

Perspectives of Cross-Curricular Activity in Japanese Mathematics Education

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Abstract: Historically, we can find cross-curricular activities (“life unit study”) after World War II in Japan. When we consider the arguments of “life unit study”, the following three approaches will serve as reference: the approach orientated to the independent aspect, the approach orientated to the societal aspect, the approach orientated to the scientific aspect. By reflecting the critique of “life unit study”, it is suggested that a balanced approach should be carried out. In other words, teachers had better focus on one aspect according to the aim of classroom teaching, and balance three approaches on the whole.

Kurzreferat: *Perspektiven fächerübergreifender Aktivität im japanischen Mathematikunterricht.* Historisch gesehen gibt es seit dem 2. Weltkrieg fächerübergreifende Aktivitäten in Japan. Argumente für eine “Studieneinheit Leben” werden im Hinblick auf drei - unabhängige-, gesellschafts- bzw. wissenschaftsorientierte - Zugänge betrachtet. Ein Nachdenken über Kritik zur “Studieneinheit Leben” legt eine ausgewogene Unterrichtsmethode nahe. Das heißt, der Lehrer solle sich nur auf einen Aspekt entsprechend seines Unterrichtsziels konzentrieren und dabei die drei Zugänge in ausgewogener Weise berücksichtigen.

ZDM-Classification: D40, M10

1. The present state of Japanese mathematical education

In Japan, with the introduction of 5 days schooling in a week, a new national curriculum will be enforced from year 2002. The Curriculum Council reported that the course of study will be revised in one or two years. This report focuses on the reduction of the number of units assigned to each subject and the establishment of new subjects focussed on cross-curricular activity. The number of units assigned to each subject in a year are reduced at a nearly equal rate. In mathematics, the number of units per year will be changed as shown in Tables 1 and 2. In the present curriculum, mathematics is taught in two types in junior high school; mathematics as a compulsory subject (mathematics as core), and mathematics as elective subject (mathematics as option).

But in the future curriculum, another type of subject i.e. comprehensive study will be introduced in addition to the previous two types. We can treat comprehensive contents which will be related to mathematics (cross-curricular activity). In Tables 1 and 2, one unit means 45 minutes in elementary school (from grade 1 to 6), and 50 minutes in junior high school (from grade 7 to 9).

Grade	1	2	3	4	5	6	7	8	9
Mathematics as core	136	175	175	175	175	175	105	140	140
Mathematics as option									35

Table 1: Number of units of mathematics in the present curriculum

Grade	1	2	3	4	5	6	7	8	9
Mathematics as core	114	155	150	150	150	150	105	105	105
Mathematics as option							0-30	50-85	105-165
Cross-curricular activity			105	105	110	110	70-100	70-105	70-130

Table 2: Number of units in the future curriculum

In mathematics as compulsory subjects in the 8th and 9th grades, 1 unit per week will be reduced in the future curriculum. But students can select mathematics as elective subjects. Therefore some students who select mathematics as elective subject can study more mathematics. For example, when we assume the students who select mathematics as elective subjects in junior high school, the number of units per week will become as shown in Tables 3 and 4 (Syoda, 1997).

Grade	7	8	9
Math	3	4	5

Table 3: Maximum number of units in the present curriculum

Grade	7	8	9
Math	4	5	5

Table 4: Maximum number of units in the future curriculum

In the cross-curricular activity, the personality of pupils/students and their international understanding are gradually emphasized. Several materials such as international understanding, information, environment, welfare are stated to be treated in classroom teaching, but concrete materials and methods have not been indicated till now. The truth is, teachers are entrusted to find their own materials. Therefore, in the next paragraph, I would like to consider the approach of cross-curricular activity from the perspective of history in Japan, and consider the points which will serve as reference in future.

2. Cross-curricular activities from the perspective of history

2.1 Life unit study

Historically, cross-curricular activity was emphasized after World War II. It was called the “core curriculum”. In this curriculum, all subjects are integrated based on “life unit study”. There were several opinions about the interpretation of “life unit study” (Inagaki, 1994). In the opinion of Wada (1951) who was assigned to the Ministry of Education, Science and Culture at the time, the aim of “life unit study” is to foster the ability of pupils/students to derive their own problems from the real world, then select appropriate conditions in the problem and get the conclusions which satisfy the conditions. It was he who distinguished the word “unit” from the real world problem.

