Development of a Continuous Educational Program Framework to Foster Science Literacy
-for development of the programs focusing on each generation-
<Summary of the final report>

April 2010

The Advisory Council on Fostering Science Literacy
National Museum of Nature and Science, Tokyo

I. Concept of a continuous educational program framework to foster science literacy at science museums

1. Necessity of fostering science literacy

- Science literacy is a cluster of comprehensive abilities in science that people possess appropriate knowledge and ways of thinking regarding science and technology, deal with changes in natural world and human society, and make reasonable decisions and take actions.
- Science education have emphasized economic values such as the promotion of industry by raising capable workers and vocational abilities, and cultural values for hobbies and refinement; with little effort made to develop the ability to participate in socially important matters in a self-restrained manner.
- Science literacy is vital for people to properly respond to the problems concerning science and technology they face in social life.
- Fostering science literacy will materialize a society in which people can live in prosperity, in terms of the connection between individuals and society and globally.
- Lifelong fostering of science literacy should be conducted by diverse bodies including lifelong learning, organizations such as science museums, a variety of media, businesses, non-profit organizations, local communities and households, although schools are still required to play a basic role of it.
- For effective development of the matters outlined above, new methods and ideas such as programs for each generation of people are required.

An example of educational program (F3 The story of vegetables, see P.8)

2. Future social roles of science museums for fostering science literacy

- The society in which we are living has been changing, and the positioning of science in society is also about to change. Assuming these changes, the future social roles of science museums in science literacy cultivation should be considered.

- Science museums are required to play the social roles of contributing to fostering science literacy and raising the degree of maturity of science culture in order to build a society in which people can enjoy happiness throughout their lifetimes. Therefore, science museums should make constructive efforts to solve problems related to education, studies, living, the environment, industry, the economy and so on.

- Science museums should act interactively by encouraging people to participate in society as well as participating in society by museums themselves, in ways such as issuing a message to people and society.

- It is important for science museums to show new values and ideas as well as research results based on historical systems referring to the latest findings and trends of science and technology.

- Science museums should play the role of organizations that assist lifelong learning, which facilitate self-realization of people, by systematically providing diverse programs that suit the different generations of people and the context of individual's life.

- Science museums are required to play a role of assisting as liaison between diverse bodies that foster science literacy such as public halls, NPOs, schools, households and local communities by integrating what is learned at workplaces, schools, households, etc., on the stage called the community from the viewpoint of the enhancement of communication between adults and children in the community.

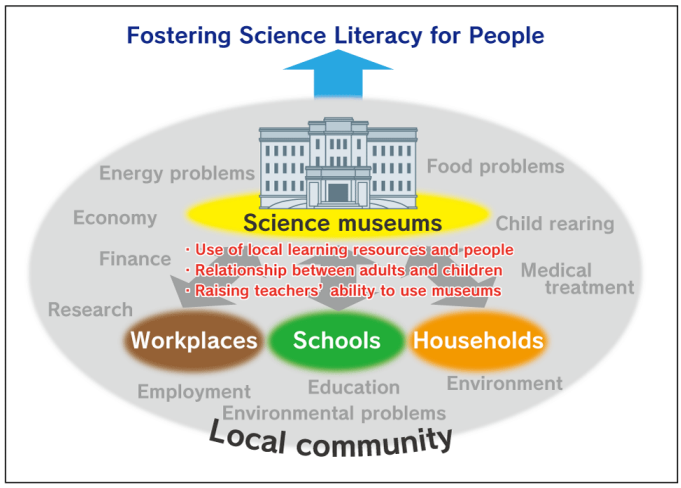

Figure 1. Roles of science museums in collaboration with various bodies

3. Features of a continuous educational program framework to foster science literacy at science museums

A continuous educational program framework to foster science literacy at science museums

- In this report, “A continuous educational program framework to foster science literacy” compose a continuous learning system to foster science literacy sought in each generation/life stage that focuses on issues in natural world and the human society.
- This framework is a continuous learning system not only develop and improve the knowledge and attitudes of each generation and life stage of people concerning science and technology, but also make individual people feel their growth and make society support such growth through communications between science museums and society.

