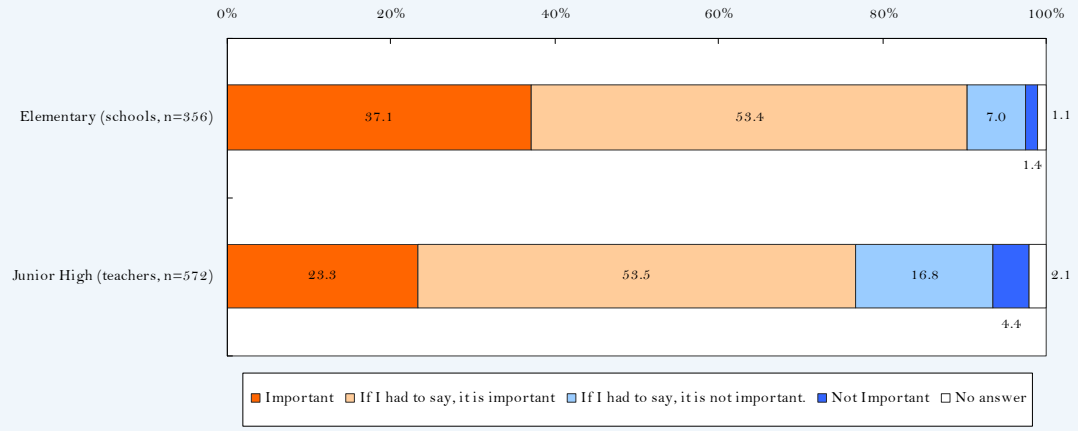
To nurture S&T literacy, we have seen the school education plays an important role and it is essential to improve it. In addition, cooperation with society is hoped for. In reality, in the "2008 Fact-Finding Report

on Elementary School Science Education and Junior High School Science Teachers" conducted by the Japan Science and Technology Agency and the National Institute for Educational Policy Research, many respondents opined that cooperation with external specialists are necessary to increase elementary and junior high school students' science ability, but many schools have never set up opportunities for external experts to teach their students (Figure 1-2-15).

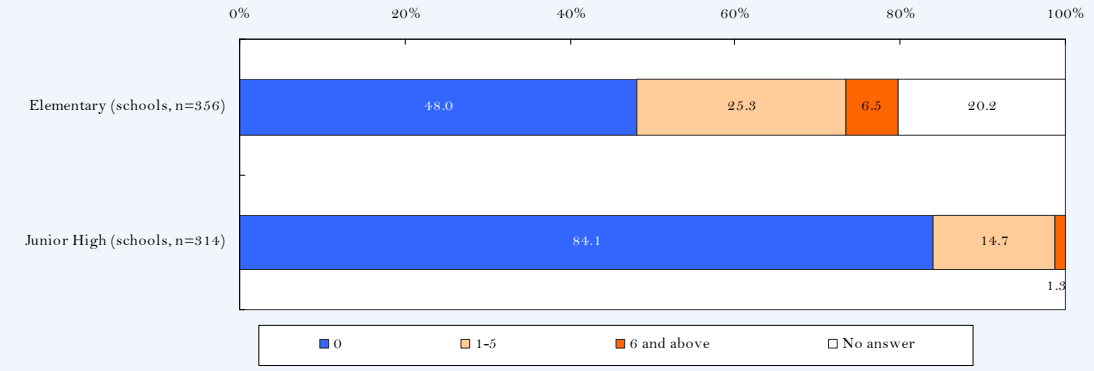
It is therefore necessary to design a plan for not only elementary, junior and senior high schools, universities and graduate schools, but also various organizations such as science museums, museums, associations related to S&T, NPOs and companies to cooperate with each other and cultivate the S&T literacy required for each stage of a person's life, from infant to early education, through higher education to maturity and then to old age. These measures and the multiplier effects they generate are expected to improve the literacy level in S&T of the Japanese public. (Figure 1-2-16).

Figure 1-2-15/Importance and Actual Situation of Links with External Experts to Improve Students' Ability

Question: In order to improve the understanding of students who are good in science, do you think links with external experts are important?

