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USING SPACE MATERIALS TO SUPPORT EDUCATION:
APPROACHES BY JAXA SPACE EDUCATION CENTER

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ABSTRACT

This paper describes the goals and principles pursued and approaches taken by the Space Education Center of Japan Aerospace Exploration Agency to assist young people in their development as human beings. To reach out to a large number of children, the Center works closely with school teachers, by providing some of them with direct, customized support and some others with indirect support. The Center is gradually expanding the partnership with entities outside Japan, making the maximum use of the existing cooperation frameworks for space activities. Some examples at the global level and at the regional level are presented. The Center aims to create synergies of efforts made by the existing mechanisms for cooperation. It also aims to ensure that the regional efforts that the Center promotes would contribute to global efforts. The recent efforts of the Center to promote water rocket and CanSat activities offer good examples of creating such synergies and supporting objectives set by multiple mechanisms for cooperation in space education.

1. INTRODUCTION

Japan Aerospace Exploration Agency (JAXA) established a Space Education Center on 1 May 2005 by an executive decision by its President. The Center was officially opened on 19 May 2005 at Sagamihara campus of JAXA, where it is now located.

In developing the concept of the Space Education Center, Professor Yasunori Matogawa played a central role. Based on his in-depth experience with public relations in space activities and educational activities with the use of space materials and topics and through his interactions over decades with children across the country in person at meetings or through telephone interviews and in radio and television programmes, he had been developing a plan to establish a focal point for space education in Japan, with the aim of igniting the flame of curiosity in children's mind toward nature and all forms of lives on the Earth with the use of attractive space materials. He also recognized the need to have a solid base to provide support to school teachers around the country who would be united through their care and love for children. The Space Education Center was brought into reality to serve as such a focal point for space education and the base for the network for teachers.

At the time when the tendency among government agencies and entities was to

reduce the number of departments and divisions, it was not simple to establish such a Center. It required administratively creative solutions. It should also be noted that the Center was established within half a year after the new President of JAXA, Dr. Keiji Tachikawa, was appointed on 15 November 2004. To some extent, the creation of a Space Education Center in such a short time was an indication of the growing recognition by the top management of JAXA of the need to contribute to education for young people in Japan.

1.1 Background

Educational activities of JAXA and its predecessors* had been carried out as part of the public relations and outreach activities. The focus of those activities is to increase public awareness and enhance public understanding of the activities of JAXA that would bring societal benefits to the Japanese citizens. The goal of those activities is to secure public support for its space activities.

The growing recognition of the fundamental difference between public outreach and education resulted in the establishment of a separate unit dedicated to space education, which would focus on the development of human beings through space activities.

* JAXA was created in October 2003 as a result of the merger of three separate entities: Institute of Space and Astronautical Science (ISAS), National Space Development Agency (NASDA) and National

1.2 Organization and structure

The Space Education Center itself was a virtual entity which was treated like a project to be undertaken, with defined objectives, functions and activities. To carry out the activities of the Center, the Space Education Office was created by transforming the Education Group of the Public Affairs Department. The establishment of the Space Education Center, therefore, did not result in an increase in the number of organizational units or regular staff of JAXA. Fig. 1 shows the structure of the Space Education Center.

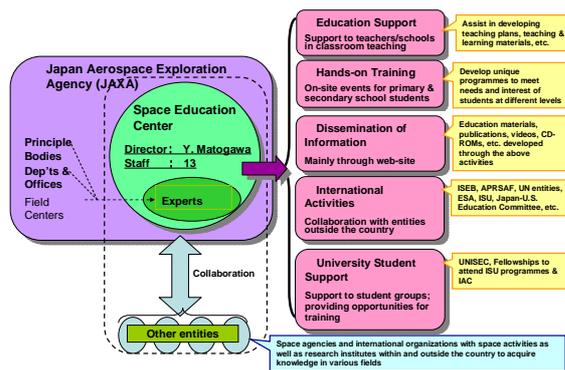


Fig. 1: Organizational structure of the Space Education Center

With the staff of 13, the Space Education Center carries out the following main activities: i) providing support to teachers and schools in their classroom teaching (education support); ii) organizing one-day events and short-term courses with hands-on training activities (hands-on activities); iii) disseminating educational programmes and

materials (information dissemination) mainly through web-site; iv) supporting university students; and v) participating in educational activities organized by entities outside the country or organizing activities with partners outside the country through international cooperation.