Responding to diverse science fields

- Science museums are required to think extensively about science fields, which are diversifying, and the relationships between science and other studies, etc., in order to respond to the diversifying needs of people and problems related to their lives, the economy and society.
- This framework should be considered the relationships between a broad range of fields and actual life.

Suiting each generation and life stage of people

- If diverse bodies in society collaborate based on this framework, it will be possible to provide the programs that are required for various scenarios in life and programs that provide opportunities for people to learn in various stages of life, including school students.
- To provide learning opportunities suitable for each life stage, subdivision into five groups could be considered; for example, “preschooler～lower elementary school”, “higher elementary school～junior high school”, “high school～higher education”, the “families/prime”, “middle～old ages”.

New framework of learning

- The problem solving is vital for science literacy cultivation programs because the fields and methods of science education have changed as new fields in science and technology have emerged and they are expanding.
- In the future, in addition to current activities, to foster science literacy, science museums are expected to play the role of creative places by providing opportunities to think about unknown solutions and actions to take in order to solve the problems that people are facing, attaching importance to problem solving-type learning.

Cultivating comprehensive views and ideas

- Science literacy is a cluster of comprehensive abilities that people possess appropriate knowledge and ways of thinking regarding science and technology. This framework is developed aiming to cultivate such comprehensive abilities of individuals.
- Four goals for this framework provided by science museums have been set: “Awe and appreciation toward nature”, “Knowledge and understanding”, “Attitude” and “Communication”.

Table 1. Goals of a continuous educational program framework to foster science literacy

Cultivation of sensitivity	Raise interest in science and natural phenomena with programs for experiences to foster sensitivity and willingness. Become able to deal with science and natural phenomena with curiosity and interest through hands-on activities.
Attainment of knowledge and understanding of concepts	Become able to Understand the characteristics of science and technology to make sense of familiar natural phenomena and the functions of technology.
Fostering of the habit to think scientifically	Have and analyze questions concerning phenomena, and perform investigations to answer questions or find the answers from wide-ranging information and ideas. Become able to identify and analyze questions in phenomena and to investigate the solution by applying diverse knowledge and ideas by self.
Development of the ability to properly respond to circumstances in society	Properly explain what has been learned to people. Make decisions based on circumstances in society, applying scientific knowledge and attitude and considering the advantages and risks. Participate in building a society whose people can live in prosperity by spreading wisdom in society, such as handing down one’s own knowledge and ability to following generations. Become able to express appropriately what has been learned to the other people and make decisions applying scientific knowledge and attitudes in the social context and considering benefits and risks. Participate in developing a sustainable society by returning the wisdom to society conveying knowledge and skills to the next generation.

- This framework provided by science museums are systemized as shown in Table 2, taking into consideration learning opportunities to suit each generation and life stage of people and the comprehensive views and ideas required by science literacy, as stated above.

Table 2. A continuous educational program framework to foster science literacy at science museums <Four goals and five generations>

