Science-Centered And Fieldwork-Based Integrated Learning With Local Actions And Global Perspectives

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ABSTRACT

Masakazu GOTO who was a former science teacher and has been working as a researcher at NIER, developed the innovative curricula to show how interesting science learning was. He explains his practical experience as a science teacher and as a researcher of local nature and science education. He developed the innovative curricula (Goto, 1997a), the teaching materials (Kasai & Goto, 1988; 1998a; 1998b), the new assessment method (Masuda & Goto, 2002), and the educational system. The curricula were the student-centered, inquiry-based, fieldwork-based, integrated, collaborative and cooperative, and school-based. Science instruction is based on his idea to act locally and think globally. Therefore they think highly of real experiences including many fieldworks and hands-on activities. They were based on Earth Systems Education (Mayer, 1988) and Global Science Literacy (Mayer, 2002). He developed them into integrated learning by unifying the other subjects (Japanese, social studied, fine art and English, etc.) and established the network among the subjects and the partnership between school and local community. He worked as a teacher, a coordinator between school and museum, a facilitator to support student's study, a researcher of local nature, an instructor for the museum, and a volunteer for local society. His curricula were awarded the best science education prize of Toray corp.. (Goto, 1997a)

Key words: Integrated Learning, Integrated Curricula, Fieldwork, Earth Systems Education, Global Science Literacy

Introduction

The educational reform is happening all over the world. In the age of decentralization and information, teachers are requested to organize their own curricula dynamically considering their locality and globalization. Global Science Literacy (GSL) as a curriculum construct, seeks to broaden students understanding of the nature of science and include the objectives (fostering global views and understanding of different cultures, etc.) of the Global Education in the social study. It is based on Earth Systems Education (ESE). Its basic philosophy is based on the systems view and thinking. It is that science is the process that we as humans use to understand the world we live in and its environment in space (Mayer & Fortner, 1995). Therefore all science instruction should start with some aspect of the Earth systems (biosphere, solid earth, atmosphere and hydrosphere) which are local natural environments, and expand to the solar system, or the universe. As we live on Earth, the central and important subject for science teaching should be the Earth, particularly our familiar natural environments. Science teachers should teach science through not textbooks but real experiences. They should also teach science through the integrated ways and holistic approaches as much as possible in addition of the disciplined ways. It is the best way that children learn science in the life-related contexts (real experiences) because their learning is not based on disciplined but

integrated. Wherever possible we should start with fieldwork in familiar environments and expand our study from local natural environments to such wider areas as regional environments, national environments, global environments and at last, the universe. GSL & ESE focus on the science knowledge that will enable the world's citizens to understand the need for global efforts at environmentally sustainable economic and social development. It can also contribute to the Education for Sustainable Development (ESD) (UNESCO, 2004). Outdoor education and fieldwork provide an important basis for learning about the Earth Systems. Since the Earth systems must be the focus of science education for a sustainable future, outdoor education (fieldwork) must be a focus of science education efforts, not just something extra to be added-on to school curricula if convenient. It integrates children's learning because of its character. Therefore the fieldwork program will be central to efforts to accomplish the goals of the science education of the future and be necessary for the integrated learning in the age of decentralization of education in the 21st century.

General Description of the Integrated Curricula

As a science teacher in Minami-shitaura lower secondary school, one of the lower secondary schools of Miura City, Masakazu GOTO developed the curricula (Goto, 1997a) for the seventh and ninth grades of his school which addressed integrated learning centered on fieldwork (outdoor learning). Because his students' fieldwork was in their local area it provided practical integrated learning closely related to their daily lives. The collaborative study among students in fieldwork not only teaches them how to cooperate in scientific research but also facilitates their communication abilities.

Each student did five field related projects, each with a different purpose. The content of each project was organized to help the student to understand the local environment and to acquire the knowledge and skills needed to conduct the fieldwork through a range from introductory level to advanced level. In the last field project each student developed a proposal for his or her own fieldwork which was subject to my advice and approval. The students then conducted their study on their own time, after school and on weekends. Therefore they had ample time to complete their research. In their research they were often required to know content from subjects other than science. In this way their interests were broadened from science to other subjects. As their teacher, then, he organized the science-centered integrated curriculum (Fig.1) to include content from other subjects.

