A Case Study on the Curriculum Development of ICT Education with Special Emphasis on Spiral-Approach

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1. Background

In Japan the Fundamental Law of Education or the Basic Act on Education sets forth the basic national aims and principles of education in accordance with the spirit of the Constitution of Japan; “All people shall have the right to receive an equal education corresponding to their ability, as provided by law. The people shall be obligated to have all boys and girls under their protection receive ordinary education as provided for by law. Such compulsory education shall be free.” (Article 26).

The Basic Act on Education, which was promulgated and put into effect in March 1947, sets forth in more detail the aims and principles of education in accordance with the spirit of the Constitution, defining the central aim of education as “the full development of personality, striving for the rearing of people, sound in mind and body, who shall love truth and justice, esteem the value of the individual, respect labor and have a deep sense of responsibility, and imbued with an independent spirit, as builders of a peaceful state and society.” To achieve this aim, the Law sets forth national principles of education such as equal opportunity of education, nine-year compulsory education, coeducation, and prohibition against partisan political education. In it are established as specific national principles of education: equal opportunity, compulsory education, co-education, school education, social education, prohibition of partisan political education, prohibition of religious education for a specific religion in the national and local public schools and prohibition of improper control of education.

Nevertheless, the circumstances surrounding education have changed greatly in respects such as the progress of science and technology, advanced information technology, internationalization, the ageing society with falling birthrate, and family lifestyles. At the same time, the environment surrounding children has changed significantly, and a variety of issues have come to light.

In light of such circumstances, the existing Basic Act on Education was completely revised and the revised law established in December 15, 2006. The revisions to the law clearly set out principles for education considered to be extremely important today while at the same time inheriting the universal principles set out in the previous law. Such principles include placing value on public-spiritedness and other forms of the “normative consciousness” that the Japanese people possess, as well as respecting the traditions and culture that have fostered said consciousness.

In addition, the Basic Act on Education prescribed that the “Basic Plan for the Promotion of Education” be formulated to lay down the basic policies and measures to be taken to promote education. The first comprehensive plan by the Government about education was formulated on July 1st, 2008.

More specific provisions relating to the school system, educational administration, financial support and other matters are specified in the School Education Law and many other education laws and regulations which were enacted based on the spirit of the Fundamental Law of Education.

Under this general framework, major characteristics of each of the different types of institution of formal education, Kindergarten, Elementary Schools, Lower secondary Schools and Upper secondary Schools, are decided by the Japanese Government.

With regard to the teacher training, elementary and secondary school teacher are trained mainly in the universities (including graduate schools) or junior colleges approved by the Ministry of Education, Culture, Sports, Science and Technology (hereafter called MEXT).

Most elementary school teachers are trained at 4-year elementary teacher training courses at universities under the umbrella of the national university corporate. Lower secondary school teacher are trained mainly at such types of universities as those under the national university corporate, local public or private universities, while upper secondary teachers are trained at universities (undergraduate courses) and graduate schools, universities under the national university corporate, local public and private.

In order to become a teacher of an elementary or secondary school, one is required to obtain a teaching certificate awarded by the prefectural Board of Education under certain conditions. For each level or type of school, teaching
certificates are classified into three major categories: regular, special and temporary. The regular certificate is subdivided into three classes: advanced, first and second. In addition, for the lower and upper secondary school levels, each type of certificate is further divided into several categories according to the kinds of subjects.

2. General Framework of School Curriculum Development

MEXT lays down the educational contents and the minimum number of school days per year for kindergartens, and the subjects to be offered in elementary, lower secondary and upper secondary schools, as well as the standard number of yearly school hours for each subject in these schools.

MEXT also specifies objectives and standard content of each subject or each area of school activity in the “Course of Study”, which presents national guidelines for the curriculum for each of the four school levels such as kindergarten, elementary school, lower and upper secondary school, while in the teacher training universities the objectives and contents of subjects required for receiving certificate are able to decide in principle by each university itself. The content of the Courses of Study for the respective schools is prescribed and announced by MEXT based on a report uts advisory organ, the Central Council for Education.

Each school organizes and implements its own curriculum in accordance with the provisions of the relevant statutes and the Course of Study, and also in due consideration of the actual circumstances of the school and the locality in which it is located, as well as of the characteristics of children enrolled and the stage of their mental and physical development.

