JAPAN'S ONGOING REFORM IN MATHS: WILL 'MODELLING' HELP?

Keiichi Nishimura, Ph.D.

Tokyo Gakugei University

Outline

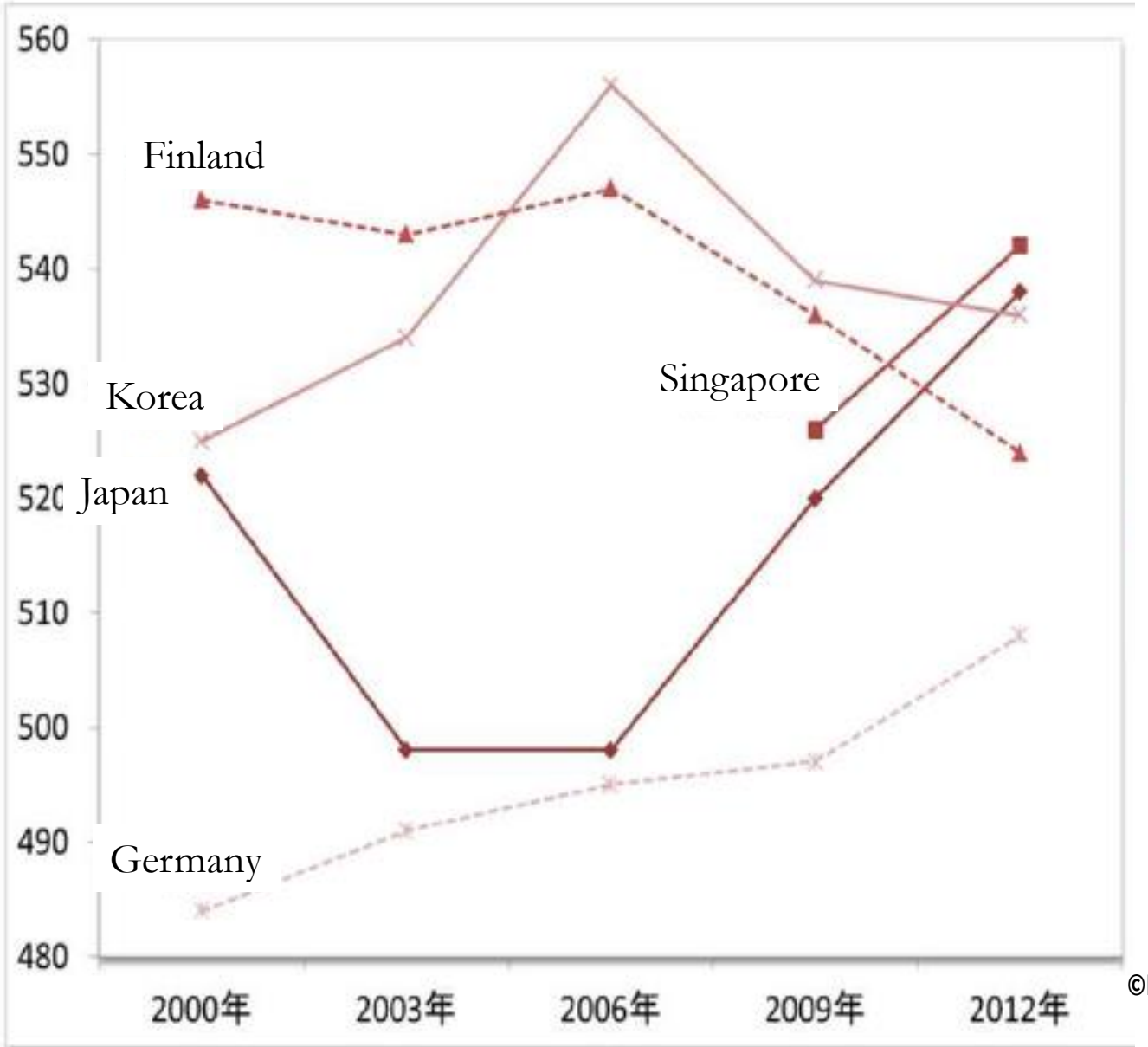
1. **Japanese maths education : overview**
   - Lesson Study – 'key' for all good features
     - Lesson study creates a 'research community' to think and experiment together
   - Key issues
2. **modelling in Japan - journey of my 'research community'**
   - The lonely 90s
   - Pisa Shock and the 2000s
   - Towards '*mathematical decision making*'
3. **Ongoing reform: including the entrance examination**
   - Huge opportunity but also key issues

1. Maths education in Japan

Japanese maths performance:
TIMSS

	TIMSS(1995)	TIMSS-R(1999)	TIMSS2003	TIMSS2007	TIMSS2011
1	Singapore 643	Singapore 604	Singapore 605	Taipei 598	Korea 613
2	Korea 607	Korea 587	Korea 589	Korea 597	Singapore 611
3	**Japan 605**	Taipei 585	Hong Kong 586	Singapore 593	Taipei 609
4	Hong Kong 588	Hong Kong 582	Taipei 585	Hong Kong 572	Hong Kong 586
5	Belgium 565	**Japan 579**	**Japan 570**	**Japan 570**	**Japan 570**

PISA



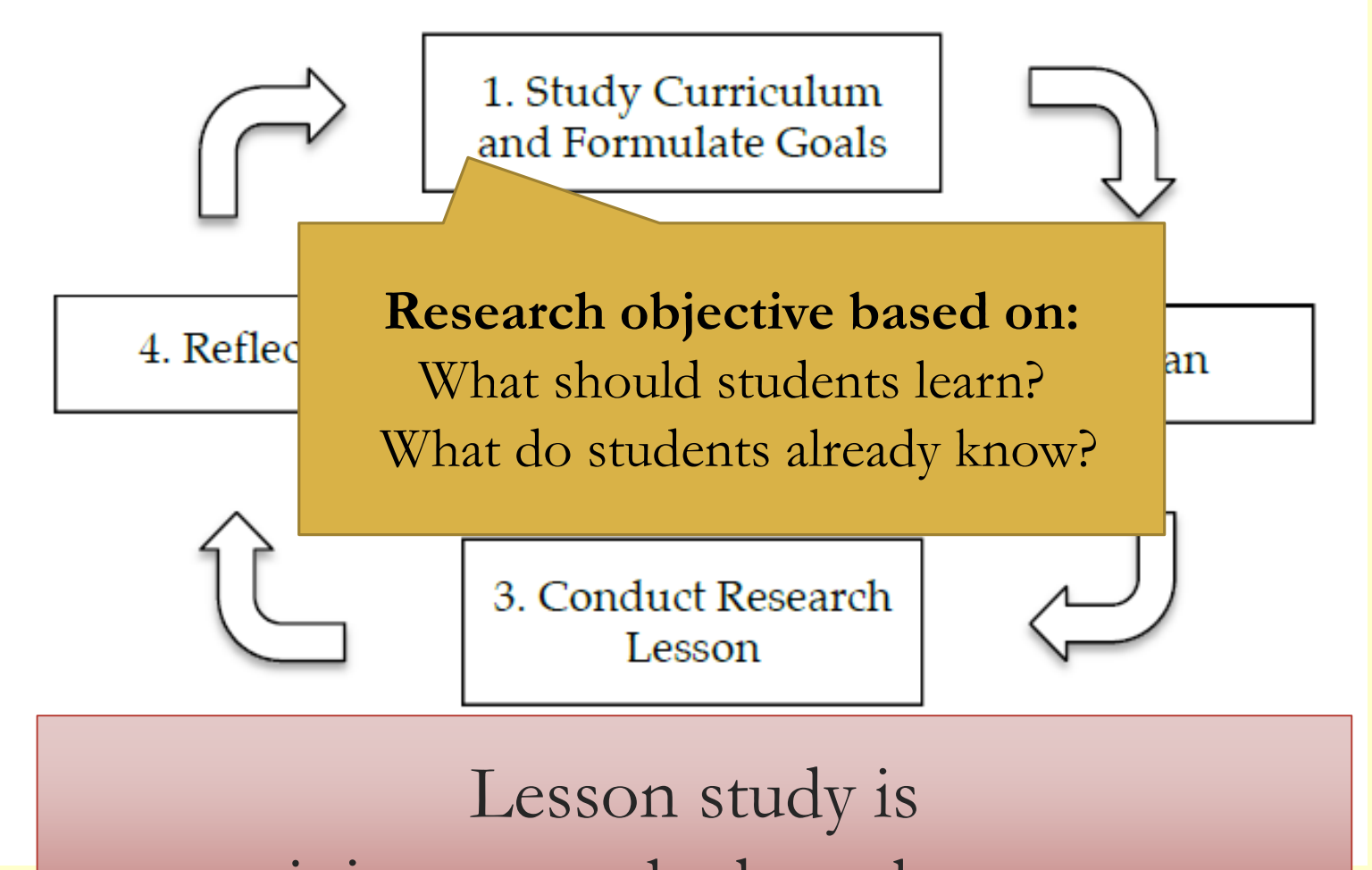
Japanese Secret 1:

Problem Solving Approach – a typical lesson structure

1. **Introducing a single key problem**
2. **Student solving the problem on their own**
3. **Whole class discussion orchestrated by the teacher - designed to deepen student understanding**
4. **Summarizing**