Relationships with Other Subjects

Japanese (Language): Students learned from an essay about the wild birds in Japan during their Japanese class. In cooperation with the Japanese teacher, science teachers took their students to observe and investigate the birds in their local place near the school. A local expert on bird-watching was invited as an instructor. They appreciated bird-watching guided by him much more after knowing about the birds through reading the essay in the Japanese lesson.

Homemaking: Students investigated flora and fauna in the fieldwork of the science lesson. After that, with assistance of the homemaking teachers, they cooked and ate some of the plants and animals such as fried vegetables with cone flour, grilled horsetail with sweet soy sauce flavor, dandelion coffee and fried fish and beetles. That experience made students familiar with the local environment.

English: Students wanted to make use of English and communicate with each other through English. The fieldwork was a nice opportunity for them to use English by interacting with real materials (flora and fauna) and each other in the outdoors. They enjoyed using English in their science lessons and became proud of their communication abilities in English. Even the students who didn't like the regular English lessons showed their interest in English communication by identifying their findings in nature. English teachers developed some English textbooks like Encyclopedia on the Miura Peninsula and Flora and Fauna on the Muira Peninsula in cooperation with science teachers. Science and English teacher-teams made the study of science and English interesting through experiments

and fieldwork conducted in English. The eighth grade students also made paintings of some plants and wrote a poem about them in English.

Fine art: The seventh grade students drew a sketch of a natural object found in the outdoors. The eighth grade students also carved a wood plate whose motif was the flora and fauna found in nature. The seventh grade students' knowledge, understanding and experience on nature in the science fieldwork were helpful for their drawing their sketch. The eighth grade students could also select the flora and fauna as a motif with some knowledge about the nature, in making their sculpture work. Science teachers helped fine art teachers to hold these lessons in the fine art class.

Social studies: Social studies are related to the fieldwork because students learned about their local community through investigating it. They became interested in the local history and the environments where plants grew. They also became acquainted with environmental issues such as nature conservation, contamination, and garbage problems. The fieldwork deepened the relationship between science and social study. In the third field project students collected many beverage cans thus cleaning up and beautifying their local area.

Other subjects: In the future such integrated learning can be expanded by including activities such as those related to music and technology (making musical instruments and playing them in a natural cave), and physical education (country trekking while appreciating the beauty of nature).

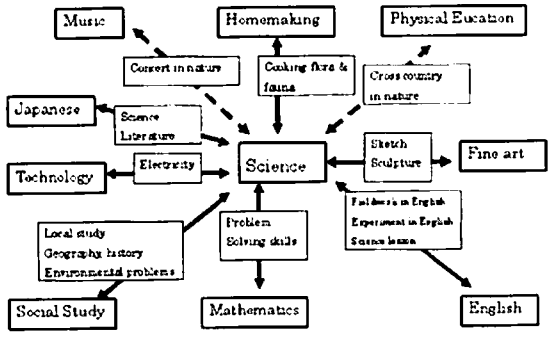

Figure 1. Integrated curriculum network in school

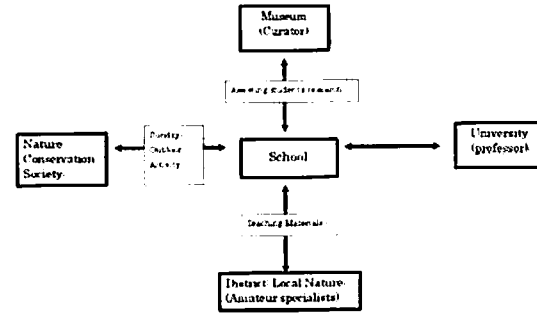

Figure 2. School-centered network

The Learning Network (Goto, 2000a) Making use of public facilities and personnel:

Students found many plants and animals, and identified different geographical features in their local areas. Teachers could not respond to all of their findings and ideas. Therefore the students needed to make use of local specialists, such as museum curators, who could support and facilitate their learning. Therefore teachers established a learning network (Fig. 2) including school and out-of-school resources. Teachers not only taught science in the class but also coordinated such a learning network.