Taking an example from the latest version of the Course of Study for Elementary School opened to public in 2008 and put effective in 2011, it says in the ‘Chapter 1 General Provisions’ the general policies regarding curriculum formulation and the treatment of the contents as follows; namely, for the General Policies regarding Curriculum Formulation, ‘

1. Each school should formulate a proper curriculum in compliance with the Basic Act on Education, the School Education Act, the provisions of other laws and regulations concerned and those indicated in this chapter hereinafter, in order to accomplish the well-balanced development of individual pupils as human beings, with full consideration toward the circumstances of the school and its local community, and toward pupils’ stages of mental and physical development and their individual characteristics, thereby conducting education to achieve the goals listed in the above documents.

In providing educational activities, each school should create specifically tailored educational activities by making use of originality and ingenuity, in order to foster in pupils a zest for life. In doing so, each school should be committed to enhancing its instruction to enable pupils to solidly acquire basic and fundamental knowledge and skills, to foster the ability to think, to make decisions, to express themselves and other abilities that are necessary to solve problems by using acquired knowledge and skills, to cultivate an attitude of proactive learning and to develop pupils’ individuality. In working toward these goals, each school should enhance its pupils’ language activities, giving consideration to the developmental stages of the pupils, and in cooperation with pupils’ homes at the same time, consideration should be given to help pupils establish good learning habits.’

2. Moral education should be implemented throughout all educational activities with moral education classes being the primary period in which it is administered. Therefore, each school should give proper instruction not just during the moral education classes, but during the classes for all subjects, foreign language activities, the period for integrated studies and special activities, in accordance with their respective characteristics, while giving consideration to the developmental stages of the pupils. The objectives of moral education are based on the basic spirit of education stated in the Basic Act on Education and the School Education Act. Moral education is aimed at cultivating morality as a foundation for developing Japanese citizens with a proactive attitude who would apply a spirit of respect for human dignity and reverence for life in specific activities at home, school and other social situations, have a generous spirit, respect traditions and culture, love one’s country and hometown which have fostered such traditions and culture, create culture with a distinctive character, honor the public spirit, make an effort to develop the democratic society and state, respect other countries, contribute to world peace and the development of the international community and the preservation of the environment, and have interest in exploring possibilities for the future. In providing moral education, each school should give consideration to deepening the human relationship between teachers and pupils and amongst pupils themselves, helping pupils think deeper about their own ways of life and developing their inner sense of morals by providing them with rich experiences in cooperation with pupils’ homes and the local community, such as overnight school trips, volunteer work and experiential learning activities in nature. Particular consideration should be given to help pupils acquire basic life habits and social rules, learn to make judgment on what is right and what is wrong and refrain from doing anything wrong as a person.
3. Each school should give proper instruction on physical training and health promotion through all of the school’s educational activities, while giving consideration to the developmental stages of the pupils. In particular, with respect to instruction on promoting dietary education and developing physical strength, safety-related instruction and instruction on maintaining and promoting both mental and physical health, such instruction should take place not only in the physical education period but also in the periods of home economics, special activities and other educational activities, in accordance with the characteristics of each period. At the same time, each school should give consideration so that pupils will develop the foundation necessary to live safely, healthily and actively throughout their entire lives, by way of encouraging proper physical training and health promotion in pupils’ daily lives in cooperation with their homes and the local community.'

And for the Treatment of the Contents,

1. All schools are obliged to deal with the items listed in Chapter 2 onwards concerning all subjects, moral education, foreign language activities and special activities, except in special cases otherwise indicated.
2. When it is particularly necessary, each school may include additional contents not specified in Chapter 2 onwards. It is possible to teach contents beyond what is stated in Treatment of the Contents. However, in this case, care must be taken not to deviate from the objectives and contents of all subjects, moral education, foreign language activities, special activities and those of each grade described in Chapter 2 onwards, nor impose an excessive workload on pupils.
3. The order of the items listed in Contents regarding all subjects, moral education, foreign language activities and special activities or the contents of each grade, which appears from Chapter 2 onwards, does not reflect the order of instruction to be given unless otherwise specified, and each school should make proper adjustments to the treatment of these items.
4. The contents of subjects and foreign language activities whose objectives and contents cover two grades are the items to be taught over a period of two school years. Each school should give instruction throughout the course of two years in a planned manner in two separate grades or in either grade, unless otherwise specified, in accordance with the circumstances of the pupils, school and local community.
5. Each school does not necessarily need to follow the grade-wise order of the instruction items for all subjects, moral education, foreign language activities, and special activities in such special cases as in classes composed of pupils from two or more grades, provided that the objectives of all subjects, moral education, foreign language activities, and special activities can be achieved.’