In carrying out those activities, the Center collaborates with the Public Affairs Department as well as other offices, departments and research institutes within JAXA that have educational elements in their activities or that have space engineering and science expertise.

2. GOALS AND PRINCIPLES

2.1 Goals of the Center

The Space Education Center considers space activities as a common thread that links many different aspects of human activities. With the use of attractive space materials and topics, the Center sets its goal on inspiring young people and guiding them to realize the importance of all forms of lives, the importance of being part of the society and the importance of servicing the society for the benefit of all. The Center also helps the young people to see the links between space and the nature, life, human history, our present culture and our future.

It should be noted that the Space Education Center was not established to focus on securing future workforce to support space activities. Job opportunities in space-related areas are still considered to be limited, in both the public sector and industry in Jpana,[†] and JAXA has not yet experienced, or increased its concern over, a shortage of qualified applicants for its vacancies particularly for new graduates.

2.2 Principles of the Center

There are a few principles that the Center follows in its activities to achieve its goals.

Understanding the thinking process behind what young people acquire as knowledge is considered essential. The Center endeavours to take advantage of children's simple curiosity embedded in their minds toward nature, lives and space and to offer them opportunities to learn the joy of solving mysteries by themselves.

Associated with the above principle is the need to increase young people's appreciation of science and technology, to acquire insight in their daily lives and also to master the logical thinking process.

Importance of life, or dignity of life is considered a very important message that the

Center aims to convey to young people. By inviting them to learn more about the origin and evolution of the universe and guiding them to realize how difficult it is to find Earth-like planets, the Center aims to help them more appreciate all forms of lives on our planet.

Another thing that the Center emphasizes is the spirit of "Never Give Up". The Center considers it important for anybody who wants to achieve something significant in this challenging world.

The Center places importance on increasing appreciation of young people of their roles in the society and the importance of servicing the society for the benefit of all its members. Examples of how a large number of people with various backgrounds can build a global system that could benefit the global society, for example, could be used to show the power of collective efforts made toward common goals.

Using "space" as a unique source of interest, imagination and inspiration, the Center endeavours to work on children's minds. The ideal children for the Center would be those whose minds are full of curiosity, adventurous spirit and engineering mind, always aiming for the excellence in whatever they do.

[†] For example, space-related industries had the workforce of more than 10,000 personnel in 1995. It experienced a constant decline, to be just above 6,000 in 2004.[1]

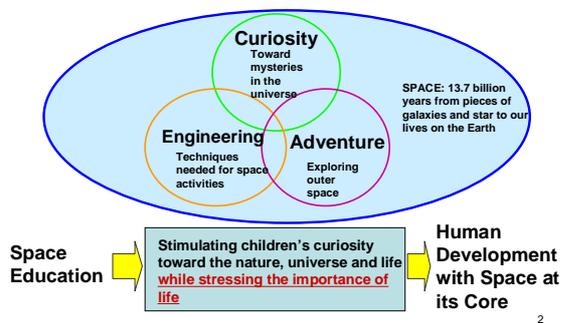


Fig. 2: Ideal minds of children for the Center

The Center makes efforts to guide children toward this ideal image mainly through its support to teachers and its hands-on, on-site activities.

3. SUPPORT TO TEACHERS

Close collaboration with teachers is considered most essential by the Center, as the teachers are considered to have much better understanding of young people's needs and feelings through their daily interactions.

3.1 Direct, customized support

The Center provides customized support to those teachers who have contacted the Center with specific requests to help their classroom teaching or extra-curriculum activities with the use of space materials or topics.