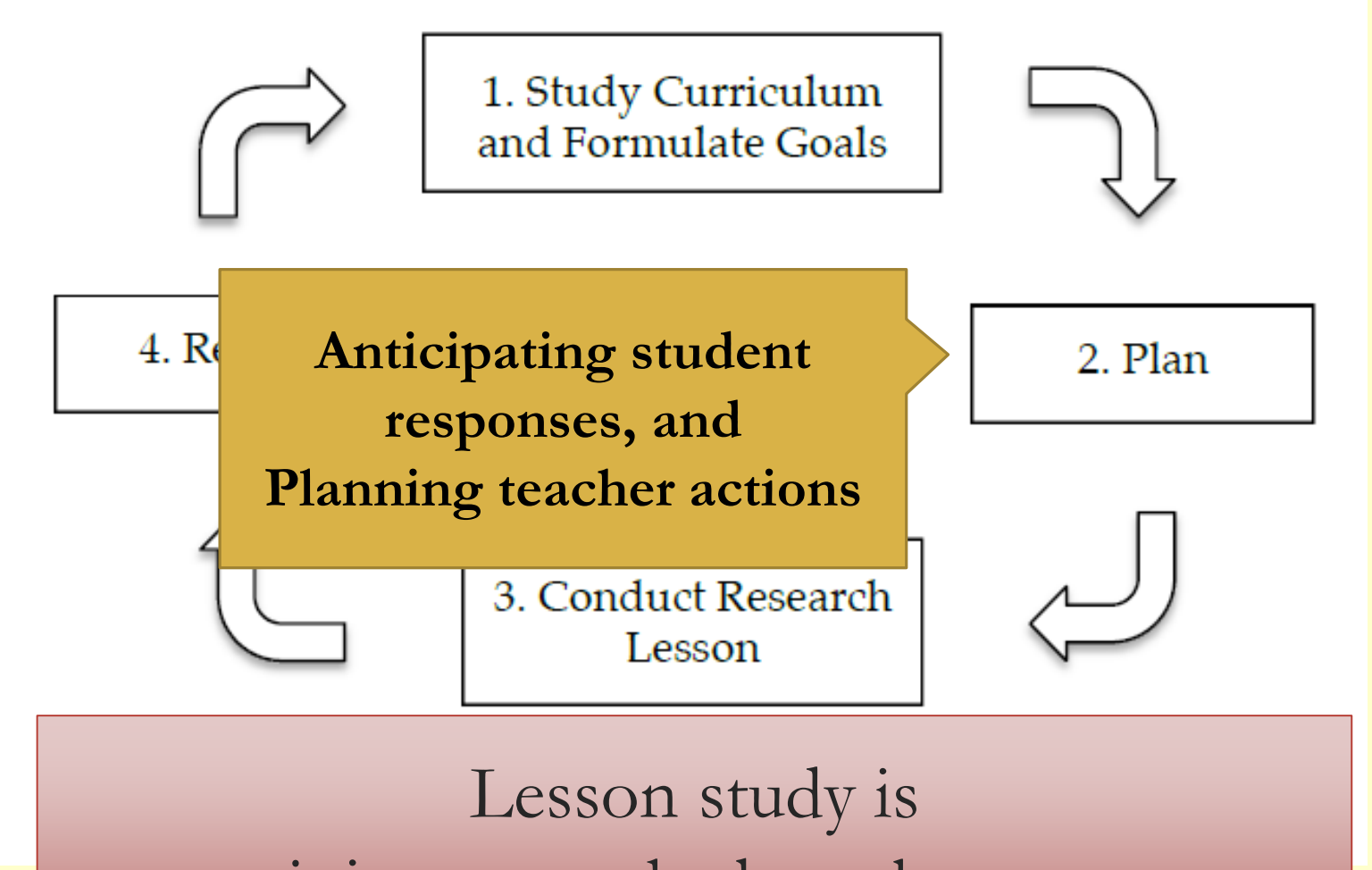
Share and compare with others. Then, based on students' ideas, summarize such ideas mathematically.

Japanese secret 2: Lesson Study



Lesson study is
joint research about lessons

Japanese secret 2: Lesson Study



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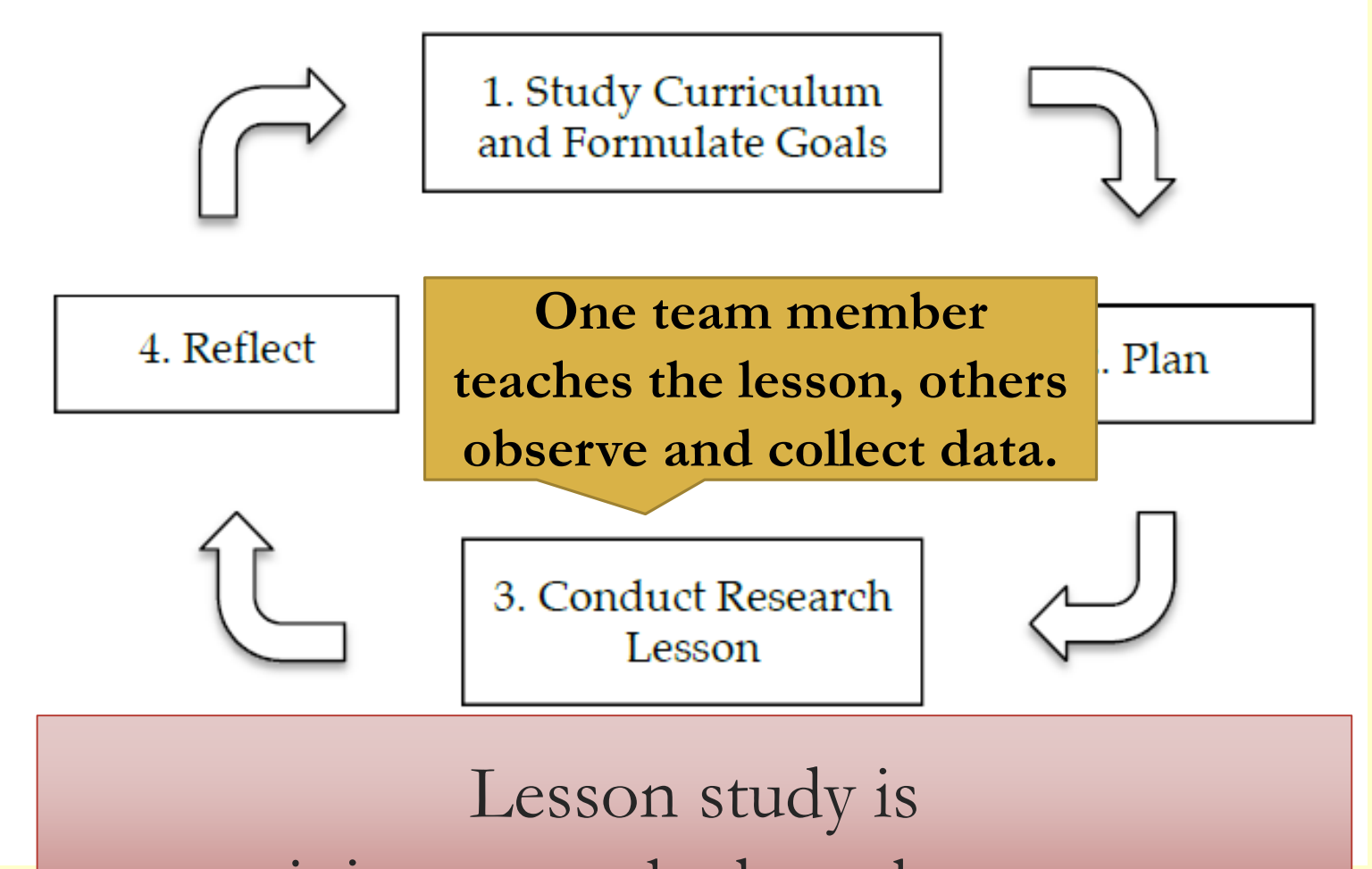

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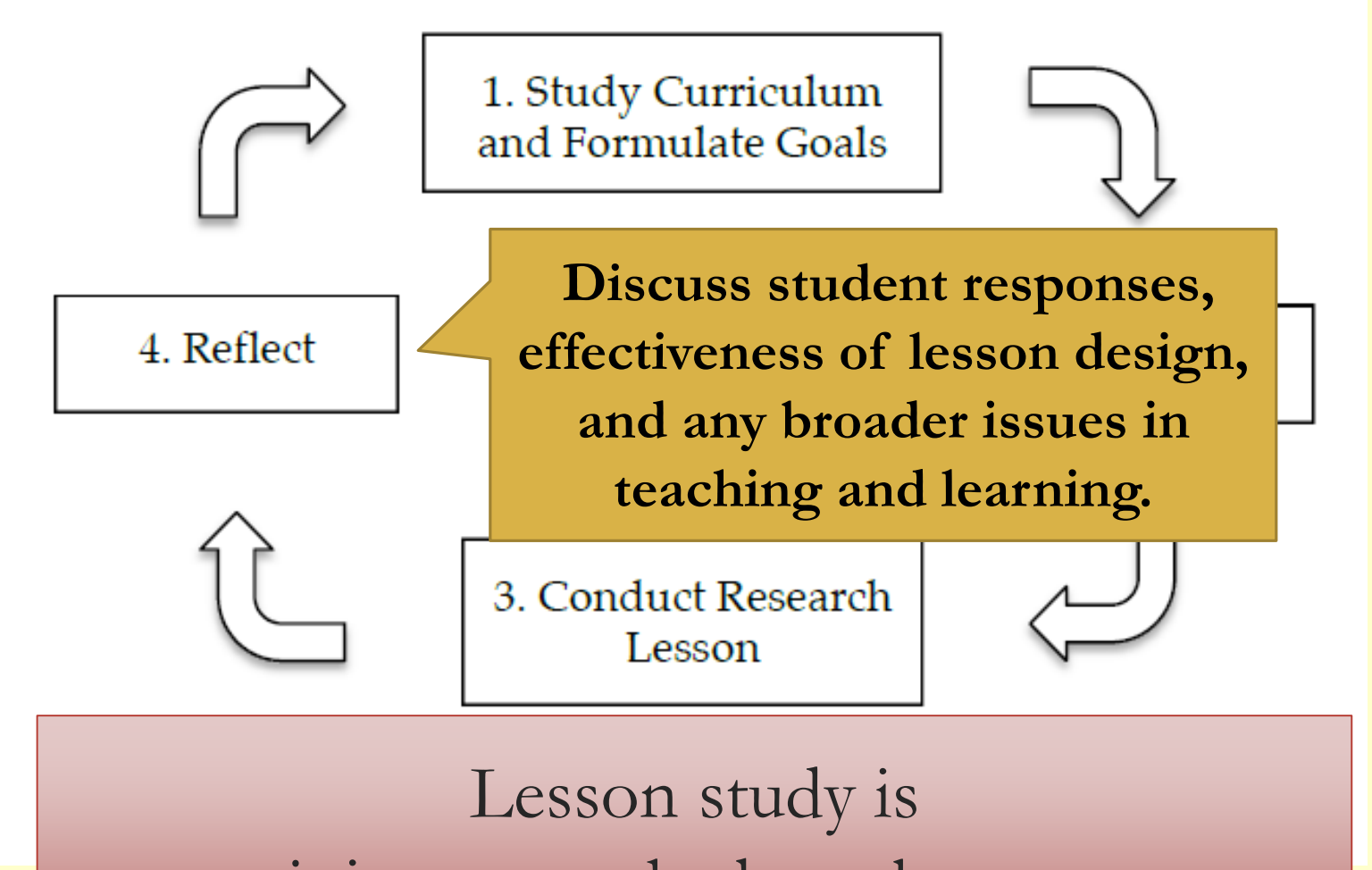
Japanese secret 2: Lesson Study