3. New Curriculum Coping with the Information-oriented Society

Table 1 shows the summary comparative of the distinctive features of curriculums according to several viewpoints such as Approach, Focus, Role of teachers, Emphasis, Learning activities, Major posture, Role of teacher, Task, Topic and Error. This reminds us the change of society, not change in society, suggested in the literature ‘The Third Wave’ written by Alvin Toffler in 1980 pointing out that Family- and community-based society as the ‘First Wave,’ society representing principles such as Normalization, Specialization, Concentration and Centralization as the ‘Second Wave’ and society represented by Diversity caused by the co-existing of heterogeneous factors. In addition, these findings bring us to the trends of educational software development shown on Table 2.

In elementary and secondary school education, it has become a nation wide assignment to prepare students with the necessary qualifications for an advanced information telecommunication network-based society in the future so that they will be able to take appropriate measures for the computerized society.

In information education at schools, children learn how to operate computers, how to select the necessary information subjectively from a considerable amount of information and transmit such selected information as their own (called as “ability to exploit information”). The revision of the Course of Study also contributes to the generous promotion of information education.
Table 1  Is this ‘New Curriculum’ - New Developments in Teaching and Learning

<table>
<thead>
<tr>
<th>Viewpoint</th>
<th>Until 1990’s</th>
<th>‘New’ Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach</td>
<td>Emphasis on Content</td>
<td>Process-oriented</td>
</tr>
<tr>
<td>Focus</td>
<td>Teacher-centered</td>
<td>Learner-centered</td>
</tr>
<tr>
<td>Role of Teacher</td>
<td>Expert</td>
<td>Supporter, guide</td>
</tr>
<tr>
<td>Emphasis</td>
<td>What to know?</td>
<td>How?</td>
</tr>
<tr>
<td>Learning activities</td>
<td>Individual</td>
<td>Group</td>
</tr>
<tr>
<td>Mental posture</td>
<td>Competitive spirit</td>
<td>Collaboration</td>
</tr>
<tr>
<td>Role of Learner</td>
<td>Passive</td>
<td>Active</td>
</tr>
<tr>
<td>Task</td>
<td>Premeditated</td>
<td>Adaptive</td>
</tr>
<tr>
<td>Topic</td>
<td>Forced</td>
<td>Deliberation</td>
</tr>
<tr>
<td>Error</td>
<td>Failure</td>
<td>Accepted, learn from errors</td>
</tr>
</tbody>
</table>

Table 2  Trends of Educational Software Development

<table>
<thead>
<tr>
<th>Viewpoint</th>
<th>Past</th>
<th>Present and future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Oriented</td>
<td>Free content modified with software on the web/electronic networks</td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td>Explorable with and without network capability</td>
<td></td>
</tr>
<tr>
<td>Teacher driven</td>
<td>Learner-centered (disorientation)</td>
<td></td>
</tr>
<tr>
<td>Instructional</td>
<td>Open-ended (distraction)</td>
<td></td>
</tr>
<tr>
<td>Individual base</td>
<td>Collaboration (ex. Cooperation in writing on the web)</td>
<td></td>
</tr>
<tr>
<td>Age dependent</td>
<td>Promoting continuity (Age independent)</td>
<td></td>
</tr>
<tr>
<td>VDU centered</td>
<td>Multimedia with the Internet capability</td>
<td></td>
</tr>
<tr>
<td>Text</td>
<td>Image</td>
<td></td>
</tr>
<tr>
<td>Vague and uneasy to understand</td>
<td>Intuitive</td>
<td></td>
</tr>
</tbody>
</table>

With regard to the information education at schools, children learn how to operate computers, how to select the necessary information subjectively from a considerable amount of information and transmit such selected information as their own (called as “ability to exploit information”). The revision of the Course of Study is also sure to contributes to the generous promotion of information education.