Generation and life stage		Preschooler ～ Lower Elementary School	Higher Elementary School ～ Junior High School	High school / Higher Education	Families / Prime	Middle and old ages
Learning environment		School education (basic learning based on curricula corresponding to the development stage, etc.) Learning at science museums (learning through experience using plenty of objects learning extensive subjects such as environment and medical treatment outside of school, etc.)				
Four goals (*1)	Practical aspects of goals (*1)	Degree of emphasis of aspect (*2) / Goal required by this generation and life stage	Degree of emphasis of aspect (*2) / Goal required by this generation and life stage	Degree of emphasis of aspect (*2) / Goal required by this generation and life stage	Degree of emphasis of aspect (*2) / Goal required by this generation and life stage	Degree of emphasis of aspect (*2) / Goal required by this generation and life stage
Awe and appreciation	・Have an interest and curiosity in familiar events and topics related to science. ・Desire to observe and investigate questions. ・Have an interest in people involved in the fields of science or technology. ・Desire to act to maintain sustainable society.	○Feel wonder of phenomena through experiences that familiarize with science and technology. (*3)	○Feel curiosity and interest as well as the relationship between science and the daily life through experiences that familiarize with science and technology. ○Have a willingness to observe and investigate questions.	○Have an interest and curiosity in science, have a willingness to investigate questions, and understand the value of science, through experiences that familiarize with science and technology. ○Have an interest in people involved in the fields of science or technology.	(Families) ○Raise the awareness of value of science and the necessity of science literacy while learning together with children. (Prime) ○Continuously have an interest and curiosity in science and technology and a willingness to investigate questions. ○Desire to act to maintain sustainable society.	○Obtain a lot of information concerning science and technology, and have a continuous interest and curiosity. ○Desire to act to maintain sustainable society.
Knowledge and understanding	・Able to scientifically explain about familiar natural phenomena and mechanisms of technology. ・Understand the nature of science and technology. ・Understand that human life has been changed by technology. ・Understand that science and technology are mutually reliant.	○Understand familiar natural phenomena and mechanisms of technology through experience and realize one's own capability of understanding.	○Acquire scientific knowledge that directly relates to the daily life through experiences that familiarize with science and technology. (*3)	○Broaden understanding of knowledge and roles of science and technology related to the daily life and the society.	(Families) ○Deepen and broaden understanding of knowledge and the concepts, of science and technology that support living and society while learning together with children. (Prime) ○Continuously deepen and broaden understanding of knowledge and the roles, of science and technology that support living and society by obtaining a lot of information.	○Continuously deepen and broaden understanding of knowledge and the roles, of science and technology that support living and society by obtaining a lot of information. ○Acquire scientific knowledge matching one's own interest and curiosity, such as hobbies and culture
Attitudes	・Find problems to investigate in order to solve issues. ・Collect and choose various information to apply to problems. ・Seek answers to questions using scientific methods. ・Consider various information and ideas before reaching conclusions.	○Actively investigate interested phenomena, engage in an activity and get one's own ideas.	○Have curiosity and interest in the natural world and human society and find patterns and relationships with interested phenomena.	○Lead conclusions based on scientific knowledge regardless of uncertain information. (*3)	(Families) ○Lead conclusions based on scientific knowledge regardless of uncertain information. ○Lead conclusions concerning problems in living and society comprehensively using what has been learned and with scientific ideas. (Prime) (*3)	○Lead conclusions concerning problems in living and society comprehensively using what has been learned and with scientific ideas. ○Utilize what has been learned to one's hobbies and culture.
Communication	・express appropriately one's own questions and ideas and convey it to people. Make decisions to solve problems using scientific knowledge and attitudes in the personal and social context. Analyze about the application of science and the implementation of technology and make decisions, taking into consideration advantages and risks for society and environment from a diverse points of view. ・Provide one's own scientific knowledge and ability in accordance with the social context.	○Get one's own ideas about interested phenomena and become able to engage in an activity with others.	○Express what has been learned and convey it to people in an understandable way. ○Consider what has been learned in relation to one's career development.	○Apply acquired knowledge and skills to the daily life considering the link with society. ○Apply what has been learned to one's career development	(families) ○Express what has been learned and convey it to people considering the link with society. (Prime) ○Identify problems of the local community and find the better way to solve them. (*3)	○Identify problems of the local community and make decisions to find the better way to solve them. ○Properly and effectively pass the knowledge and the abilities on to the next generation in accordance with the social context. (*3)

*1 The table shows four goals of continuous educational program framework to foster science literacy and four practical aspects for each of the targets.

*2 Darker shading indicates greater emphasis of practical aspects as goals for each generation and life stage of people.

*3 The targets written in yellow boxes are particularly important (emphasized goals) for applicable generation and life stage of people.

II. Practice of a continuous educational program framework to foster science literacy

1. Concept of the development of a continuous educational program framework to foster science literacy

- The National Museum of Nature and Science developed new educational programs mainly focusing on the five generations defined in this report in accordance with this framework.
- The Advisory Council set the major theme of “living and ourselves” and sub-themes under the major theme, which include water, food, and energy, considering the problems we are facing (water, food, energy, the earth and the humanosphere), which have been pointed out as problems related to living in the wisdom of science technology project, and concepts (energy, particles, life, the earth) stated in the revised curriculum guidelines.
- Although a wide range of goals were set for the development of educational programs, considering the diverse experiences, etc., of people, the major goals are those emphasized in this framework, from the aspect of lifelong learning. That was given as follows.

