Conforming a mathematics education course to new concepts of “well-being”

Hideaki Miyashita
Iwamizawa Campus, Hokkaido University of Education, Japan

Abstract

The Japanese system, including education, is weakening, though it once worked well. It is required to conform the system to the new infrastructure and concepts of *well-being*. And this conformation is important especially in the case of teacher training course, because those who are to educate others for *well-being* must have ability/trait for *well-being* themselves.

From this point of view, I subject a type of ability/trait which is apt to be expressed "of designer". I report the courses I am now achieving in my teacher-training college, as what I have reached from my experience of inquiring into and practicing "designer raising".

Keywords: Mathematics Education, Teacher Training, Well-Being, Design

Preface

In Japan, a culture where the individuality/diversity are strongly oriented is on the way to be formed. It comes with the formation of a new style of social infrastructure, which results as a compound of the technological, economical, political, social, and so on. Therefore it is definite, not a whim of the general public.

In every field of the society in Japan, "conforming the existing to the new situation" is subjected. For example, in the field of business, it becomes required to develop such goods, media, or means of distribution, as to meet the trend of individuality/diversity.

In the field of education, this subject takes forms as: (a) Inquiry into the meaning of "well-being" in such a culture where the individuality/diversity is strongly oriented. (b) Design of the study course where students are disciplined to the type of ability: (1) Creating/developing a "well-being" for the public (Ability for the good producer). (2) Creating her/his own "well-being" (Ability for the good consumer).

1. Current social situation in Japan

The Japanese system is changing, with such an appearance as "end of Japanese style of management/labor", with such backgrounds as "weakened competitiveness", "population

decrease, change of population composition", and with action for "restructuring".

In parallel with it, Japan has been shifting, more and more, to an individuality/diversity-oriented society, with people's changing consciousness about labor/job, promotion, prosperity, happiness, value, etc. Some of the factors of this trend are: (a) Change of consumption patterns. -- The public becomes less focused on general goods and demands items which suit individual tastes. (b) Expansion of service-oriented economy (shift from product-oriented to service-oriented). (c) Change of employment/working/schooling patterns. -- Some young people prefer being free-timers to having permanent jobs. (d) Change of family/community patterns. (e) Informationalization, personal media. -- IT/ICT drastically extends our personal power. It breaks the limit of the individual.

2. "Well-being" in the new stage

Here I use the word "well-being" to mention a phase in one's life which one feels satisfied.

The view of "well-being" depends on each of us. But here we assume that our way of using the word is, in a given common situation, mostly similar to the others', whence we can say of the goal of human communities in this way: "the goal of human communities is the well-being of present and future generations".

There are many "well-being". Here let us focus on the followings (they should become marked in such a situation as we are facing now, transitional to a stage which is, from the view point of technology, drastically new) :

(1) Learning

In the case of youth, "success at school" accounts for most of "well-being" about learning. Indeed, it effects on person's succeeding stage, that is, maturity. Youth should, especially, develop positive attitudes toward achievement, and ability to continue learning throughout life. In the case of adult, who confront with problems under economic and societal pressures, need to be comfortable to acquire new knowledge and skills for solving problems.

(2) Adaptation

Adaptation to the information age (information-oriented society) -- *Extension of person's ability (in particular, physical function) by importing IT. Good use of IT for producer/consumer activities (information strategy). Adaptation to new media. Making digital contents, dispatching information, net group working.*

Adaptation to the diversification of working patterns -- *Career-up. Skill-up, self-development, self-realization. Applying human resource business (personnel agencies).*

(3) Design

Able to design, creative (creating a culture), productive, positive toward achievement, taking initiative, independent. Specifically : *Ability to shift difficulties to chances. Effectively strategic toward the situation (especially, such situation as the restructure of the "existing" and the destruction of the "constraints" take place). Intending and practicing the globalization of the activities. Achieving superiority by using differentiation-strategy. Efficient functioning, optimization, restructuring.*

Good use of material : *Having detailed knowledge of material (science). Receptive to material, that is, sensitive to its possibility/potential.*

3. "Designer" - personal trait/ability needed in the new stage

Japan has been struggling to improve its standard of living and its superior position among the countries of the world. Today, however, it has declined into a structural depression and is trying to go through by restructuring its traditional systems which have become out-of-date.