Upon receipt of requests, staff of the Center start holding numerous consultations with the teachers concerned to identify goals and to develop plans for their classroom activities. From among those experts of space science and technology as well as pedagogy and other fields who collaborate with the Center, it finds appropriate experts to provide knowledge and expertise to develop teaching and learning materials according to the plans developed with the teachers. Once the plans and teaching and learning materials have been developed, the Center sends its staff and appropriate experts of JAXA to provide on-site support to the teachers during the planned classroom activities. Fig. 3 below shows the process through which direct, customized support is provided.

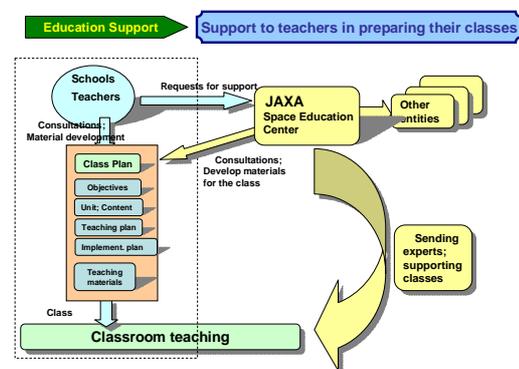


Fig. 3: Process to provide direct, customized support to teachers

When the Space Education Center started its activities in 2005, the Center received requests for support mostly from special high

schools that were designated by the Ministry of Education, Culture, Sports, Science and Technology as “Super Science High-Schools” or that were specifically encouraged by the Ministry to carry out “Science Partnership Programs”. Those high- schools were required, or in other words, allowed, to carry out special activities for classrooms with focus on science and technology within the time set aside in the established curriculum. There were few request from other schools, indicating the difficulty of many of them to accommodate additional activities in view of the already packed curriculum.

The number of requests, however, sharply increased from 2005 to 2007. In Japanese Fiscal Year 17, or from April 2005 to March 2005, the Center provided customized support to 17 schools, with 1 elementary school, 4 junior high schools and 12 high schools. In the following fiscal year, the number increased to 27, with 1 kindergarten, 8 elementary schools, 3 junior high schools and 15 high schools. As of September 2007, half way through in the current fiscal year, the Center is currently supporting 41 schools and has received requests for support from 75 schools.

Providing direct, customized support to teachers and schools consumes enormous amount of staff time and efforts. However, this activity continues to be the primary activity of the Center.

3.2 Indirect support

Many school teachers in Japan are too occupied with the existing curricula and overwhelmed with administrative work. It is difficult for those teachers to set aside time for additional activities to address space subjects.

For those teachers, the Center has begun developing materials that could be easily used by them to integrate space topics into the existing curricula. Introductory education materials are designed for use by teachers at the beginning of a study unit to stimulate students’ interest in the subjects to be learned in the unit.

The Center has completed the guidebook on introductory materials for science teachers, and this guidebook is also available in English. The Center plans to develop similar guidebooks for other subjects. The substantive work has been completed for the introductory educational materials for “Homemaking” course, and the work is underway for “Social Science”.

4. HANDS-ON ACTIVITIES

Hands-on, on-site educational activities of the Space Education Center mainly consist of events and short-term courses at various places in Japan, organized as part of “Cosmic College”. It aims to achieve the following

objectives: i) to increase interest of young people in science and technology; ii) to help form groups of young people who are fond of science and technology; iii) to guide young people to think and solve questions by themselves; iv) to encourage collaborations with others; v) to lead young people to appreciate the importance of life.

Depending on the age as well as the level of knowledge of space science and technology, there are different levels of courses offered to elementary to high school students.

4.1 Kids course

“Kids course” is for the kindergarten children to the second-year students of elementary schools, from 5 to 7 years old. It is designed for them to participate together with their parents. The programme helps to establish close links between the participating children and their parents by making or doing something together while having fun. Examples of activities in this course include building basic models of rockets or learning about the constellations and associated mythologies.

4.2 Fundamental course

“Fundamental course” is for the third-year elementary school students up to the third-year students of junior high schools, from 8 to 14 years old. The participants are given

opportunities to learn about basics of space science and technology such as basics of rocket science and engineering, space environment and Earth sciences. The programme includes some scientific experiments that are conducted by the participants.

