Teacher Education in Japanese Mathematics Education

Toshikazu Ikeda
Yokohama National University
Yoshiaki Kuwahara
Shinmei Junior High School
Outline

- States and issues in Japanese teacher education
- Pre-service education: Example in Yokohama National University
- In-service education
- Lesson Study
First Report by the Education Personnel Training Council (1997)

- Improvement of the teacher education curriculum
  ① Wide understanding of liberal arts
  ② Problem Solving Ability, Humanity
  ③ Knowledge and skills of subject matters

The number of credits for subjects concerning teaching methods of mathematics

→ From about 2 credits to 8 credits
Second Report by the Education Personnel Training Council (1998)

- Promotion of reeducation of currently employed teachers through master course
- System of night master course for teachers is gradually introduced in teacher training university
Facilitation of cooperation in the cultivation, appointment, and training of teachers.
Issue in teacher preparation university

- In 2001, the Ministry of Education, Culture, Sports, Science and Technology is planning to integrate teacher training university, keeping the quota of 10,000 students.
Example in Yokohama National University

In 1997: Faculty of Education → Faculty of Education and Human Sciences

◇ Pre-service education: 230 students. Focus on Elementary School Education

◇ First class license of elementary, junior high, senior high math

In 2000: Introduction of a New Curriculum based on the first report by the Education Personnel Training Council
Aims in mathematics education
in Yokohama National University

[Mathematical points of view]

- To foster students’ ability to think mathematically.
- To enable students to understand mathematical concepts and ideas existing behind elementary and secondary mathematics.
- To foster students’ ability to represent mathematically.
- To foster students’ ability to utilize technology.
Aims in mathematics education in Yokohama National University

[Educational points of view]

- To enable students to understand the objectives and contents of mathematics
- To enable students to understand Teaching methods including assessment of mathematics
- To foster students’ ability to construct and analyze a classroom teaching
- To foster students’ ability to utilize the textbook of mathematics
Curriculum of mathematics education in YNU

1. Introduction to Math.

2. Teaching methods of elementary math.
   - Calculus I - IV
   - Algebra I - IV
   - Geometry I - IV
   - Probability & Statistic I - IV

3. Analysis of Classroom teaching
   - Problem solving and mathematical thinking
   - Contents taught in Secondary math.
   - Development of Teaching material

4. Assessment
   - Teaching Practice [elementary level] (4 weeks)
   - Teaching Practice [secondary level] (2 weeks)

5. Observation of Classroom teaching
   - Lesson plan & observation

6. Report to graduate
In Case of Yokohama National University
(For Prospective Elementary School Teacher)

Introduction to Mathematics for elementary school teachers

Mathematical concepts and ideas existing behind elementary mathematics

Core

Technology

Presentation

1. Mathematics for teachers
2. Mathematics for a real world
3. Mathematics for a joy
4 areas of arithmetic

- Number & Calculations
- Quantities & Measurements
- Geometric Figures
- Mathematical Relations

7 quantities treated in arithmetic

- Volume
- Area
- length
- Weight
- Time
- Velocity

Introduce the idea of integral calculus by starting from arithmetic contents.

How do you explain this formula to students?

\[(\text{Area of circle}) = (\text{radius}) \times (\text{radius}) \times \pi\]

Radius: 1

Area seems to be more than 3 unit squares. Further, area is less than 4 unit squares. ??!??

Therefore, Area is 3.14??

Ancient Mathematician found this.

It is not clear!! Let’s consider how mathematician thought of the area of circle.
We calculated the area of circle (radius: 1) by calculating the sum of 4 rectangles. However, the answer “3.495…” is not equal to “3.1415…” Why not?

We calculated the extra partition. Therefore, area is bigger than “3.1415…”

What can we do so that the area of rectangles is approaching to “3.1415…”. We need to divide the area into as many rectangles as possible.

From a simple example, students learned the idea of integrated calculus.

Each group has a responsibility to get a correct answer!!

Let’s divide the area into 12,000 rectangles. G.C. can only calculate up to 250. So let’s cooperate by sharing parts with 12 groups.


Total the values calculated by each group. The result is 3.1595…, not 3.1415….

Which group is wrong?