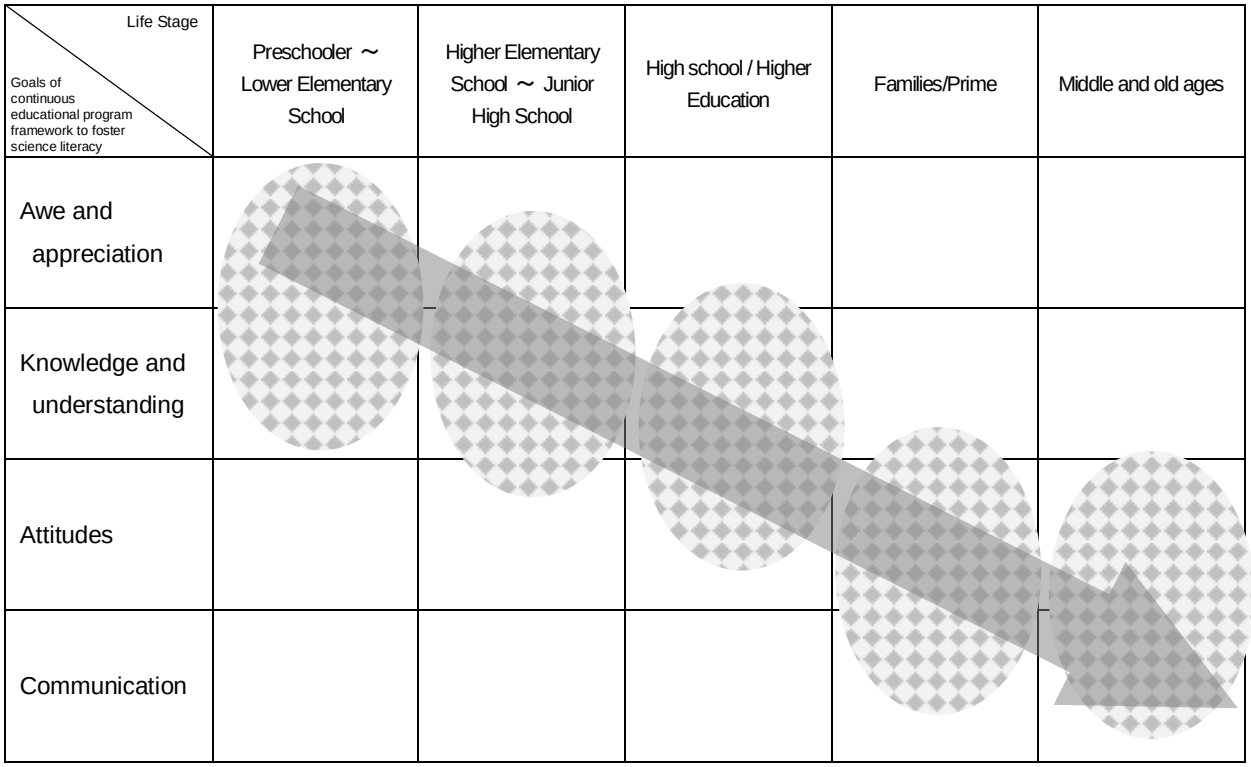

Figure 2. Major targets of scientific literacy cultivation programs for each generation of people (the shaded ovals are the main target areas for each generation of people)

- Learning programs were developed from broad aspects by regarding

themes as symbols of fields: “water = natural environment”, “energy = artificial environment” and “food = life of individual and culture”.

- Familiar subjects are used in the educational programs as the first approach of learning which motivates people in order to make museums more accessible. Additionally, the educational goals are set clearly which are emphasized on the each program for the smooth transition from the first approach to the next step of fostering science literacy.

