MATHEMATICAL CURRICULUM PROPOSED NOW AND STATISTICAL EDUCATION IN JAPAN

Way of Thinking about Revise of "Corse of Study"
Focus on Statistical Curriculum

NOBUAKI KAWASAKI
Senior High School ar Otsuka, Tsukuba University

MASAMI ISODA
The University of Tsukuba

Sometimes, These words are used in my presentation.
These are important for the foreseeable feature.

MATHEMATICAL CURRICULUM

STATIS APAN

Way of T f Study”

- Proactivity
- Collaboratory
- Mathematical activity
- Critically
- Making new problem

Sometimes, These words are used in my presentation.
These are important for the foreseeable feature.

ORDER OF PRESENTATION

1. Japan's education system

2. Course of study (Utilization of data)

   — Elementary school and junior high school —

3. Course of study

   — Senior high school —

4. Why Japan's course of study are revised?

5. Viewpoint to train power of judgement

   Mathematical activity

ORDER OF PRESENTATION

6．About Statistics

7．Example of instruction 1
— Educational material of scatter diagram —

8．Example of instruction 2
— Educational material of interval estimation —

9．Future tasks

1． Japan’s education system

Japan’s standard education system is as follows:

・Compulsory education

6～12 years old

（1） Elementary School

From 1st grade to 6th grade

(There is no entrance examination.)

・Compulsory education

12～15 years old

（2） Junior High School

From 7th grade to 9th grade

Before enting to college, there are three types of school.

1． Japan's education system

The standard education system is as follows:

- Compulsory education

12～15 years old

（2） Junior High School

From 7th grade to 9th grade

(There is an entrance examination.)

- Not Compulsory education

15～18 years old

（3） Senior High School

From 10th grade to 12th grade

There are compulsory subject and non-compulsory ones.

1． Japan’s education system

The standard education system is as follows:

・Not Compulsory education

15～18 years old

（3） Senior High School

From 10th grade to 12th grade

(There is an entrance examination.)

・Not Compulsory education

18 years old ～

（4） A College Education

2． Course of study (Utilization of data)
Arithmetic curriculum of elementary school

Each grades has surly statistical teaching materials. Each contents is as follows: (2020～)

1st grade (6~7 years old)

- Expressing Quantity by Using Picture or Figure

  Expressing quantity by using picture or figure

2nd grade (7~8 years old)

- Simple Table and Graph

  Simple table and graph

Feature of elementary school and junior high school is that each grades treats statistical teaching material. Please see the red square.

2． Course of study (Utilization of data)
Arithmetic curriculum of elementary school

3rd grade (8~9 years old)

- Table and Bar Graph

  Classification or arrangement of data, and table

  Feature of bar graph, and method of using them

4th grade (9~10 years old)

- Classification or Arrangement of Data

  Methods of classification by two points of view

  Feature and utilization of line graph

2． Course of study (Utilization of data)
Arithmetic curriculum of elementary school

5th grade (10~11 years old)

- Feature and Utilization of Circle Graph or Band Graph

  Feature and utilization of circle graph or band graph

  Methods of statistical problem-solving

- Average of Values of Measurement

  Meaning of Average

6th grade (11~12 years old)

- Consideration of Data

  Meaning of central values and methods of finding them

  Feature of table or graph expressing frequency distribution, and method to use them

  Statistical problem-solving method according to purpose

- Situations or Events That Are Possible to Occur

2． Course of study (Utilization of data)
Arithmetic curriculum of elementary school

Key Point of elementary school

Kinds of Data treated “Quality of data” and “Quantity of data”

Contents

- Classification and Arrangement
- Table and Graph
- Relative Frequency
- Proportion

Purpose

- Utilization for Daily Life
- Solving Problem

Summary of elementary school about contents and purposes is follows.

3． Course of study (Utilization of data)
Mathematics curriculum of junior high school

Each grade has surly statistical teaching materials. Each content is as follows: (2021～)

7th grade (12~13 years old)

- Trends of Distribution of Data

  Necessity or meaning of histogram or relative frequency

- Probability Gotten by Many Numbers of Observations or Trial

  Necessity or meaning of probability gotten by methods of many numbers of observations or trials

3． Course of study (Utilization of data)
Mathematics curriculum of junior high school

8th grade (13~14 years old)

- Comparing of each Distribution of Data

  Necessity or meaning of quartile range and box plot

  Expression by box plot

- Probability Gotten by Base of Numbers of Outcomes

  Meaning and necessity of probability

  Finding value of probability

These are the contents of 10 grade now.

3． Course of study (Utilization of data)
Mathematics curriculum of junior high school

9th grade (14~15 years old)

- Sample Survey

  Necessity and meaning of sample survey

  Sampling, and arranging of samples

Following the previous contents are arranged as next page,

3． Course of study (Utilization of data)
Mathematics curriculum of junior high school

Kinds of data treated “Quality of data” < “Quantity of data”

	Contents	Purposes
7	Gathering data Using table and graph for purpose	Critical thinking and make decision
8	Grasping tendency of data Focusing some populations Comparing by using quartile range or box plot	Grasping tendency of data Comparing different kind of set Critical thinking and make decision
9	Sample survey	Estimating tendency of population Making decision Criticizing of method of investigation or Result

Each grades has the key word “Critical”.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Only Mathematics Ⅰ is a compulsory subject.
Others are 5 subjects that school selects contents.

(2022～)

Subjects	Grades	Credits	Compulsory	Sellect contents in the subject
Mathematics Ⅰ	10	4	○	×
Mathematics A	10	2	×	○
Mathematics Ⅱ	11	4	×	×
Mathematics B	11	2	×	○
Mathematics Ⅲ	12	3	×	×
Mathematics C	12	2	×	○

There are 6 subjects in case of senior high school.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Only Mathem
Others are 5 s

These subjects include Statistics.
Students that want to go to college will learn Mathematics I ~MathematicsB.

Both course of Humanities and Sciences

Subjects	Grades	Credits	Compulsory	Sellect contents in the subject
Mathematics Ⅰ	10	4	○	×
Mathematics A	10	2	×	○
Mathematics Ⅱ	11	4	×	×
Mathematics B	11	2	×	○
Mathematics Ⅲ	12	3	×	×
Mathematics C	12	2	×	○

There are 6 subjects in case of senior high school.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Character of Each Subject （10 grade)

Mathematics Ⅰ

- Connection with contents of junior high school
- Basic of feature and competency that enable all students to think mathematically

Mathematics A

- Complementing contents of Mathematics Ⅰ
- Being conscious of goodness of mathematics
- Making qualities and competency of mathematically thinking

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Character of Each Subject （11 grade)

Mathematics Ⅱ

・Improving qualities and competence of many students thinking mathematically

Mathematics B

・Problem solving or decision making by utilizing mathematical knowledge and skill.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Character of Each Subject （12 grade)

MathematicsⅢ

- For the students that want to study special field needed mathematics.
- Improving the way of thinking mathematically.

MathematicsC

- Advanced contents with comparing to ones of Mathematics Ⅰ.
- Getting device of mathematical expression.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Mathematics I

(1) Number and Formula

(2) Figure and Measurement

(3) Quadratic Function

(4) Analysis of Data　Utilization of Data

The contents of mathematics in junior high school
Are constructed four fields. Number and formula,
figure, function, and utilization of data.

This is the connection with contents of junior high school

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Mathematics I

(1) Number and Formula

(2) Figure and Measurement

(3) Quadratic Function

(4) Analysis of Data

Utilization of Data

The contents of mathematics in junior high school
Are constructe ber and formula,
figure, function, and utilization of data.

Systematic!

This is the connection with contents of junior high school

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

(4) Analysis of Data

- **Scattering of data**

  Variance, standard deviation

- **Correlation of Data**

  Scatter diagram, correlation coefficient

- **Way of thinking hypotheses testing**

  Recognizing the usefulness of data analysis

  by means of mathematical activity,

  and instruct students understand the following things.

This is the first time treated in compulsory subject.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

(4) Analysis of Data

- Scattering of data

  Varian

- Correlati

  Scatte

First time.
Compulsory subject.
It may be a diificunt, but, •••

- Way of thinking hypotheses testing

Recognizing the usefulness of data analysis

by means of mathematical activity,

and instruct students understand the following things.

This is the first time treated in compulsory subject.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

(4) Analysis of Data

・Scattering of data

・Co

・Wa

Rec

by means of mathematical activity,

and instruct students understand the following things.

Since some students take a course only Mathematics Ⅰ , it has students understand “The way of thinking of hypotheses test” through concrete example, considering practical cases.

This is the first time treated in compulsory subject.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Concrete example

Thirty people used new pillow made from new material. Twenty-four students said that the new pillow is comfortable.

Then is it possible to decide that people can sleep very well if they use the new pillow?

Theorem of hypotheses test
Binominal distribution ← 11 grade(Next grade)

Independent trials
and probability ← MathematicsA

This concrete example are introduced in the course of study.