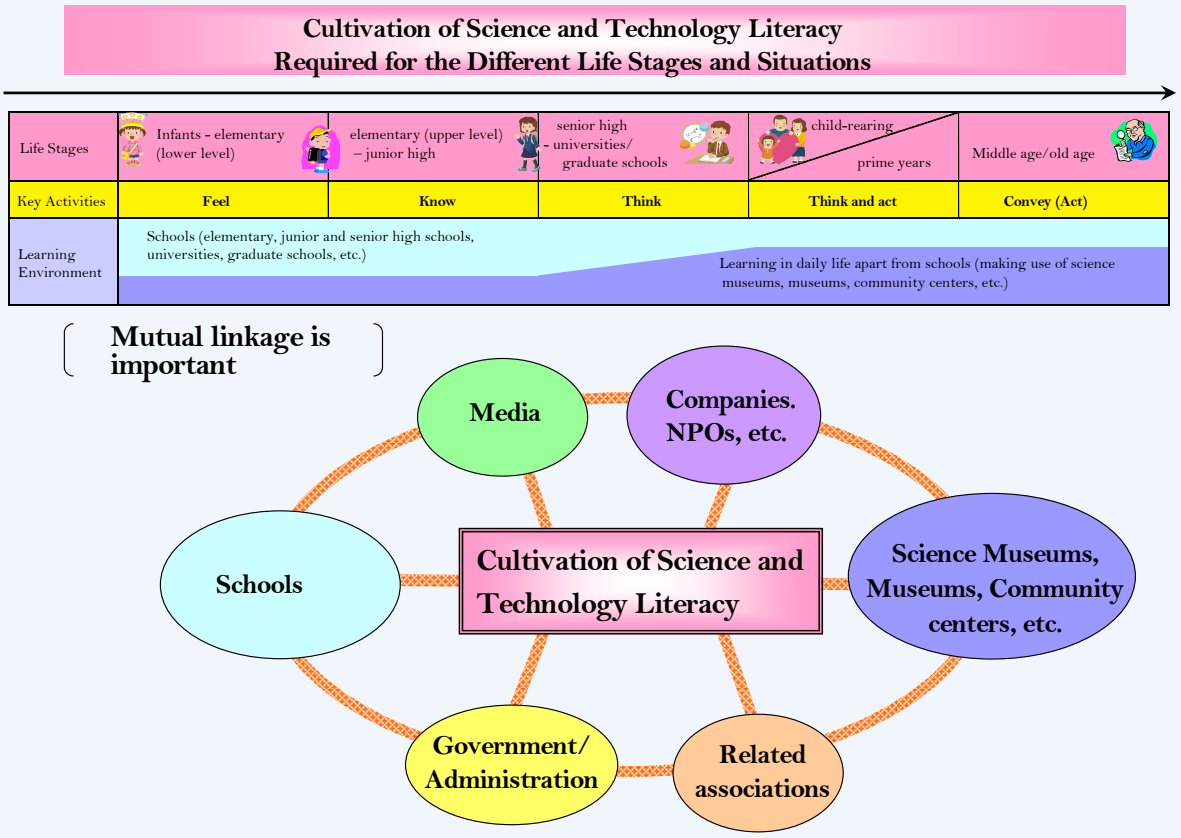


Question: In your school, how many times per year do external experts (researchers or people working in S&T fields) come to teach your students about S&T? (both full participation or volunteered participation of students)



Source: Created by MEXT based on the "2008 Fact-Finding Report on Elementary School Science Education and Junior High School Science Teachers " commissioned by the Japan Science and Technology Agency and the National Institute for Educational Policy Research

Figure 1-2-16/Links with Various Organizations to Nurture S&T Literacy



Source: Created by MEXT based on the National Museum of Nature and Science's "'Creating Activities to Cultivate Scientific Literacy' – Development of Programs for Different Generations"

Examples of some activities related to the cultivation of S&T literacy organized by various organizations around the country are introduced below.

1) Implementation of Learning Programs by Science Museums and Museums

a) Development of learning programs catered to different generations (the National Museum of Nature and Science)

In science museums and museums, opportunities are provided for the public to learn more about nature and science through experiential activities using real objects, and to link S&T with society, thus enabling them to have more interests and care in S&T and to feel their usefulness. The National Museum of Nature and Science is designing a systematic approach to cultivating S&T literacy and developing a learning program (Figure 1-2-17) based on this approach by making full use of the above-mentioned opportunities and working with various organizations such as schools, companies, academic associations to enable the Japanese public across the generations to achieve S&T literacy in various situations. Various forms of learning opportunities such as exhibitions, public seminars, and events are conducted there for not only school children, but also for the public across the different generations, from youths to senior citizens. In addition, the museum also takes the learning needs of the different generations and the Revised National Curriculum Standards for science into consideration, and is developing a key learning program that sets, for example "water", "food" and "energy" as themes for the topic "Issues Related to Real Life," to connect

the different generations.