Lesson study is
joint research about lessons

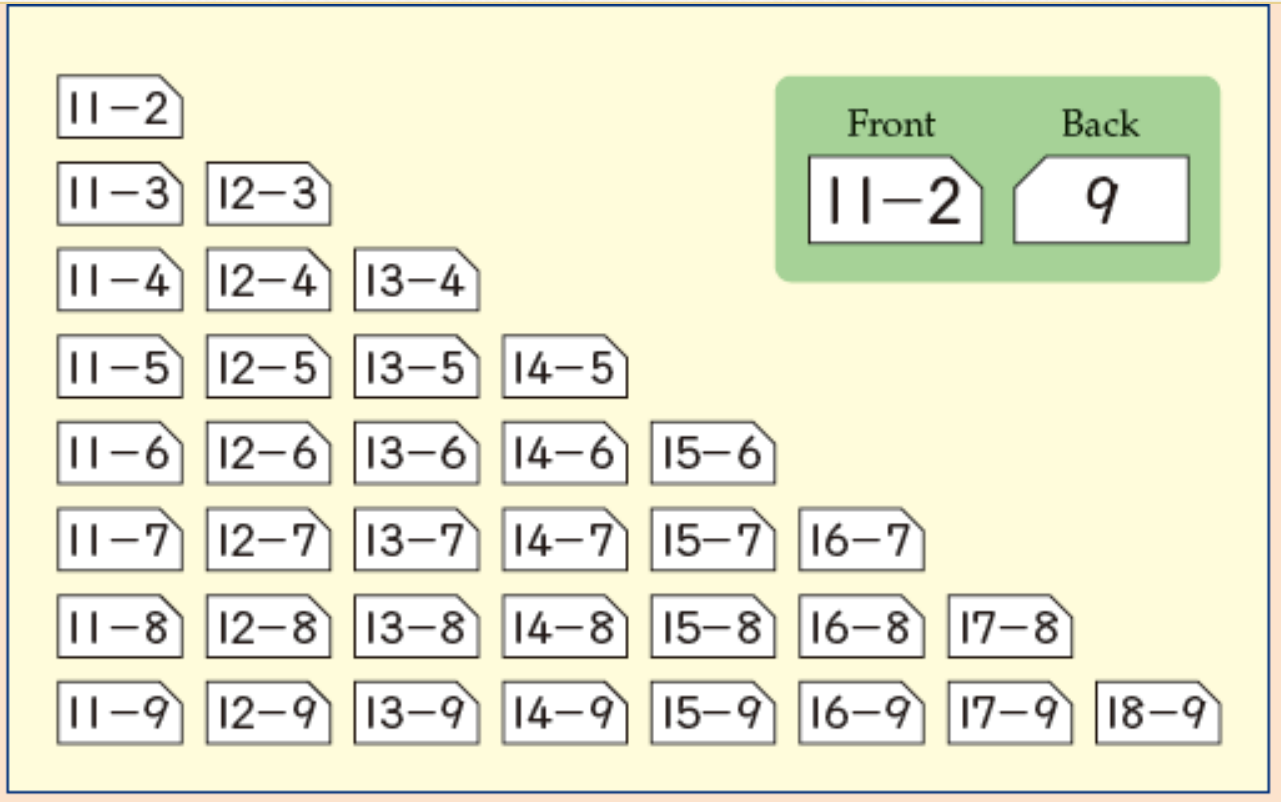
Focusing lessons and Neriage

- **Lesson study helps 'focus' the lesson**
  - What is the objective of the lesson?
  - For that, what should students take away from the lesson?
  - So, what **'discussion'** should they have?
- ***NERIAGE* – orchestrating to ensure the desired discussion takes place with the whole class listening**
  - planned carefully
  - Anticipating all possible student responses
  - With 'teacher responses' prepared for all contingencies
- **VERY detailed planning – nothing left to chance!**

Key consequences of systemic Lesson Study

- **Professional development of teachers**
  - eg.. Problem solving approach – in classrooms
- **Improved curriculum/teaching/materials/textbooks**
  - What are the essential concepts/skills which must be taught?
  - In what order should they be taught?
- **Linkages between academic researchers and teachers**
- **Mechanism to introduce new ideas**

What combination should we teach use subtraction?



$13-9$

$$
\begin{aligned}
&13-9\\
=&13-3-6\\
=&10-6\\
=&4
\end{aligned}
$$

$$
\begin{aligned}
&13-9\\
=&10+3-9\\
=&10-9+3\\
=&1+3
\end{aligned}
$$

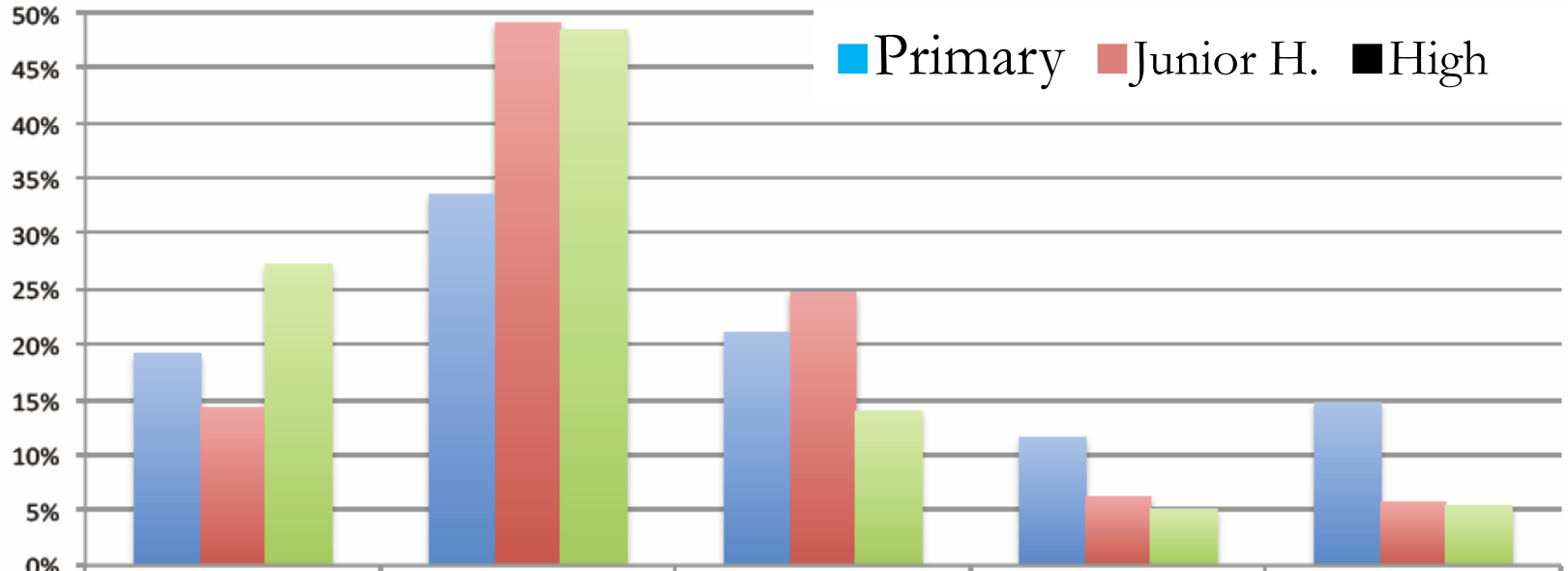
14 Subtraction

1 There are 13 acorns.
We used 9.
How many acorns are left?

(Tokyo Shoseki, 2011)

http://www.globaledresources.com/products/books/mathematics-international/

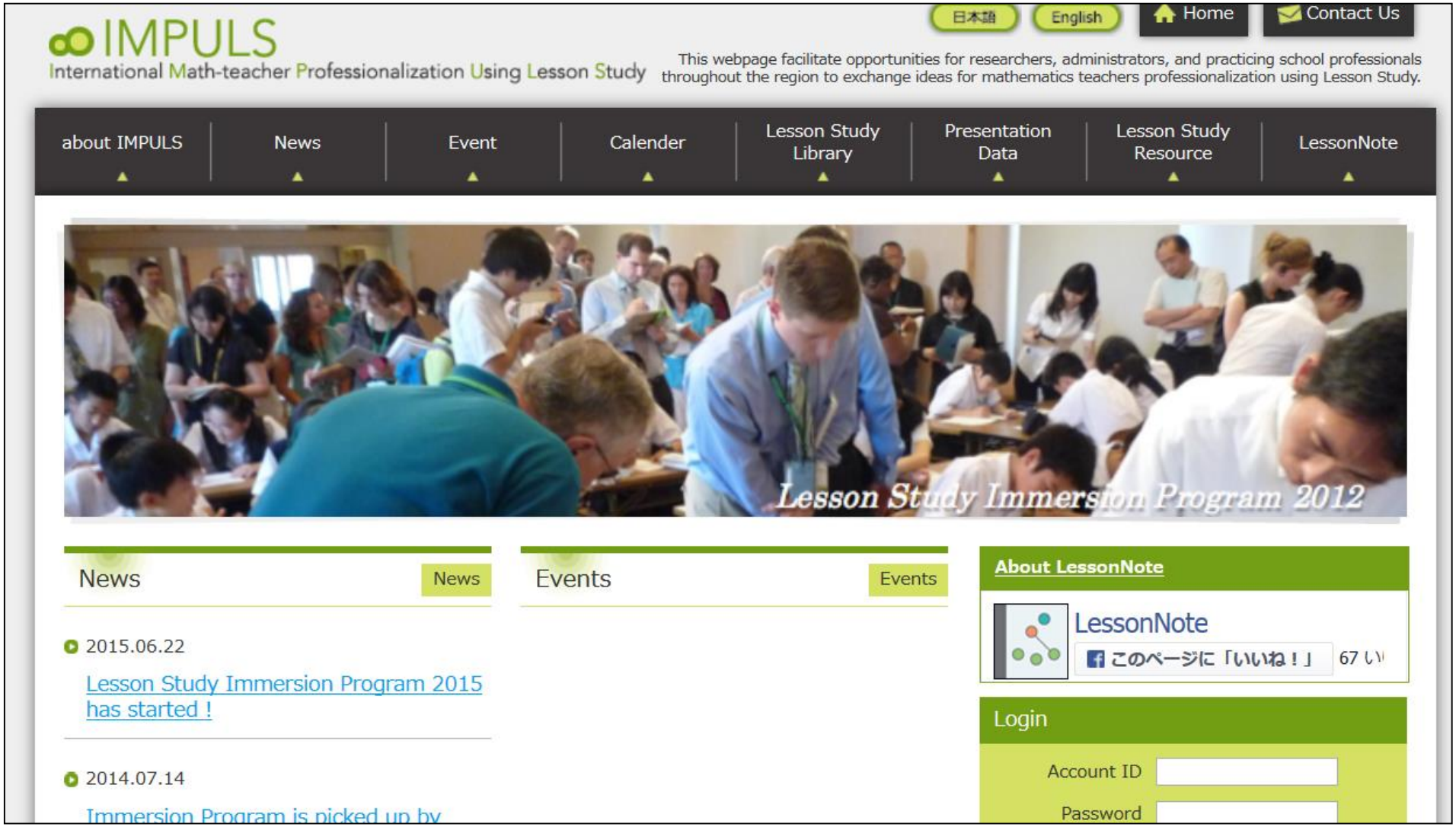
How many Maths Research Lessons do you attend each year?



	0	1～2	3～4	5～6	7～
Primary	19.1%	33.6%	21.1%	11.5%	14.7%
Junior H.	14.3%	49.1%	24.7%	6.2%	5.7%
High	27.2%	48.4%	13.9%	5.1%	5.4%

(IMPULS, 2013)

International Math-teacher Professionalisation through Lesson Study (IMPULS) project

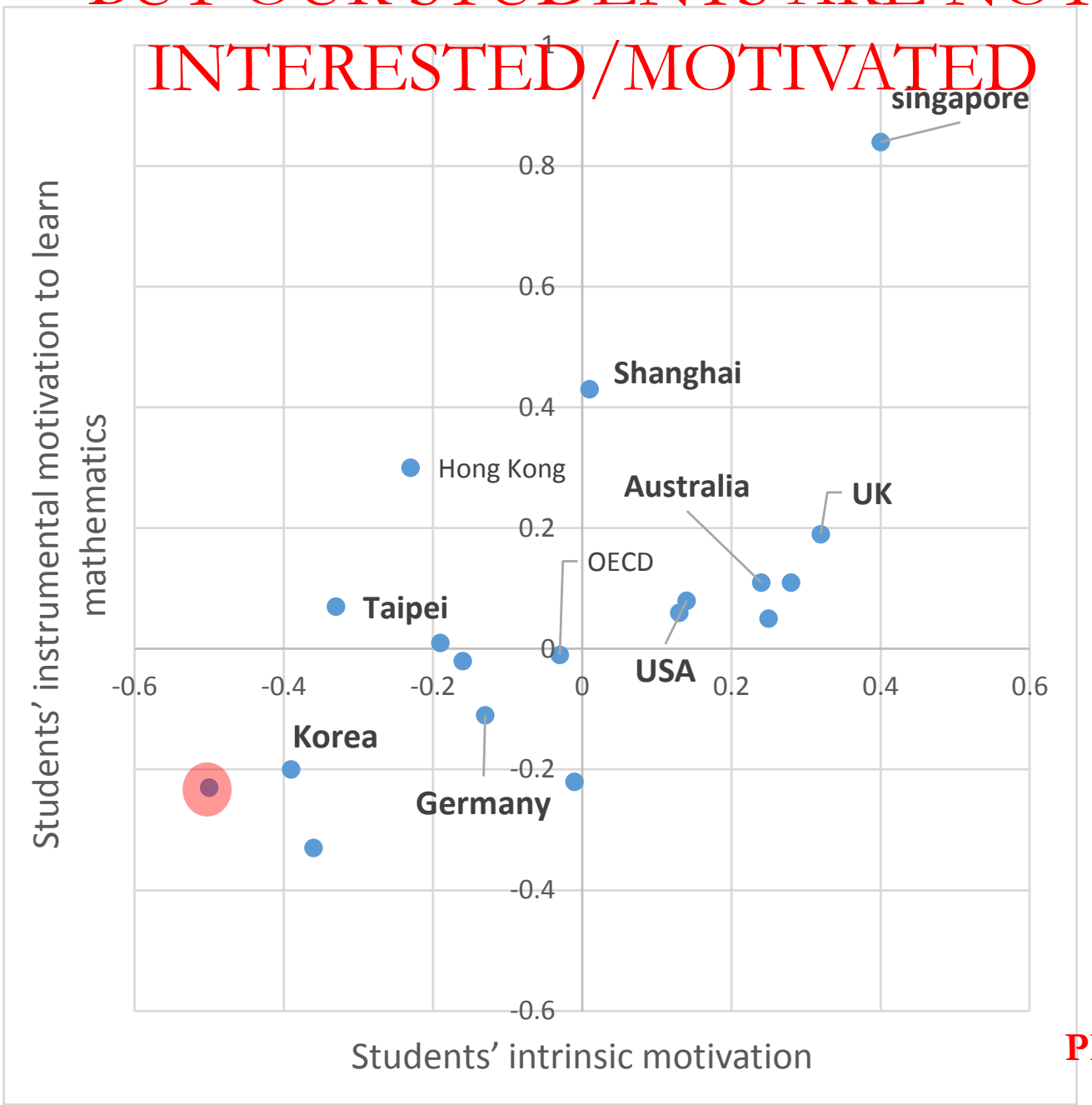


http://www.impuls-tgu.org/en/

Key issues in maths education in Japan

- Problem solving approach stops at junior secondary (will discuss later)
  - University entrance exams encourage cramming
- Students interest and motivation in maths is low
- Student ability to apply maths in real life is limited

BUT OUR STUDENTS ARE NOT INTERESTED/MOTIVATED



PISA2012

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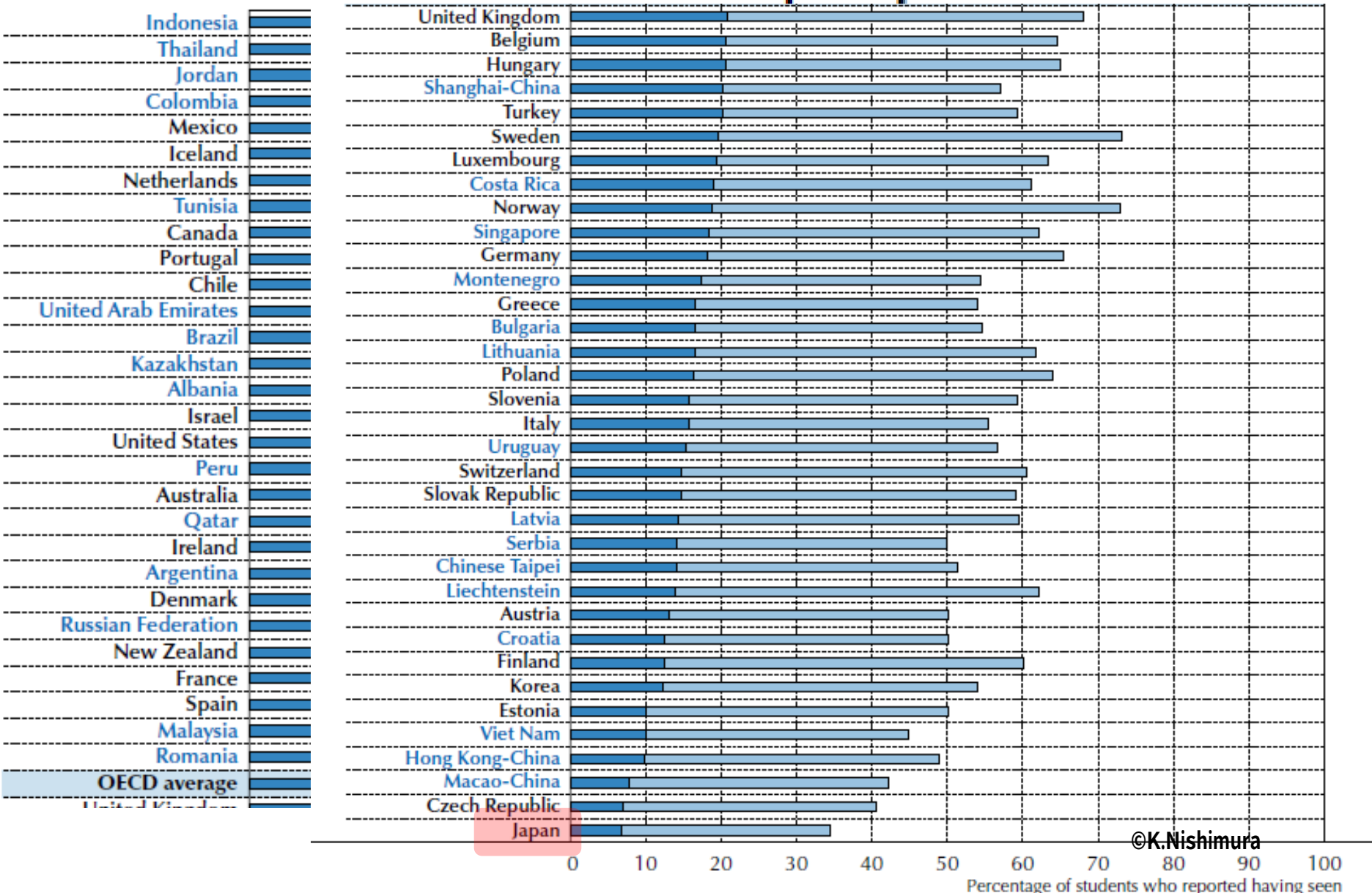
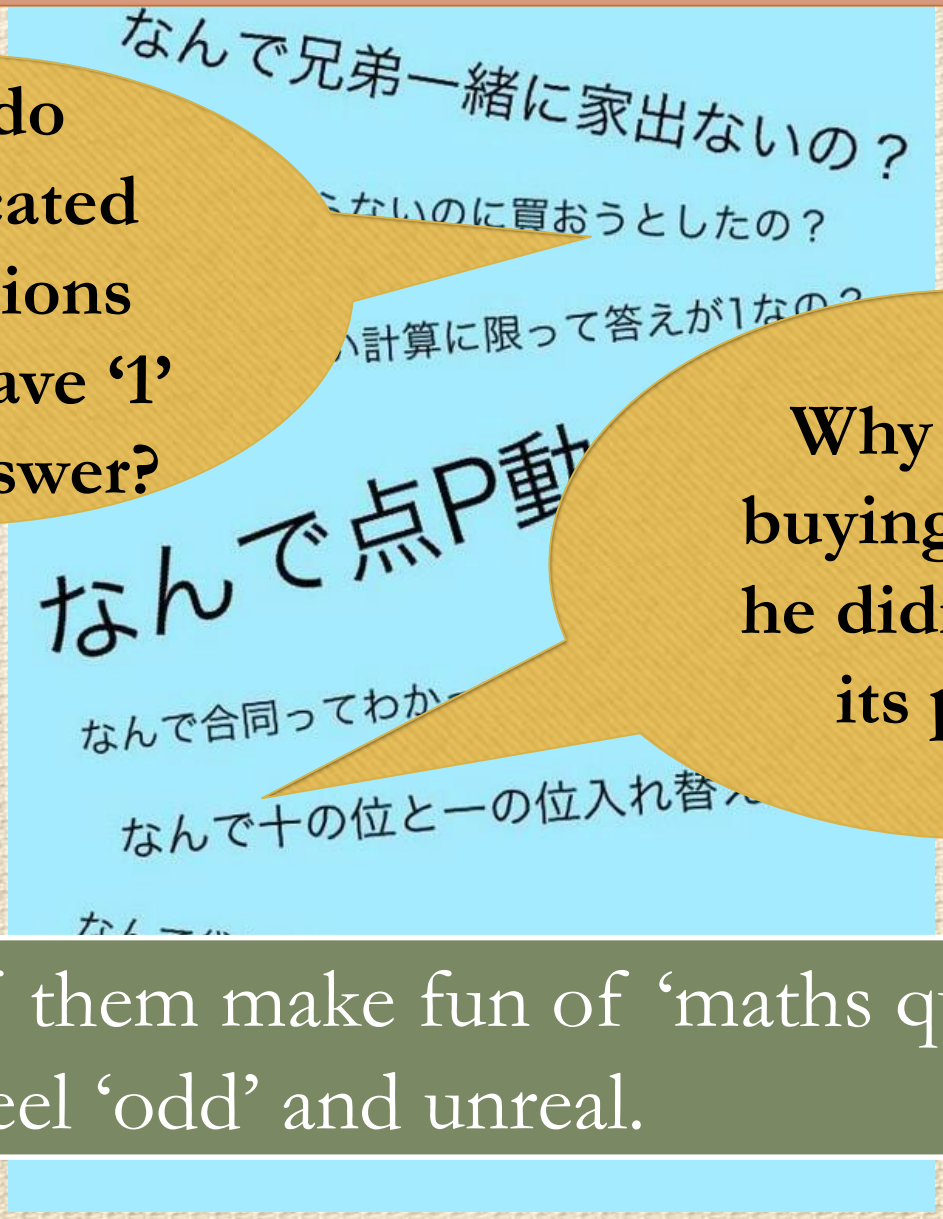
Percentage of students who reported having seen real-world problems in their mathematics lessons frequently or sometimes



Students twitter about maths



Why do complicated calculations always have '1' as an answer?

Why was he buying it when he didn't know its price?

- Most of them make fun of 'maths questions' which feel 'odd' and unreal.

2. modelling in Japan

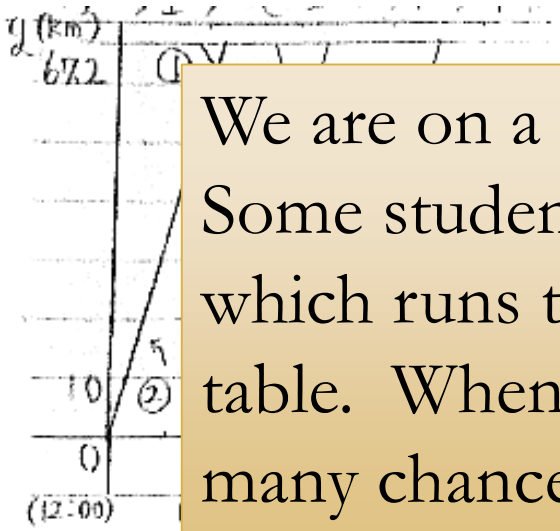
The lonely 90s

- **A small group of enthusiast-teachers and researchers doing lesson study on application-oriented modelling**
  - Modelling totally neglected in curriculum
- **What we learned;**
  - Modelling makes students think 'deeply'
  - Common assumption that student can apply maths simply is not true
    - They often could not even apply simple maths
  - Need to teach how to apply maths specifically

One example of problems we developed

ジェットフォイル				
期間	新潟発→両津着	備考	両津発→新潟着	備考
5月1日～5月31日	06:10→07:10	-	07:30→08:30	-
	07:00→08:00	-	08:30→09:30	-
	08:00→09:00	-	09:30→10:30	-
	09:00→10:00	※	10:30→11:30	※
	10:00→11:00	-	11:30→12:30	-
	11:00→12:00	-	12:30→13:30	-
	12:00→13:00	-	13:30→14:30	-
	13:00→14:00	-	14:30→15:30	-
	14:00→15:00	-	15:30→16:30	-
	15:00→16:00	-	16:30→17:30	-
	16:00→17:00	-	17:30→18:30	-
	17:00→18:00	※	18:30→19:35	※

※印　5／1～5／5の間運航



We are on a school trip going to an island by ferry. Some students want to take pictures of the jet foil, which runs the same route but on a different time table. When can we take a picture next? How many chances will we have?

2 Uses of graphs of linear functions

Q Nozomi's school is planning a field trip to Sado island. Between Niigata harbor and Ryotsu harbor on Sado island, you can take either a ferry or a jet foil. The ferry that Nozomi and her friends are riding will leave Ryotsu harbor at 12:40 and will arrive in Niigata harbor at 15:00.
Nozomi wants to take pictures of the jet foil coming from the Niigata harbor as a memory of her field trip. How many chances will she have to take pictures of the jet foil?

Today this problem is used in a textbook used by 300,000 students.

14:00 → 15:00	14:30 → 15:30

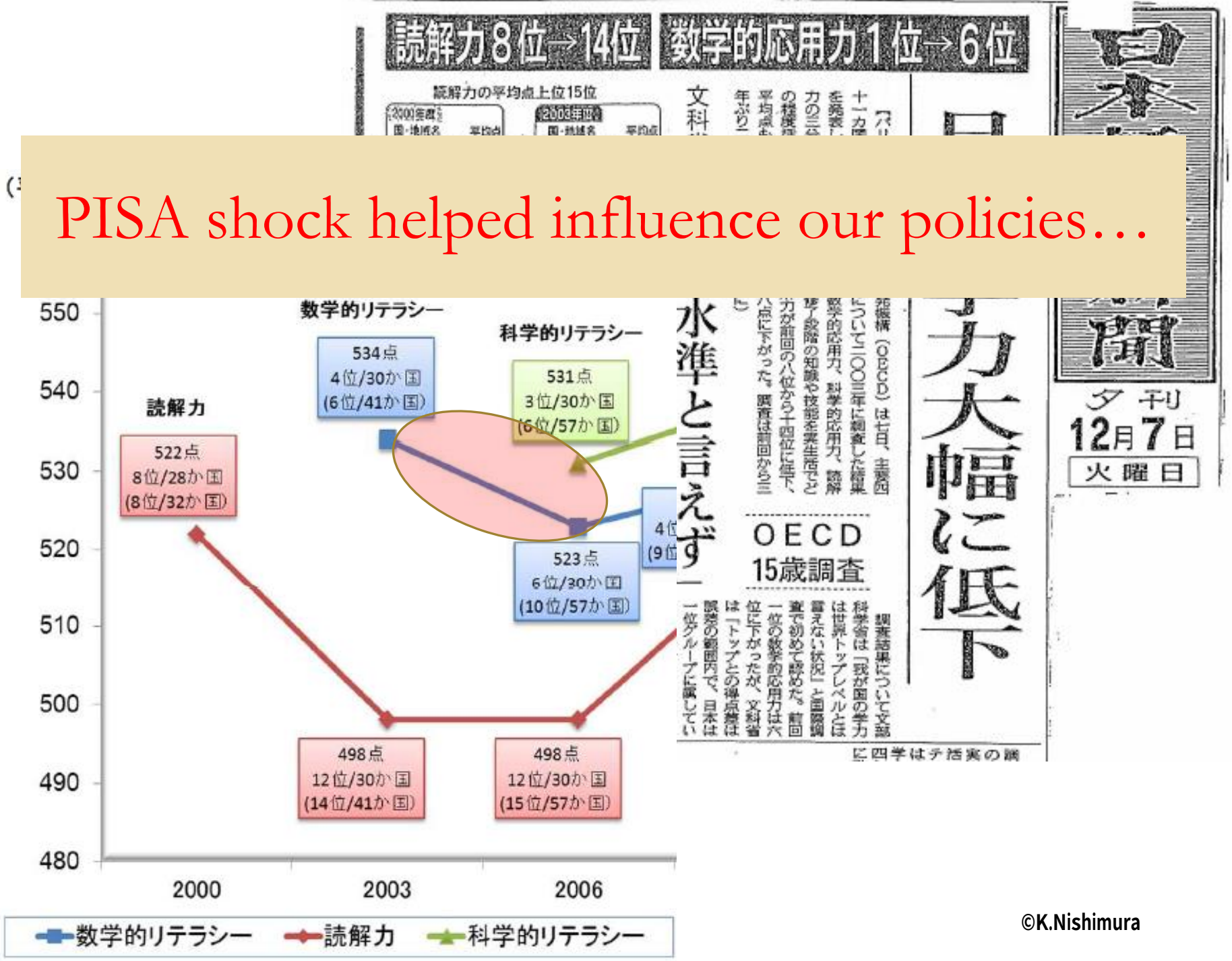
Time table for Jet foil
(Effective Date: May 2 – 6, 2009)

Prob. 1 The graph below shows the service of the Jet foil that departs Niigata harbor at 12:00, arriving in Ryotsu harbor at 13:00.
Draw the graph showing the ferry that Nozomi and her friends will be riding, departing from Ryotsu at 12:40 and arriving in Niigata at 15:00.

(Tokyo Shoseki, 2012)

http://www.globaledresources.com/products/books/mathematics-international/index-7-9.html

PISA shock helped influence our policies…



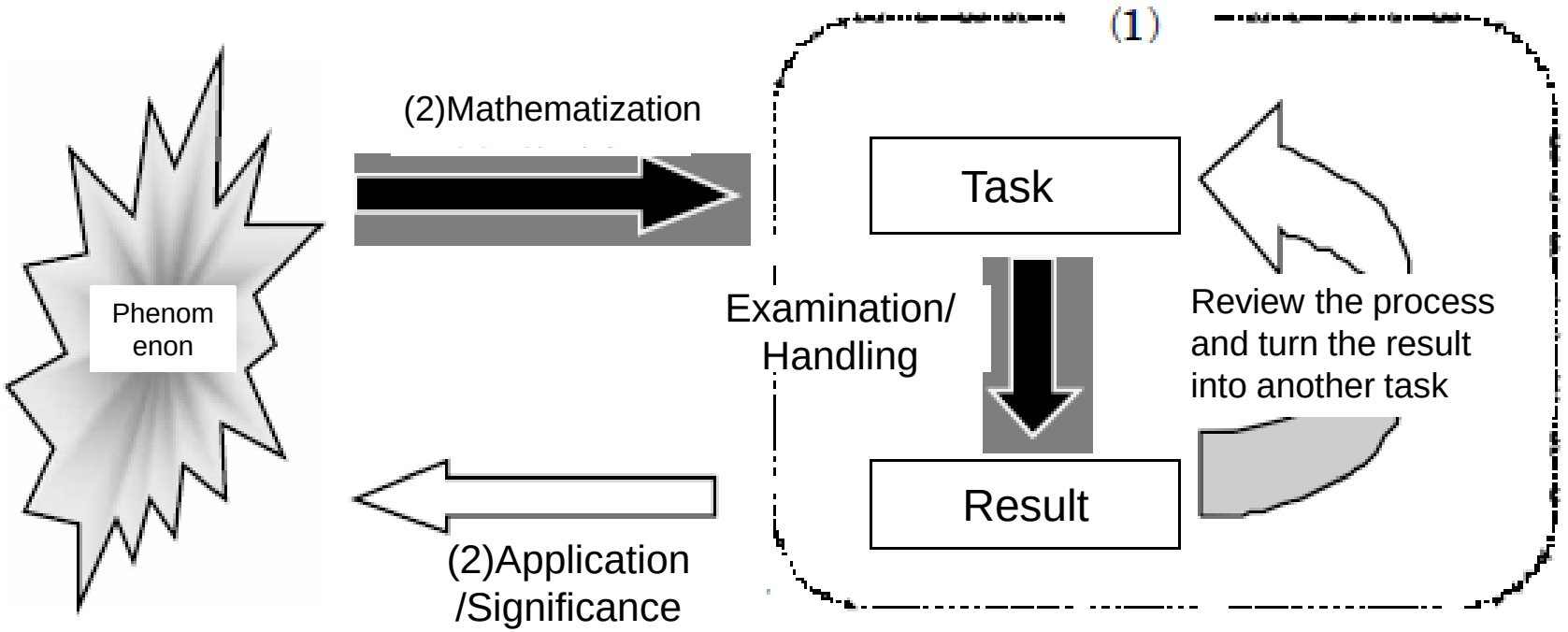
National Assessment Test Items (2007~)

- **For years 6 and year 9**
- **Decision to include in the tests two types of problems to test:**
  - **Knowledge; and**
  - **Application**

Curricular focus on application for the first time!

http://www.impuls-tgu.org/en/resource/National_Assessment/index.html

The curriculum guidelines were revised to emphasize "Mathematical Activities" in secondary level.



(MEXT, 2009)

Ch. 2

Systems of Equations ····· 30

Sec. 1 Systems of equations and solution methods ····· 32

(1) Systems of equations and their solutions

(2) How to solve systems of equations

(3) Various systems of equations

Sec. 2 Uses of systems of equations ··· 44

(1) Uses of systems of equations

Typical problems used today

Sec. 2

Uses of systems of equations

1 Uses of systems of equations

Q Yoshihiro bought some 300-yen pieces of cake and some 350-yen pieces of cake. Altogether he bought 10 pieces of cake and paid 3300 yen.
How many of each did he buy?

Another example…

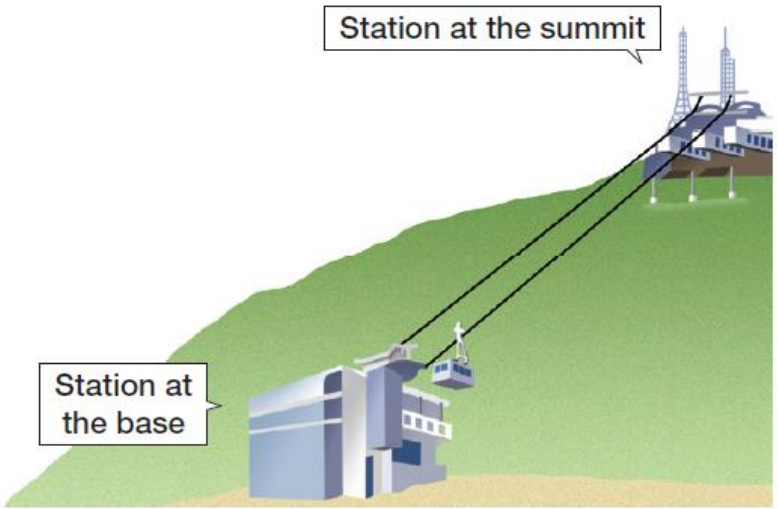
Ch. 6

The Pythagorean Theorem ····· 148

Sec. 1 The Pythagorean Theorem ····· 1
(1) The Pythagorean Theorem
(2) Converse of the Pythagorean Theo
Sec. 2 Uses of the Pythagorean Theorem ····· 1
(1) Uses of the Pythagorean Theorem
(2) Various problems

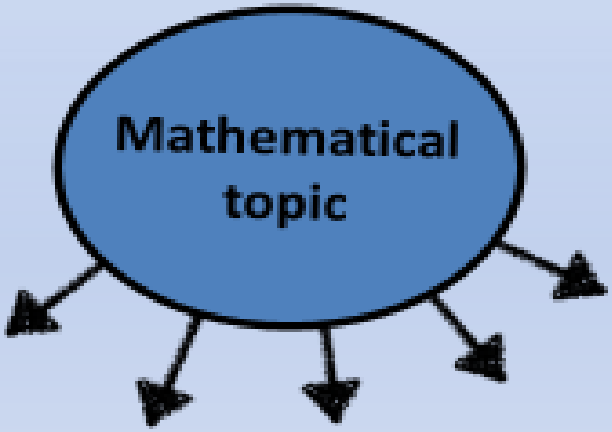
Let's use the Pythagorean Theorem in problems from our surroundings.

Prob. 3 At Mt. Hakodate Ropeway, the horizontal distance between the station at the base and the station at the summit is about 800 m and the vertical distance is about 300 m.
If we assume the cable of the ropeway is straight, about how many m will it be?



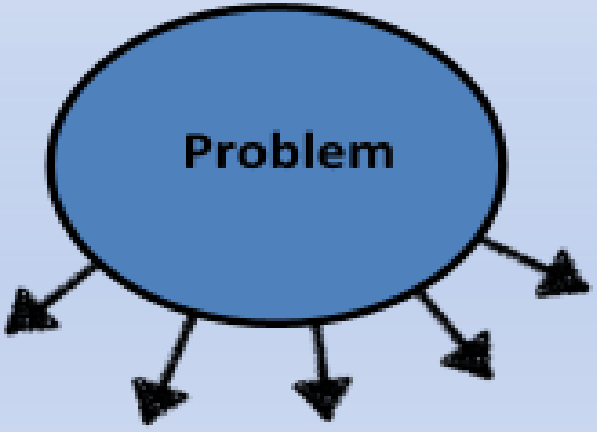
But still not authentic…

"Textbook"
Concept tasks



Exercises and Applications

"Authentic"
Problem solving tasks
tasks



Choose appropriate mathematical tools

Who chooses the mathematical ideas to employ?

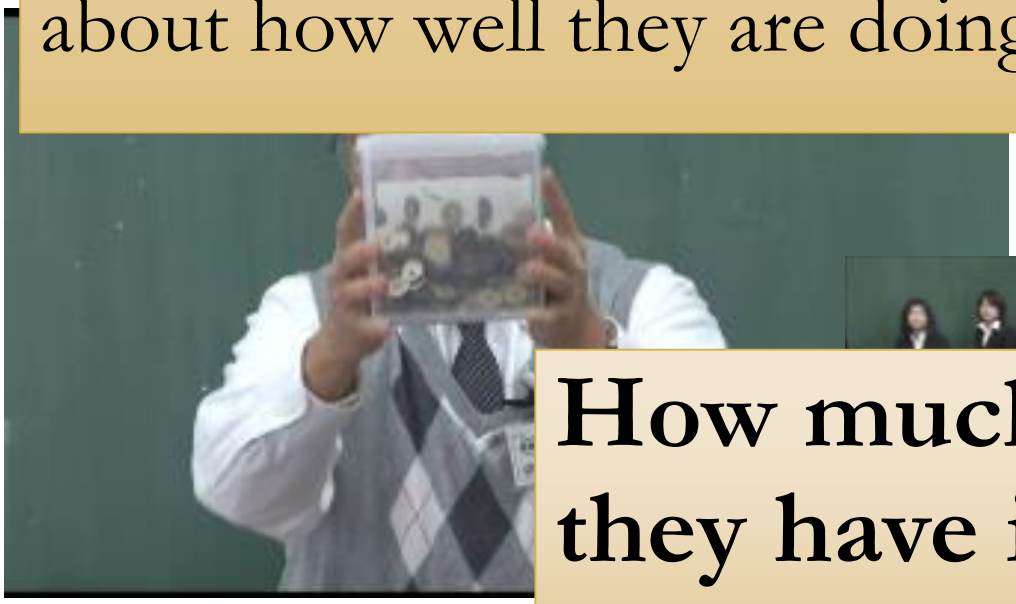
Malcolm Swan, 2012

Our ongoing work: two approaches

- **Mathematical modelling competency**
  - For the curriculum change
  - Centres around specific maths concepts
- **Ability for decision making using mathematics**
  - Using modelling
  - But more open ended problems with multiple strategies
  - Using maths for creating the basis for decision making
  - Solution must be satisfactory to a larger number of people

Lesson Study example on modelling

Students set up a weeklong campaign to collect donations. On day 3, they want to make an announcement about how well they are doing.



How much do you think they have in the box?

How can we figure it out?

Lesson Plan

- How do they decide what to teach and how?
  - Examine what knowledge/skills their students have about 'functions'
  - Consider how they could build on students' existing knowledge and instincts to explore and apply their use of 'functions'

What students learned at the elementary Level

How long is the wire on the right?

It's going to be a chore to measure the whole length of the wire.

I wonder if we can use the idea of proportional relationships.

2 Think about how to figure out the total length of the wire shown above without measuring the whole length.

1 The length of the wire above is proportional to what quantity?

2 The weight of the wire shown above is 240g. When 3m of the same wire was weighed, it was 48g. Using this information, find the total length of the wire.

Length x(m)	3	
Weight y(g)	48	240

(Tokyo Shoseki, 2011)

Make a Plan for Solving the Problem

展開

解決の方針の立案

「どうやって求めたらよいかを考えてみよう。」

解決の方針を立てる。

S_1：①3種類の硬貨を種類ごと
②それぞれの枚数を数える
③枚数から合計金額を求め
S_2：①3種類の硬貨を種類ごとに分ける
②それぞれの合計の重さを量る
③それらを1枚あたりの重さ
ことによって枚数
④枚数から合計金額を求め
S_3：①3種類の硬貨を種類ごと
②それぞれの合計の重さを
③例えば5円硬貨1枚の重
硬貨全体の重さの比が5円と5円
硬貨全体の金額との比が等しくな
るから，比例式で求められ
S_4：①この募金箱の中のお金の
さを量る。
②3種類の硬貨をよく混ぜ
取り出し，その重さを量
③②と①の重さの比と，取
お金の金額(数えて求める
金額の比が等しいことか
式で合計金額を求める

Teacher:
How will you estimate?

Student 1:
Divide coins by type
Count each type
Calculate the total amount

Anticipated responses

Student 2:
Divide coins by type
Weigh each type as a group
Weigh one coin of each type
Calculate the total amount

Student 4:
Weigh the box as a whole
Mix the coins well and take a sample
Count the sample to see how much
Weigh the sample
Use the proportion to calculate the total

Video 

- **After the lesson, what went wrong and how to improve is discussed – but using observation as hard evidence**

- **This was a public lesson in a university model school – many observers**

Towards mathematical decision making: Bowland Shock

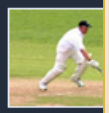
BOWLAND MATHS

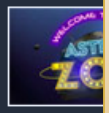
www.bowlandmaths.org.uk

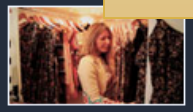
Imaginative resources for rich problem solving in secondary school Maths

Home | About *Bowland Maths* | Classroom projects | Assessment tasks | Professional development | Lesson Study project

BOWLAND MATHS HEADLINES







FASHION
How can you tell the Next Big Thing from a load of Old Hat?

JOEY IN PERIL
It is only 12cm long and weighs just 60 grams. Will this orphaned kangaroo survive?

MASCOT WANTED
Pupils at the Q School need to come up with a mascot for the school's new gadget.

Bowland Maths materials are free for non-commercial educational use, and can be viewed online or downloaded from this website.

Welcome to Bowland Maths

Many problems with realistic contexts, open-ended, involving "values" and subjective judgement.

Classroom projects – the *Case Studies*

Classroom projects

At the core of Bowland Maths are 26 extended mathematical investigations called *Case Studies*. Each case study includes teaching materials to support 3-5 maths lessons. Many, but not all, include ICT activities.

Assessment tasks

Assessment tasks

Bowland Maths includes a collection of over thirty 20-60 minute tasks with progression guides to support formative assessment of progress in mathematical reasoning and problem-solving skills.

Professional development

Professional development

The Bowland materials demand different approaches to teaching, such as collaborative learning through discussion and reflection, self- and peer-assessment and the use of less structured tasks. These 7 video-based professional development modules help teachers explore these techniques.

http://www.bowlandmaths.org.uk/

BOWLAND
MATHS
Assessment Tasks

Water Availability

We thought this was just right to cultivate skill critically lacking in Japan

which country has the greatest need: Algeria, Jordan and Turkey. What would be your

Starting point
for our research group

Towards "mathematical decision making"

- **We now know how to show different approaches and how to improve them. But is that enough?**
- **Our research group was not satisfied**
  - We want students to walk away with clear experience of critiquing and improving their own answers
  - Loosely comparisons – not powerful enough for student learning – need a proper '*NERIAGE*'
- **Can we learn better if the class made a decision as a whole?**

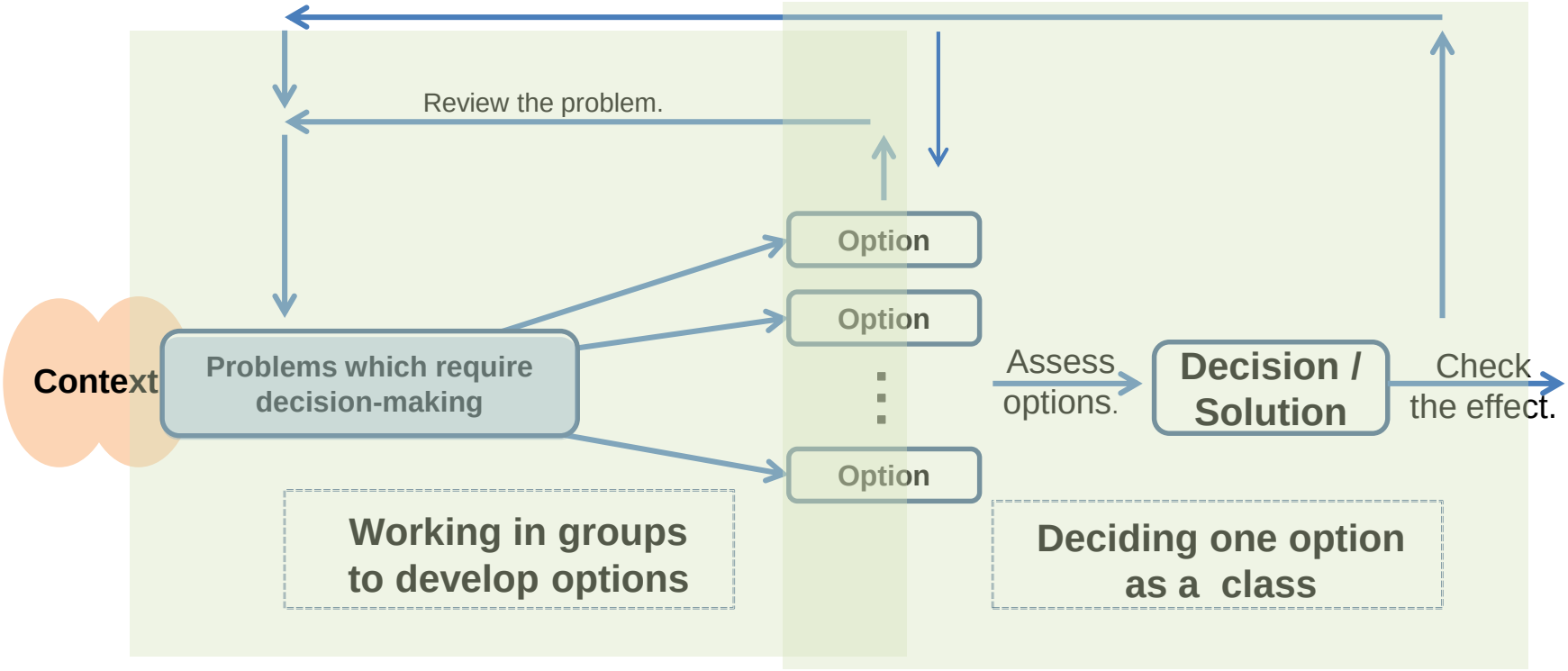
In cognitive psychology

- Decision making is about selecting one or more options from several alternatives. (Takemura, 1996, p.81)
- It is important for a person to explain easily the reasons behind the selection to oneself and others to support the correctness. (Kobashi, 1988, p.49)

"Mathematical Decision Making"

- **More than modelling,**
  - **Includes social consensus building**
  - **Need to develop and examine options**
  - **Understand assumptions**
  - **Social values must be reflected in criteria for final decisions**
- **Require students to**
  - **Deeply examine options**
  - **Understand the meaning of indicators**
  - **Repeat the modelling process**

We have developed a framework



Problem solvers must constantly think about social values behind decision making

Developing teaching materials

- Central work for our research group now
- 6 groups developing different ‘tasks’ through lesson study
- One example “Selecting Cute character”
  - “Cuteness” or “Amiability” – subjective judgement
  - What does it mean?
  - Can we use data to describe people’s preferences in terms of ‘eye’ position, which is critical for making it ‘cute’?
  - Use such data to make a decision about which character to use

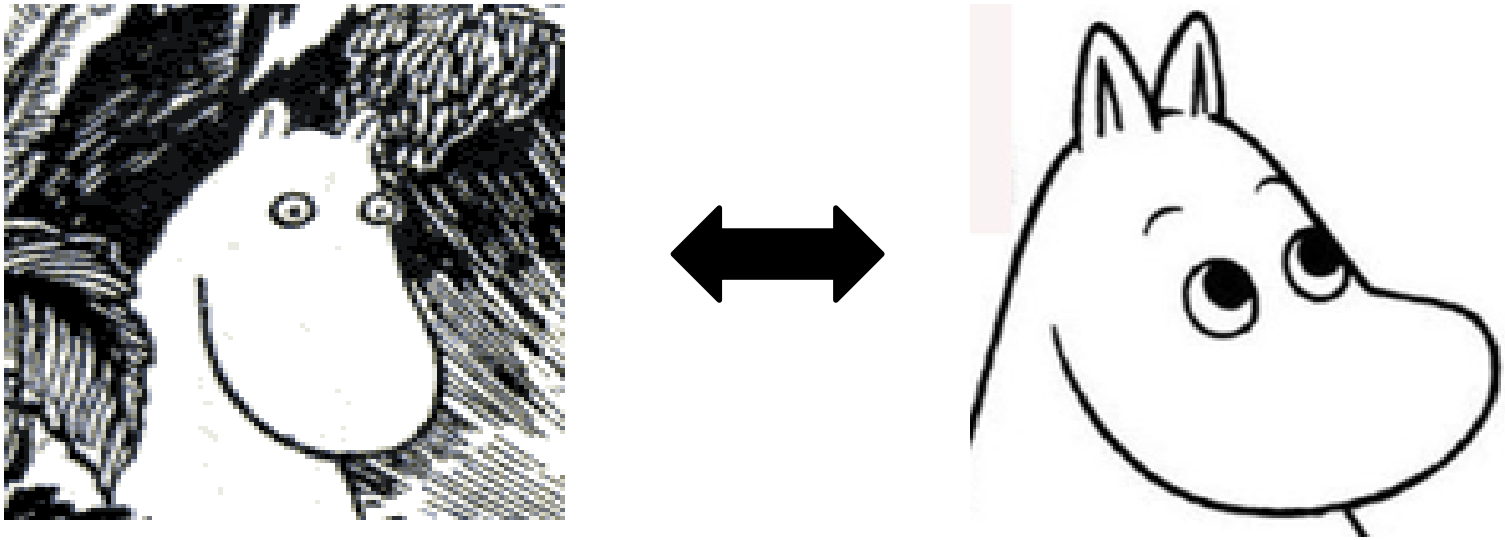
"Cute" Character

"As part of the campaign to have healthy teeth, the school has decided to award a "good teeth badge" to the pupils who have good teeth. The badge must be appealing to students. Can we select a 'cute character' to be put on the badge this year?"

This task was designed for primary students – so we simplified to focus on the eye position

The first phase: Moomin

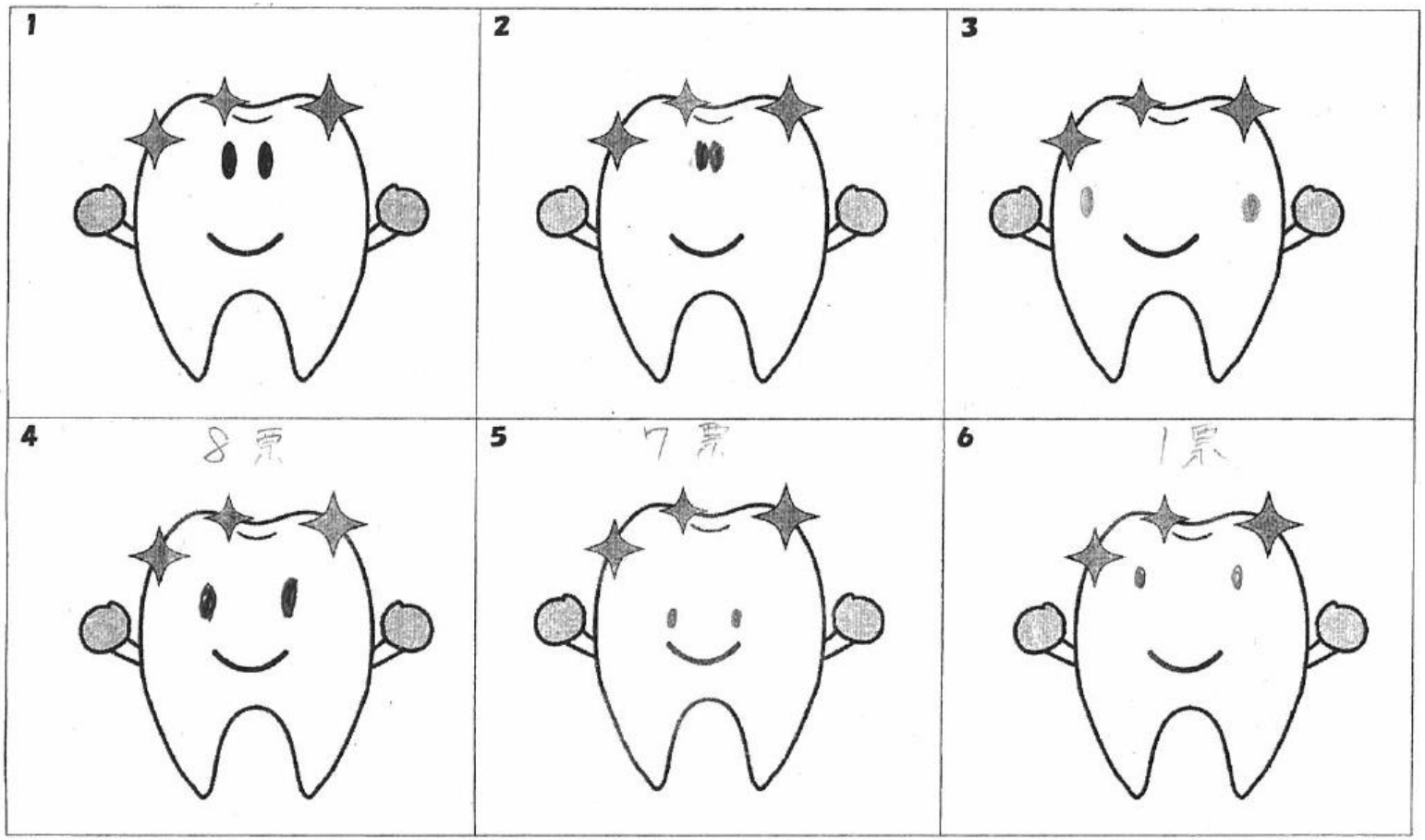
Comparing the original Finnish version and the Japanese version of Moomin



They started to notice that ‘cuteness’ is related to factors such as the position of the eyes and the outline of the face, etc.