3． Course of study (Utilization of data)

Mathematics curriculum of senior high school

Cor

Thi
new
the
The
slee
can

Reference

P(X=24)=0.000553

P(24≦X≦30)=0.000715

I am interested in students' response.

- Group discussion is possible (Collaboratory)
- Since possibility that many way of thinking will come out, critical thinkings are possible.

and probability

This concrete example are introduced in the course of study.

We will replace this problem
with another problem.
Replaced problem is ones of coin tossing.

Number of tossing : 30 times
Number of getting front side of coin: 24 times
If n is defined as the number of getting front side of coin, what is the probability that $24 \leqq n \leqq 30$?

Experiment is also possible.

and probability
This concrete example are introduced in the course of study.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Mathematics Ⅱ

(1) Many Kind of Expression (Formula)

(2) Figure and Equation (Analytic Geometry)

(3) Exponential Function and Logarithm Function

(4) Trigonometric Function

(5) Way of Thinking Differential and Integral

※ There is no statistical educational material.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Mathematics Ⅲ

(1) Limit

(2) Method of Differential

(3) Method of Integral

※ Differential and Integral of various functions.
※ There is no statistical educational material.

MathematicsⅢ is the same.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Mathematics A

(1) Feature of Figure (Elementary Geometry)
(2) Number of Outcomes and Probability
(3) Mathematics and Human Activity

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

(2) Number of Outcomes and Probability

- Number of outcomes

  Principle of counting

  Permutation, Combination

- Probability

  Probability and the basic property

    Complement event, exclusive event, expectation

  Independent trials and probability

  Conditional probability

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

(2) Number of Outcomes and Probability

・Number of outcomes

Junior high school : Population is not big.
Senior high school : Population is big.

Permutation, Combination

・P

Expectation are being related to distribution of probability(MathematicsB). (Systematic)

Probability and the basic property

Complement event, exclusive event, expectation

Independent trials and probability

Conditional probability

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Mathematics B

(1) Sequence

(2) Statistical Inference

(3) Mathematics and Social Life

Linear approximation is included.

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

(2) Statistical Inference

- **Distribution of Probability**
  - Random variable and distribution of probability
    - Average, variance, and standard deviation of random variable
  - Binominal distribution
- **Normal distribution**
  - Continues random variable
  - Normal distribution
- **Statistical Inference**
  - Population and sample
  - Way of thinking statistical inference
    - Interval estimation, test of hypothesis

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

(2) Statistical Inference

・Distribution of Probability

Rand

Ave n variable

Binor

Opportunity of learning statistics will Increase!

・Normal distribution

Continues random variable

Normal distribution

・Statistical Inference

Connection with contents of Mathematics Ⅰ.

Population and sample

Way of thinking statistical inference

Interval estimation, test of hypothesis

3． Course of study (Utilization of data)
Mathematics curriculum of senior high school

Mathematics C

(1) Vector

(2) Curves on the Plane and Complex Plane

(3) Device of Mathematical Expression

(3) Device of Mathematical Expression

・Significance or goodness of mathematical expression

Figure, table, statistic graph, discreet graph, and matrix

School will choose two contents out of three ones because of restricted times of mathematics lesson.

4．Why Japan's course of study are revised?

The following wording is included in Japan's course of study. (Key words.)

◎ Prediction of feature of today or future

- Artificial intelligence makes many decisions.
- Many familiar things working are optimized by the process of internet.
- Greatly change of social and life
- Prediction will come to be more difficult because of complex various events.
- Era that prediction is quite difficult will come.

The course of study includes these wordings.
Course of study is conscious of the future.

4．Why Japan's course of study are revised?

The following wording is included in Japan's course of study. (Key words.)

◎ Prediction of feature of today or future

・Artificial intelligence makes many decisions.

What kind of competency Is needed for them?

because of complex various events.

・Era that prediction is quite difficult will come.

The course of study includes these wordings.
Course of study is conscious of the future.

4．Why Japan's course of study are revised?

◎ Desirable Competencies

- Being challenged various things by students
- To resolve the problem with other people cooperatively.
- Identifying the information
- Making conceptual realization of knowledge
- Connecting new value by reconstructing information
- Reconstructing the purpose in complex circumstance changing

The way of thinking is "desirable competencies".

4． Why Japan's course of study are revised?

◎ Desirable Competencies

- Being challenged various things by students
- To resolve the problem with other people cooperatively.
- Surly, the course of study is conscious of the future. But,・・・・
- Connecting new value by reconstructing information
- Reconstructing the purpose in complex circumstance changing

The way of thinking is "desirable competencies".

4． Why Japan's course of study are revised?

◎ Desirable Competencies

How can we conduct ?

cooperatively.

- Surly, the course of study is conscious of the future. But,・・・・
- ge
- Connecting new value by reconstructing information
- Reconstructing the purpose in complex circumstance changing

The way of thinking is "desirable competencies".

4．Why Japan's course of study are revised?

◎ Curriculum Management

Contents that have to be thought to achieve the purpose of curriculum

(1) What comes to be able to do?

(2) What should be learned?

(3) How to learn?

(4) How development of each children is assisted?

(5) What could be learned?

(6) What are needed for carrying out?

To realize competencies, there is the curriculum management.
How to implement these curriculum management?

4．Why Japan's course of study are revised?

◎ Curriculum Management

Contents that have to be thought to achieve the purpose of curriculum

(1) What comes to be able to do?

(2) Wh

(3) Ho

(4) Ho dren is
ass

(5) Wh

(6) What are needed for carrying out?

Collaboratory and Proactively

To realize competencies, there is the curriculum management.
How to implement these curriculum management?

4. Why Japan's course of study are revised?

◎ Curriculum Management

Not only teachers or students but also all national people have to think about these contents for the future.

(2) Wh

(3) Ho

(4) Ho dren is
ass

(5) Wh

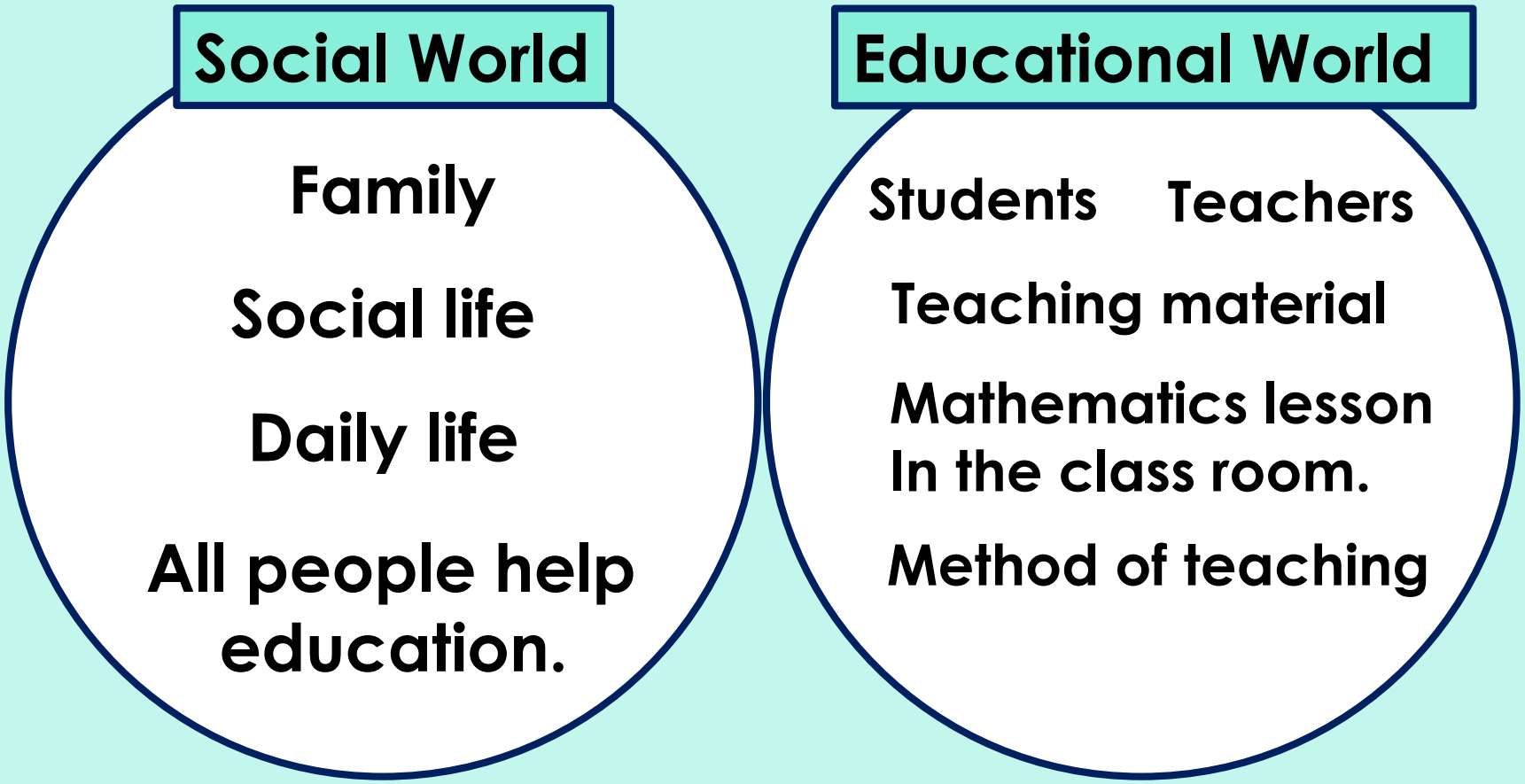
Collaboratory and Proactively

(6) What are needed for carrying out?