Figure 1-2-17/Systematic Diagram of "Cultivation of Science and Technology Literacy" in Science Museums and Museums

Life Stages	Infants-elementary (lower level)	Elementary (upper level) – junior high	Senior high-universities/graduate schools	Child-rearing / Prime years	Middle age/old age
Learning Environment	Learning in schools				
	Learning in daily life apart from schools (making use of museums, etc.)				
Keywords	Important to feel	Important to know	Important to think on one's own	Important to act on one's thinking	Important to convey one's knowledge and abilities to future generations
4 Goals					
Feel - cultivation of sensitivity -	- Get in touch with science and technology and feel the wonders around you!	- Have an interest in science and technology and feel the linkages with life! - Observe, and find out the answers to your questions!	- Get in touch with science and technology, feel the linkages with our daily life and how science is useful to society! - Have an interest in people working in science and technology fields!	(Child-rearing) '- Have fun learning together with your children and feel the importance of science! (Prime years) - Continue to have an interest in science and technology! - Feel the need to act for the benefit of society!	- Get more information about science and technology and continue to have an interest in these subjects! - Feel the need to act for the benefit of society!
Know - knowledge acquisition/ concept understanding -	- Know how nature and technology around you work, and have many "I got it!" experiences!	- Through scientific experiences, know more about the relationship between science and life!	- Learn more about science and technology that affect our daily life and society!	(Child-rearing) '- Have fun learning together with your children and understand many things about scientific things related to daily life and society! (Prime years) - Get a lot of information and continue to learn widely about the knowledge and role of science related to daily life and society!	- Get a lot of information and continue to learn widely about the knowledge and role of science related to daily life and society! - Take in scientific information related to your interests and education!
Think - cultivation of habit of thinking scientifically -	- Actively research things of interest and concern and have your own way of thinking!	- Have an interest in nature and society, and think about the rules that make them work and how they are inter-connected!	- Use your scientific knowledge to choose the information you require and have your own way of thinking!	(Child-rearing) '- Use your scientific knowledge to choose the information you require and have your own way of thinking! (Prime years) - Utilize what you have learnt about issues related to daily life and society and think scientifically!	- Utilize what you have learnt about issues related to daily life and society and think scientifically! - Utilize what you have learnt in your interests and education!
Act - cultivation of ability to act accordingly in social situations -	- Proactively get involved with science and act together with your friends!	- Convey what you have learnt intelligibly! - Think about occupations around you that are related to science and technology!	- Utilize what you have learnt from science's linkage with society and make use of it in your daily life! - Utilize what you have learnt in your future job selection and daily life!	(Child-rearing) '- Convey to other people what you have learnt about science's relationship to society! (Prime years) - Think about better solutions to regional issues!	- Find out about regional issues, think about better solutions and participate in social and regional activities! - Utilize your knowledge and abilities according to the social situations, and convey your ideas and methods to future generations!

Source: National Museum of Nature and Science "'Creating Activities to Cultivate Scientific Literacy' – Development of Programs for Different Generations"

b) Integration of science museums and science learning in elementary and junior high schools (Izumo Science Center)

The Izumo Science Center in Izumo City, Shimane Prefecture was opened on July 20 2002 and is unique nationwide as a facility that combines the function of lifelong learning with a systematic science learning program (school education) based on a year-long plan.

The Science Center carries out science education for third year elementary to third year junior high school students, and these students participate in science classes at the Center twice a year. The total number of students who took part was 17,500.

The Center aims to improve students' creative and unique learning abilities and motivation from the basics to high-level learning by providing unique experiences and experimental learning lessons that

cannot be replicated in schools because it is quite difficult for ordinary schools to have a variety of experiment equipment, high-tech devices and well-trained staff it has. Each class consists of three lessons (45 minutes x 3 lessons), and in the first lesson, students participate in dynamic participatory-style experiments in the science hall using large-scale visual systems and large-scale observation devices and increase their intellectual curiosity toward natural events and phenomena they usually cannot observe or touch. In the second and third lessons, students use the experiment equipment and devices in the laboratories to observe and experiment on their predictions in order to cultivate the ability to solve problems.