4.3 Advanced course

“Advanced Course” offers a six-day, comprehensive programme for those who have completed “Fundamental Course”. The participants are given opportunities to learn about various specific subjects relating to space activities, such as the mechanism of flying and rocket development, the history of the universe and its future, unique features of the Sun, status of the Earth, planets and the search for life in the universe, space environment and the International Space Station. The programme offers a wide range of hands-on activities, such as developing and flying hot-air balloons, observations of constellations and satellites as well as building rovers and computer programming to run the rovers.

4.4 High-school course

Starting from March 2006, courses for high-school students are being offered once a year. The three-day programme is designed for the participants to acquire advanced knowledge of various space-related subjects and to have opportunities to interact with

researchers and experts of JAXA. The high-school course was held at Tsukuba Space Center in March 2006 and at Sagami-hara Campus in March 2007.

4.5 Educator's Course

The primary objective of the “Educators Course” is to provide training opportunities for school teachers as well as leaders of voluntary groups of young people interested in space activities to carry out educational activities with the use of space topics and materials. There are three-day courses and one-day courses. The Space Education Center shares with the participants of these courses the methods and materials that the Center has developed for Cosmic College courses. The programme of the Educators Course includes not only lectures on space education as part of scientific education as well as on space and education, but also hands-on training for the teachers, for example, through experiments with various types of tiny rockets, such as alcohol rockets and bubble rockets.

5. SYSTEM OF COLLABORATIONS FOR EDUCATION SUPPORT

The collaborations with various entities engaged in education are the key for success. The Center makes its maximum efforts to exchange ideas with associations of teachers, boards of education as well as publishers of

textbooks and companies of educational materials. The Center endeavours to work with not only those entities involved in space science, space development, life science and Earth science, but also with those other entities engaged in studies on humanities and civilizations as well as arts and philosophies. Fig. 4 reflects the comprehensive approach that the Center undertakes in expanding its activities to support education.

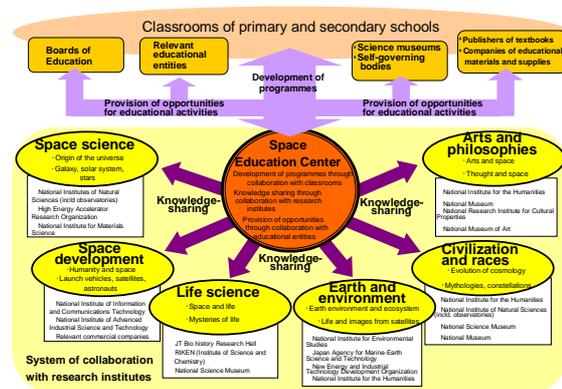


Fig. 4: System of collaborations for education support

6. INTERNATIONAL COOPERATION

Based on its goals and principles, the Space Education Center is expanding partnerships to entities of other countries and international organizations. In doing so, the Center endeavours to use as much as possible the existing frameworks for cooperation in space activities. Fig. 5 below summarizes the approach that the Center takes in expanding space education activities through

international cooperation.

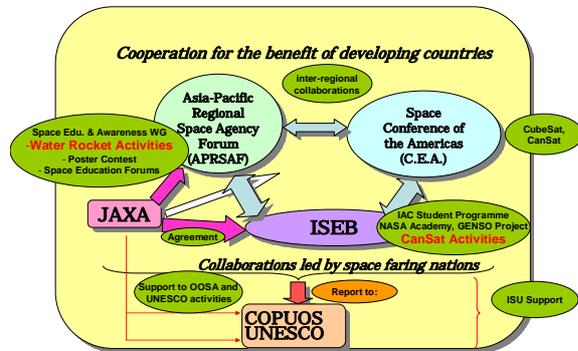


Fig. 5: Approach of the Space Education Center for international cooperation

As much as the circumstances allow, the Center endeavours to create synergies among the initiatives that are taken under different frameworks for cooperation.