One of those on which its success depends is the education, especially the one for today's youth who will be the leaders and the citizens of tomorrow. Japan is committed to preparing young people for their challenges and, therefore, to improving education.

The demands today's educators are responsible to answer are those of a changing/challenging society. In the preceding section, I referred to "abilities required to be well-being in changing/challenging society". They, one of which is "trait/ability of designer", become the goal of today's education. (Here, "changing/challenging" means: "not allowed to be peace in the existence, obliged to develop a new direction", "disadvantage changes to advantage", "business chance calls at newcomers", "the seeds from which our future grows are pursued".)

We use the word "designer" to express, ideally, a person who can do "designing a total solution", for which the following traits/abilities are required : To see a matter in perspective. Introducing structure/frame/module/flowchart ("from global to local"). To simulate a solution with strictly logical calculation. To do effective presentation. To use IT in a best way toward the given, as infrastructure/tool for work, realizing high quality and remarkable effectiveness.

"Designer" implies "good problem solver". A designer, as an inquisitive, investigative person, seeks to identify needs and seeks innovative solutions. In idea development process, a designer collects, analyzes and interprets facts, while realizing her/his own adaptation and progress. Intuition and imagination must be paired with technical skill. Indeed, it

is a designer's trait required for conceiving a product-out which is sound, working, and welcome.

4. Relation between design and mathematical ability

"Designer" implies "problem-solver". And the "problem-solving" of this sense is well-suited to "mathematics" -- this conformity is well-argued in the form of "mathematical problem-solving". Thus, the subject "mathematical sense/ability as designer's trait" holds.

Indeed, mathematical sense/ability is one of the most important elements of designer's trait, in the following sense : *Analyzing, clarifying, simplifying, organizing. Keeping to logic (being consistent/reasonable). Structural way of thinking, viewing, processing, expressing, representing, communicating. Schematic. Frame/module -oriented thinking. Functional thinking. Numeral calculation. Calculus of logic (operation, inferring, reasoning). Logical design. Using techniques of geometry. Programing. Simulation. Visualization. Using diagram/graph. Freely thinking. Adaptive to contents-free. Adaptive/flexible to logical machines/systems such as computers, network systems. Developing very special skills which are used in devising solutions to complex problems. Versatility.*

And in a world increasingly globalized and dominated by technology, mathematical knowledge and skills become very important and central to the ability/competency.

The range of design on which mathematics is engaged is wide. The points of contact between design and mathematics may be expressed by a “works-mathematics matrix”, where “works” are: *Design (Grand design, Information design, Communications design, Media design, Architectural design, Curve and surface design, Lighting design, Engineering design, Industrial design, Projects design), Planning, Programing, Visualization, Simulation, Exploration, Research, Modelling, Presentation, Representation (graphical, digital, sculptural, musical), Computer graphics, CAD, Animation, Virtual reality, GIS, Using design tools, Operation of logical machine/system, Instruction/learning, etc.*

5. Setting up the subject of "mathematics course for designer raising"

5.1 Reason of "mathematics course for designer raising"

We are facing a highly individuality/diversity-oriented society to come. In this new era, our way of living deeply depends on our ability for being positive and independent, preparing for what to come, and creating our own solutions for new types of problems. Not floating in the flow of individualization/ diversification, but grading one's own personality up by making "differentiating oneself from others" a strategy -- This becomes an image of "establish one's independence" in the era to come.

Correspondingly, as for education, the discipline for nurturing this type of ability becomes a promising item for "sale". Let us express this ability as follows: *(a) Ability for the good producer* -- Creating/developing a "well-being" for the public. *(b) Ability for the good consumer* -- Creating/developing her/his own "well-being". And the course for nurturing this ability can be called "design course" in a broad sense. I characterize the "design course" as a course where the study on "well-being" is properly realized, and, in this sense, I inquire into the nature of the "design course" and the way of realize it.