They developed a hypothesis that “the position of the eyes is the key in friendliness.”

First phase: creating characters and testing popularity via questionnaire

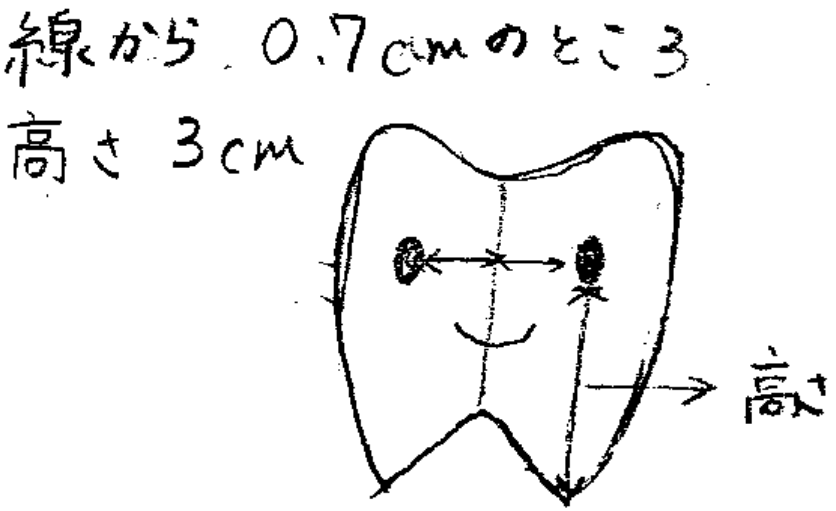


The second phase

Why do some ‘eyes’ look more ‘friendly”? Can you describe the friendly eyes?

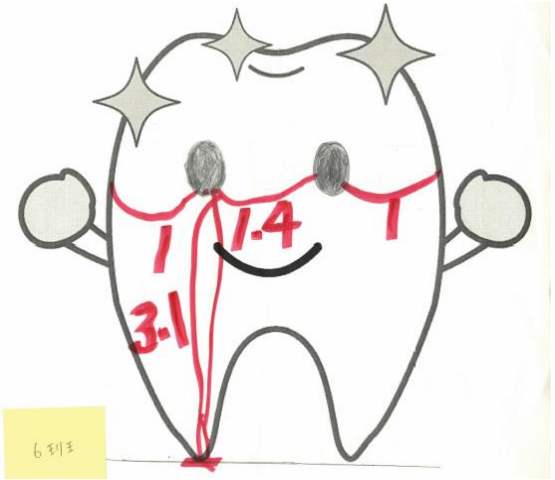
They examined the position of eyes individually

Using distance



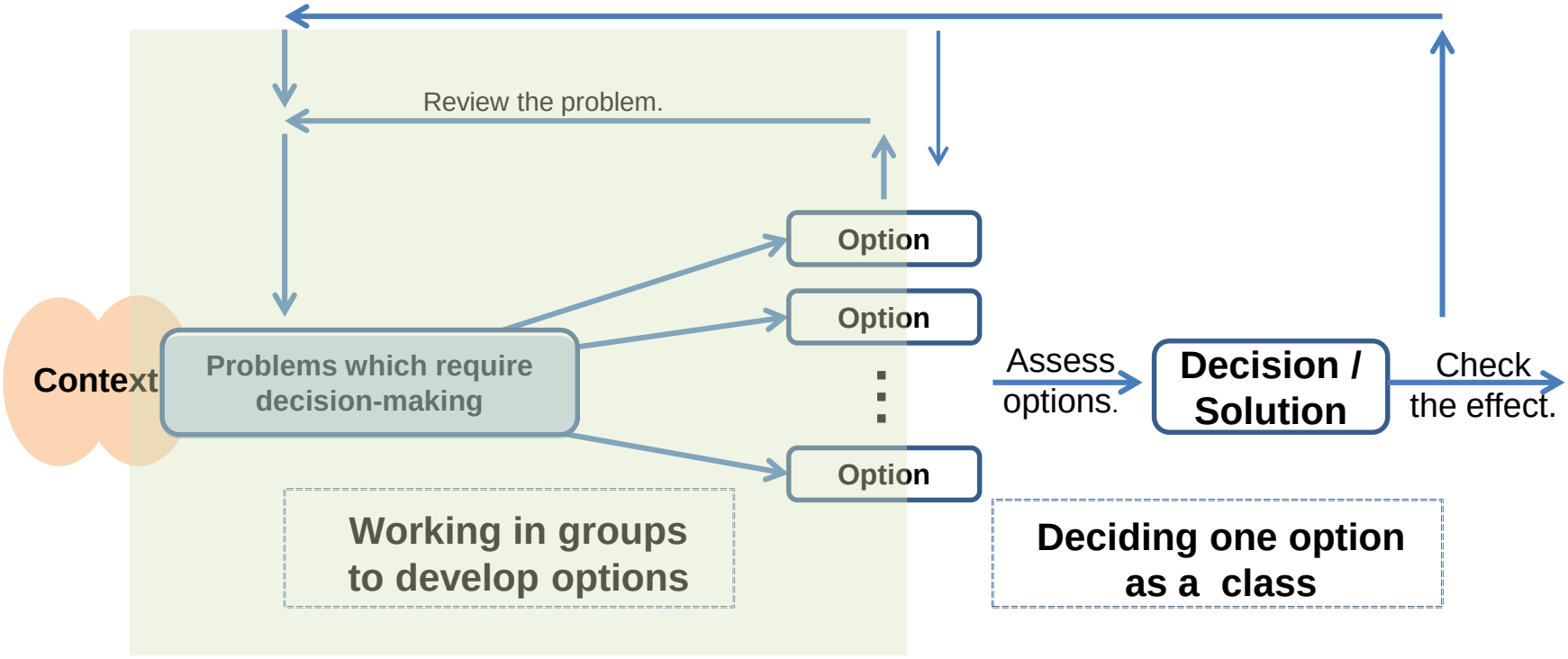
Creating a grid

Using proportions



1 : 1.4 : 1
1 : 3.1

We have developed a framework



Problem solvers must constantly think about social values behind decision making

Our findings so far

- Still a big gap between:
  - the maths students are supposed to know and
  - the mathematics that the pupils use in decision-making.
- Maths content taught in Japan may need to change
  - E.g. Need more statistics and simulation?

Our findings so far

- **It is not easy to make 'explicit' what students should learn in mathematical decision making**
  - Tried to use student reflection
  - But teachers (who are not researchers) often do not understand what the pupils should learn
  - Guidance on assessments and teacher training are essential (← Bowland has this.)

Mathematical decision making: next steps

- What sequence should be followed in introducing key ideas and skills? What kind of tasks at what grade?
- How do we do NERIAGE - a whole 'class' discussion for mathematical decision making?
  - so that students experience rigorous evaluation and judgement process
- Develop tasks
- Training teachers

3. Ongoing reform in Japan

Japan's ongoing reform

- Large scale reforms led by the Abe cabinet
  - Moving from teaching knowledge to teaching competencies
  - Changing both university entrance examinations as well as senior high school curriculum – very unusual in Japan
  - Moving to computer-based tests
  - In maths, improved use of ICT (calculators and computers)

Our aspirations

- Moving from efficient assessment of subject based knowledge

- To developing problems with appropriate contexts to push students to think, evaluate, judge and communicate
- Cross-disciplinary teaching to cultivate skills
  - Thinking AND Judging

Our challenges

- **Though 'modelling' is most likely to be introduced in the entrance exam:**
  - We cannot use interviews/reports because of the large number of applicants
  - Exam items must have simple solutions
- **Can we develop problems to test modelling/decision making for large scale assessment?**
  - If not, we fear that senior high schools may continue with superficial cramming of similar problems

Our challenges

- **We must change teacher culture – through lesson study.**
- **What else can we do to induce them to focus on real competency building?**

Open questions related to modelling

- **What is the right balance between 'mathematical content' and 'modelling' or more broadly mathematical processes?**
  - What do global experts say? What do teachers in classrooms from around the world say?
  - Japan comes from a strong tradition of focussing on mathematical contents – but want to avoid overreacting?
- **How can we introduce 'assessment' in large-scale for modelling?**
- **What other ways can we push for change?**

GOOD IDEAS AND COMMENTS MOST WELCOME!

Bowland Japan

数学的判断力を育む学びの創造　ボーランド・ジャパン

ボーランド・ジャパンがリニューアル！
コンテンツが新しく追加されました！

NEW

Bowland Japan Index

- HOME
- 活動計画
- 組織
- ボーランド・ジャパンの教材の紹介 NEW!!
- Bowland Mathsの教材の紹介 NEW!!
- イギリス BowlandMaths 代表からの挨拶

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Bowland Japan

Bowland Japan(
Bowland Charita
と同様，非営利E
を展開してまいり

Bowland Maths.の教材の紹介

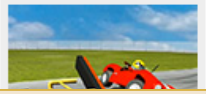
Bowland Maths.では，教材のことを「ケーススタディ」と呼んでいます。ビジネスをはじめ法律や医学分野の教育で取り入れられている，「現実の問題を取り上げ，その思考過程を通じて学習していく方式」を応用しています。ケーススタディは，2012年に８つが追加され，26種となりました。以下に紹介します。
各教材のタイトルをクリックすると，さらに詳しい情報をご覧頂けます。

Bowland Charitable Trustのご支援により，現在，『交通事故を減らそう』『エイリアン』『クラッシュとスト』『アウトブレイク』『ピザは温かいままで』を，日本国内で公開しています。随時，追加公開予定です。

2010年に行った「Bowland maths.に関するイングランド実地調査」の報告書はこちらです。現地での授業の様子も報告してあります。

このページの教材の分析並びにイングランド実地調査は，科研費・基盤研究(B)「社会的文脈における数学的判断力の育成に関する総合的研究」「数理的意思決定力の育成に関するホリスティック・アプローチ研究」の成果の一部です。

主な数学的活動を全て表示



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車の衝突事故の衝撃度について，付属のソフトウェアを使いシミュレーションし，車種（コンパクトカー，ス

…める。

We established Bowland Japan to introduce similar problems in Japan

http://bowlandjapan.org/

Thank you