6.1 Global Frameworks

6.1.1 International Space Education Board

One of the frameworks for cooperation that the Space Education Center supports is the International Space Education Board (ISEB), established by Canadian Space Agency, (CSA), European Space Agency (ESA), JAXA and National Aeronautics and Space Administration (NASA) of the United States of America in October 2005 to achieve the following objectives: i) to increase science, technology, engineering and mathematics literacy achievement in connection with space; and ii) to support the future workforce needs of space programs. The membership is open to

any public organisation carrying out space activities and pursuing education programmes. The membership was already expanded once in 2006 to include the French Space Agency.

Among the several joint activities pursued by ISEB, the Space Education Center took the initiative to promote CanSat development and experiments as basic space engineering hands-on training for students. In cooperation with the University Space Engineering Consortium (UNISEC), it organised the first international CanSat workshop within the framework of ISEB, in February 2007. While the original idea of fitting all basic satellite functions into a 350-ml alumni juice-can came from Stanford University of the United States, the activities to build CanSats and to compete for the accuracy of bringing them back after their release from up in the air have become popular among Japanese universities with aeronautical engineering laboratories [2]. Through the workshop, the Center provided opportunities for students of the countries represented by ISEB members to establish contacts with those Japanese university students engaged in CanSat activities.

6.1.2 Entities of the United Nations system

The Center considers it important to work with entities of the United Nations system such as the United Nations Educational, Scientific and Cultural Organization (UNESCO). This is in view of the global reach

that they have to benefit a much larger number of countries and people than the Center could possibly do by itself.

UNESCO has provided the Center with opportunities to participate in its space education activities held in multiple cities in Colombia, Vietnam and Ecuador, in the past to introduce water-rockets as an educational activity.

The “water rocket” is a rocket basically made of plastic bottles, normally for carbonated drinks, and it flies as the water inside the bottle is jettied out by the pressurized air also inside the bottle that serves as the body of the rocket. The activity to build and launch water rockets became popular in Japan not only as fun events for children but also for schools to introduce in their curricula in science. [3]

Following the introduction of water rocket activities at UNESCO space camps and workshops, Bogota Planetarium in Bogota, Colombia as well as the high school for gifted students in Ho Chi Minh, Vietnam contributed to further promoting water rocket activities as educational activities.



Fig. 6: Water rocket activities at Bogota Planetarium (Bogota, Colombia)

While the Center provides assistance to teachers and educators in developing countries in promoting water rocket activities for educational purposes, those teachers and educators can help the Center improve the teaching methods and materials with water rockets by giving their feedback. The Center considers this exchange of experience with the water rocket activities for educational purposes as a mutually beneficial way of cooperation in space education.

In view of the positive feedback received from many teachers and educators in Colombia and Ecuador, the Center currently plans to work with UNESCO to make the Center’s Educator’s Manual and DVD on water rocket activities available not only in Japanese and English but also in Spanish in 2008.

6.2 Regional Frameworks

6.2.1 Asia-Pacific Regional Space Agency Forum

In the region of Asia and the Pacific, the Center uses the framework provided by Asia-Pacific Regional Space Agency Forum (APRSAF). The Center serves as the secretariat of APRSAF Space Education and Awareness Working Group and places importance on its activities.

It was within the framework of APRSAF that the Center introduced the idea of water rocket competition as a regional event for secondary school students. After two regional events, held in 2005 and 2006, the number of participating countries increased to 13.



Fig. 7: First APRSAF Water Rocket Competition held in Kitakyushu, Japan in October 2005



Fig. 8: Second APRSAF Water Rocket Event, held in Jakarta, Indonesia, in December 2006

To further promote water rockets as educational activities in the region, the Center is widely distributing the Educator's Manual and DVD for water rocket activities that were published in December 2006 for any interested teachers and educators.

For younger primary school students, APRSAF Space Education and Awareness Working Group began hold an annual regional poster contest since 2006. The second APRSAF Poster Contest is being held under the same theme as the one for World Space Week,[‡] i.e. "50 Years in Space". This is an indication of the efforts made by the Working Group to align its regional efforts in space education with global initiatives.

[‡] The United Nations General Assembly, in its resolution 54/68, declared 4-10 October as "World Space Week" to celebrate every year at the international level the contributions of space science and technology to the betterment of human condition. United Nations Office for Outer Space Affairs and the World Space Week Association play coordinating roles in promoting World Space Week events around the world.