5.2 Vision and mission of the course

A traditional way of characterizing a course/university is to apply categories or standards which are academically proper. Against this, I subject the "design course" as "a space where new wave is continuously and lively spouting (fashion space)" and apply it to "mathematics education course", The output of the course is an individual/personality who can adapt her/himself well to the situation by using her/his mathematically-strengthened ability.

5.3 Ability to be disciplined

The (general) ability which we are to discipline, as the goal of the course, is:

(1) Ability for being designer -- *Receptive to material. Analyzing/understanding material. Designing appearance. Receptive to product-for-sale. Receptive to consumer. By using digital tools, making a work efficient, improving the quality of the outcome (computer/net literacy). Creative, keeping to be original.*

(2) Ability for being good producer/trader -- *Receptive to business (production/trade). Achieving a "product for sale" as the outcome of work. Commercial strategy in the era of individuality/diversity. Receptive to corporation management. Foresighted/farsighted. Information strategy. Competency. Endurance.*

(3) Ability for being good consumer -- *Receptive to material with knowledge. Strategic use of product.* For this, I especially focus the following learning experience: *Using tools (information tools, digital design tools, mathematics). Practicing to be designer (information designer, project designer, life-style designer).*

5.4 Method for designing the course

I contrast the *"mathematics education as designer raising"* with such an education style as follows (this may be called "traditional"): (1) Course specialization - general education course, basic course, specialized course, teacher training course, etc. (2) Gener-

ally weak to take the stance of "making students understand soundly the application/usage" (that is, the stance of "mathematics as tool"). (3) "Story" lacks, therefore students cannot have a course, objectives, or a goal-vision, of studying mathematics; in short, they cannot learn mathematics. (Because mathematics is, in nature, content-free, teachers must be especially careful about telling/showing clearly : "where you reach finally", "what it is for", "what you are doing now", "what you are to do next".) (4) Non-integration of the curriculum, where mathematics and each are treated as either or as polarities, causes students to be at a disadvantage when it comes to making intelligent decisions toward problems of actual living.

We may introduce and design our course in the form of “tool-oriented”, “story-leading”. That is: (1) Each class is organized in the style of : project-setting, achievement-improving, and goal-reaching. Most idealistically, mathematics is expected to be introduced as a set of basic and practical tools. At least, it should not be posed/taught with the appearance of "basic knowledge", "pure mathematics". (2) It is aimed that the learner becomes to understand the significance/value of each subject in experience of using tools properly in works. Indeed, this is the essence of mathematics-understanding. (3) In the style of "improving skills for using tools", the learner enters the stage of deep understanding of mathematical contents and of extending the domain of application. Thus the class is truly a mathematics class. (The tool-oriented instruction must not be negligent of mathematics!)

Though this method of education may sound idealistic in the case of primary/secondary education, it should be usual in the case of college/university. But, still, planning must be most careful. (In order to make the instruction to be "story-leading", it is required to introduce "integration of different fields", "spirally ascending the steps of course", and so on.) An exemplary laboratory environment characterized by research, innovative teaching, and service is required. And teachers must develop themselves to proficiency in the sense that : they know-of/experience well discovering and forging connections within and among mathematics, science, the arts, and the humanities.

5.5 Elements of course design

A way of inquiring "mathematics course for raising designer" may be the one that uses "course", "student", "teacher/faculty" and "facility" as prime elements/factors, in such a manner as fallows :

(1) Subjects : *Mathematical subjects. Information design. Material. Representation, display, expression. Simulation. Technology. CG. Server-system. Tools. Page-making, etc.*

(2) Learners ability/trait to be aimed at : (a) General ability -- *Knowledge, skill. Attitude, intention, disposition, belief. Sense, perception, reception. Foresighted, farsighted. Competency. Endurance. Tolerance. Adaptation. Strategy. Demonstration, presentation. Inquiry, exploration. Curiosity. Soundness/relevance of information and reasoning. Think essentially, simply. Construct questions. Use appropriate technologies.* (b) Ability for making business -- *Knowledge, understanding about trade/industry, "product for sale". Commercial strategy. Corporation management. Information strategy.* (c) Ability for good consumer -- *Knowledge about material. Receptive to material. Strategic use of product.*

(3) Students : *Grade, number, experience, preparation, ability, disposition, etc.*