The museum: Students found many plants and animals. Subsequently, some students visited the museum on the Saturday afternoons or on Sundays so that curators might help identify their specimens. They had an opportunity to see how specialists identified and investigated flora and fauna. Some students interested in nature attended Sunday field excursions conducted by the museum staff.

The nature conservation society: The nature conservation society offers a field excursion once a month. Teachers often advised students interested in nature to join these trips. Some students joined such field excursions as bird-watching and nature walks. Science club students often participated in them during the three years they attended my school. They reported on their activities in club meetings and participated in science competitions. In 1996 several science club members were awarded the

governor's prize for their excellent work.

The integrated learning includes not only science but also homemaking, Japanese languages, fine art, social study, technology (its content related with science), mathematics (graphs and statistics), and English. he collaborated with several teachers of other subjects in order to coordinate and facilitate students learning the goals established in these subjects. In these curricula students deepened their understanding of science and got more interested in science through knowing the relationship between science and other subjects.

In order to improve his curricula he developed a plan to make use of such community resources as museums, universities and institutes and their personnel. For example, he invited specialists and local experts on bird-watching, geology and flora and fauna of the Miura Peninsula to visit his classes and instruct his students about their interests. He also took interested students to the museum for their study on Saturday afternoons and Sunday. After students had completed their research, he arranged to exhibit their results in the local community hall so that they would have an opportunity to communicate them to local citizens. Integral to his curriculum leads the learning network (fig.2). The learning network has many levels. For example, the network of school subjects, the network of students' communication, the network of school and community facilities.

His school is now linked to the Internet so the future students in the school will also be able to communicate their research to students in other schools and people out of school. This capability will further improve their in-school learning. Students will extend their learning from the school to their local community, from their school to the nation of Japan, and finally from their school to the world through the Internet. They will make use of various informations sharing networks and thus expand their learning organically. He call this method of fieldwork-centered and student-centered science learning, Expansive and Organic Learning (Goto, 1997b; 2002). It is based on the basic principles of Global Science Literacy.

Considering the real purpose of education at school, teachers should think more highly of improving students' various abilities in addition to the ability to answer questions and solve problems. Teachers must help students foster the ability, interest, attitude, and skills to continue to learn for the enrichment of their lives during and after their school years. Integrated curricula and student-centered instruction are good examples of instructional processes that can increase student interest in science. Learners, whether they are students or teachers, expand their worldview through learning. They find out about themselves and their local environments, and how to live and enjoy their lives through learning and care about their native place. This contributes to the education for a life-long learning society for sustainable development which is supported and can only be sustained by socially and scientifically literate people.

Teaching Method

The teaching methods he used were inquiry-based, student-centered and interactive approaches and include team-teaching. He included several kinds of fieldwork for different purposes. They include fieldwork where he decided the topic or objective and other fieldwork where the student made the decision. He also used individual to small and large group activities. As students develop and expand their learning from science to other subjects in these curricula, he cooperated with teachers of other subjects to plan. When students made use of community resources in their learning, he coordinated the teaching with the specialists.

Teacher's Role

In the fieldwork-centered curricula, a science teacher should correlate and integrate the classroom science lesson with the fieldwork. He should also show students how to apply their knowledge and

skills mastered in the classroom to the real natural world. Therefore he should carefully plan the daily classroom lesson as well as the fieldwork. He should also hold interesting lessons in the classroom in order to facilitate student's research in the outdoors. Also a science teacher should play a central leading role in coordinating and organizing the fieldwork-centered curricula with other subject teachers because science is focused as a central subject in these curricula. Finally, they should coordinate students' questions to the community specialists related to their discoveries and participate in the informal learning experiences that occur outside of the school with an aim to expanding students' studies if necessary. For the last ten years teachers developed many teaching materials to support and facilitate students study and investigation of the local nature.