Within the framework of APRSAF, space education workshops and seminars are also being organized for school students and teachers in developing countries, to give them opportunities to learn about various subjects related to space activities and also to take part in hands-on activities.

In doing so, the Working Group agreed that those workshops and seminars should be organized in cooperation with UNESCO.



Fig. 9: Space Education Seminar (Jakarta, Indonesia, December 2006)

At its last meeting held in December 2006, the Working Group also agreed to start joint activities for university students with CanSat activities. When the Space Education Center organized the International CanSat Workshop in February in Tokyo, it was held within the frameworks of both ISEB and APRSAF. The Workshop was attended by more than 150 students, university teachers, educators and space experts from 15 countries, including Colombia and 10 from Asia and the Pacific.



Fig. 10: International CanSat Workshop (Tokyo, Japan, February 2007)

6.2.2. Europe, Latin America and Africa

As for other regions, the Center considers it important to work with those entities that serve as the focal points for cooperation in the region.

For example, in Europe, cooperation with ESA is considered very important to the Center, and it uses the annual ESA-Japan Meeting as the well-established framework for cooperation over more than 30 years.

In Latin America and the Caribbean, the Center takes as many opportunities as possible to work with those countries serving as Pro Tempore Secretariat of the Space Conference of the America in the past, present or future, such as Chile, Colombia, Ecuador and Guatemala. The Center has already established contacts with teachers and educators in Colombia and Ecuador through UNESCO space camps in those countries, in which the Center participated and introduced

water rocket activities. As for Chile, in response to interest expressed by the University of Chile, the Center has introduced “CanSat Kit” developed by a team of the University of Tokyo together with a commercial entity and helped the University establish contact with the developer of the Kit. The Center intends to continue its support to the University of Chile in order to introduce CanSat activities as part of its curriculum for engineering students.

The Center intends to take opportunities to work with other regions as offered by development agencies of Japan. One of such examples is the introductory session for space education that the Center provided in the month of September in 2006 and in 2007 to groups of science teachers of secondary schools from African countries (Kenya, Gambia, Ghana, Malawi, Namibia, South Africa, Tanzania and Uganda) who were participating in the teachers training session organized by Hiroshima University with the support of Japan International Cooperation Agency (JICA).



Fig.11 Training session for African science teachers (Sagamihara Campus, JAXA, September 2007)

6.3 Creating synergies

The Space Education Center has made efforts to create synergies between the initiatives taken by ISEB and APRSAF for example through CanSat activities.

As the Center is invited to participate in inter-governmental meetings, the Center shares its successful examples of regional initiatives, such as water rocket activities. That is what the Center did in the Fifth Space Conference of the Americas.

When there is enough interest in educational materials developed by the Center, it then makes those materials in other languages than Japanese.

While the Center endeavours to create synergies between the initiatives taken by different frameworks for cooperation to promote space education, the Center considers it important to use practical examples or hands-on activities that have proven to be successful and have been well received by teachers and educators.

7. CONCLUDING REMARKS

To some extent, we in the Space Education Center are trying to establish a network of space education efforts at various levels, through various cooperation frameworks and through not only organizations but also individuals who share the goals and principles of the Center.

In the efforts to highlight the importance of space activities for the society, the focus has often been made on stressing the benefits of space science and technology and their applications to enhance safety, security, predictability, responsiveness, stability and convenience at the societal level, aiming for the enrichment of the society as a whole. While those efforts should continue, perhaps a little more attention should be made to individual needs particularly those of young people.

What the Center is pursuing now is perhaps the reflection of the lessons learned in the Japanese society. In the excessive pursuit of material richness, efficiency and productivity, something important might have been forgotten in the pursuit of happiness as human beings.

The attempt by the Center to establish a network of space education efforts is an attempt to create a coalition of forces around the world who want their children to lead lives

full of happiness and joy. It is our believe that the enhancement of human development at individual level through space education will contribute to the establishment of a solid foundation for global peace, so that one day, when human beings eventually start living in space, there will be no human sorrows and sufferings that we have observed too often on the Earth.

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