To realize competencies, there is the curriculum management.
How to implement these curriculum management?

4．Why Japan's course of study are revised?

Proactively Collaboratory



I made this figure. This is my image of the course of study. Both of these worlds can do many types of practices that are proactively and collaboratively.

5． Viewpoint to train power of judgement

◎ Mathematical Activity

Definition of Mathematical Activity

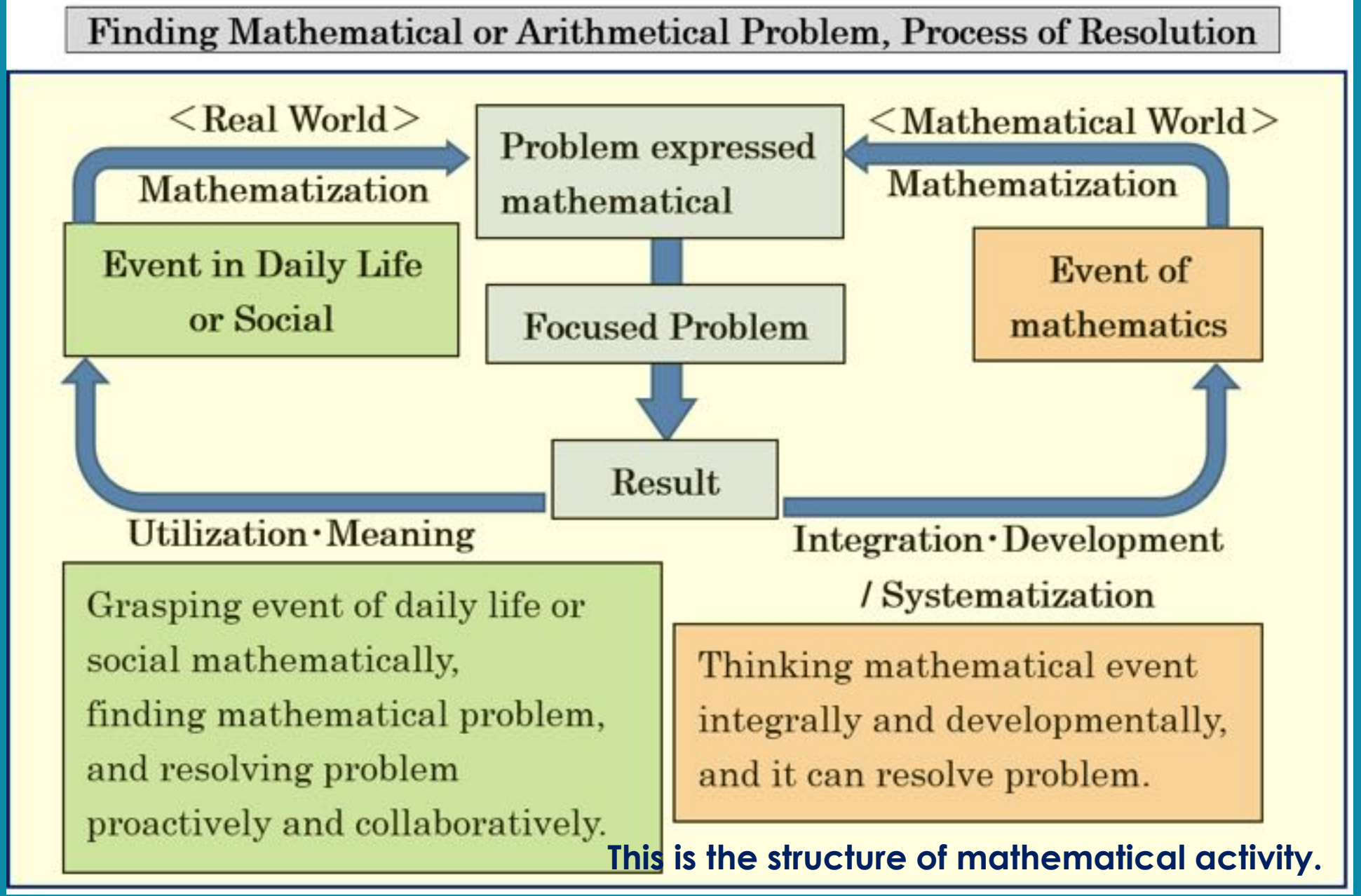
- Grasping event mathematically, finding mathematical problem, and doing process proactively and collaboratively.

- Proactive activity that is conscious of purpose concerned to mathematical learning.

Please see the next figure.

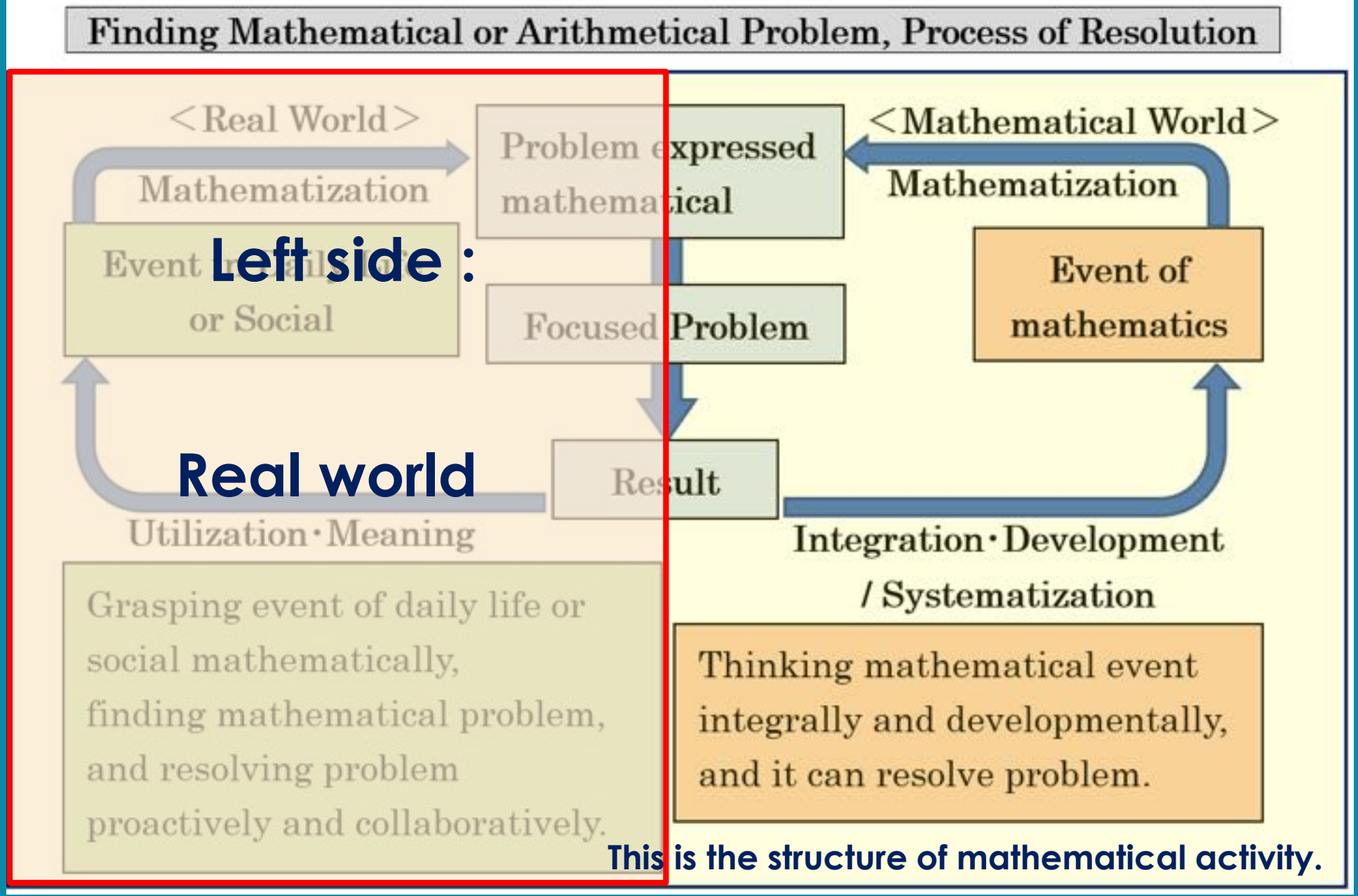
Mathematical activity is the method of training power of judgement.

Image of Learning Process of Arithmetic or Mathematics



This is the structure of mathematical activity.

Image of Learning Process of Arithmetic or Mathematics



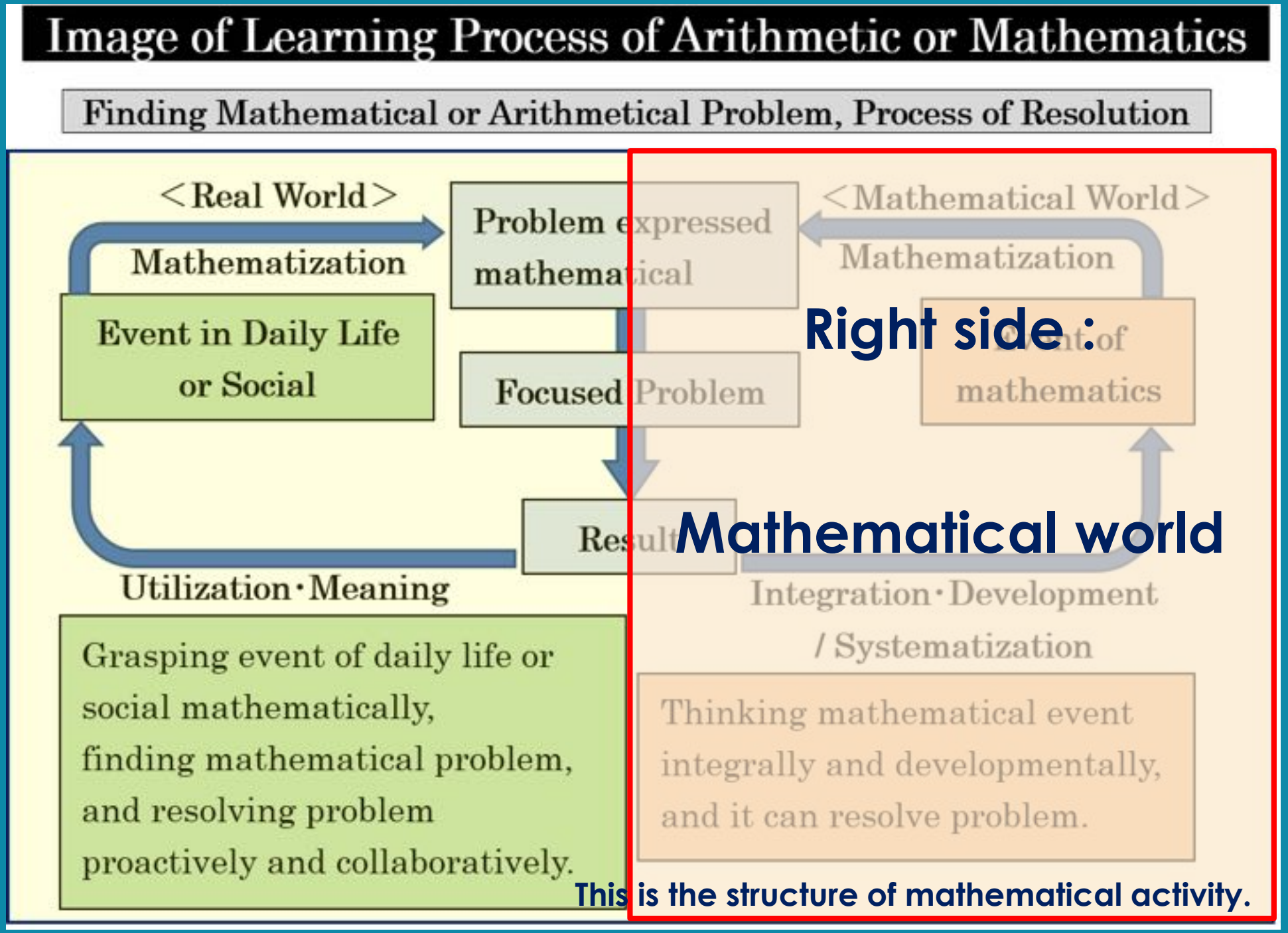
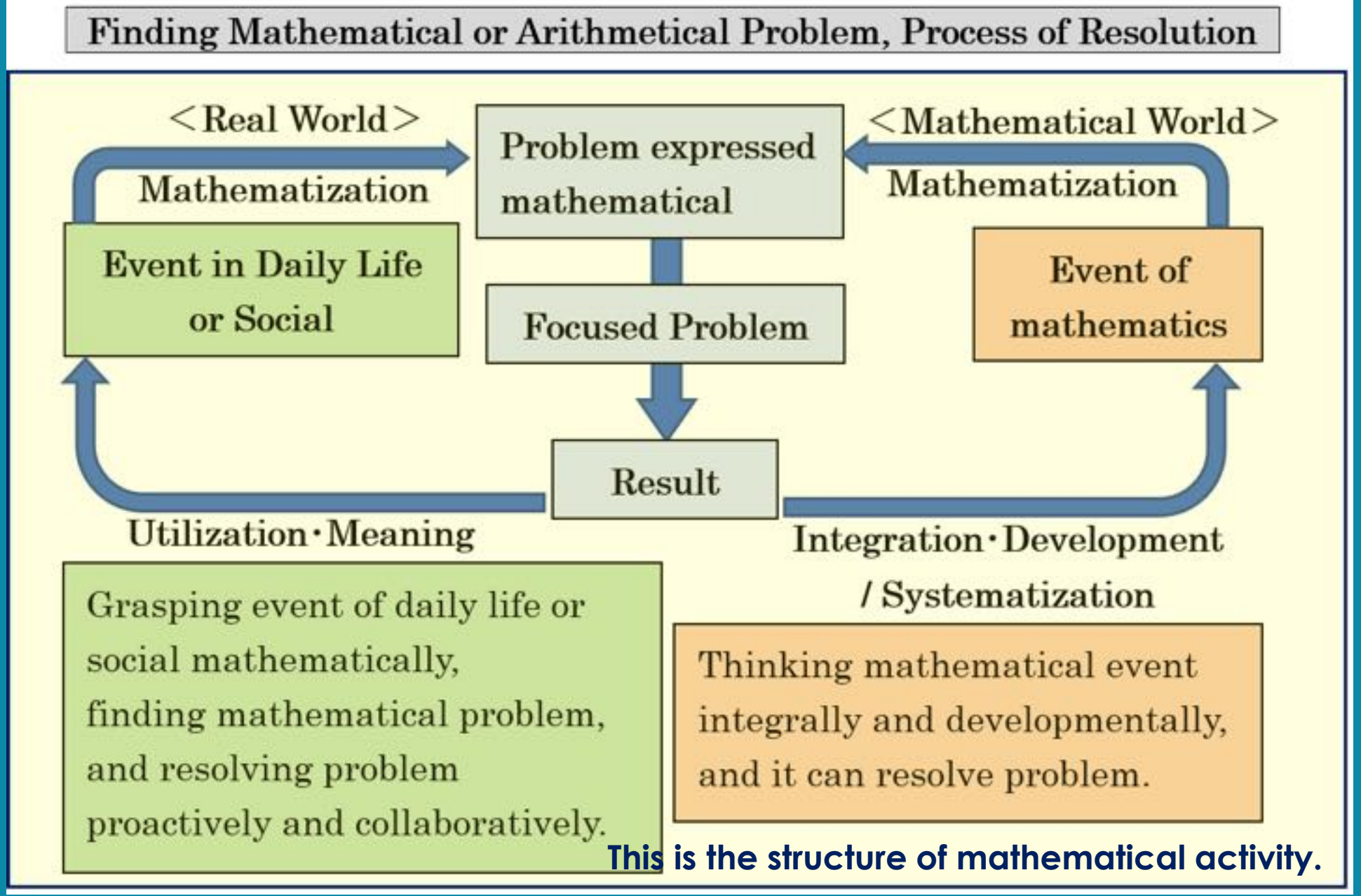


Image of Learning Process of Arithmetic or Mathematics
Finding Mathematical or Arithmetical Problem, Process of Resolution
<Real World>
Mathematization
Event in Daily Life or Social
Problem expressed mathematical
Focused Problem
Result
Utilization・Meaning
Grasping event of daily life or social mathematically, finding mathematical problem, and resolving problem proactively and collaboratively.
<Mathematical World>
Mathematization
Content of mathematics
Integration・Development / Systematization
Thinking mathematical event integrally and developmentally, and it can resolve problem.
Right side :
Mathematical world
This is the structure of mathematical activity.

Image of Learning Process of Arithmetic or Mathematics



This is the structure of mathematical activity.

Image of Learning Process of Arithmetic or Mathematics

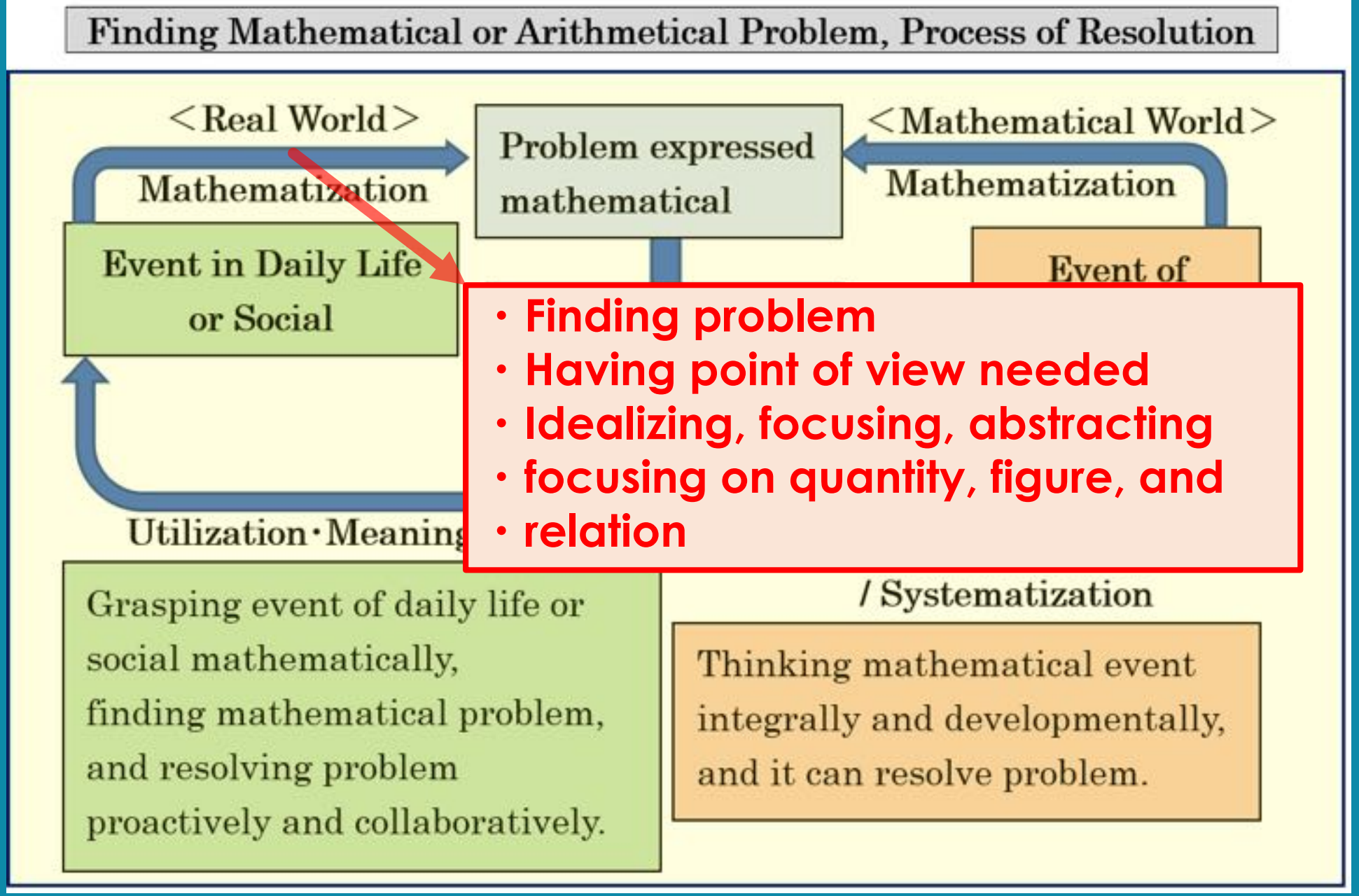
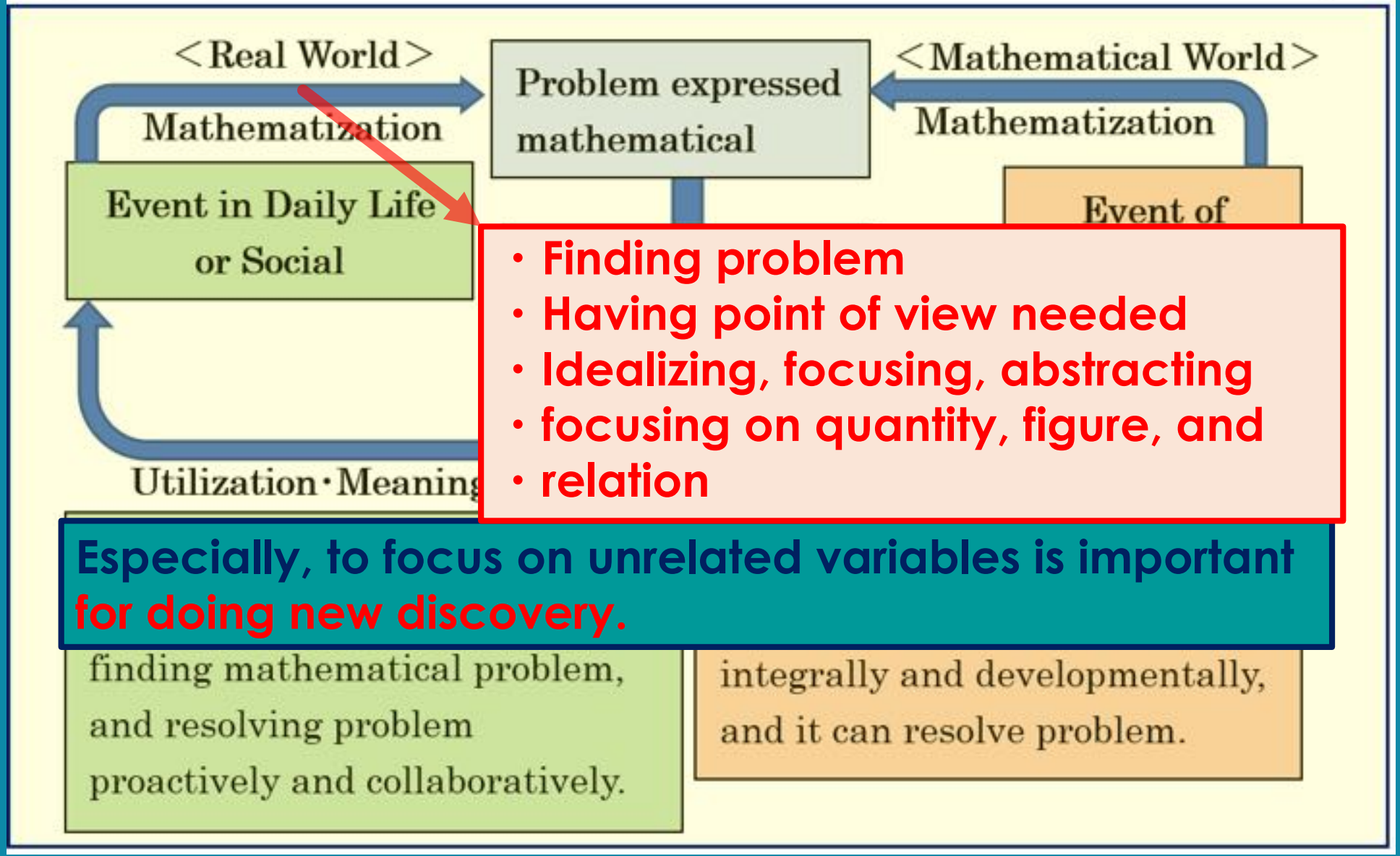


Image of Learning Process of Arithmetic or Mathematics

Finding Mathematical or Arithmetical Problem, Process of Resolution



- Finding problem
- Having point of view needed
- Idealizing, focusing, abstracting
- focusing on quantity, figure, and
- relation

Especially, to focus on unrelated variables is important for doing new discovery.

Image of Learning Process of Arithmetic or Mathematics

Focusing something specified

Problem, Process of Resolution

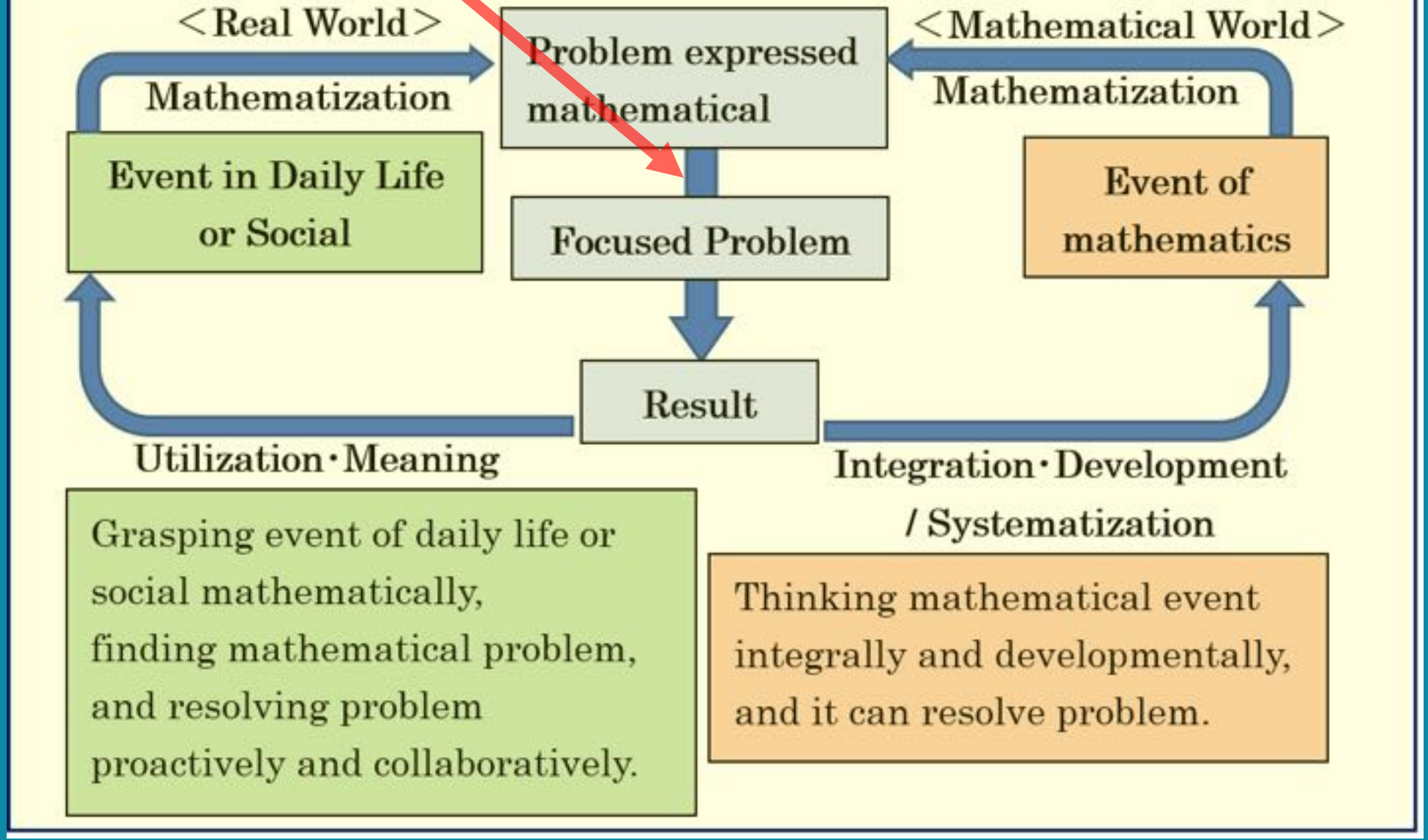


Image of Learning Process of Arithmetic or Mathematics

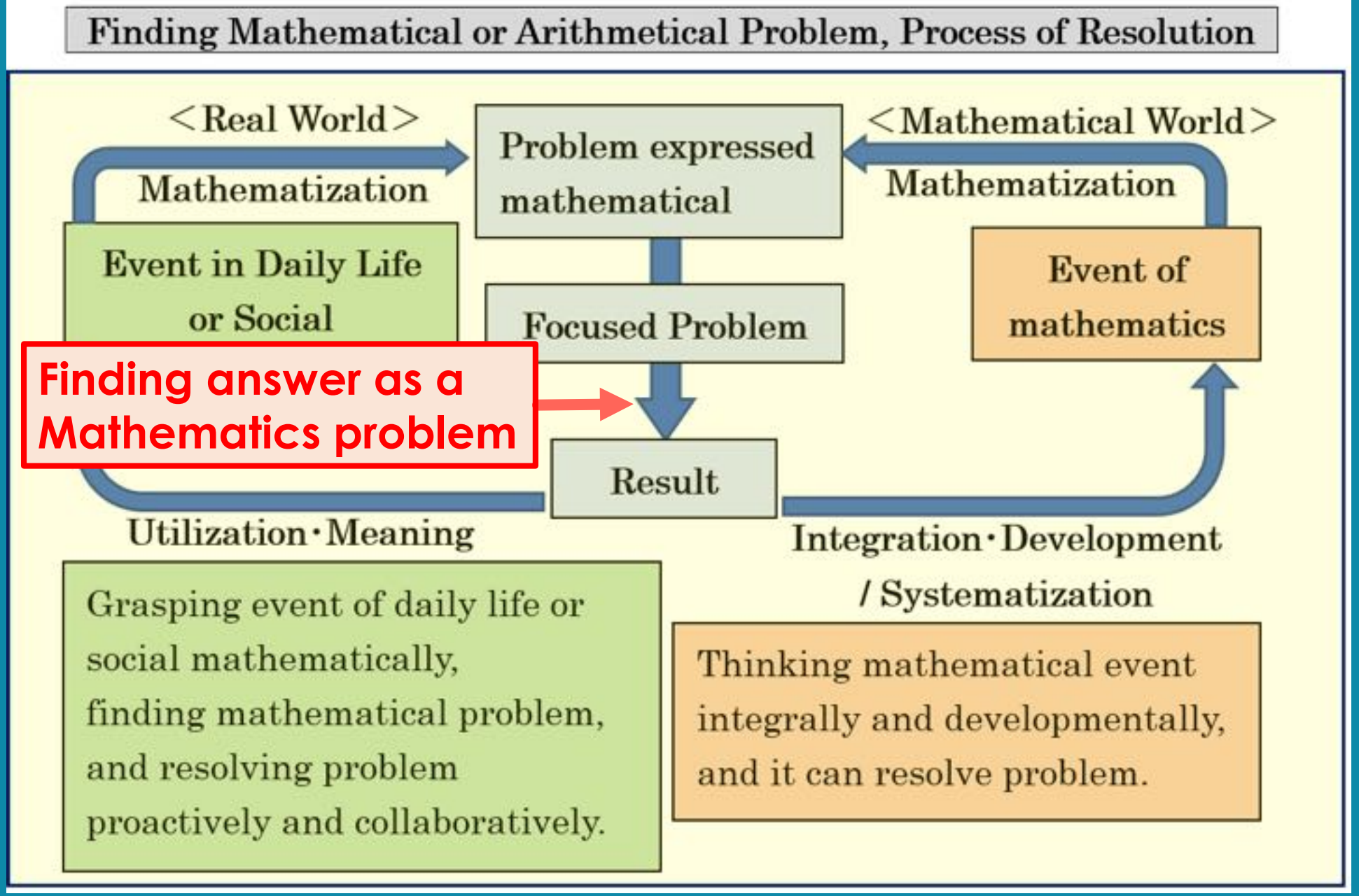


Image of Learning Process of Arithmetic or Mathematics

Finding Mathematical or Arithmetical Problem, Process of Resolution

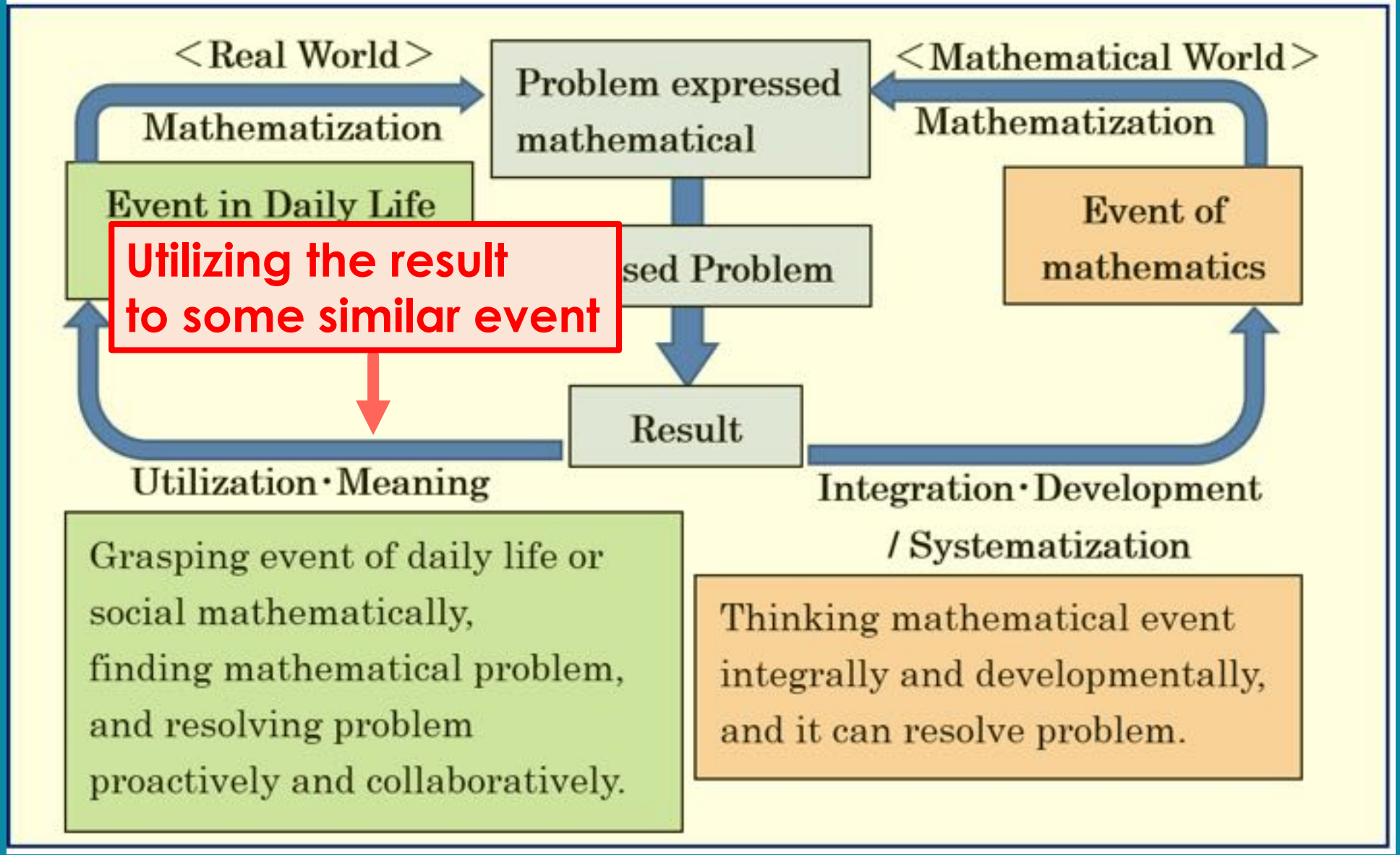


Image of Learning Process of Arithmetic or Mathematics

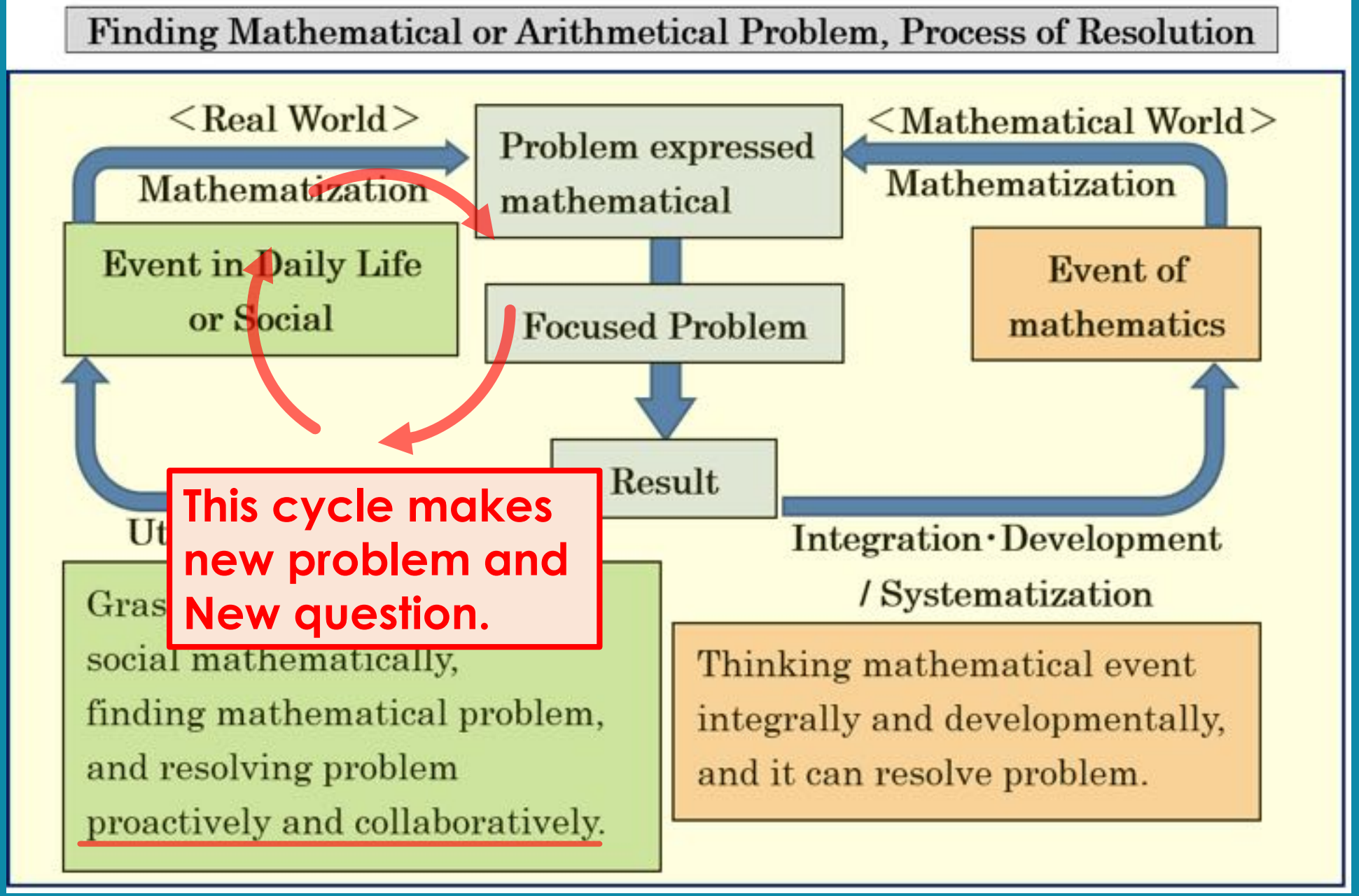


Image of Learning Process of Arithmetic or Mathematics

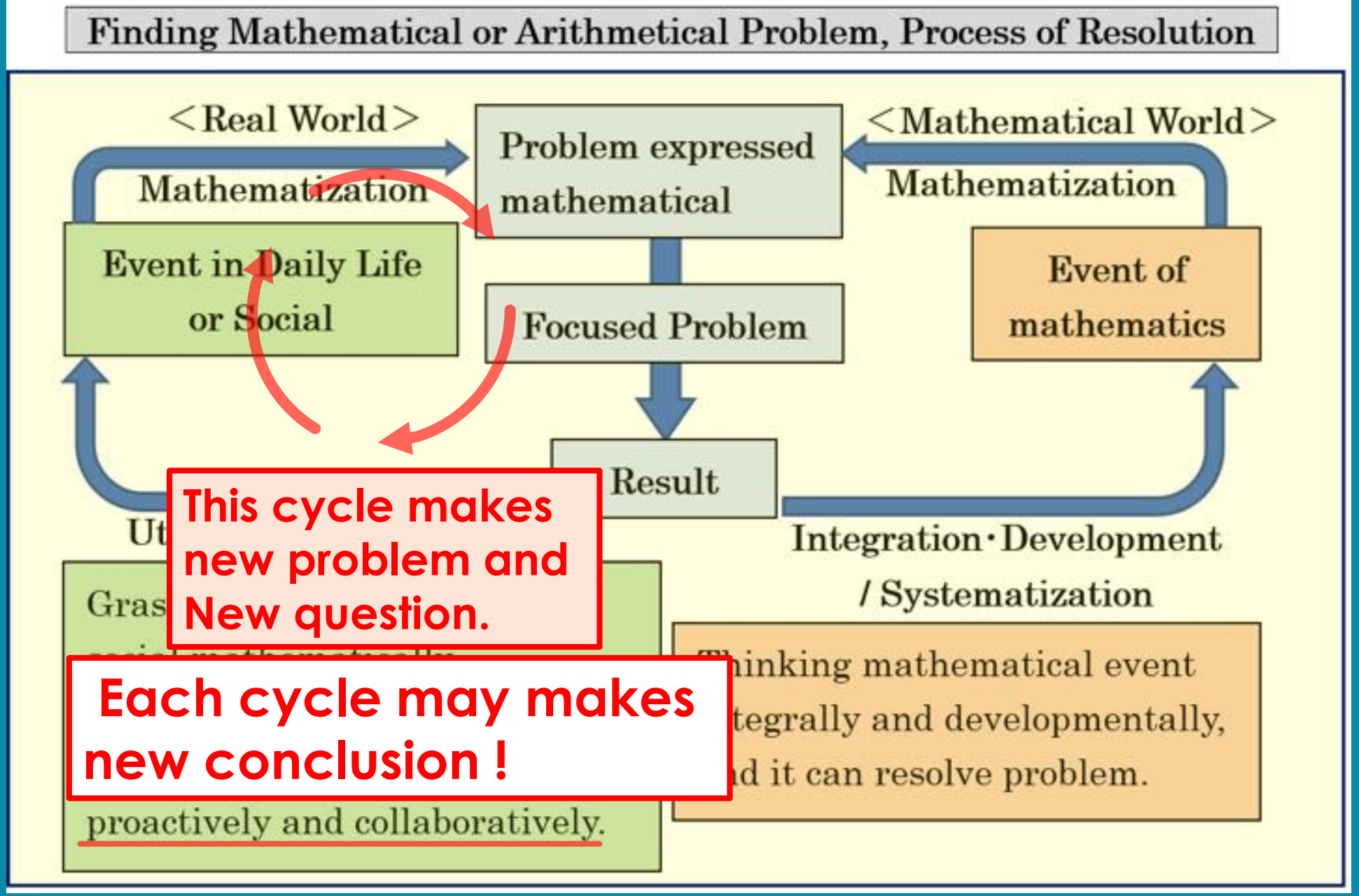