On the other hand, for further utilization and teaching learning of ICT in higher education including teacher training universities, the Government partially revised the Standards for the establishment of Universities in March 2001 and make institutional amendments to quality classes using the Internet as formal classes. The government also has been promoting the exchange of studies on education through joint classes and workshops between universities that are located far away from one another, by connecting such universities by satellite communication, which may be one of the examples to consider the content of the ICT curriculum in teacher education universities.

The Government still keeps on working toward improving the foundation of ICT environment and increasing students’ information literacy, and will also establish specialty courses and information-related courses with the aim of fostering specialists who will play an important role in developing the advanced information telecommunication network-based society of the future.

In this connection, we are now ready to learn from the basics of the methods on curriculum development in school science education curriculum.

4. Lessons from the School Science Education Curriculum

The Courses of Study for the respective schools, elementary school and secondary schools were revised almost every ten years and their latest versions were made public in 2008 and 2009. Through the comparison of descriptions in General Provisions of the present and latest versions, it is clearly found that all teachers at all school levels are much more expected to consider about the stage of children’s mental and physical development when they develop the curriculum in schools.

The area covered by the curriculum during compulsory education, elementary and lower secondary levels, to which the author preferably would like to include the upper secondary school level due to the full enrollment there right now, has grown wider. Hence this reminds us a ‘real situation’ in society and in education as well.

As we agree from the statements in the Courses of Study and related documents by the MEXT, the curriculum includes the whole experiences which a learner undergoes during schooling, and covers the educational aims and goals,
courses, classroom activities, teaching and administrative staff-student relationships, resources and many other factors which impinge on the teaching-learning situation in schools.

In science education, the fundamental scientific concepts are ‘energy,’ ‘matters,’ ‘life,’ and ‘time and space.’ All of these are taught in elementary to lower secondary schools in the sense of ‘Spiral Approach’ targeting as goals both ‘Fostering ability and attitude to do science’ and ‘Development of scientific concepts and view of nature.’

In this connection, just like this science education in schools ICT education will also have to identify fundamental concepts to make them arrange in terms of concept formation, though ICT and its related fields are still rapidly developing and hence it is harder to finalize now.

5. Education Now and the Future

Responding to the change of society ‘Learner-centered approach’ is now becoming reconsidered as one of the key issues in globalized education as shown on Tables 1 and 2. This is characterized by both (1) Learn with focus on learners, and (2) Learning in a real situation, which differs for individual learner, and teachers should therefore facilitate so as to enable their students to learn from experience, activities and work, leading to development of learners in all aspects – physical, mental or emotional, social and intellectual.

On the other hand, modern education, focusing on real life, will enable us to gain spiritual development, resulting in the ultimate salvation of mankind.

In adopting the above approach, teachers will have to refrain from simply transferring subject matter through recitation to their students. Students who will be provided with varied learning experiences that serve their needs. Teachers will learn on an interactive basis with their students in real situations. They will fully appreciate the potential of individual students, who will be encouraged to develop to the highest level possible. Students in each class will have a variety of teachers i.e. parents, brothers and sisters in their families, neighbors, community leaders, local wisemen, artists, holders of different occupations in the local or regional communities.

In order to follow and overcome such trends and prospects in education, we will apply to the ICT education curriculum the so-called ‘Spiral Approach,’ where ‘Spiral’ means that approach comes from a basic idea and the concept to compose and re-construct knowledge repeatedly come across, and the curriculum with the form that traces up-grading process like a spiral figure.

As we all know, the idea of the ‘Spiral Approach’ stems from the intellectual way of organizing content topics in a curriculum proposed by Brunner, J. S., who insisted on (1) the learning theory of assuming dependence on three kinds of symbol systems and actions of the image such as the sense operation as for the learner’s development of the re-organization knowledge, and aiming at the transformation of the action by making the cognitive system, and (2) the organization of the lesson content structurized in relation to a basic idea, the concept, and these that composed knowledge and the learning system. That is, it is aimed to proceed even to a similar step to a mature learner by studying a basic idea with which the structure of various studies is formed in the form that the child gradually complicates. It is also thought that the child’s recognition is deepened more and more and broadens by basic various ideas' having a spiral style and being progressed many times in a word.