A real world problem in this context is one which treats

everyday life and the world around us, but is not concerned with the reason why pupils/students have to solve the problem. In “life unit study”, it was emphasized for pupils/students to clarify the reason why they have to solve the real world problem. Therefore mathematical knowledge and skills were intended to be acquired through the pupils’ own problem solving process.

There were a lot of arguments to develop the curriculum based on “life unit study”. For example, in junior high school, the following points were argued (Shimada et al., 1949):

- a) What kinds of “units” are picked up in textbook? The environment of pupils/students is quite different between the urban areas and the suburbs.
- b) Who sets up the initial situation (or problem), and how does the teacher develop the classroom teaching?
- c) How does the teacher distinguish the mathematical issues from non mathematical issues, and how does he/she treat them?

These arguments are concerned with the methods of concretization of “life unit study”. With regard to a), it was considered that the textbook was to be composed of exemplary topics, therefore teachers had better pick up the good materials according to the actual situation. With regard to b), it was considered desirable for teachers to present a good situation so that pupils/students can derive their own problem at first, and participate in the discussion after they had derived their own problem. With regard to c), various ideas were mentioned. Some said that it was difficult to treat mathematical issues in “life unit study”, and some said that teachers had better present more closed situations so that students can derive the mathematical problems. Considering these arguments, variety of approaches were tried to concretize “life unit study”.

2.2 Critiques of “life unit study”

Several years after the endorsement of “life unit study”, it was reported that students’ mathematical ability had declined as compared with students who had studied mathematics by the previous curriculum. For examples, “life unit study” was criticized in the following points (Okuno, 1953):

- a) There were so many topics for the teacher to treat that he couldn’t treat each topic to the full extent.
- b) It was difficult for students to acquire the mathematical knowledge.
- c) It was difficult for students to systematize the mathematical knowledge.
- d) Students acquire only the knowledge available for a specific situation.

Eventually, “life unit study” was concluded to be unfit for teaching students because of the decline in the mathematical ability of students, and the curriculum was improved which targets the systematical sequence of mathematics contents for students. Since then, the Japanese curriculum of mathematics has been based on a systematical sequence of mathematics contents for students (Fukumori, 1996).

But there are several opinions stating that the intention of “life unit study” was never really understood by teachers. For example, Suemitsu (1949) insisted that it was im-

portant for teachers to find the mathematical contents from students’ activity, and not to guide students to the existing mathematics. He considered that teachers who criticized “life unit study” regarded mathematics as an existing subject. Then he suggested the following points:

– *Independent aspect*

It is possible for teachers to foster the students’ attitude to study mathematics willingly, autonomously and independently.

– *Societal aspect*

It is possible for teachers to foster the students’ ability to realize the usefulness of mathematics in a society. For students to realize the usefulness of mathematics, it is necessary for them to tackle their societal problem.

– *Scientific aspect*

It is possible for teachers to foster the students’ ability to think about a problem scientifically.

The “Societal aspect” and “Scientific aspect” were also stressed by Miura (1949). He views mathematics education in core curriculum as three complementary activities (to mathematize, to solve mathematically, to interpret) which are related to the mathematical modelling process, and indicates the following points:

- 1) In the curriculum based on the systematical sequence of mathematical contents, students can study only a part of the problem solving process (mathematical modelling process). As all activities within the problem solving process (to mathematize, to solve mathematically, to interpret) are interrelated, it is important for students to execute the full activity of problem solving (mathematical modelling).
- 2) With regard to pure mathematics, students had better execute the problem solving (mathematical modelling) process which has an important role in developing and systematizing mathematics.
- 3) To realize the usefulness of mathematics in a society, it is required to execute the problem solving (mathematical modelling) process.

3. Suggestions on cross-curricular activities in mathematics education

As mentioned before, with the increasing emphasis on personality and international understanding, cross-curricular activity will find its place in the future curriculum. In fact, several approaches are currently being tried toward introduction of cross-curricular activity (e.g. Matsumiya/Yanagimoto, 1995).