No. 6 group is wrong!!
In-service teacher training in Japan

**National**
- New teacher training on the ship
- Training in ministry of education
- Guidance of students' course to take after graduation, Training for new industrial technology teachers
- Dispatched to the Abroad, Japanese school

**Prefecture**
- New teacher training
- Experienced Teacher Training: After 5 years, After 10 years, After 15 years Training
- Dispatched to the Master Course in teacher training university

**City Town Ward**
- Annual Training Program for All teachers
- Study in a school

**School**

**Individual (private)**
- Group Research & training
- Individual Research & training
- Training for the Curriculum coordinator
- Training for the Administrator, Principal, Vice-Principal
Two Cases of Teacher Training

- **Public training**
  (Nation, Prefecture, City/Town/Ward, School)

- **Private training**
  (Individual research, Society, other Training & Research circle)
Public Training of In-service Teachers

- Novice teacher training
- Experienced teacher training (After 5, 10 & 15 years)
- Administrator training
- Dispatched training (Master course in university, company, abroad)
- School research in each school
Novice Teacher Training

- About 90 times during the first year
  e.x. 60 times in School, 30 times out of School
- The leading teacher guides a new teacher one to one.
- Extensive training
  Lectures, Lesson study, Class management
An Example of Novice Teacher Training (in Kanagawa-Prefecture)

- **300 hours in School**
  
  Leading teacher & supervisor’s guidance about all of teacher’s works (Subject teaching, Class management, Student guidance, Students’ moral guidance, General learning)

- **25 days out of School**
  
  To broaden their horizon, knowledge & skills
  
  To improve their teaching of mathematics
  
  To deepen their understanding of children’s behavior & thinking
Experienced Teacher Training

- After 5 years
  5~6 times training in 6th year
  Group training for each theme
  (Class management, Student guidance, Current Problems e.g. Bullying, etc.)

- After 10 & 15 years
  About 5 times training in 11th & 16th years
  Optional course training of personal interest
  (Subject, Class management, Students guidance, Current Problems etc.)
An Example of Subject Training in JHS (7th - 9th)

- Nominated junior high school teachers in the district come together at one school

- Contents:
  - Explanation of the national curriculum
  - Developing new lessons for a team teaching or optional course
  - Collaboration with experienced teachers
Teacher Training Apart from Schools

- To a master’s course in university
  (Study & Research)
- To a company
- Abroad
  - Language Training
  - Japanese School
  - Inspection of various countries
Collaboration on the Daily Work

- A brief meeting in a teachers’ room
- Subject meeting
  - Progress of textbook
  - The way of assessment
  - Teaching materials
  - Exchanging ideas each other
Private Training

- Taking leave for studying in master course in university
- Participating in the society or other training & research circle
- Participating in the lectures held by companies, publishers, etc.
Teacher Assessment

An Example in Kanagawa-prefecture

- By Whom
  - Self-assessment, by principal, by vice-principal

- Contents of assessment
  - Subject teaching, class management, student guidance, et.al.

- Points of assessment
  - Ability, results, enthusiasm

- 5 Ranks  (S>A>B>C>D)
Future systems introduced

- Renewal System of Teacher License connected with teacher assessment
- Commendation of superior teachers
- Salary system connected with teacher assessment
Lesson Study as teacher education

- Observation of an actual classroom teaching
- Analytical discussion about the classroom teaching
- Demonstrative teacher
- Discussion about a lesson plan
- Points to see material
- Points to see students
- Collaboration
- Teacher
Lesson Study Triangle

- Relation between children and teacher
- Relation between children and material
- Relation between teacher and material

Strong Relation Between two components
## Five styles of Lesson Study in Japan (in-service education)

<table>
<thead>
<tr>
<th>Style</th>
<th>Scale of L.S.</th>
<th>By Whom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Style 1</td>
<td>In a school</td>
<td>Principal &amp; Teachers</td>
</tr>
<tr>
<td>Style 2</td>
<td>In a City/ Prefecture</td>
<td>Teachers themselves</td>
</tr>
<tr>
<td>Style 3</td>
<td>In a City/ Prefecture</td>
<td>Board of Education</td>
</tr>
<tr>
<td>Style 4</td>
<td>From all of the prefectures</td>
<td>School attached to University</td>
</tr>
<tr>
<td>Style 5</td>
<td>In a Prefecture, From all of the prefectures</td>
<td>Academic Society &amp; Company</td>
</tr>
</tbody>
</table>
## Five styles of a Lesson Study in Japan (in-service education)