Development of Teaching Materials

Teachers developed the following teaching materials to support and facilitate students study and investigation of the local nature, society, history, economy etc.

a. *Our Native Place, Miura* (Kasai & Goto, 1988)
b. *Plants Encyclopedia on The Miura Peninsula* (Kasai, T. et al., 1988).
c. *Trees pictorial encyclopedia with real specimens like flowers and leaves* (Goto, 1986)
d. *Nature on the Miura Peninsula* (Miura City Board of Education, 2000)
e. *English Education in the New Grammatical Theory* (Kasai & Goto, 1998a)
f. *The 2nd English Education in the New Grammatical Theory* (Kasai & Goto, 1998b).
g. *Kou-chan's Adventure in the Wonderland of the Linguistic World* (Goto, 2000c).
h. *A Guide to Nature Observation* (Shibata,1999; Goto,1999)

Some of them would be explained shortly as follows:

Our Native Place Miura (English-language edition): It is an English-language edition of the side reader of the social study which explained a native place Miura. At present, training of communications skills in English education is one of the issues in Japanese English education. It devised so that a student could explain their native town in English easily about familiar nature and society, history, industry, or economy by using the side reader which can be studied in English about their native town in order to solve the issue This side reader does not only make students participate in English study very enthusiastically but it is used also for ordinary citizens by international exchange with those of Warrnambool, sister city in Australia.

Plants Encyclopedia on The Miura Peninsula: It is an encyclopedia which can be used for the cross curriculum of the science, English, and the fine-arts education published for the secondary education at the age of internationalization. After studying the plant of a hometown on the Miura Peninsula, students compare their local plants with those in Nagano Prefecture which goes by a camp school and moreover with those in Warrnammbool their sister city in Australia. The diversity of plants can be studied by comparing. "Act locally and think globally" education can be practiced through such field studies by using this encyclopedia. This is a collaborative work of the teachers of various subjects, students, and average citizens. The writers and drawers were a senior and an acquaintance. When investigating familiar plants, he sketched by having identified the plant, added explanation in English, and performed field study very enthusiastically.

Trees pictorial encyclopedia with real specimens like flowers and leaves: The trees of a school serve as good teaching materials. However, the student may be unable to identify trees correctly other than the time when the flower is in bloom. It was developed the pictorial book with real specimens, such as flowers and leaves, and 12 photographs thorough a year so that the familiar tree planted in school could be identified at any time all the year round. Since photographs was taken for a flower, a bark, a tree shape, a leaf, etc. which are the features of trees in the photograph every month, trees could be identified easily by every student.

Nature of Miura: It is a side reader which he can use when the first-year student in a junior high school in the Miura city performs flora and fauna observation and layer observation. The 200-page

book is published in the all colors with the photographs of 400 or more plants observable in the Miura city. Each photograph has intelligible brief description and the worksheet and the model observation route. In three courses for geology observation in the second half part students can observe the typical rocks and strata in the Miura city. The book also includes the description about a question, an experiment, etc. on each point for the courses, so that a student can do study by himself with the surroundings. Since the student can conduct research and natural investigation using this book, it can be used not only for science study but for integrated study.

English education by a new grammar theory: This is the book developed in order to create innovative English education in a junior high school using a new scientific language theory "generative transformational grammar," which was developed by Dr. Noam Chomsky at MIT. Although school grammar was shown by the traditional English education, using the generative transformational grammar theory gave students a concrete chance to learn scientifically about English education or language with the textbook of English for a junior high school. Since the contents were difficult, only description of an essential point could be performed. However, it was the first trial for teaching science and English in the same class, or making an opportunity to study language scientifically, and the student could catch a glimpse of the relation of science and a language theory. It became an interesting lesson especially for excellent students.