When we reflect the arguments of “life unit study”, what can we learn in the future curriculum? The three aspects mentioned before (independent, societal and scientific) will serve as reference, which will be difficult to emphasize in a curriculum based on the systematical sequence of mathematics contents. But it seems hard for teachers to focus simultaneously on all three aspects in one topic treated in classroom teaching. I believe that “life unit study” tends toward the independent aspect rather than the societal and scientific aspects, because many teachers seemed to think that basically, pupils/students should be able to derive their own problem from a given situation. As a result, I believe that it will be difficult for teachers to

focus on the societal and scientific aspects. By reflecting the critique of “life unit study”, it is suggested that a balanced approach should be taken. Teachers had better focus on one aspect according to the aim of classroom teaching, and balance three activities on the whole. In other words, it is important for teachers to clarify the aim of classroom teaching and not to be partial in dealing with all three approaches. I would like to state three approaches which concern different aims of classroom teaching.

3.1 Approach orientated to the independent aspect

In this approach, teaching focusses on the problem solving activity in the real problem faced by the pupils/students themselves. It is important for teachers to find out what pupils/students understand in reasoning and solving any problem. By setting the situation, students can derive their own problems, and teachers can foster the independent attitude in students. For example, in the following problems which were mentioned in the time of “life unit study” (Hirabayashi, 1948): “Have a discussion on how to arrange desks in your classroom?” “What order do you think best to clean up the classroom?”

3.2 Approach orientated to the societal aspect

In this approach, teaching focusses on the validity and limitation of mathematics in a society by working with the role of non-mathematical values. It is important for teachers to set up the societal topics which will be discussed from the various kinds of values (including mathematical values) by students. Through the discussion, it is expected for students to realize the usefulness of mathematics and also consider the application of mathematics critically. For example, the following problem which concerns the election of representatives is recommended for classroom teaching (Yamazaki, 1992):

“The following table indicates the result of an election in a state. This election is represented proportionally, and 5 members are elected from three political parties. The number of electors is 25084. How many members do you think best to elect from each party?”

Name of party	A	B	C	without a vote
Number of votes	12481	8987	3597	19

3.3 Approach orientated to the scientific aspect

This approach focusses on the mathematical thinking which will promote the modelling process. For example, the following types of mathematical thinking are important for the problem solver to mathematize the real problem (Ikeda, 1997):

- Type a) Are there any vague conditions?
How can we clarify the vague conditions?
- Type b) Does the variable affect the real solution?
To what degree does the variable affect the real solution?
- Type c) Is it easy to solve the mathematical problem under the present conditions?

How can we set up conditions in order to solve the mathematical problem simply?

It is difficult for a novice modeller to carry out a mathematization activity individually, so interaction with other students allowing for the exchange of experiences and mathematical thinking plays a crucial role. Therefore the teacher needs to think about asking questions and focusing students’ discussion on one issue in order that students can exchange ideas with one another as shown in Figure 1.

We can expect that, through such interaction, students will be able to transfer these ideas to their own thinking.

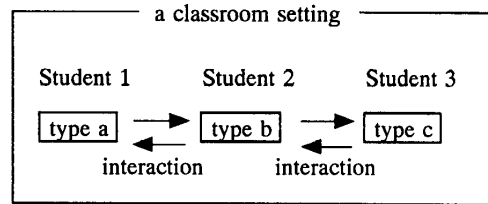


Fig. 1. Interaction between students

Compared with the previous two approaches, it is recommended that teachers should present a relatively closed format of a real problem so that pupils/students can derive mathematical thinking. For example, the following problem is recommended for classroom teaching (Kawaguchi, 1992): “How far can you see from the top of Mt. Fuji?”

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5. References

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Vorschau auf Analysethemen der nächsten Hefte

Für die Analysen der Jahrgänge 30 (1998) und 31 (1999) sind folgende Themen geplant:

- Demokratie und Mathematikunterricht
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- Mathematik in der Ingenieurausbildung
- Mathematik an Hochschulen lehren und lernen
- Mathematik und Deutsch
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Vorschläge für Beiträge zu o.g. Themen erbitten wir an die Schriftleitung.

Outlook on Future Topics

The following subjects are intended for the analysis sections of Vol. 30 (1998) and Vol. 31 (1999):

- Democracy and mathematics education
- Calculus at universities
- Mathematics and engineering education
- Teaching and learning mathematics at university level
- Concepts and issues in textbook analyses.

Suggestions for contributions to these subjects are welcome and should be addressed to the editor.