An example of educational program (E3 Smart life cafe, see P.8)

An example of educational program (W2 Creating an exhibition at NMNS "Water", see P.8)

Examples of a continuous educational program framework to foster science literacy responding to social problems at NMNS

W1 Riddle playing cards / The story of the NMNS discoveries

Want to learn about the features of sea creatures,while playing.

Become able to scientifically explain about familiar natural phenomena and mechanisms of technology.

W2 Creating an exhibition at NMNS "Water"

Want to learn comprehensively about water,which is vital for our living, and convey what has been learned to other people.

Become able to express appropriately one's own questions and ideas and convey it to people.

W3 The story of water

Want to think about the mechanism to secure large quantities of water, which is vital for our living.

Become able to provide one's own scientific knowledge and ability in accordance with the social context.

W4 The earth, life and water

Want to attain knowledge of natural history by making observations outdoors, and convey what is experienced and knowledge attained to other people.

Become able to express appropriately one's own questions and ideas and convey it to people.

E3 Smart life cafe ~Saving energy helps to save money and the earth~

Want to think about energy problems by learning how to save money and energy in daily life.

Become able to make decisions to solve problems using scientific knowledge and attitudes in the personal and social context.

E4 Energy Labo

Let's talk about the future with beer in one hand!

Want to know about the new circumstances of energy at the site and convey what can be done for a sustainable society to other people.

Become able to express appropriately one's own questions and ideas and convey it to people.

F1 Knowledge of tasty vegetables in the fields

Want to observe familiar vegetables as plants, and learn the connection between our diet and vegetables.

Become able to scientifically explain about familiar natural phenomena and mechanisms of technology.

F2 Connection between volcanos and vegetables

Want to learn about volcanos, of which there are many in Japan, and the connection between volcanoes and the growth of vegetables.

Become able to scientifically explain about familiar natural phenomena and mechanisms of technology.

F3 The story of vegetables

Want to learn about the growth and the best season of vegetables that are familiar food, to use what has been learned to deal with food problems, such as food safety.

Become able to collect and choose various information to apply to problems.

F4 Fantastic rice plants

Want to deepen general understanding of rice-- the staple food for Japanese, including culture, history and industries related to rice, and convey what has been learned to other people.

Become able to provide one's own scientific knowledge and ability in accordance with the social context.

E2 Creating an exhibition at NMNS "Energy"

Want to learn comprehensively about energy, which is vital for our living, and convey what has been learned to other people.

Become able to express appropriately one's own questions and ideas and convey it to people.

E1 The story of the sun

Want to know how the energy of the sun is used in our daily life.

Become able to able to scientifically explain about familiar natural phenomena and mechanisms of technology.

III. Future prospects of a continuous educational program framework to foster science literacy

1. Preparation of a grand design

- Carrying the framework into action, transmitting decisions down the hierarchy is required through government policy and for implementation of the policy, etc. Grand design is vital to provide programs with close collaboration with school education, social education, home education and communities.

2. Growing human resources and provision of programs

- Growing human resources is necessary to carry the framework into action. People who can manage programs, devise and develop curricula and teach children and adults in learning programs are required.

3. Collaboration

Collaboration with various bodies to establish and share this framework

- It is vital to build a network of science museums centered on the Japanese Council of Science Museums for science museums to share a philosophy. Especially, The National Museum of Nature and Science has to play the role of taking the lead in establishing and sharing this framework.
- Establishing and sharing this framework could be promoted through the approach toward the policy relating to the national education of science and technology collaborating with institutions such as the Council for Science and Technology Policy as well as schools and the media: newspapers, TV, the internet, associated scientific societies such as the Science Council of Japan, industrial associations such as manufacturers' associations, etc.

Sharing information using information communications technologies (ICT)

- The use of information communications technologies (ICT) would be effective because there are no space restrictions. It is vital to publish a mail magazine to provide a continuous flow of information to curators and teachers. Interest in this information will rise because people will receive useful information in the magazine, after which it will be effective to set up a website to provide information and a social network to exchange opinions.

Establishing and sharing this framework for individuals

- This framework should be established for individuals, and shared with individuals, by accumulating scientific experience at various occasions in life with means such as issuing science literacy passports (tentative name) in order to share the results of learning performed by various generations of people in a way that suits their own problem consciousness.

4. Evaluation

- It is vital to assess whether or not this framework contribute to the development of science literacy. Assessment of the effectiveness of This framework should be made both at the time of the provision of the programs, and throughout the provision of the programs by conducting longitudinal surveys in some representative regions by means such as receiving feedback from people concerning the results of the dissemination of This framework.

An example of educational program (W1 Riddle playing cards, see P.8)

An example of educational program (F4 Fantastic rice plants, see P.8)

Afterword ~Promotion of lifelong learning~

- Although museums are operating in harsh circumstances, science museums are expected to contribute to the materialization of a knowledge-based society whose people can live in prosperity with a mature science culture by devising a continuous educational program framework to foster science literacy making the most of the proposals in this report and in accordance with the circumstances of the relevant region and each museum.
- With the establishment, sharing and provision of this framework in communities and at museums, the academic ability and the willingness of students and adults to learn science are expected to rise, and the international standards of lifelong learning can be maintained or even raised.
- International recognition, expertise and the significance of science museums in our country can be raised by enhancing the special functions of local science museums such as collection conservation; research activities; and exhibition and education required for fostering of science literacy.
- By doing the matters stated above, people will participate in solving problems related to the natural environment and social life, which means that people can actively benefit the community and local society using what they have learned; consequently, lifelong learning can be promoted.
- Various bodies are expected to promote school education and lifelong learning referring to this framework to suit each generation and life stage of people mentioned in this report.

An example of educational program (E4 Energy Labo, see P.8)

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Fostering public science literacy is vital to build a society in which people can live in prosperity.

Science literacy is a cluster of comprehensive abilities in science that people possess appropriate knowledge and ways of thinking regarding science and technology, deal with changes in natural world and human society, and make reasonable decisions and take actions.

I. Concept of a continuous educational program framework to foster science literacy at science museums

1. Necessity of fostering science literacy

- Science literacy is vital for people to properly respond to the problems concerning science and technology they face in social life.
- Fostering science literacy will materialize a society in which people can live in prosperity, in terms of the connection between individuals and society and globally.
- Lifelong fostering of science literacy should be conducted by diverse bodies including lifelong learning, organizations such as science museums, a variety of media, businesses, non-profit organizations, local communities and households, although schools are still required to play a basic role of it.
- For effective development of the matters outlined above, new methods and ideas such as programs for each generation of people are required.

2. Future social roles of science museums for fostering science literacy

- Assuming changes in the positioning of science in society.
- Fostering science literacy and raising the degree of maturity of science culture in order to build a society in which people can enjoy happiness throughout their lifetimes.
- Acting interactively by encouraging people to participate in society, in ways such as issuing a message to people and society.
- Showing new values and ideas as well as research results based on historical systems referring to the latest findings and trends of science and technology.
- Playing the role of organizations that assist lifelong learning, which facilitate self-realization of people, by systematically providing diverse programs that suit the different generations of people and the context of individual's life.
- Playing a role of assisting as liaison between diverse bodies that foster science literacy by integrating what is learned on the stage called the community.

3. Features of a continuous educational program framework at science museums

"A continuous educational program framework to foster science literacy" compose a continuous learning system to foster science literacy sought in each generation/life stage that focuses on issues in natural world and the human society.

Responding to diverse science fields

- Think extensively about science fields, which are diversifying, and the relationships between science and actual life.
- Active collaboration between science museums and various bodies.

Suiting each generation and life stage of people

- Provision of opportunities through collaboration between diverse bodies for people to learn at various stages of life to respond to the various scenarios in life.

New framework of learning

- The problem solving-type of learning is vital because the fields and methods of science education have changed.

Cultivating comprehensive views and ideas

- Cultivating the comprehensive abilities to attain comprehensive views and ideas concerning various events in society.