(4) Teacher/Faculty : *Traits, expertise, teaching skill, experience, knowledge, professionalism, dedication, commitment, loyalty, leadership, strategy, productive, rigorous. Curriculum reviewing/improving. Career guidance/counseling.* And especially : *Understanding about education/students* -- Meaning is constructed, not prescribed. All individuals have equal intrinsic worth. All people have an innate desire to learn. Every person has the potential to change and to bring about change. Aversion to risk-taking stifles innovation and creativity. Valuable learning results from both failing and succeeding. All adults share responsibility for the well-being of all children. Ability to discern and create connections is the essence of knowing. Process of education is more than merely the accumulation of facts.

(5) Facilities : *Classrooms, laboratory, computer/network facilities, presentation facilities, design studios, testing and evaluation facilities.*

6. Case of teacher training course - metastructured *"designer raising"*

In the teacher training course, *"designer raising"* becomes metastructured, in the sense of "raising designer of 'raising designer'".

7. My practice of "mathematics education course for designer raising"

It has taken much time for me to reach the present stage of practice. The idea of "information design" and "enabling genuine-math teaching by means of media power" came to me around the end of 1980s when I got to have the Macromedia Director ("Macromind Director" was the name at that time). But I had to wait till the condition is fulfilled.

Indeed, what I have obtained now is fantastically much more than I expected then. In these over ten years, the Internet and WWW came, and information communication tools/facilities (computer, tools for multimedia contents making, equipment for digital presentation, storage media, etc.) keep remarkably progressing and becoming affordable in the

price. And my practice of "designer raising"-oriented mathematics education course has recently begun having a fixed form. I think it is time to report my practice.

7.1 Outline of development

The progress of developing my courses is as follows:

7.1.1 Conceptualizing "education as designer raising"

I have been confident that it is necessary to introduce the viewpoint of "designer raising" into the education. Here is my rough inference (not necessarily deductive): "Teacher = information designer" follows from "instruction design = information design". "Teacher = project/enterprise/business designer" follows from "teacher = planner of education". "Teacher = 'well-being' designer" follows from "teacher = instructor of 'well-being'". Thus, "teacher = designer". Finally, "teacher training = designer raising" follows from "teacher = designer".

This standpoint of education matches the social situation in Japan, where the trend of individualization/ diversification is marked in many fields, and, accordingly, career courses chosen by graduates of the teacher training course have been diversifying, and therefore students must be educated to obtain the trait required to be "well-being" in changing society. -- It is required for the faculty in teacher training course to think of their "human resource development" in a broader sense. We propose the idea of "designer" as "person-of-ability required in the changing society".

7.1.2 Conforming the education in the teacher training course to the situation

I subjected “the conformation of education to the new situation” with restricting the courses to mine. It is required to apply different types of instruction because the classes are of different condition to each other. My method is as follows :

In the case of a class where the attendants are many, and only "lecture" is allowed in the form of instruction, the instruction is made in the form of "homepage-based digital presentation".

That information design is demonstrated is one of the important effects I expect. And I explicitly make "information design" a subject as well, in the form of "instruction-design/teaching-material-making = information design". A homepage-based self-teaching system is served. This is necessary because instruction becomes prompt in the case digital presentation is its form.

In the case of a class where the attendants are not so many and, therefore, the homepage-based training is possible, the class is designed to be of "report (-as-homepage) making".

Students' results are evaluated from the viewpoints: "Do they reach an subject(content)-understanding aimed at in this stage?" "Do they reach an information-design-ability aimed at in this stage?" In this case, the homepage-based self-teaching system mentioned above works especially in the manner : (1) Report making is a work on computer -- operations required there are carefully instructed; (2) While making the report, students can refer to the system about the subject (meaning, application, etc.).

In the case of the seminar, where "self-development" is set to be student's general objective, students are to develop teaching material for WBT, to undertake interactive remote-education (make program and perform), etc., while developing the skills for planning, contents making, presentation, product-out, and so on, through practice.

7.1.3 Making a web-based infrastructural system for the "designer raising" course

"Designer raising" course mentioned above is scarcely successful if it is not accompanied by a system (practically, an infrastructure) which brings a high convenience for students' self-teaching, and a high efficiency in the class-management whence staff become able to spare energy for undertaking the course.