The Spiral Curriculum proposes that content topics should be systematically reintroduced at periodic intervals such as every academic year considering the developmental stages of learners, and which is obviously strengthened in the newly developed textbooks examined by authorities in early 2010. Two purposes are served by the scheme as (1) the previously learned knowledge of the topic is given a review, which tends to improve its retention, and (2) the topic may be progressively elaborated when it is reintroduced, leading to broadened understanding and transfer learning. Curriculum or course sequences are typically represented in scope and sequence charts, which name the topics to be studied in a total course or set of courses and lay them out in matrices, often indicating the topics suggested for each grade level.

More elaborate methods for representing both topics and lessons have been attempted, notably by Science – A Process Approach. The chart which accompanies this elementary science curriculum not only suggests a set of topics and sequence of lessons within each, but also indicates the set of prerequisite relationships which may be presumed to exist among them.

It may be that some theoretical basis will one day be proposed to replace the ‘common-sense logic’ which now underlies the design of sequences of topics for courses.

Planning sequences of instruction may be conceived as a task relevant to an entire curriculum or a total course, as, for example, a curriculum in science and mathematics for the basic education. Or, sequencing may represent a problem to be solved, and the content topics should be carefully selected in the discipline, which is also used in our daily life as different concepts and meanings combined or as pre-conceptions.
6. A Case Study - Spiral Approach and An Exemplar Application to ICT Education

The Figure 1 shows the macro-levels of the progressive differentiation of ‘Information,’ which may lead us to informatics or information sciences and information engineering, while computer networking, database, modeling, control, and recognition are also key concepts to be clarified in due course.

With bearing mind of the progress of software technology, key and basic concepts in the area of ICT education such as ‘save’ for example, which has several meanings embedded such as ‘economize,’ ‘keep safe,’ ‘not use,’ ‘preserve,’ ‘prevent,’ ‘rescue,’ ‘reserve,’ ‘retain,’ ‘sanctify’ and ‘store up,’ should be examined in the student progressive learning process.

![Figure 1](image)

Figure 1 The progressive differentiation of the word ‘Information’

7. Conclusion and Recommendations

What the author is proposing and trying to develop here in the research of this case study is closely related to the encouragement to school boys and girls to cultivate the knowledge and skill of the computer programming language in order to promote the logical thinking based on the daily and primitive concept and languages, which is derived from the science education experiences, while as all of us know the on-going progress of the computer technology sought after the better society both for the youngers and the aged.

The computer technology is progressing in the sense of both design and control technologies (DT and CT), the latter reminds us the importance of teaching and learning of the computer programming language, even though the OECD-PISA2009 survey reveals in July 2011 that the Japan is ranked as top four in terms of the Digital Reading Assessment identified by reading through the screen, information retrieval and the utilization of ICT in education, and many people in Japan as well as those who are concerned about how to utilize in existing subject matters.

![Figure 2](image)

![Figure 3](image)

Figure 2. Top page of Web-site ‘PROGRAMIN’

Figure 3 Top page of Practice with ‘Programin’

With regard to the teaching and learning of the computer programming knowledge and skill, the Japanese Ministry of Education, Culture, Sports, Science and Technology launched the Web-site called ‘PROGRAMIN’ in 2010, in order to make children familiar with the characteristics and power of computers with virtual warm ‘Programin’ or rather to promote the primitive and fundamental sense of control technology.
Figures 2 and 3 shows the top pages of the PROGRAMIN and Product Gallery respectively.

In addition, MEXT also run the web-site called ‘Product Gallery,’ as shown for Figure 4, which is set as a community space for those who are interested in the creation of programmes and want to exchange information and products.

Aside from this, Nippon Telegraph and Telephone Co., Ltd, hereafter called NTT, has also started to run the Website, Viscuit, in order for children to make familiar with visual programming.

The continuity of the teaching and learning contents is one of the crucial issues in schooling in Japan and in the world as well.

The conception of the spiral curriculum has not as yet been explicated in detail or at micro-levels in ICT education, but it appears to hold much promise for the future curriculum design efforts, since school curriculum in present and future society marked by the information-oriented and lifelong learning society should consider and follow the student psychological developmental stage focusing on the learning style and teaching style learned from the development of science education curriculum and teacher education and training curriculum as well.

References:


