

Research promotion school of the Setagaya public school district
(2010-2011 and 2011-2012 school years)

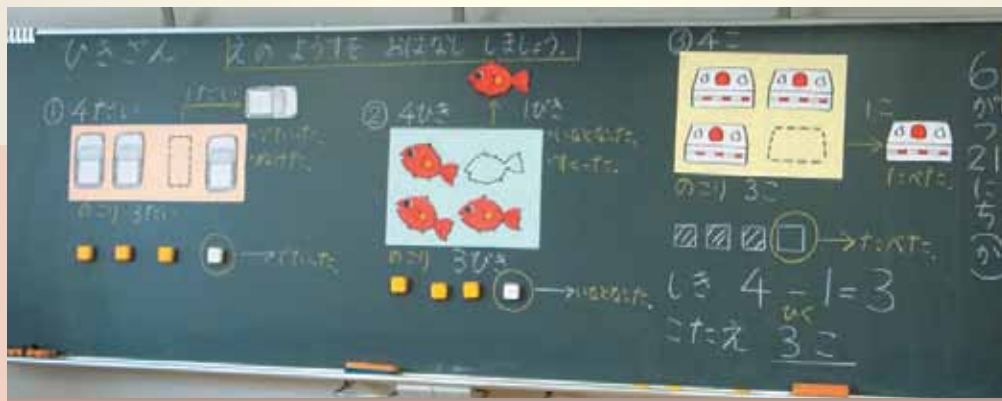
Research Theme

"Mathematics teaching that supports students
to explain their ideasto each other and learn from each other"

『説明し合い 高め合う 算数指導』

～問題解決学習を通して～

～ Learning through problem solving～



December 1st, 2011

Akamatsu
School

Matsuzawa Elementary School



This school research report is originally written in Japanese and translated into English by
the Project IMPULS for the International Seminar on Lesson Study, Nov 30- Dec 1, 2011.
<http://www.impuls-tgu.org/>

IMPULS

Address

Superintendent,
Setagaya Board of Education

I would like to express my heartiest gratitude for Matsuzawa Elementary School, as a research promotion school, with your hard effort for mathematics educational research.

It is really important to support students have insight to the solution with logical reasoning and to develop ability to explain their mathematical ideas. Through this research project, Matsuzawa Elementary School has tried to find ways to improve mathematics teaching and learning by focusing on investigating the process of students' problem solving, promoting students' ability to explain their idea with logical reasoning, and deepening students' ideas through explaining each other. I expect Matsuzawa Elementary School to establish an approach for teaching through problem solving in mathematics and to evolve quality learning.

Lastly, I would like to deeply thank to Ms. Kayoko HAYASHI, principal and all the teachers and the staff of Matsuzawa Elementary School, and all external advisors.

Introduction

Kayoko Hayashi, Principal

“From knowing to living”

This is the main theme for Matsuzawa Elementary school since 1972. Research done within the school has been put forth with this theme kept in mind. The idea of “the power to live” has been put forth from the *new course of study* that has been put into practice from this year. From this, within Arithmetic, it has been asked to foster basic abilities, skills, and mathematical ways of thinking and expressing, and to raise the will to learn.

Our research has been aiming for a lesson which each student has their own thoughts, can learn from each other, and express their thoughts through each steps of problem solving. We have been able to see students working hard along with teachers trying to effectively use the student's ideas within the lesson.

Henceforth, we are thinking of continuing the research to deepen the study. We would like to thank all of the teachers who participated and advisors who gave us advices for this research.

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Reasons for setting the research theme

“Mathematics teaching that supports students to explain their ideas to each other and learn from each other”

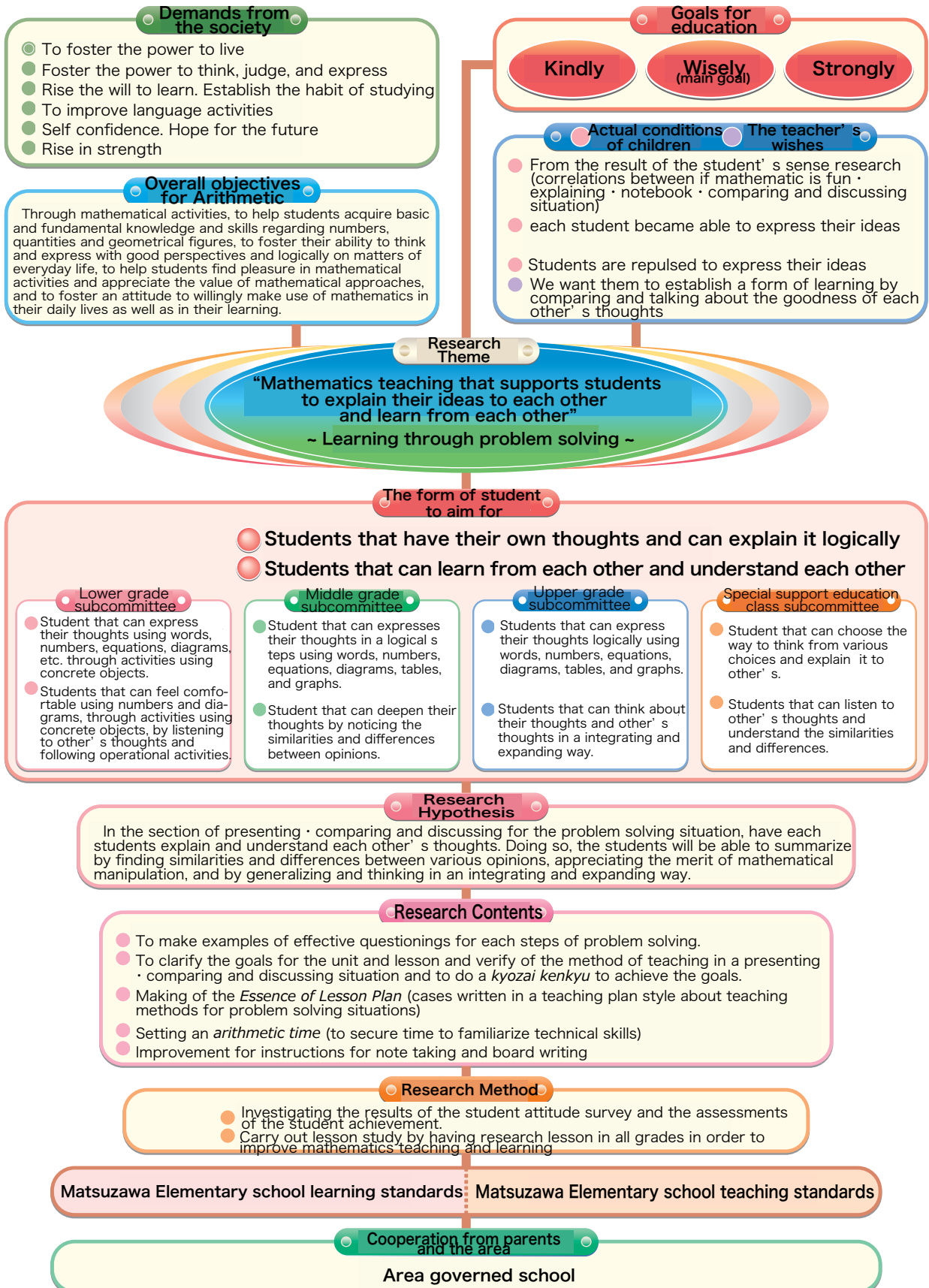
~ Learning through problem solving~

The *new Course of Study* has been put into practice since this school year. Fostering mathematical thinking and expression has been put forth from the revisions done this time. For the teaching contents, it has been asked to “enrich the kind of teaching where students are taught to think systematically, in logical steps, by reasoning, and to understand the connections among words, numbers, mathematical expressions, figures, tables, and graphs. This kind of teaching will also allow students to learn appropriate usage, problem-solving, how to explain one's ideas clearly, and how to express and communicate one's ideas to others” .

At our school, the main goal for the school is to foster “clever” students. As a part of the practice, we have been researching how to foster knowledge for students to have their own thoughts and explanations by learning through problem solving. As a result of the research, we were able to know that our students were able to express their thoughts with numbers, equations, and diagrams through individual solving but are still struggling with presenting their thoughts understandably to the class. This was because the students didn't have much experience of group discussion where they talked about each other's thoughts and learned from each other.

From the results, this year, to research how teachers should instruct and teach students, we took in activities to talk with one another to understand each other's thoughts and to present their own thoughts in an understandable way in a presenting, comparing and discussing, and summarizing situation. Also we took in activities for students to learn own their own by looking back at what they understood and learned from each other by having a group discussion.

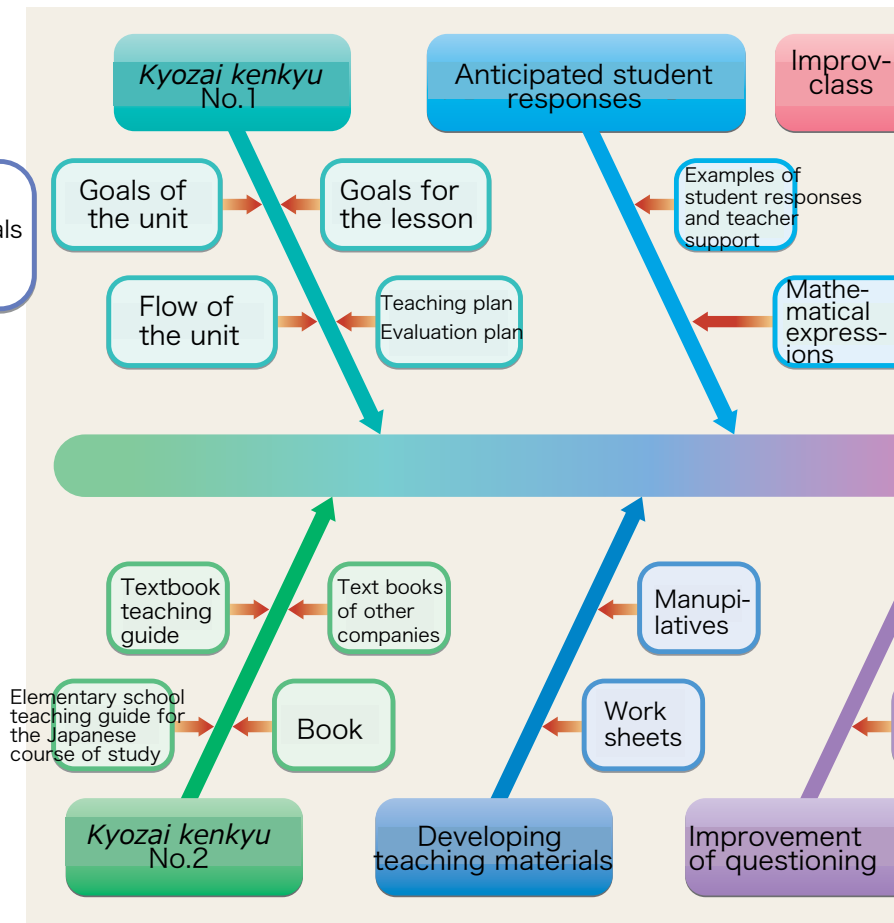
Structure of the overall Research



Ideal lessons to aim for

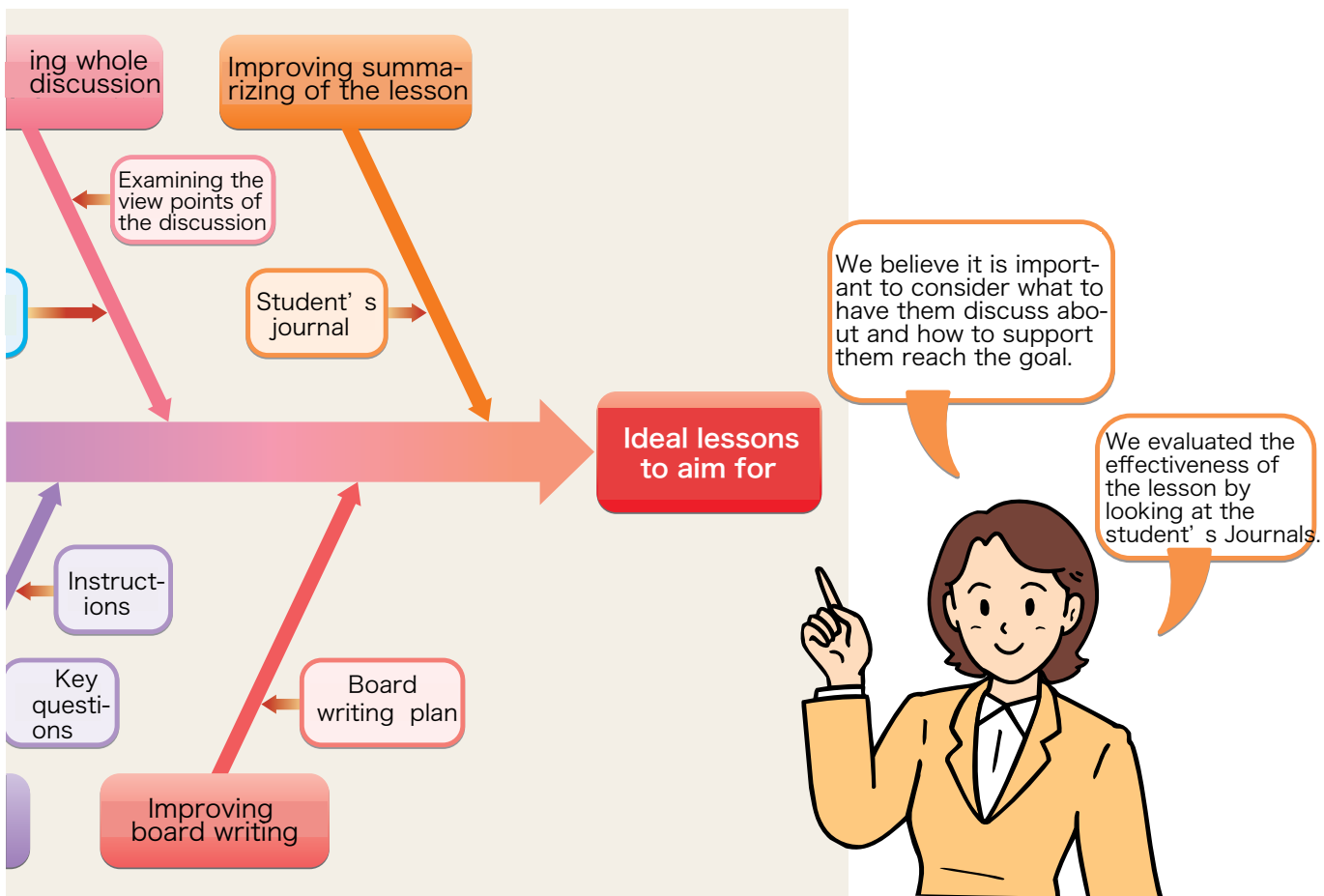
We also conduct kyozaï kenkyū by focusing on the student prior learnings and extending the topics.

Clearly set goals and teach.



Learning through problem solving at our school


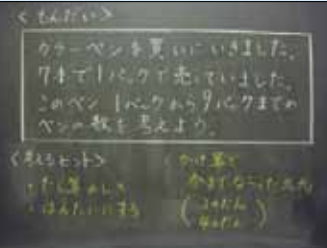

Flow of Problem Solving learning	Understanding the problem	Having insight to the solution	Individual problem solving
Student activities	Capturing the problem situation mathematically	Thinking insightfully and to have their own ideas	Expressing their ideas
Points to consider for the teacher	<ul style="list-style-type: none"> To make students be able to understand the scene properly. To make students think of the differences between problems. 	<ul style="list-style-type: none"> To think back and find information that is useful from what they have already learned. To take good care of their notebooks which are their history of what they have learned. 	<ul style="list-style-type: none"> To have children specifically write how to solve the problem and why they did so. <p>When doing so, the teacher will tell the students to not only write the equations and answers, but also use diagrams or words to describe is. (in some cases they may use number lines, graphs, and operations)</p>







Presenting the solutions		Comparing and discussing the solutions	Summary of the lesson
Explaining one's opinion	Understand other's opinion	Putting together different opinions to investigate better solutions.	Looking back at themselves.
<ul style="list-style-type: none"> To Make a point of relating between equations, diagrams, and words. <p>To be able to explain in logical steps by using "first", "next", "because", etc., in the lower grades, teach the basics for speaking step by step.</p>	<ul style="list-style-type: none"> To make them listen making relations between diagrams, equations, and words. Especially for diagrams, use a common diagram throughout the class and have every students use it when they explain. (ex. Number lines) 	<ul style="list-style-type: none"> To make them realize same ideas and have them put it together. To support students consider for various of ideas on what is good about handling problem (ex. simplify, clearly or exactly). 	<ul style="list-style-type: none"> To write the black board so that the flow of the lesson can be seen. To support students write notebook so that their own ideas and their friends ideas through the lesson can be notified so that it can become one of the elements to look back. To support students write student's journal points of views*.

*Look at p.10-11.

Examples of effective questioning for each steps of the learning through

Flow of Lesson	Understanding the problem	Having insight to the solution	Individual problem solving
Students Activities	Capturing the problem situation mathematically	Thinking insightfully and having one' s ideas	Expressing one' s ideas
Pictures of students activities			
Preferable student behavior	<ul style="list-style-type: none"> Understands the problem situation correctly. 	<ul style="list-style-type: none"> Looking for the differences between problems they have already learned Recalling necessary knowledge to solve the problem Insightfully thinking the way of thinking Insightfully thinking of the answer 	<ul style="list-style-type: none"> Trying to solve the problem by using knowledge they have already learned. Expressing their own ideas in a way everyone can understand Always looking for a better way of thinking <p>Ex. "Faster, easier, more precise" , etc.</p>
Effective questioning and advices	"Which is the necessary numbers?"	<p>"What' s different from the other problems we have already learned?"</p> <p>"What have we been learning?"</p> <p>"What is the hint to solving this problem?"</p> <p>"What do you think the answer might be?"</p>	<p>"Let' s think of other ways to solve it" (asking of various ways to think)</p> <p>"Let' s express it in a different way" (urging various ways to express)</p> <p>"Let' s write the diagram (equations, graphs)" (specify the way of expression)</p> <p>"Let' s think which way of thinking is the better?" (make notice what is good about handling problems mathematically)</p>

Presenting the solution		Comparing and discussing the solution	Summary of the lesson
<p>Explaining their ideas</p> 	<p>Understanding other' s ideas</p> 	<p>Putting together various ideas to come up with a better idea</p> 	<p>Looking back at themselves</p> 
<ul style="list-style-type: none"> Trying to explain their ideas in a way everyone can understand Speaking in front of the blackboard, with their face and body looking toward the class Explaining using equations and diagrams <p>Ex. "first ~" , "this is because ~"</p>	<ul style="list-style-type: none"> Listening to other' s presenting their solutions to understand it. <p>(shown by nodding)</p>	<ul style="list-style-type: none"> Looking for differences and similarities between their ideas and their friend' s ideas Thinking of what is good about handling problems mathematically Thinking in an integrating and expanding way. 	<ul style="list-style-type: none"> Has what they understood and reflected from today' s lesson written down Has their student journal written down <p>Ex. "Today <u>I understood A because B</u>"</p>
<p>"What do you think? (ask without repeating)" (asking other students)</p> <p>"Why is that?" (asking for evidence)</p> <p>"So?" (use when you want the student to speak continuously)</p> <p>"Is there anyone who solved it the same way?"</p> <p>"Let' s have another person who solved it the same way explain it"</p>	<p>"Can you understand this way of thinking? Can you explain it?" (have another student read the way of thinking written on the blackboard)</p> <p>"○○' s speech was great, wasn' t it? Let' s follow good ways of presenting speeches" (praise good speeches at the spot)</p>	<p>"Is there anything you noticed by looking at these ideas?"</p> <p>"What are the similarities?"</p> <p>"What are the differences?"</p> <p>"Which way of thinking is most understandable?"</p> <p>"Which way of thinking do you think is able to use at all time?"</p> <p>(Have questions ready about what is good about handling problems mathematically)</p>	<p>"What did you understand from today' s lesson" (conclude using the student' s words)</p> <p>"Write 1 to 3 points of views that fit this hour of study from what they understood · what they noticed · questions they have · what they thought from their friend' s ideas"</p>

Essence of Lesson Plan

By focusing on each process of learning through problem solving, the *Essence of Lesson Plan* has been developed so that the flow of the lesson can be easily understood. In the section of the individual problem solving, some of the major anticipated student ideas for solving the problem are highlighted. In the section of presenting and examining student ideas, effective questioning for the students to explain each other and learn from each other, and the typical students responses are highlighted.

Example of student reaction

The main examples of student reactions are given on the right side of the page. Other cases that students often make mistakes and advices for them are given here

Unit name & teaching plans

単元名 「小数のかけ算」 5年

○指導計画 (11時間扱い)

第1次

第1時 倍を表す数が小数になる場合もあることを理解する。

第2次

第2時 整数に小数をかけることの意味を考える。

第3時 整数×小数の計算の仕方を考える。(本時)

第4時 整数×小数の筆算の仕方を考える。

第3次

第3時 小数×小数の計算の仕方、筆算の仕方を考える。

純小数×純小数の筆算の仕方を理解する。

第4次

小数+小数、小数×小数でも交換・結合法則が、

小数×小数でも分配法則が成り立つことを理解する。

○本単元の指導について

(1) 単元計画の工夫

通常の指導計画では、前時の意味理解と計算の仕方を合わせて1時間で取り扱っているが、今回は意味理解と計算の仕方の2時間に分けて設定した。その為、今回は、検討場面で多く時間をとることができ、児童がじっくり考え、理解を深められるようにした。

(2) 自力解決

式だけではなく、図(数直線)を使って考えるようにすることや、一つの考え方だけではなく、複数の解決

○板書計画

Teaching methods

States the kinds of teaching methods that will be used in order to achieve the goal for the whole unit

Board writing plan

*Refer next page

5/19 (木)

1m80円のリボンがあります。2.4m買ったときの代金はいくらかになるでしょうか。

式 80×2.4

小数 2.4倍

数直線をつかう

答え 192円

80×2.4の計算の仕方を考えよう

○0.1m分で考える $80 \div 10 = 8$
 $2.4 \times 10 = 24$
 $8 \times 24 = 192$

○24m分で考える $2.4 \times 10 = 24$
 $80 \times 24 = 1920$
 $1920 \div 10 = 192$

○計算のきまり $80 \times 2.4 = 192$
 $80 \times 2.4 = 192$
 $8 \times 24 = 192$
 $80 \times 24 = 1920$

0.1m分の代金 24m分の代金

8 ← 80 (円) 1920 (円)
 0.1 ← 1 (m) 2.4 (m)

まとめ 小数×整数は整数×整数にすると計算できる

○児童の反応例と手だて

本時では、既習事項である整数×整数の計算の仕方を根拠に、計算の仕方を考え、表現していく学習活動である。その計算の方法を式だけに表すだけではなく、図を使って説明し、友達との共通点や相違点を見つけて、学習を深めていきたい。

本時では、以下の3点を取り上げて整数×小数を整数×整数にすると求められることに気付かせていきたい。

- (1) 0.1m分を求めて代金を求める。
- (2) 2.4m分を求めてから、2.4m分の代金を求める。
- (3) 計算の決まりを使う。

他に交換法則を使い、既習事項である小数×整数に直して計算する児童もいるが、本時のねらいに則していないためここでは取り上げず、次時に紹介をする。

Evaluation

It specifically states how the students changed through this hour of lesson.

The goal and teaching of the lesson

States examples of questions and student reactions that fits the purpose by narrowing down the points for each steps of the problem solving learning.

Understanding the problem

Makes the problem and the goal for the period clear.

Having insight to the solution

Confirms and reminds knowledge that has already been learned. Also confirms how to insightfully think of answers and ways to think. If the teacher is going to narrow the way of thinking, it is done here.

Individual problem solving

Picks up 3to4 predicted reactions of the students. It is lined up so that the preferable way of thinking is lined up from left to right. It is also in the order the solution was presented.

Comparing and discussing the solution

It states examples of effective questions and student reactions in order to summarize the lesson in an integrative and extensive way by having students talk with each other, find out similarities, and classify the many ideas that came up.

Summary of the lesson

Have the student come up with the conclusion in their own words by looking back at what they learned this lesson.

○本時の指導 (11時)

ねらい (整数) × (小数) の計算の仕方考えることができる。

課題把握
 1 m 80 円のリボンがあります。2.4 m 買ったときの代金はいくらになるでしょうか。
 式 80×2.4
 80×2.4 の計算の仕方考えよう。

見通し
 かける数である小数を、整数に直して計算できそうです。
 計算の決まりを使う。

自力解決

① 0.1 m 分で考える
 式 80×2.4
 $= (80 \div 10) \times (2.4 \times 10)$
 $= 8 \times 24$
 $= 192$

言葉
 0.1 m 分にして考えると、8 円になる。2.4 m 分は 0.1 m の 24 倍だから 8×24 をする。

② 24 m 分で考える
 式 80×2.4
 $= 80 \times (2.4 \times 10) \div 10$
 $= (80 \times 24) \div 10$
 $= 1920 \div 10$
 $= 192$

言葉
 2.4 m 分の代金は、24 m 分の代金の $\frac{1}{10}$ になる。

③ 計算の決まり(1)
 式 $80 \times 2.4 = 192$
 $\div 10 \quad \times 10$
 $8 \times 24 = 192$

計算の決まり(2)
 式 $80 \times 2.4 = 192$
 $\times 10 \quad \div 10$
 $80 \times 24 = 1920$

発表・検討
 ○どのように考えたかを説明する。
 T: 80×2.4 の計算の仕方を説明しましょう。
 (4つの考え方を発表する)
 ○4つの考え方について検討する。
 T: 4つの考え方で似ている考えはありますか。
 C: ①と③(1)が考え方は違うけど式が似ています。
 C: ①は言葉で表しているけど③(1)は計算だけで表しています。
 C: ②と③(2)も似ています。
 C: つまり2通りの考え方に分けられます。
 T: 4つの考え方で同じところはありますか。
 C: どの考えもかける数の2.4を10倍して整数にしています。

まとめ
 ○学習を振り返る
 C12: 整数×小数の計算はまだ習っていないけど、整数に直すと計算することができます。
 C13: 式だけでなく、図などがあると分かりやすいです。
 ○学習感想を書く(分かったこと、気が付いたことなど)

評価
 (整数) × (小数) の計算は、かける数の小数を整数に直すと計算できることが分かり、根拠をもって説明できる。

Instructions for note taking

By looking at the actual conditions from the results of the investigation, copying the blackboard and listening to other's ideas had a correlation for the lower grades. We expected that by having the teacher write down the student's opinions in order so that it is easier to understand, and by having the students copy it to their notebooks, it will be easier to understand other's ideas.

Also for the middle and upper grades, there is a correlation between writing their ideas on their notebooks and listening to other's ideas. Furthermore, the writing their ideas also correlated with the comparing and talking about each other's ideas. From these results, we believe it is important to give students to give time to write their ideas and other's ideas, and provide them effective instructions for note taking in order for the students to be able to explain and to come up with better ideas. For that we have set the goals for improving student note taking, according to the developmental stage, and instruct how to show the flow of the lesson, their opinions, and the other's opinions on their notebooks.

Note taking goals for the lower grades

Can write down what is written on the blackboard

Diagram expression to instruct

- Can show the problem situation and the way of solving by using symbols such as circles.
- Can show the relation between addition and subtraction with a tape diagram (second grade).
- Can show series of whole numbers on the number line.
- Can show the composition and decomposition of numbers using the cherry diagram.

Handwritten student work for a math problem. The problem asks for the number of people on a bus. The student uses a tape diagram to show $37 - 18 = 19$, and then $19 + 8 = 27$. There are also some calculations and diagrams involving numbers 19, 8, and 27.

Note taking goals for

Can write what the teacher

Diagram expression

- Can show the size of diagram.
- Can show the relations division by using a tape
- Can show the series of on the number line
- Can show the size of the area model.

Handwritten student work for a math problem. The problem asks for the number of buses. The student uses a tape diagram to show $38 \times 3 = 114$, and then $114 \div 7 = 16$. There are also some calculations and diagrams involving numbers 38, 3, 114, and 7.

Student's journal point of views

What they understood

What they noticed

What they want to think about



the middle grades

down
and others said

to instruct

the number using a number

between multiplication and
diagram and a number line.
decimal numbers and fractions

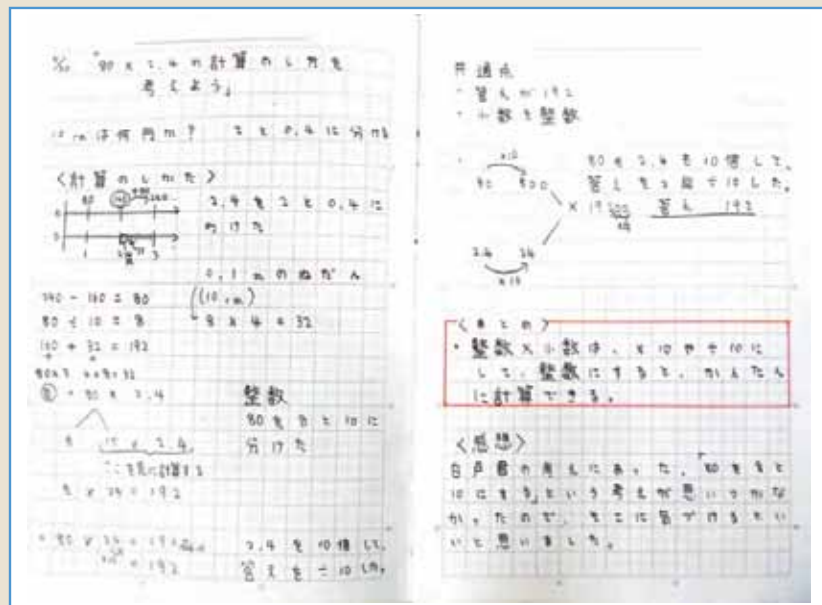
quantity using the rectangular

Note taking goals for the upper grades

Can write down points that they thought were important by listening to their friends way of thinking

Diagram expression to instruct

- Can show the relations between multiplication and division (decimal numbers and fractions) on the number line.
- Can show the relations between quantities on a table.
- Can combine the permutation and show it on a tree diagram.



next What they thought from other's way of thinking

Instruct to write based on the goal for the hour

Teaching according to individuals (Special support education class subcommittee)

Teaching based on the teaching plan for individuals

For children in the special support education class, a teaching plan for each child is made every year. This teaching plan clearly states the goals and the steps to achieve it, which is set according to each child's actual conditions. It is used to teach each subject and to help them live one's own life.

The teaching plan for each child is made with the child's parents, and every person who interacts with the child should understand the goal and the supporting plan written on the teaching plan and use them all the time.

年度		年度	種別	種別	種別	種別	NO.
学年	学期	教科	単元	学習目標	指導計画	評価計画	
1	1	算数	数の概念				
1	2	算数	数の概念				
1	3	算数	数の概念				
1	4	算数	数の概念				
1	5	算数	数の概念				
1	6	算数	数の概念				
1	7	算数	数の概念				
1	8	算数	数の概念				
1	9	算数	数の概念				
1	10	算数	数の概念				
1	11	算数	数の概念				
1	12	算数	数の概念				
1	13	算数	数の概念				
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1	99	算数	数の概念				
1	100	算数	数の概念				

Groups according to the developmental stages

In the special support education classes there are children from the first grade to the sixth grade. There are also differences between each child in their developmental stage.

To advance the learning effectively, for literature and mathematics, the children are divided into groups according to their developmental stages and not their grades.



Setting assignments in small steps

Set assignments in small steps according to the development stage and acquisition situation of each student along the flow of the contents to teach for each subject. It is made to go on to the next step after acquiring one step.

It is made to work on the assignment and after acquiring one step to go on to the next step to carefully develop knowledge.



Improving teaching materials • manipulatives

To have the child be able to work on the assignment with enjoyment, use teaching materials that attracts each child's interests.

Since operations of objects are necessary, especially for children learning the concepts of numbers, use teaching materials that are easy and safe to deal with according to the conditions of development of fingers.



From the results of the student attitude survey and the assessments of the student achievement

We researched the correlation between the activity of writing down their own ideas, other' s ideas, and copying the black board on to their note books, and the activity of explaining their ideas, listening to other' s ideas, and talking with each other about them.

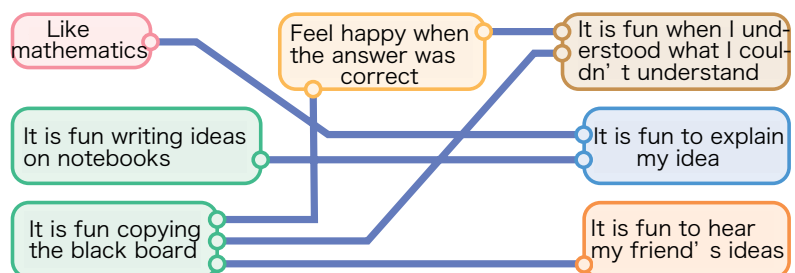
From the results below, we put together an examination of note taking and presenting · comparing and discussing situation for the lower · middle · upper grades and for the special support education class.

- ◆ Research done July 2011
- ◆ How to see Pearson' s product moment correlation coefficient
 $-1 \leq r \leq +1$

$0.4 < |r| \leq 0.7$ — Relatively strong correlation
 $0.7 < |r| \leq 1.0$ — Strong correlation

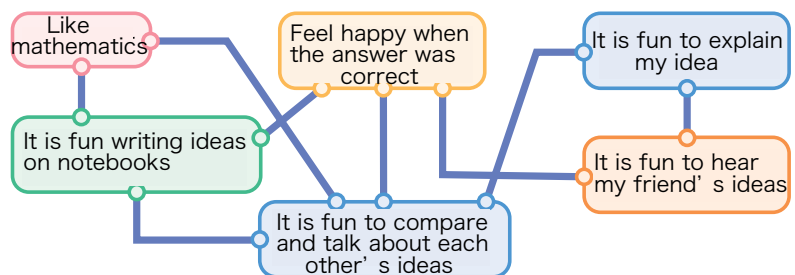
Lower grade

To be able to write their ideas on their notebooks, listen to other' s ideas and tell other' s their own ideas actively by devising how to make them work on activities such as copying the black board.



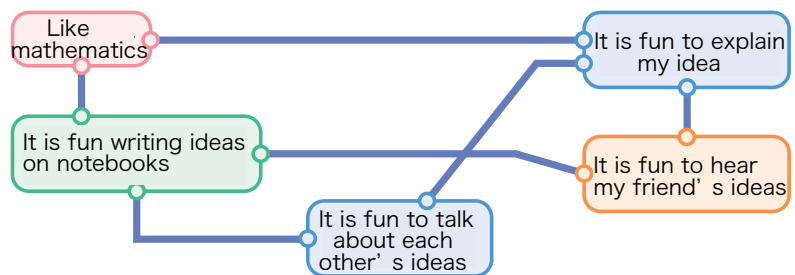
Middle grade

To be able to have confidence in themselves and compare their ideas from their friend' s ideas by having the habit to write down their own opinions on their notebooks.



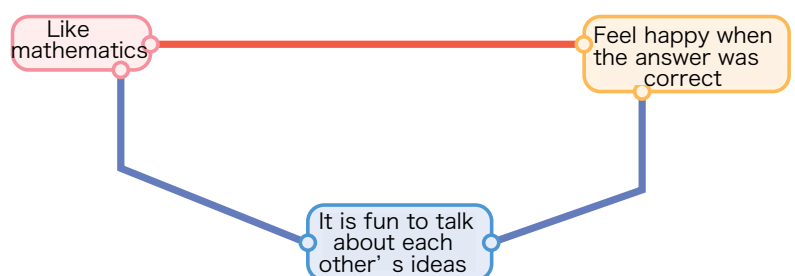
Higher grade

Make students be able to participate in the debate actively and listen to other' s ideas by making a point of writing down ideas noticeably on notebooks.



Special support education class

To see how much the student understands the concepts of numbers, device the way to present the assignment, have them feel the joy of reaching the answer, and let them have more opportunities to explain one' s thoughts with confidence.



Board writing plan

As a part of the Kyozaï Kenkyū, we thought that it is important to the flow of the lesson (assignment, question, student's ideas, and We try to develop a board writing that the teacher needs not to not only for seeing the flow of the lesson but also for self-evaluating the actual board writing and examined at the subcommittee meetings along with what they said on to their notebooks by looking at learned through the board writing. In addition, it can be used to teacher to improve their expressions for the lesson.

Write the date and the object

The object should clearly show what the students are supposed to think about for this period.

Write the problem

The teacher should write the problem, which they had ready beforehand. When writing it, the teacher should read it out loud with the students. Tell the students to write along with the teacher and make up the problem together to have them think of the numbers and words that might come up in the problem.

Having insight to the solution

Have students think about what the differences between today's problem and the problem they worked on during the previous hour are, and confirm the point they are going to think about today. Have insight for the way of thinking (if there are any knowledge that can be used that they already know) and the answer (predict what the answer might be). The teacher should narrow down the way of thinking so that it will fit the object.

Write the equation and the reason

- ① In mathematics, it is important for students make decisions on what operation should be used. Not only have them write the equation but also have them think of why it is so.
- ② After the class agree on what operation can be used, it is important to clearly state what they should solve independently (for example, by having them think of why it will become that equation). When presenting, be sure to let them notice that they can use the knowledge they have already learned in the past.

めあて 計算のしかたを考えよう。 自分の考え 数直線

問題 $\frac{2}{5}$ mの辺の正方形の青いペンキを $\frac{3}{4}$ dl 使った。このペンキは 1 dl あたり何 m² ぬれるだろうか。

式 $\frac{2}{5} \div \frac{3}{4} = \frac{8}{15}$ 答え $\frac{8}{15}$ m²

自分の考え

Aさん $\frac{2}{5} \div 3 = \frac{2}{15}$

$\frac{2}{15} \times 4 = \frac{8}{15}$

Bさん $\frac{2}{5} \div 3 = \frac{2}{15}$

$\frac{2}{15} \times 4 = \frac{8}{15}$

1辺の量 \times ペンキの量 = 全体量

$\square \times \frac{3}{4} = \frac{2}{5}$

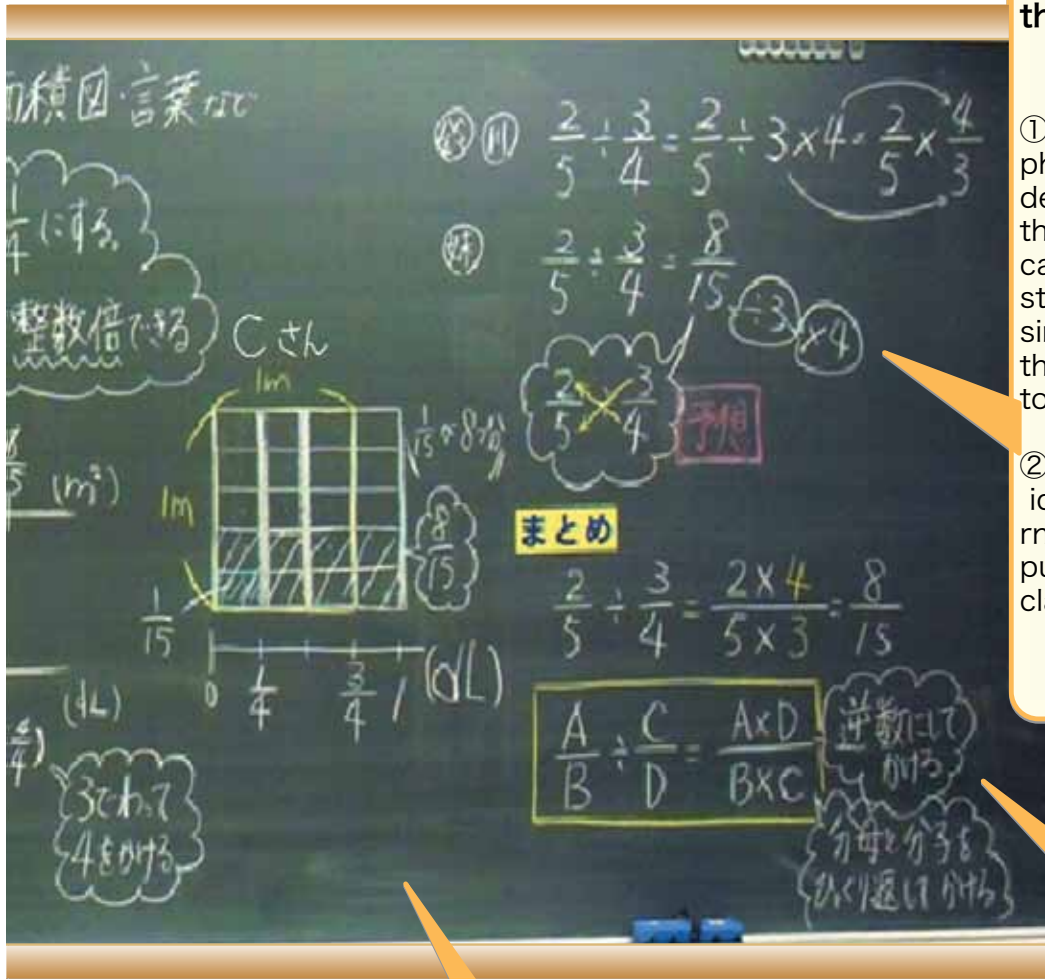
$\frac{2}{5} \div \frac{3}{4}$

develop a board writing plan. Board writing should be able to show summary of the lesson) that the teacher has organized in advance. erase the writing throughout the period. Board writing can be used on how the lesson has been done. After the lesson, we recorded Students were able to put together and understand other' s though- the board writing. They were also able to look back at what they think in logical steps. By making a board writing plan, it can lead the

Present so that they can talk about the ideas

① Add key words and phrases that the students said along with the various ideas that came up so that the students can look for similarities, group them, and put them together.

② Make use of the ideas for further learning by naming it or putting it up in the classroom.



Reveal student ideas and figure out how they come out

When solving problems individually, students use equations, diagrams or graphs. They can express their ideas with equations, diagrams, and words. The teacher should help the students express their ideas using various ways in everyday lessons. Also, the teacher should have the students be able to think in various ways by asking them if there are no other ways to solve the problem. Try to have as many students as possible to speak. It is also important to have students figure out the way of thinking on their own.

Write a summary of the lesson based on today's learning

Write a summary of the lesson that fits the object. The summary should be based on what the students talked about and debated about. It is favorable to use the words the students used.

Teaching standards

Matsuzawa Elementary school teaching standards was developed in 1987 in order for our students to become independent learners, and for our teachers to teach each student according to their achievement levels. We precisely stated it into three contents, which are “basis for teaching”, “basic considerations”, and “basic learning attitudes and abilities”, so that teachers with not much experience can use it for their everyday classroom practices and also to have every teacher be able to teach in the same way. It was revised in 2010.

Basis for teaching

Major premise of a lesson

- 1 Students are the ones that learn
- 2 Students have the power to grow on their own
- 3 Every student is different

Basis for teaching

Teaching				Evaluation
Teaching steps	Teaching materials	Learning activities	Learning forms	
1. Analyze the goal for the lesson and the unit, and teach by clarifying the goal that must be achieved. 2. Use teaching materials that students show interest in and that provides opportunities to solve the problem. Have each student have an assignment to solve. 3. Take time for each student to work on the teaching materials on their own, use aiding materials, and to ask in order to solve the assignment. 4. Give students a chance to self evaluate and also evaluate each other, to look back at one's learning, and to have a feeling of achievement and the will for the next period.	5. Use books, ICT, audio-visual aids to have the student work on the assignment on their own and to foster information processing abilities. 6. Developing and using developmentally appropriate materials and the materials that close to the students everyday lives. In order for the students to gain the solid understanding.	7. Attempt to establish the way of thinking by making use of the students' ideas into the lesson and by using various learning activities to increase the willingness to learn. 8. Foster certain knowledge and brilliant sensibilities by making a point for activities that can be actually experienced by the students to realize the heart, phenomenon, and object.	9. Keep in mind to advise each student by looking around at each one of them during class learning and to take in individual teaching · group learning according to the development of learning. 10. Improve the ways of placing the desks and the use of the floor. Also, think of a lesson outside of the classroom to develop a form which students can learn from each other.	1. Try to unify the teaching and the evaluation, and evaluate synthetically from the point of view of each subject to acquire achievements that are in harmony. 2. To be ready to assist each student, grasp each students' actual condition by reviewing the pretest and the behavior observation data. While teaching a class, check the student's remarks, work, notebook, and behaviors to find points that are troubling them and the way they think, from the point of view of each subject, to assist them. 3. Have them acquire confirm achievements by checking how much they understood the unit at the end of the unit and by reinstructing those who haven't understood the unit yet.

Basic considerations

How to talk	Questioning	Reactions	Board writing	Notebook
<ul style="list-style-type: none"> ○Talk in a cheerful way watching out for the speed, loudness, place, and attitude of talking. ○Talk with appropriate intervals. ○Talk with an exact intention ○Think about the student and talk in a gentle way. 	<ul style="list-style-type: none"> ○Use questions according to each student's ability, actual conditions, and reactions. ○Use a question that will lead to the object. ○Use questions that can create various ways of thinking and point of views ○After questioning, you must wait ○Do not lead the student so they will think as the teacher intended but cherish the student's unique thoughts ○Make differences between questions used for instructions, suggestions, and advices. 	<ul style="list-style-type: none"> ○Deepen the thoughts by cherishing wrong thoughts ○The teacher must not restate or conclude the student's thought s. ○Listen carefully for soliloquies and murmurs ○Do not miss reactions that may deepen, change, or develop the idea ○Make use of the student's reaction to correct, assist, or put in order. ○Improve the use of pointing intentionally and letting the students speak freely and point each other according to the development. 	<ul style="list-style-type: none"> ○Write carefully and clearly keeping in mind the size of the words, the stroke order of kanji, and the conjugational ending. ○Keep in mind the positions that the students are looking at the blackboard.(ex. The reflection of the blackboard, the height, etc.) ○Make use of the materials and words the students made and wrote. ○Devise the use of chalks, cards, and small blackboards. ○Keep in mind to devise the composition of the board writing so that it will help organize and deepen the ideas. ○Make use of the remarks to write down the developing process of thoughts and the connections between the main points in a structured way. 	<ul style="list-style-type: none"> ○Not only have the student copy the board writing but also have them add or correct necessary things ○Take enough time to write ○Have the students write down not only the result but also have them take note of important things so they can notice the steps of thinking ○Make use of what is written on the notebook at the next lesson

Basic learning attitudes and abilities

	Listen	Speak	Write	Read	Learn together
First grade	<ul style="list-style-type: none"> <input type="checkbox"/> Look at the person talking when listening <input type="checkbox"/> Think of the outline while listening 	<ul style="list-style-type: none"> <input type="checkbox"/> Look at the person you are talking to and talk clearly <input type="checkbox"/> Clearly answer to what you are asked 	<ul style="list-style-type: none"> <input type="checkbox"/> Write what the teacher instructed and also write what you thought <input type="checkbox"/> Write what you experienced, close matters, etc. in simple sentences 	<ul style="list-style-type: none"> <input type="checkbox"/> Read easy readings to the end and enjoy it. <input type="checkbox"/> Understand what is written while reading 	<ul style="list-style-type: none"> <input type="checkbox"/> Can share information and learning materials with each other <input type="checkbox"/> Do not say things that will hurt others
Second grade	<ul style="list-style-type: none"> <input type="checkbox"/> Think of what the person is talking about while listening <input type="checkbox"/> Listen while understanding the order of the story and the situation of the scene 	<ul style="list-style-type: none"> <input type="checkbox"/> Talk in a loud and clear voice toward everyone <input type="checkbox"/> Talk alternatively given the content the opponent is talking about 	<ul style="list-style-type: none"> <input type="checkbox"/> Write what the teacher instructed or correctly write what they understood <input type="checkbox"/> Write so the order of matters are noticeable 	<ul style="list-style-type: none"> <input type="checkbox"/> Read interesting and easy books to the end <input type="checkbox"/> Understand the orders and the situation while reading 	<ul style="list-style-type: none"> <input type="checkbox"/> Cherish ideas and the way of thinking unique to that student <input type="checkbox"/> Acknowledge and praise device points
Third grade	<ul style="list-style-type: none"> <input type="checkbox"/> Understand the content of the story while listening <input type="checkbox"/> Listen without losing the point 	<ul style="list-style-type: none"> <input type="checkbox"/> Talk in an appropriate loudness according to the situation <input type="checkbox"/> Can correctly answer given the content the opponent is talking about 	<ul style="list-style-type: none"> <input type="checkbox"/> Simply write what is necessary <input type="checkbox"/> Write in an unified structure so the point is clear 	<ul style="list-style-type: none"> <input type="checkbox"/> Read various kinds of readings with interest <input type="checkbox"/> Read while understanding the point of the content 	<ul style="list-style-type: none"> <input type="checkbox"/> Help and teach each other <input type="checkbox"/> Can clearly say what they do not understand
Fourth grade	<ul style="list-style-type: none"> <input type="checkbox"/> Can think of opinions and questions while listening <input type="checkbox"/> Can listen for important points and main points of the story 	<ul style="list-style-type: none"> <input type="checkbox"/> Can talk in an appropriate speed and volume according to the situation <input type="checkbox"/> Can talk without missing the subject 	<ul style="list-style-type: none"> <input type="checkbox"/> Can write in order adding or correcting necessary things <input type="checkbox"/> Can write so the main point is clear 	<ul style="list-style-type: none"> <input type="checkbox"/> Read various kinds of readings <input type="checkbox"/> Can catch the main point and think about the connections between the points 	<ul style="list-style-type: none"> <input type="checkbox"/> Feel happiness for helping other' s learning <input type="checkbox"/> Can speak thinking about others
Fifth grade	<ul style="list-style-type: none"> <input type="checkbox"/> Can compare other' s ideas from their own idea while listening <input type="checkbox"/> Can understand the main contents and substances while listening 	<ul style="list-style-type: none"> <input type="checkbox"/> Can talk on the topic according to their notes <input type="checkbox"/> Can talk in proper manner 	<ul style="list-style-type: none"> <input type="checkbox"/> Can write according to the opponent and the condition of the scene <input type="checkbox"/> Can note important things <input type="checkbox"/> Can clearly write the substance and the main theme thinking of the whole structure 	<ul style="list-style-type: none"> <input type="checkbox"/> Can clarify the purpose of the reading and can read so that it fits it <input type="checkbox"/> Can understand the main theme and the subject while reading 	<ul style="list-style-type: none"> <input type="checkbox"/> Can help and encourage friends that are having trouble <input type="checkbox"/> Can understand the pleasure of working together and learning
Sixth grade	<ul style="list-style-type: none"> <input type="checkbox"/> Can put together their opinions while listening to other' s <input type="checkbox"/> Can listen with a problem to think about according to the purpose 	<ul style="list-style-type: none"> <input type="checkbox"/> Can talk thinking about the time and order <input type="checkbox"/> Can talk effectively according to the purpose 	<ul style="list-style-type: none"> <input type="checkbox"/> Write effectively with accuracy <input type="checkbox"/> Can take notes about important things <input type="checkbox"/> Can write sentences that fit the purpose and content of what they are trying to express 	<ul style="list-style-type: none"> <input type="checkbox"/> Can pick the right reading according to the purpose <input type="checkbox"/> Can read according to the purpose of the reading and the kind or form of the writing 	<ul style="list-style-type: none"> <input type="checkbox"/> Can learn mutually acknowledging the goodness of each other' s learning content and learning attitude <input type="checkbox"/> Can learn by working and competing with each other
Special support Education class	<ul style="list-style-type: none"> <input type="checkbox"/> Can listen quietly looking at the person talking <input type="checkbox"/> Can listen while making sure of the main contents of the story 	<ul style="list-style-type: none"> <input type="checkbox"/> Can talk clearly about close matters <input type="checkbox"/> Can respond correctly with words and gestures about everyday conversations such as responses and greetings <input type="checkbox"/> Develop their own way of expressing things 	<ul style="list-style-type: none"> <input type="checkbox"/> Have interest in words and can correctly write them <input type="checkbox"/> Can write what they experienced, close matters, etc. in easy sentences 	<ul style="list-style-type: none"> <input type="checkbox"/> Take interest in illustrated books and picture book and try to read it themselves <input type="checkbox"/> Can understand what is written and roughly understand the story <input type="checkbox"/> Can understand what the pictures and symbols stand for 	<ul style="list-style-type: none"> <input type="checkbox"/> Have interest in other' s behaviors and remarks <input type="checkbox"/> Can learn with each other in friendly manner by helping and encouraging each other

Learning standards

From the “*Matsuzawa Elementary school teaching standards*”, we specifically stated the belongings, attitudes, and behaviors that we want the students at Matsuzawa Elementary school to at least acquire. This is put up in every classroom, and is commonly understood by every teacher just like the teaching standard is.

Matsuzawa elementary school learning standards

★ Before the class starts

- Put their books, notebooks, pencils, erasers, and things that are necessary for the class neatly on their desks

★ The beginning and ending of the class

- Say the words to start and end the lesson

★ How to listen when someone is presenting

- Look at the person talking
- Nod and make brief responses while listening
- Put your hands on your lap

★ What to do when you have something to say

- Raise hands quietly
- When called on, say “yes” and then stand up to present

★ How to present

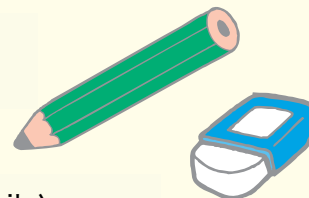
- Look at the person who is listening
- Talk clearly to the end

★ How to take notes

- Write carefully within the square
- Use a plastic sheet

★ Inside the pen case

- ◇ 5 to 6 pencils (do not use mechanical pencils)
- ◇ Red colored pencil (red pen)
- ◇ Eraser (one that erases good)
- ◇ Ruler that is about 15cm
- ◇ Felt tip pen



Results and pursuable future research

Findings

- Students were able to express one's idea by using not only words but also mathematical expressions and diagrams. Because of the cohesive use of the diagrams and expressions throughout the grades, the whole class discussion became deeper and productive. Moreover students were able to express their ideas in the similar ways regardless who teach the lessons.
- By crystalizing what we expect students to do in each stage of the problem solving and the major points of the teacher instruction, students were able to learn autonomously.
- By preparing effective key questions in each stage of the problem solving, students were able to express one's idea using various ways and talk each other clearly focusing on what should be discussed.
- By planning blackboard writing, the flow of the lessons became more coherent. Students became able to look back what they learned by looking at the board writing. Then they use it to put the various ideas together in integrating and expanding ways, and to evaluate their learning during the lessons by themselves.
- By making an *essence of lesson plan*, we were able to show the flow of the lesson, such as how we support students to discuss using various students' ideas and how we summarize the lesson, easier to understand.

Pursuable future research

- Some students still talk in a low voice or talk without looking others when they talk one's idea, so it is hardly to say that all the students have fully developed positive attitudes when they talk each other. It is necessary to continue teaching what is the merit to pursuit more through explaining ideas each other.
- We have found that there is relatively strong correlation between "It is fun writing ideas on notebooks" and "I like mathematics". Thus, it is necessary for us to continue providing enough time for the students to write down one's idea on to their notebooks so they can understand the merits and importance of writing own idea on their notebooks.
- By conducting *Kyozai Kenkyu*, we have realized that we can teach more focused and coherent ways, and use student's various reactions including their misconception effectively. Henceforth, it is important to keep on conducting *Kyozai Kenkyu*.
- By using Matsuzawa Elementary School Teaching Standards and Matsuzawa Elementary School Learning Standards, all the classrooms could to conduct lesson in coherent ways. Henceforth we would like to continue research of Matsuzawa Elementary School by using these standards.

Acknowledgement

Kazuyuki SHIRAI, Vice-Principal

We have been carrying on the study, based on the research lessons, as the 2010-2011 research promotion school of the Setagaya public school District. The research theme was “mathematics teaching that supports students to explain their ideas to each other and learn from each other”. This year took a lot of time discussing about how to have students learn from each other and where to aim for from the student’s explanations. I feel that through the research, the realization of a lesson to make good use of student’s thoughts is coming close.

This year is our Matsuzawa Elementary school’s 125th anniversary and since the opening of the school, there is something called a major premise of a lesson that has been practiced. “Students are the ones that learn”, “Students have the power to grow on their own”, “Every student is different” are the three contents of the premise. The research started from the keywords of new course of study, but the lesson we were aiming for was actually based upon these major premises. I think that we were able to carry on a research that fit time, along with taking over the traditions of Matsuzawa Elementary school.

Lastly, I would like to thank the advisors and teachers that helped in the research of 2010-2011. Thank you very much.

External advisors

Director, Tagara preschoolMr. M. Araki	Setagaya board of Education..... Mr. S. Hirakawa
Professor, Tokoha Gakuen University.....Mr. S. Kurosawa	Setagaya board of Education.....Mr. T. Tachibana
Associate professor, Showa Women’s University	Setagaya board of Education.....Mr. M. Takibuchi
Ms. N. Sato	Setagaya board of Education.....Mr. K. Aoshika
Akishima-city board of Education.....Mr. T. Sugiyama	Setagaya board of Education.....Ms. K. Tsukamoto
Specially appointed professor of Tokyo Gakugei University	Setagaya board of Education.....Mr. D. Kuribayashi
From De Paul University.....Mr. A. Takahashi	Setagaya board of Education.....Mr. K. Hirayama
Professor, University of Tsukuba.....Mr. K. Tsubota	Setagaya board of Education.....Mr. H. Takasaki
Chair person, Komae-city Board of Education.....	Setagaya board of Education..... Mr. K. Tsumura
Mr. Y. Nakano	Setagaya board of Education.....Ms. A. Sakata
Professor, Kamakura Women’s University.....Mr. K. Hirota	
Professor, Tokyo Gakugei University.....Mr. T. Fujii	

Research Participant Teachers

Principal Ms. K. Hayashi	Vice-Principal Mr. K. Shirai	Research chief	Member of Research promotion team		
Lower grade subcommittee	Middle grade subcommittee	Upper grade subcommittee	Special Support Education subcommittee		
<ul style="list-style-type: none"> ○ Ms. M. Matsuno Ms. H. Miyamoto Ms. M. Muroi ○ Mr. S. Sato Mr. Y. Nakasato Ms. M. Daimaru Mr. H. Miyazaki ○ Ms. M. Suzuki Ms. N. Kamata 	<ul style="list-style-type: none"> ○ Ms. S. Erabe Ms. M. Yamauchi Ms. H. Onuki Ms. N. Nakayama Mr. H. Aiuchi Ms. C. Suzuki ○ Ms. T. Yoshinaga Ms. Y. Ohara 	<ul style="list-style-type: none"> ○ Mr. M. Osaka ○ Ms. M. Osawa Mr. H. Watanabe Ms. M. Sano Ms. M. Kodama Mr. S. Sato ○ Mr. M. Yoshino ○ Mr. H. Hata Ms. M. Sudo 	<ul style="list-style-type: none"> Ms. K. Nagakawa Ms. N. Toya ○ Ms. H. Tsunoda ○ Ms. C. Yamanoi Ms. Y. Watanabe Mr. Y. Edagawa Ms. K. Kashima Ms. H. Hatao Ms. S. Nakanishi 		
Mr. Y. Kamei	Mr. M. Takahashi	Ms. Y. Takatsuki	Ms. R. Ono	Ms. A. Miyamoto	Ms. H. Katayama
Ms. M. Niihara	Ms. Y. Koizumi	Ms. F. Honme	Ms. E. Nakaide	Mr. S. Mita	Ms. T. Masutani
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Ms. Y. Suzuki	Ms. Y. Ogawa	Mr. K. Hashimoto	Mr. M. Yagi	Mr. T. Murata	Mr. H. Sajou
Ms. A. Okada	Ms. M. Fujieda	Ms. M. Motonaga			
Ms. N. Takizawa	Ms. M. Iwasaki	Ms. S. Taira	Mr. M. Mihei	Ms. M. Hayasaki	Mr. T. Uematsu
Ms. M. Orihara	Ms. M. Hara	Ms. J. Kuga	Ms. S. Kouda	Ms. R. Fujioka	Mr. H. Honma