Thus, in 1995, I started a system for this purpose, which is web-based, with an appearance of self-teaching system. (See *http://m.iwa.hokkyodai.ac.jp/icsu_about/*) The url of the homepage for self-teaching is : *http://m.iwa.hokkyodai.ac.jp/school/*

From the viewpoint of software, the system is: web server (*Apache*) + dynamic page script (*PHP*) + database (*PostgreSQL*). Primary instances (tables) of which the database consists are : instructor, student, class, class-instructor, class-student, chat, notice.

7.2 Courses

Type	Class Name	Semester	
		Spring	Fall
"Audit"	Elementary School Mathematics	●	●
	Information Design (Irregular)		●
	Course Development (Irregular)	●	
"Make & Present"	Computer Literacy Development	●	
	Lower Secondary School Mathematics	●	●
	Upper Secondary School Mathematics	●	
	Mathematics Information Design		●
"Plan & Product"	Integrated Research Activity (Irregular)	●	●
	Seminar on Mathematics Education	●	●

(1) "Elementary School Mathematics"

The instruction is made in the form of "homepage-based digital presentation". Contents are : Essence, way of understanding, of a subject; Instruction design, instruction method; Mathematical subjects of which the elementary school mathematics consists.

The contents displayed on the screen are the webpages, which are "presentation" version of the "self-teaching" pages (http://m.iwa.hokkyodai.ac.jp/mathedu/), and stored in the server. Some pages include such materials as Shockwave movie, QTmovie. -- By means of visualization and animation, mathematical subjects become easy to be understood, whence instruction itself becomes efficient.

Students can minutely and repeatedly study, in the "self-teaching" homepage, more of the contents presented in a lecture room.

(2) *"Lower Secondary School Mathematics"*

In this course, students advance their learning by making and presenting (1) teaching script (spring semester) and (2) teaching material (fall semester) in the form of homepage with Flash contents (five reports per semester). Through the practice, mathematical subjects are instructed/learned. The learning is of practical and problem-solving type.

Each student is given a theme, which is a mathematical subject in the lower secondary school mathematics. They must, firstly, understand its meaning/essence. They do this by using the web-based self-teaching system (http://m.iwa.hokkyodai.ac.jp/school/). They can learn "homepage-making" too, in the same way.

Next, they are to make instruction scenario (spring semester) and teaching materials (fall semester) for teaching the subject.

The learning brings to students the followings : a) Understanding the stance -- "To view the school mathematics from a higher standpoint of mathematics"; b) Progress of class-design ability; c) Progress of digital-contents-making skill -- *Computer/network literacy, application-software-operation skill*; d) Discipline of general ability -- *Acting subjectively and independently. Adapting to works of problem-solving type. Making habit*

of completing works by the deadline. Making habit of getting results, etc.

(3) *"Mathematics Information Design"*

In this course, students are to learn the instruction performance.

Students make teaching materials which are web contents, and make mock of class (simulation of class).

Students have already passed the first semester of *"Lower Secondary School Mathematics"* and there gotten the hang of studying mathematical subjects and representing their understanding to web contents.

General discipline this course brings to students is the same as *"Lower Secondary School Mathematics"* does, which is described before. Indeed, this course, as a general discipline, is meant to be an development of *"Lower Secondary School Mathematics"*.

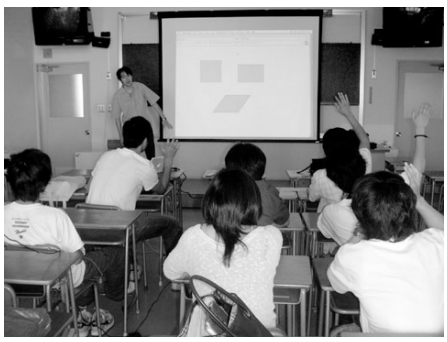
(4) *"Upper Secondary School Mathematics"*

This course is a development of *"Secondary School Mathematics"* and *"Mathematics Information Design"*. Students are to make inquiry into assigned mathematical subjects, make web-based teaching material (Flash contents), make presentation, and make mock of class (simulation of class). In fact, students are to inquire just the fundamental notions of calculus and linear algebra through the course. Other subjects are intentionally left out. Here I give "core" the priority over "broad".