<table>
<thead>
<tr>
<th>Style</th>
<th>Main Aim of L.S.</th>
<th>Methods to disseminate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Style 1</td>
<td>to attain the school objectives</td>
<td>Announcement</td>
</tr>
<tr>
<td>Style 2</td>
<td>to promote professional development</td>
<td>Convey from older teachers to younger teachers</td>
</tr>
<tr>
<td>Style 3</td>
<td>to develop and spread new contents and approaches</td>
<td>Call for attendance at the beginning of semester</td>
</tr>
<tr>
<td>Style 4</td>
<td>to develop and spread new contents and approaches</td>
<td>Announcement, Homepage</td>
</tr>
<tr>
<td>Style 5</td>
<td>to cultivate activity of lesson study</td>
<td>Announcement, Journal, Homepage</td>
</tr>
</tbody>
</table>
Lesson Study in Japanese 2nd grade

Demonstrating Teacher: Mr. Saitou

What are the differences and similarities between the “3” in the number 13 and the “3” in the number 31?

Aim 1
To find out the difference and similarity between “3” of 13 and “3” of 31.

3 times of 1
3 times of 10

Aim 2
To appreciate the numeral system in Japan.

Zyu
ten
Iri, Ni, San, ..., Hachi, Ku

1-99
Introduction

13 and 31 are separated. So, let both of numbers close to the center.

You can find same numbers in both of them. Namely 1 and 3. But the place is opposite.

Are “3” of 13 and “3” of 31 same or different?
Are “3” of 13 and “3” of 31 same?

So, let’s recall how to read the numbers!

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| いち | に | く | じゅう | じゅう | じゅう | じゅう | じゅう | に | に | に | 三十 | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん | さん |

In case of 13, there is no “Zyu(10)” after “San(3)”. However, in case of 31, there is “Zyu(10)” after “San(3)”
Lesson Study in Japanese 2nd grade

Classroom teaching

Are there any patterns in this reading system?

Are there any strange things?

“Zyu (10)” is repeated.

“Ichi, Ni, ..., Hachi, Ku” is also repeated.

There is no “Ichi (1)” over “Zyu (10)” in “10-19”.
Analytical Discussion of lesson

Students are required to understand the difference between the “3 of 13” and the “3 of 31”, and further understand the similarities such as both of them are three times of . I think that it is enough for grade 2 students to just understand the difference based on place value system.

“3 of 13” is located in the place of one. “3 of 31” is located in the place of ten.

“3 of 13” and “3 of 31” are different.

Does anyone think “3 of 13” and “3 of 31” are the same?

I expected students to understand both of them. However, it was difficult for them to understand both difference and similarity. Therefore, I stopped to expect it and changed the issue.
Analytical Discussion of lesson

I appreciated teacher’s response to students answer. By pretending not to know the fact, teacher could encourage students’ willingness to present their idea in a class.

You can find out many “3”. Wonderful! How many “3” in this paper?

“3” is still existing.

Is it really? I cannot find out another “3”.

Hi! Hi! Hi! Hi! Hi! 30
Can you find any patterns in this reading system?

From zyu (10), zyu, zyu, zyu...

I cannot understand what he said.

Zyu (10) is repeated.

"1, 2, 3, 4, ..., 8, 9"
"1, 2, 3, 4, ..., 8, 9"
"1, 2, 3, 4, ..., 8, 9"

What does he want to say?

Same pattern is repeated.

You can see “san (3), san, ···” over Zyu (10) and “ni (2), ni, ···” over zyu (10).

Can you find any strange things?

There is no “Ichi(1)” over “Zyu(10)” in “10-19”.

Why is it?
In the classroom teaching, teacher had to ask children “Can you find any pattern in this reading systems?”. If teacher can devise the writing on the blackboard like this, they will be able to derive their own question “Why does teacher make a blank over zyu (10)?”.
Effectiveness of Lesson Study

Lesson study might be effective for teacher in the following points in particular.