In addition, the center provides various lifelong learning activities related to science and manufacture for children and adults on Saturdays, Sundays and national holidays. The activities include the Izumo Boys and Girls Invention Club and "Local Parents and Children Classroom" carried out by Children's Club and the PTA.

2) Examples of Universities' Support to Scientific Experiments for Children in the Region

a) "Delivering programs of experiment schooling" to elementary and junior high schools (tie-up between Ochanomizu University and the City of Kita, Tokyo)

As a strategy to combat the trend of students turning away from science in elementary and junior high schools, the Ochanomizu University with the City of Kita Education Board has been implementing "Delivering programs of experiment schooling" since 2006. Unlike ordinary delivery lessons, the university does not conduct lessons such as scientific experiments at the schools, but rather trains the school teachers in the activities to be carried out later, and provides university lecturers who act as assistants to the teachers in actual lessons. The lecturers and teachers discuss beforehand what experiments from the textbooks to teach, and plan and prepare experimental lessons which use for example, the electronic microscopes, to get students interested. In actual lessons, university lecturers only assist the teachers in the lessons and experiments. This way, in addition to increasing students' interest in science and experimental lessons, the opportunities to train teachers to teach better are also presented. As a result, this program continues to expand year by year, and in 2010, 24 schools, approximately half of the 50 elementary and junior high schools in the City of Kita, have implemented this "Delivering programs of experiment schooling" program.

In addition, Ochanomizu University, in cooperation with the City of Kita's Living Environment Division, produces and implements environmental learning programs for the residents in the city. As part of the effort, the university also collaborates with companies. The university develops a program and trains an instructor based on a contract with companies. The city office approves the program based on a memorandum between the university and the city, and the company provides a lecture for the residents in the city. This is a perfect example of how the "Knowledge of the University" is provided to companies and society, and is a new type of industrial - academic - governmental cooperation venture different from the conventional way of manufacturing, and which deserves more attention.

b) Dispatch of teaching assistants to elementary and junior high schools (tie-up between the Tokyo University of Science and Noda City, Chiba Prefecture)

Noda City, Chiba Prefecture signed a partnership agreement with the Tokyo University of Science in April 2005 to develop "Cooperative Activities" focusing on science and arithmetic/mathematics education for students and teachers. The activities are divided into 4 types: "dispatch of students and graduate students," "hands-on learning program for children," "education training," and "R&D." Under the "dispatch of students and graduate students" program, undergraduate and graduate students are dispatched to science and arithmetic/mathematics classes in elementary and junior high schools as teaching assistants. Under the "hands-on learning program for children" program, activities such as "exciting science lectures (special lectures)" and "ICT[1] seminars for children" in elementary and junior high schools, "parent-child science lectures (stay-in)" at the university during summer, "learning through work experience" for junior high school students to learn more about future careers, and "visits to the research office" for elementary students are conducted. Under the "education training" program, besides "teachers' training seminars" and "public seminars" for the general public, there are also projects where supervisors of teachers and teachers provide support in teaching courses at the university, and the "Teaching Assistant Experience" course for students aspiring to become teachers. Under the "R&D" program, they are developing curriculum for science and arithmetic/mathematics and materials utilizing the specialty of university.

These varieties of cooperative activities not only increase children's interest and motivation toward science and arithmetic/mathematics, but also provide opportunities for them to think about their future and careers. In addition, they also strengthen the cooperative inclinations of teachers in the elementary and junior high schools by helping them to deepen their research into science and arithmetic/mathematics materials, and to enrich school activities by utilizing educational resources beyond the school compounds.

In addition, Noda City carries out various other activities such as nurturing "Local Education Coordinators," facilitators that link local talents and educational resources in the universities, companies and the natural environment to school education.

Exciting Science Lesson: Superconductivity experiment using liquid nitrogen
Photo: Noda City's Education Committee

c) Student tutors conducting senior high school students' experiments in molecular biology (Graduate School of Science, Osaka University)

The Graduate School of Science, Osaka University implements a project called "Giant Impact - Science career education to enjoy science and thinking and to move young people and give them the strength to live," (a project under MEXT's "Science Partnership Project") and which aims to let high school students enjoy the fun of thinking and nurturing their interest toward science, through molecular biology experiments such as genetic modification and

Molecular Biology Experiment
Photo: Graduate School of Science, Osaka University

1 Information and Communication Technology

questions regarding these experiments.