A guide to nature observation: It is broadcasted in NHK a program of a guide for children to do nature observation in 1999. These days, there are taken up problems with a child' s insufficient natural experience. This TV program was made for the student of a junior high school from the child of elementary school upper classes to play and investigate in nature during the summer vacation. The TV program for 15 minutes consists of ten, which covers all the familiar nature where children can perform observation, exploration, and research. The book tied up with the program was marketed. The book is made of 110 pages, including pictures, descriptions, worksheets, and introduction of the natural history museum etc. so that a child may watch a program and can actually perform natural investigation and research. The TV program was devised with synthetic contents so that children "Act locally and think globally".

Educational Effect

He thought there were many educational benefits of the field-centered, student-centered, inquiry-based and integrated science-centered curriculum. Some of them are:

(1) Students got more interested in their local environment, appreciated and loved their birthplace much more than before.
(2) Integrated learning could make students understand the relationship among different school subjects in studying real situations and appreciate fun of study in the integrated ways. A school-centered network was established by science teachers.
(3) More students became interested in science and the science lesson.
(4) Some students joined volunteer activities to conserve the local nature.
(5) Some students contributed to developing the teaching materials for science education
(6) Students and teachers cooperatively held a special exhibition in the city hall in order to show and exhibit their research results and other works related to fine art and Japanese language. This exhibition gave an opportunity for students and local people to communicate through their work. It contributed to civic understanding of school education. Parents also were proud of their children's work and understand school education much better.
(7) The Science Lab became a school museum where students' work was exhibited along with many teaching materials and tools.
(8) Some excellent students were awarded the governor prize of the Kanagawa Prefecture for their researches on local nature. Many students joined the science club because they were deeply impressed by the achievement of science club students and they were on TV after being

interviewed by TV staffs for their great achievement.

Summary and Conclusion

Japan introduced the New Course of Study (1998), so to speak, the Japanese National Curriculum in 2002. The objectives "Zest for Living" of the new Course of Study are to foster self-learning and self-thinking ability for life-long learning. The main themes of the New Course of Study are Introduction of Integrated Study, Five-day school system, and Inquiry-based Learning. Fostering a zest for living is to cultivate an ability to learn, think, judge and act on their own and to solve a problem. Teachers at each school are expected to design the time for Integrated Study on their own character and ingenuity for cultivating such an ability. They should collaborate with each other, make use of such resources as the out-of-school facilities and resource persons education for implementing the better Integrated Study and establish the partnership with local persons and the network with facilities to create the enriched quality school.

Science is human beings' common culture. Science instruction is education which enables common communication in the world beyond the diversity of all the language, culture, and society. The science instruction using the natural environment of the local area develops into integrated study reasonable, as shown above. Therefore, it is possible to use science instruction as the core of integrated study. Since Earth Systems Education relates with the systems of familiar nature or the earth the contents which a student learns, and since GSL contains the target of the global education which raises understanding of different cultures and thinking on the global perspectives, it gets used with the base of not only integrated science education but integrated learning.

The Education for Sustainable Development proposed by UNESCO is expected to be implemented in the time for the Integrated Study. ESD (UNESCO, 2004) is fundamentally about values, with respect at the center: respect for others, including those of present and future generations, for difference and diversity, for the environments, for the resources of the planet we inhabit. They are related with the objectives and instruction methods of Earth Systems Education (ESE). ESD mirrors the concern for education of high quality, demonstrating characterisitics, such as interdisciplinary and holistic, value-driven, critical thinking and problem-solving, multi-method, participatory decision-making and locally relevant. ESE emphasizes it, too. It calls for a re-orientation of educational approaches for its curriculum and content, pedagogy and examinations. The teacher needs to develop teaching materials, teaching tools, curricula, and methods considering the actual situations of his local area to carry it out.

The philosophy of Global Science Literacy and Earth Systems Education can provide a rationale and basis for integration of not only content from the disciplined sciences but also such different subjects as fine art and social studies. It agrees mostly at the objectives of ESD. It is very effective as an organizing philosophy for the total integrated curriculum as well as for the integrated science curriculum in the 21st century.

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