The goal is that students reach understanding : (1) The idea of differentiation/integration is the linear approximation of functions. (2) Linear algebra is a simple extension of "number and quantity" in the elementary school mathematics.

"*Mathematica*" is used as a tool for making precise visual expressions. Students must master the basics of *Mathematica* during the first three weeks. In order that their learning is efficient and completed in the period, students are recommended to have a book where "application of Mathematica to the study in linear algebra and calculus" is the theme.

Students present teaching scripts (web contents) they made */"Lower Secondary School Math"*



Students make mock of class */"Math Information Design"*

General discipline this course brings to students is the same as *"Lower Secondary School Mathematics"* and *"Mathematics Information Design"* do.

(5) *"Seminar on Mathematics Education"*

In this seminar, it is ruled that students are responsible for developing their own ability. Here ability for planning, computer/media-literacy (web-design, etc.) and presentation (digital, in English) are regarded basic.

The ability/skill to be developed is about: a) Mathematics education : Objectives of mathematics education. For each mathematical subject, its meaning. Instruction/learning media. Instruction/learning method. Instruction design. b) Making plan/proposal, practice, presentation, goal-reaching. c) Digital contents making : Homepage making, web design (HTML, Flash, etc.). CG. Digital movie editing. d) Web-based instruction. e) Interactive remote education.

And the tasks/assignments (varied yearly) are : a) Develope ability. -- Especially, make the experience in university mathematics be a sound selling point. b) Realize one's own ability in the form of personal homepage. c) Design an ICT-oriented mathematics class and practice it in a city school. d) Make and achieve one of the programs of "CS (Communication Satellite) Distance Learning" presided by Iwamizawa city. The program is broadcasted at the Iwamizawa City Community Network Center via interactive distance education system. e) Make an exhibition in the campus festival. f) Presentation in a cross-universities meeting. g) Presentation (in English) to visitors from foreign countries. (http://x.iwa.hokkyodai.ac.jp/~sm/)

Left : Distance education via communication satellite
Right : Self-teaching mathematics website
/ *"Seminar on Mathematics Education"*

8. Conclusions

In this monograph, I subjected a standpoint from which the education is regarded as "designer raising", by pointing the importance of design ability. And I specified the constituents of education, especially mathematics course, to give a framework for considering “designer raising”.

Such education programs as are designed from department-oriented or course-structure-oriented standpoint would not work. It tends to go exhaustive about contents. It is not a way to make students gain real power.

Design ability is an integration of various types of ability and raised just through "design"-oriented practices. An appropriate way of discipline of design is to make a regular instruction (instruction on traditional academic specialized field) embody task working, or problem solving. What instructors do in designer raising course is not to teach about design, but to make students do design. And this method leads to an improvement of the instruction itself.

The ability to design is requisite for an average teacher. Thus, I discussed, by introducing my practice, “teacher training as designer raising” in the traditional teacher training course. Students/trainees are urged to design instruction together with necessities, to make digital contents, etc. Here the subject of the task must be authentic. Otherwise, students become to set themselves just to answer the assignment -- the task triggers/generates/develops little.

Reference

Miyashita,H. (2003). Design of metastructured quality education which is information design oriented and IT-strengthened - Case of teacher training course. *Journal of the Asian Design International Conference, Vol.1* (CD).

_____ (2003). On e-educator training for "information design"-oriented e-education. *SSGRR 2003s : International Conference on Advances in Infrastructure for Electronic Business, Education, Science, Medicine, And Mobile Technologies on the Internet* (L'Aquilla, Italy), http://www.ssgrr.it/en/ssgrr2003s/papers.htm, #38.

_____ (1997). Practice of "WWW Online Class". *Journal of Hokkaido University of Education (Section IC)*, vol.48, no.1, pp.271-286.

_____ (1995). Multimedia and mathematics education: Breakthrough by communication technology. (in Japanese) *Study in Curriculum Development, vol.4* ("Children and communication"), Tokyo-shoseki, pp.238-252.