Two 3-day courses were held for 66 high school students in 2010. In this project, undergraduate and graduate students from the science faculty were dispatched to facilitate students' understanding of the lessons in real time, and to help them acquire a habit of thinking scientifically. Participants do not use commercial experiment devices, and by experiencing the steps and operations of the experiments, they learn about their significance and discover what it means to "understand." Students who have taken part made the following comments:

-I could understand the fun of learning biology, and how important it is to think by myself.

-The joy I experienced when I understood something is like nothing I have experienced before and it was the first time for me to feel the joy of thinking. I was very happy and just couldn't control myself from crying.

They not only experienced the most advanced science, but also enjoyed learning and thinking.

3) Support by Companies for Science Education

For companies in which young employees are the source of their energy, it is a vital concern to increase the interest and concern of children in S&T and to cultivate their creativity and knowledge about science and mathematics. With an aim to increase students' interest in science and lecture effectiveness, METI has therefore, been implementing "science education project in collaboration with the local industry" and the "Project targeted at school students for fostering engineering-related personnel" since 2008, and companies and NPOs have been implementing various projects as the coordinator between the education field and industrial players in various regions in Japan with support from METI. To support such activities, the ministry produced and delivered a guidebook "Guidelines for Creating Science Lecture Plans for Companies" in order to teach the steps and points for planning science lectures.

In addition, according to the "Survey on Corporate Philanthropic Activities" conducted annually by the Japan Business Federation (Keidanren), companies are spending more amount on "school education and social education" activities such as dispatching teachers to schools and creating and developing equipment for experiments, and on "academic and research" activities such as providing scholarships and research grants[1].

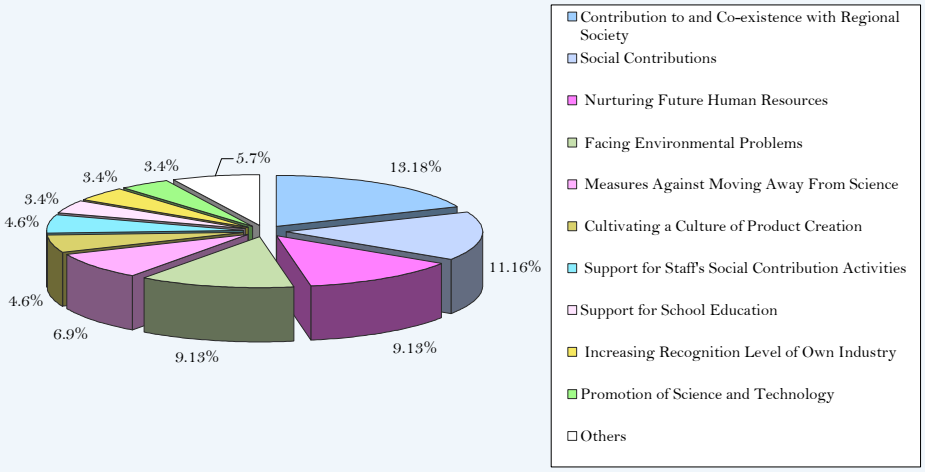
Furthermore, according to the "Human Resource Education and Training to Support Foundations of Competitiveness" survey (November 2010) conducted by the Council on Competitiveness-Nippon,[2] 27 out of 28 member organizations implement a total of 115 science education support activities, and in FY 2009 carried out delivery lectures to more than 200,000 students. Such support by industries to science education has been increasing recently. The survey also mentions that companies used to conduct these activities as part of their "Contribution to and Co-existence with Regional Society" and "Social Contribution," but in recent years, with a declining birth rate and a shunning of science and engineering subjects by university students, more and more companies are starting to worry about securing human

1 The survey on corporate philanthropic activities was conducted in 2009 targeting member companies of Keidanren and 1% club corporate members, and 367 companies responded (45 companies responded as consolidated companies, and included in this number are approximately 3900 consolidated companies.). The largest expenditures for the different categories in 2009 were "School Education and Social Education" (18.8%), "Academic, Research" (14.8%), "Health, Medicine, Sports" (12.7%) and "Environment" (12.4%).