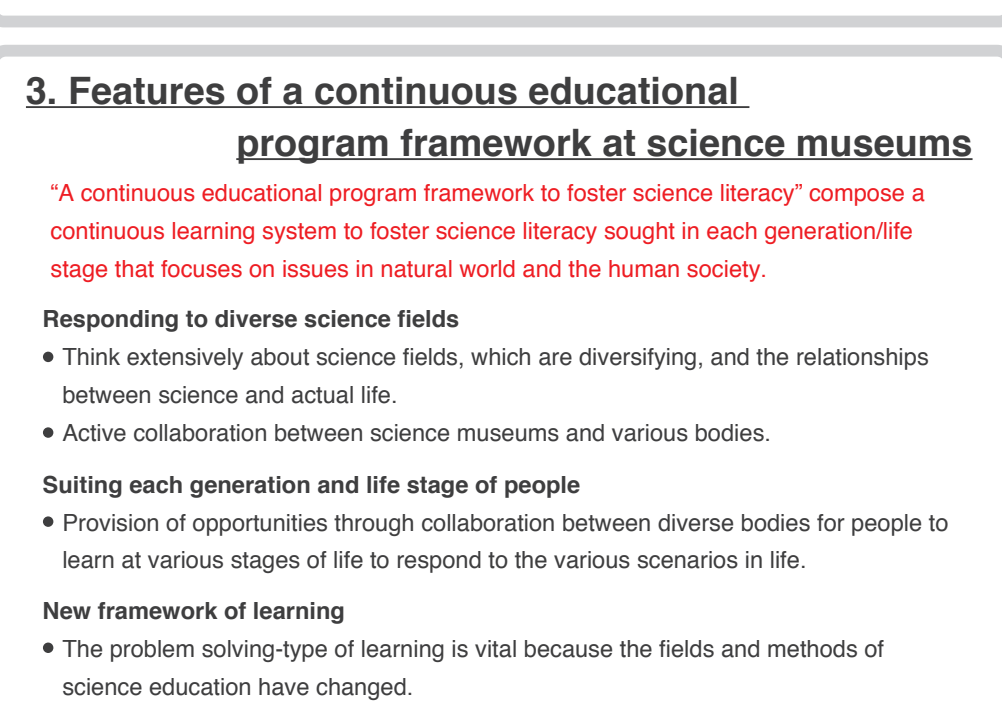
A continuous educational program framework to foster science literacy at science museums

<Four goals and five generations>

Goals of a Continuous educational program framework to foster science literacy \ Life Stages	Preschooler - Lower Elementary School	Higher Elementary School - Junior High School	High school Higher Education	Families / Prime	Middle and old ages
Awe and appreciation	Feel wonder of phenomena through experiences that familiarize with science and technology.	Feel curiosity and interest as well as the relationship between science and the daily life through experiences that familiarize with science and technology. Have a willingness to observe and investigate questions.	Have an interest and curiosity in science, have a willingness to investigate questions, and understand the value of science, through experiences that familiarize with science and technology. Have an interest in people involved in the fields of science or technology.	Raise the awareness of value of science and the necessity of science literacy while learning together with children. Continuously have an interest and curiosity in science and technology and a willingness to investigate questions. Desire to act to maintain sustainable society.	Obtain a lot of information concerning science and technology, and have a continuous interest and curiosity. Desire to act to maintain sustainable society.
Knowledge and understanding	Understand familiar natural phenomena and mechanisms of technology through experience and realize one's own capability of understanding.	Acquire scientific knowledge that directly relates to the daily life through experiences that familiarize with science and technology.	Broaden understanding of knowledge and roles of science and technology related to the daily life and the society.	Deepen and broaden understanding of knowledge and the concepts, of science and technology that support living and society while learning together with children. Continuously deepen and broaden understanding of knowledge and the roles, of science and technology that support living and society by obtaining a lot of information.	Continuously deepen and broaden understanding of knowledge and the roles of science and technology that support living and society by obtaining a lot of information. Acquire scientific knowledge matching one's own interest and curiosity, such as hobbies and culture.
Attitudes	Actively investigate interested phenomena, engage in an activity and get one's own ideas.	Have curiosity and interest in the natural world and human society and find patterns and relationships with interested phenomena.	Lead conclusions based on scientific knowledge regardless of uncertain information.	Lead conclusions based on scientific knowledge regardless of uncertain information. Lead conclusions concerning problems in living and society comprehensively using what has been learned and with scientific ideas.	Lead conclusions concerning problems in living and society comprehensively using what has been learned and with scientific ideas. Utilize what has been learned to one's hobbies and culture.
Communication	Get one's own ideas about interested phenomena and become able to engage in an activity with others.	Express what has been learned and convey it to people in an understandable way. Consider what has been learned in relation to one's career development.	Apply acquired knowledge and skills to the daily life considering the link with society. Apply what has been learned to one's career development.	Express what has been learned and convey it to people considering the link with society. Identify problems of the local community and find the better way to solve them.	Identify problems of the local community and make decisions to find the better way to solve them. Properly and effectively pass the knowledge and the abilities on to the next generation in accordance with the social context.

