


 筑波大学
University of Tsukuba

Free Program for SEAMEO School Network
 from the University of Tsukuba, Affiliate Member of SEAMEO

Teaching Mathematics to Develop Mathematical Thinking as Higher Order Thinking: How do you teach? Why?

Lesson 2: How to Introduce Number

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Adopting a 21st Century Curriculum

Revitalizing Teacher Education


Mathematical Thinking

- General Objective
 - Principles for Curriculum and Textbook Writers
- Specified in the Textbook
 - Embedded as task sequence by Authors
 - Rivalled by teachers and students through using
- Planned process by Teacher
 - Teachers' thinking embedded into process by given tasks and sequence
 - Considered how it will be possible to appear from students
- Actual Thinking by students in classroom
 - Students thinking in the classroom which explained by them
 - Teachers observe and assess them
- Discussed by teachers after observation of Class
- Mathematical Thinking as Data based on Researchers' Framework for Journals on Social Scientific Studies

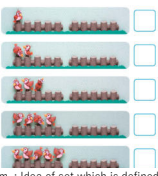
Terminologies for Curriculum Designers

Terminologies used by teachers to develop students' mathematical thinking

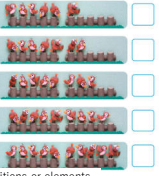
10 is Ten '10' (one word) or 1+0 (two words)?



Term.: Order of Number/Numeral



Term.: Idea of set which is defined by conditions or elements.



Mathematical Values, Attitudes and Habits for Human Character

Mathematical Values:
Generality and Expandability
Reasonableness and Harmony
Usefulness and Efficient
Simpler and Easier
Beautifulness

Mathematical Attitude attempting to:
See and think mathematically
Pose question and develop explanation such as why and when
Generalize and extend
Appreciate others' idea and change representation to conceptualize

Habits of mind for Citizen to live:
Reasonably and critically with respecting and appreciating others
Autonomously Creatively and innovatively in harmony
Judiciously using tools such as ICT
Empowerly in imagining the future through lifelong learning

Mathematical Thinking and Processes

Mathematical Ideas for:
Set, Unit, Compare, Operate, Algorithm, Fundamental principle, and Varied representation such as table, diagram, expressions, graph and translations.

Mathematical Thinking:
Generalization and Specialization
Extension and Integration
Inductive, Analogical and Deductive reasoning
Abstracting, Concretizing and Embodiment
Relational and Functional thinking
Thinking forward and backward

Mathematical Activities for:
Problem Solving
Exploration and Inquiry
Mathematical Modeling
Conjecturing, Justifying and Proving
Conceptualization and Proceduralization
Representation and Sharing

Content

- Numbers & Operations
- Quantity & Measurement
- Shapes, Figures and Solids
- Pattern & Data Representations

- Extension of Number and Operations
- Measurement & Relations
- Plane Figures & Space Solids
- Data Handling & Graphs

- Number & Algebra
- Space & Geometry
- Relationship & Functions
- Statistics & Probability

Curriculum Standards: SEABES-CCRLS (by SEAMEO-RECSAM (Mangao, Ahmad, Isoda; 2017))

Teach number/numeral (digit) up to 10








Why it is difficult to find 0?

0 is developed under the place value system in India and China.

Term.: Idea of the Permanence of Form

Show necessity to extend the known form on set A to unknown set B which includes set A.

Show reasonableness or function of extended form.



Japanese textbooks adapted to Indonesia & Thailand at the introduction of number at grade 1

What do you teach, How and Why?

Make Sense VS Sense Making
How difference? Which Approach do you prefer?

Develop children who will challenge by and for themselves by using what they learned!

For enabling children to think by using learned, Japanese textbook has the task sequence for future learning

Task Sequence: Consider the process to develop Mathematical Thi.

- ① $a+b=c$
- ② $b+c=a$
- ③ $c+a=b$
- ④ $a+c=b$

General or Special?
Sp. → Ge. or Ge. → Sp.

Mathematical Ideas for:
Set, Unit, Compare,

Mathematical Thinking:
Generalization and Specialization

Teach numeral (digit) up to 10

Terminology:
Arabic Numeral/Number (no magnitude, order and so on)
Denominated number (for quantity)
Translation (=) between A, N, and D, N.
Concrete Object (Discontinuous N.)
Semi-concrete Object (Model, Fixed denomination)
Number

How do you use these terminology?

Which number shall we begin to teach?
Why?
Why 3 instead of 1?
What is your answer?

Because for counting objects children have to:

- Fix the first object
- Fix the direction of counting
- Find the last object

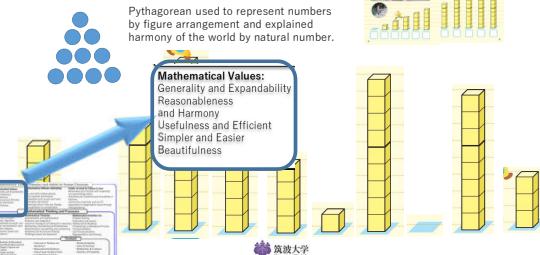


Beautiful?

• What is the beautifulness of things?

Pythagorean used to represent numbers by figure arrangement and explained harmony of the world by natural number.

Mathematical Values:
Generality and Expandability
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Usefulness and Efficient
Simpler and Easier
Beautifulness



Set Number VS Ordered Number

References

- Masami Isoda, Raimundo Olivos edited (2020). *Teaching Multiplication with Lesson Study: Japanese and Ibero-American Theories for International Mathematics Education*. Cham, Switzerland: Springer. (Open Access)
- Masami Isoda, Aki Murata (2020). *Study with your friends: Mathematics for Elementary School (12 vols.)*. Tokyo, Japan: Gakko Toshio.
- Masami Isoda, Aki Murata, Aida Yap (2015). *Study with your friends: Mathematics for Elementary School (12 vols.)*. Tokyo, Japan: Gakko Toshio.
- Masami Isoda, David Tall (2019). *Mathematics for Junior High School (3 vols.)*. Tokyo, Japan: Gakko Toshio.
- Dominador Dixon Mangao, Nur Jahan Ahmad, Masami Isoda edited (2017). *SEAMEO basic education standards (SEA-BES): Common core regional learning standards (CCRLS) in mathematics and science*. Penang, Malaysia: SEAMEO-RECSAM. <http://www.seam-edu.org/sub-488-bes/images/docs/SEAMEO-ASEAN-Curriculum-SEABES-CCRLS-Standards.pdf>
- Maitree Inprasitha, Masami Isoda, Patsy Wang Iverson, Ban Har Yap (2015). *Lesson Study: Challenges in Mathematics Education*. New Jersey, USA: World Scientific.
- Masami Isoda, Shigeo Katagiri (2012). *Mathematical Thinking: How to develop it in the classroom*. New Jersey, USA: World Scientific.
- TEH Kim Hong, ISODA Masami, GAN Teck Hock (in printing). *Mathematics Challenges for Classroom Practices at the Lower Primary Level*. Penang, Malaysia: SEAMEO-RECSAM.
- ISODA Masami, TEH Kim Hong, GAN Teck Hock (in printing). *Mathematics Challenges for Classroom Practices at the Upper Primary Level*. Penang, Malaysia: SEAMEO-RECSAM.
- GAN Teck Hock, ISODA Masami, TEH Kim Hong (20aug21). *Mathematics Challenges for Classroom Practices at the Lower Secondary Level*. Penang, Malaysia: SEAMEO-RECSAM.

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|-----------------------------------|--------------------------------------------------------------|-------------------------|
| TOPIC 1: INTRODUCTION | L1: Introductory discussion to develop mathematical thinking | |
| TOPIC 2: NUMBERS | L2: How to introduce number | L3: What is number |
| TOPIC 3: ADDITION AND SUBTRACTION | L4: How to introduce addition | L5: What is addition |
| | L6: How to introduce subtraction | L7: What is subtraction |

Until when your children use counting for calculation? Until Grade 6? Why children use counting for addition and subtraction. How JP textbook try to develop the children who are able to find the answer for addition and subtraction with out counting.

References