2 The Council on Competitiveness-Nippon (COCN) was established in 2006 by a group of business leaders who were keen to strengthen the international competitiveness of Japanese industries.

resources for the future and in recognizing the need to raise children's interest in science, are implementing activities such as "Nurturing Future Human Resources" and "Measures Against Moving Away From Science" (Figure 1-2-18).

Figure 1-2-18/Goals and Considerations of COCN Member Organizations on Science Education Support Activities

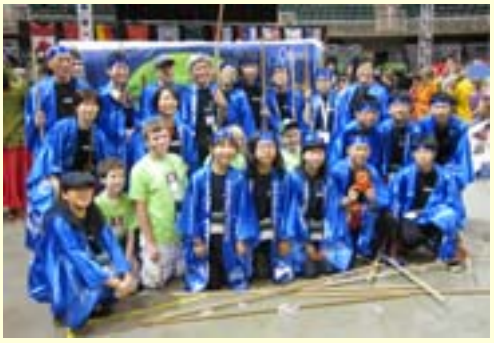


Source: Created by MEXT based on COCN's "Survey on Support Activities for Science Education" (October – November 2009)

[Column 7] Utilizing Retired Technicians – Variety of Science Education Support Activities by Organizations such as Companies, Public-interest Corporation

The Hitachi Science Club, established in May 2009, collaborates with Hitachi City Board of Education, to conduct various activities carried out mainly by retirees from Hitachi, Ltd. such as support for science lectures in elementary and junior high schools, dispatch of "Science Lab Uncles" to elementary schools, implementation of "Science and Math Academy" for motivated junior high school students, conducting "Manufacturing Factory" and "Wonder Land" workshop experience for the joys of manufacturing and science, so as to allow students to experience the "joys of science" and "moving moments of manufacturing." The main feature of this club is the assembly of many retired technicians and the deep cooperation with the board of education and the schools, to support lectures by the teachers according to the Revised National Curriculum Standards created by MEXT.

In addition, the Japan Institute of Invention and Innovation has been implementing "Activities for Invention Club for Schoolchildren" since 1974 with an aim to nurture the dreams and passion of young people toward S&T and to produce people with imaginations while respecting their free imagination.[1] Among these activities, retired technicians and teachers at the Kariya Boys and Girls Invention Club[2] carry out extra-curricular science education support activities to nurture students' creativity through a variety of handiwork, and to acquire basic knowledge and skills required to make their ideas into products, enabling them to not only enjoy learning, but also to nurture their ability to see and think scientifically. Every Saturday, meetings on curriculum guidelines are also conducted by teachers to try to implement improved and more effective teaching methods based on reviews. In particular, students have been taking part in Odyssey of the Mind (a creative problem-solving world competition for children) every year from 2004, and came in 2nd, behind the USA, in 2010.



Odyssey of the Mind 2010
Commemorative Photo of Participants
Photo: Kariya Boys and Girls Invention Club

In addition, the NPO Galileo Studio has been developing and introducing experiments that can be carried out with familiar objects, conducting science experiment lessons and shows, and supervising experiments shown on TV with the aim of "conveying the joys of science to all people in society." It also carries out activities to support science volunteers.

Furthermore, newspapers have also been organizing various competitions such as those listed below to assess and commend the imaginations and creativity of children.

-Mainichi Shinbun's Natural Science Observation Contest
Contest on independent scientific research with themes such as the observation of habits of animals and plants growth record, minerals, geology, astronomy, weather, etc. targeting all elementary and junior high school students (1960 -)

-The Yomiuri Shimbun's Japan Student Science Award*
Independent science research contest targeting all junior and senior high students. Established in 1957, the year of the "International Geophysical Year," with the hope of promoting science education in Japan after the war and to produce excellent scientists for the future.

-The Asahi Shimbun Company's Japan Science and Engineering Challenge (JSEC)*
Science independent research contest with the aim of nurturing senior high school students who lead the S&T future of Japan (2003 -)

*Students with excellent results in these contests will be sent to take part in the Intel International Science and Engineering Fair (ISEF) in USA every year.

1 As of end 2010, there are 205 clubs in all 47 prefectures and more than 8500 club members have enjoyed the creative activities.

2 The Kariya Boys and Girls Invention Club and the Chiba Boys and Girls Invention Club were established in 1974 and they are the oldest clubs in Japan. The former club has 740 members and is one of the largest invention clubs in Japan. About 7% of the elementary school students and about 2% of the junior high school students in Kariya City belong to this club.