Particularly important (emphasized goals) for applicable generation and life stage of people.

II. Practice of a continuous educational program framework to foster science literacy



The Advisory Council set the major theme of "living and ourselves" and sub-themes under the major theme, which include water, food, and energy, considering the problems we are facing (water, food, energy, the earth and the humanosphere).

III. Future prospects of a continuous educational program framework to foster science literacy

For establishing, sharing and implementing this framework...

Grand design

Grand design is vital to provide programs with close collaboration with school education, social education, home education and communities.

Cultivation of human resources

People who can manage programs, devise and develop curricula and teach children and adults in learning programs are required.

Collaboration

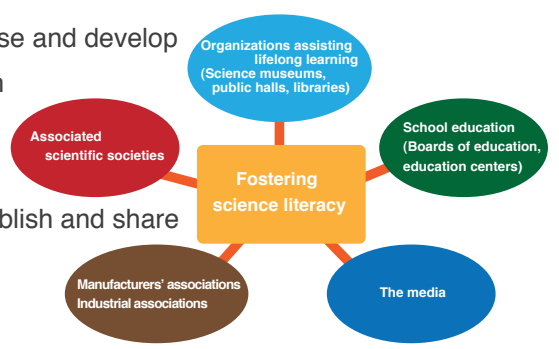
Collaboration with various bodies to establish and share this framework.

Sharing information using information communications technologies (ICT).

Establishing and sharing this framework for individuals.

Evaluation

Assessment of the effectiveness of this framework should be made.



Contribution to the promotion of lifelong learning by establishing, sharing and implementing a continuous educational program framework to foster science literacy.

A continuous educational program framework to foster science literacy at science museums <Four goals and five generations>

Generation and life stage		Preschooler ～ Lower Elementary School		Higher Elementary School ～ Junior High School		High school / Higher Education		Families / Prime		Middle and old ages
Learning environment		School education (basic learning based on curricula corresponding to the development stage, etc.)								
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	・Desire to observe and investigate questions.										
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	・Seek answers to questions using scientific methods.										
	・Consider various information and ideas before reaching conclusions.										
Communication	・express appropriately one's own questions and ideas and convey it to people.		○Get one's own ideas about interested phenomena and become able to engage in an activity with others.		○Express what has been learned and convey it to people in an understandable way. ○Consider what has been learned in relation to one's career development.		○Apply acquired knowledge and skills to the daily life considering the link with society. ○Apply what has been learned to one's career development		(families) ○Express what has been learned and convey it to people considering the link with society. (Prime) ○Identify problems of the local community and find the better way to solve them. (*3)		○Identify problems of the local community and make decisions to find the better way to solve them. ○Properly and effectively pass the knowledge and the abilities on to the next generation in accordance with the social context. (*3)
	Make decisions to solve problems using scientific knowledge and attitudes in the personal and social context.										
	Analyze about the application of science and the implementation of technology and make decisions, taking into consideration advantages and risks for society and environment from a diverse points of view.										
	・Provide one's own scientific knowledge and ability in accordance with the social context.										

*1 The table shows four goals of continuous educational program framework to foster science literacy and four practical aspects for each of the targets.

*2 Darker shading indicates greater emphasis of practical aspects as goals for each generation and life stage of people.

*3 The targets written in yellow boxes are particularly important (emphasized goals) for applicable generation and life stage of people.