① **learn to see material**

- Can teacher identify mathematical essential points of materials?
- Does teacher deprive of students’ opportunity to think mathematically?
Effectiveness of Lesson Study

② learn to see students

・ Can teacher understand what students understand?
・ Can students understand teacher’s asking questions?
・ Does teacher ignore of students’ ideas by his/her selfish reason?
・ Can teacher accept and evaluate students’ ideas appropriately?
・ Can students discuss cooperatively?
**Effectiveness of Lesson Study**

① *learn to see material* + ② *learn to see students*

- Can teacher develop the material by considering both mathematical essential points and students’ interest?
- Can students find out their own problems from the original problem that teacher presents at first?
- Can teacher assist students’ cooperative discussion and summarize the mathematical essential ideas derived from their discussion?
What do you consider important when introducing a mathematics lesson?

(3) To make students clarify an ambiguous situation.

Check 3 in the following figure!

By Mr. Tezima

Answers of students

Students’ own problem

Why did we derive a variety of ideas?
Learn to see material
Identifying mathematical essential points

To identify essential mathematical ideas and a wide range of mathematical ideas
Ex: Division with a remainder “13 ÷ 5 = “

If I had two more, the quotient would become 3

The quotient is 3 with a lack of 2

No, your idea is not good.

By Mr. Tsubota

[Aim of teacher]
The quotient is 2 and the remainder is 3
Learn to see material
Identifying mathematical essential points

Wide and deep mathematical insights are required for a teacher.

Ex: Division with a remainder “13 ÷ 5 = ”

[ Aim of teacher ]
The quotient varies based on the situation

Teacher can pick up students’ mutter as well as focus on mathematically essential points.
Learn to see students

students’ ideas ignored by teacher’s selfish judgment

Which animal do you think is the biggest among a lion, a frog, and a turtle made by the clay?

Focus of teacher: Measuring Volume

Let’s measure the weight of three animals to compare the volume

Um... Are there other ideas?

It is not appropriate for a teacher to ignore a student’s idea in this situation.
Are mathematical essential ideas elicited from students’ collaborative discussion summarized at the end of lesson?

Students developed the formula to calculate the area of trapezoid.

15, July

If you have the panel, please show us at the beginning.

At the end of the lesson, the teacher puts the panel on the blackboard.

Summary

\[ S = \frac{(a+b) \times h}{2} \]
Ideas that will be useful for his/her future teachings

Lesson Study A

Lesson Study B

Lesson Study C
Some Remarks on Lesson Study

- Teachers who demonstrate their classroom teaching should assert a theme in their teaching.
- Too many suggestions before a teaching demonstration sometimes soften a teacher’s assertion in unproductive ways.
- A collaborative atmosphere, including opposition between teachers’ ideas about a theme, cultivate a lesson study.
Future Issues to be discussed in Japan

- It is necessary for teachers to discuss the issues that are useful in a future teaching. Namely, it is expected for teachers to discuss the following questions for instance.

  - If you have a chance to teach the same topic next time, how do you want to treat them?
  - Is there any alternative teaching methods?
  - What is the points that is useful in a future teaching?
Future Issues to be discussed in Japan

- We often observed the stereotyped classroom teaching. (ex. Understand a problem - Solving individually - Presentation by students - Negotiation)
- The most important task for the teacher is to accept students’ ideas and evaluate them flexibility. If a teacher couldn’t do so, students might not come to life.
Revised National Standard concerning teacher license

In 2001

<table>
<thead>
<tr>
<th>Types of License</th>
<th>Subjects concerning...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Math et. al.</strong></td>
<td><strong>Teaching</strong></td>
</tr>
<tr>
<td>Elementary</td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>8 credits</td>
</tr>
<tr>
<td>First Class</td>
<td>8 credits</td>
</tr>
<tr>
<td>Second Class</td>
<td>4 credits</td>
</tr>
<tr>
<td>Junior High</td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>20 credits</td>
</tr>
<tr>
<td>First Class</td>
<td>20 credits</td>
</tr>
<tr>
<td>Second Class</td>
<td>10 credits</td>
</tr>
<tr>
<td>Senior High</td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>20 credits</td>
</tr>
<tr>
<td>First Class</td>
<td>20 credits</td>
</tr>
</tbody>
</table>
The number of new teachers & the number of teachers

- Elementary: 407,000
  - (Male):(Female) = 2:3

- Junior High: 255,000
  - (Male):(Female) = 3:2

- Senior High: 266,000
  - (Male):(Female) = 5:2

Total population (1000 students): 6

Total teachers: 12,000

Number of teachers in 2002:
- Elementary: 407,000
- Junior High: 255,000
- Senior High: 266,000