Image of Learning Process of Arithmetic or Mathematics

Finding Mathematical or Arithmetical Problem, Process of Resolution

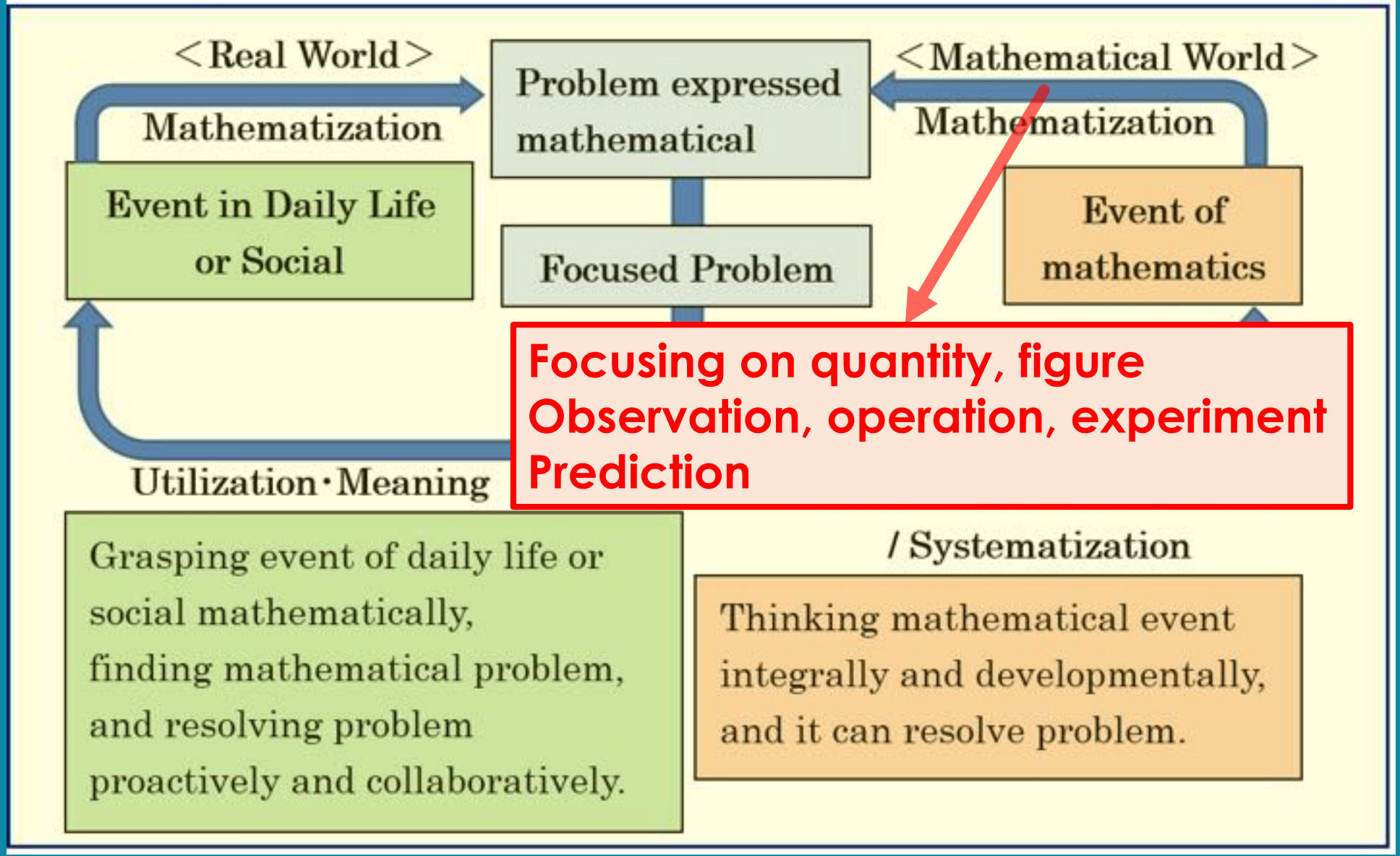


Image of Learning Process of Arithmetic or Mathematics

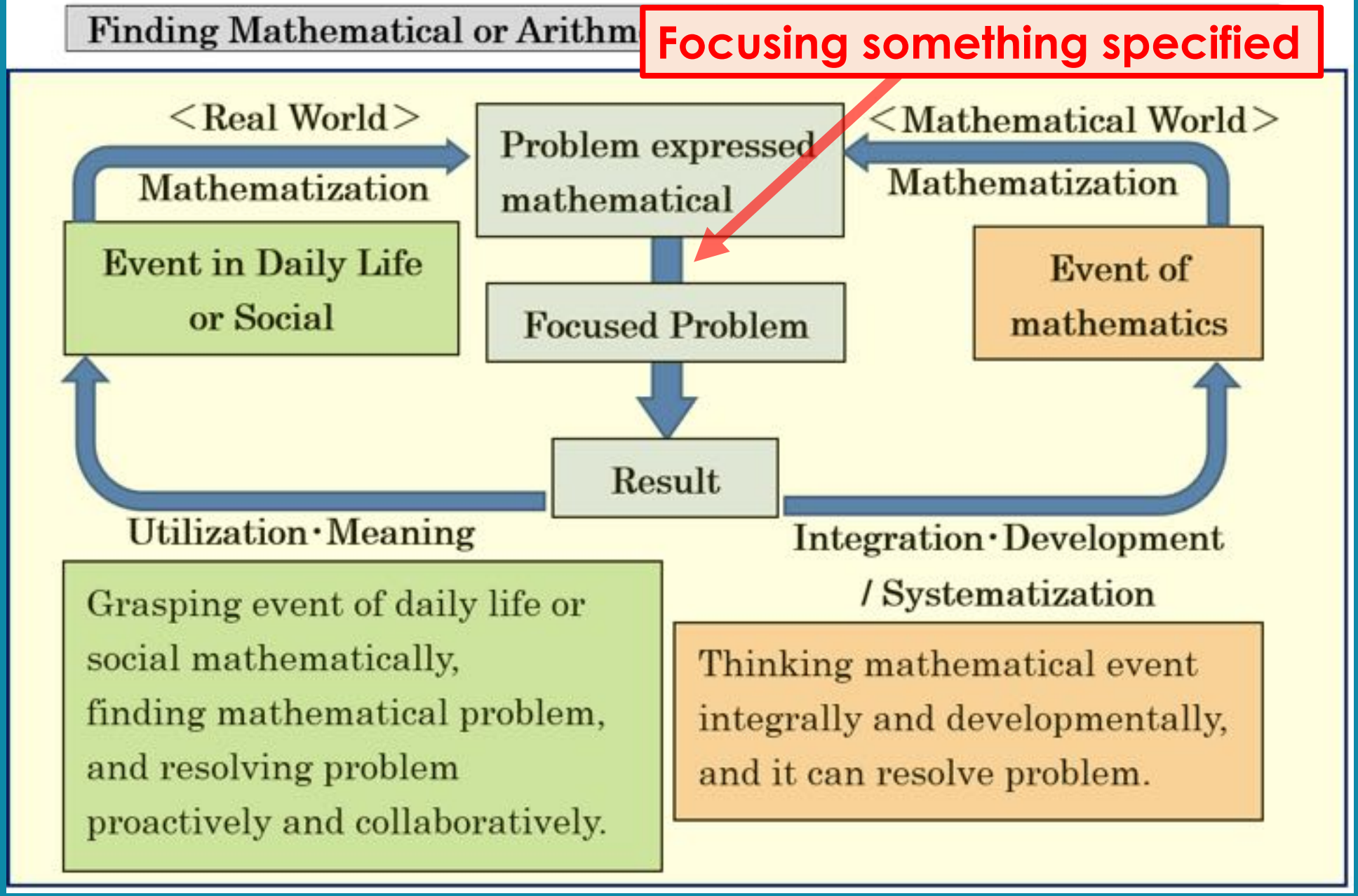


Image of Learning Process of Arithmetic or Mathematics

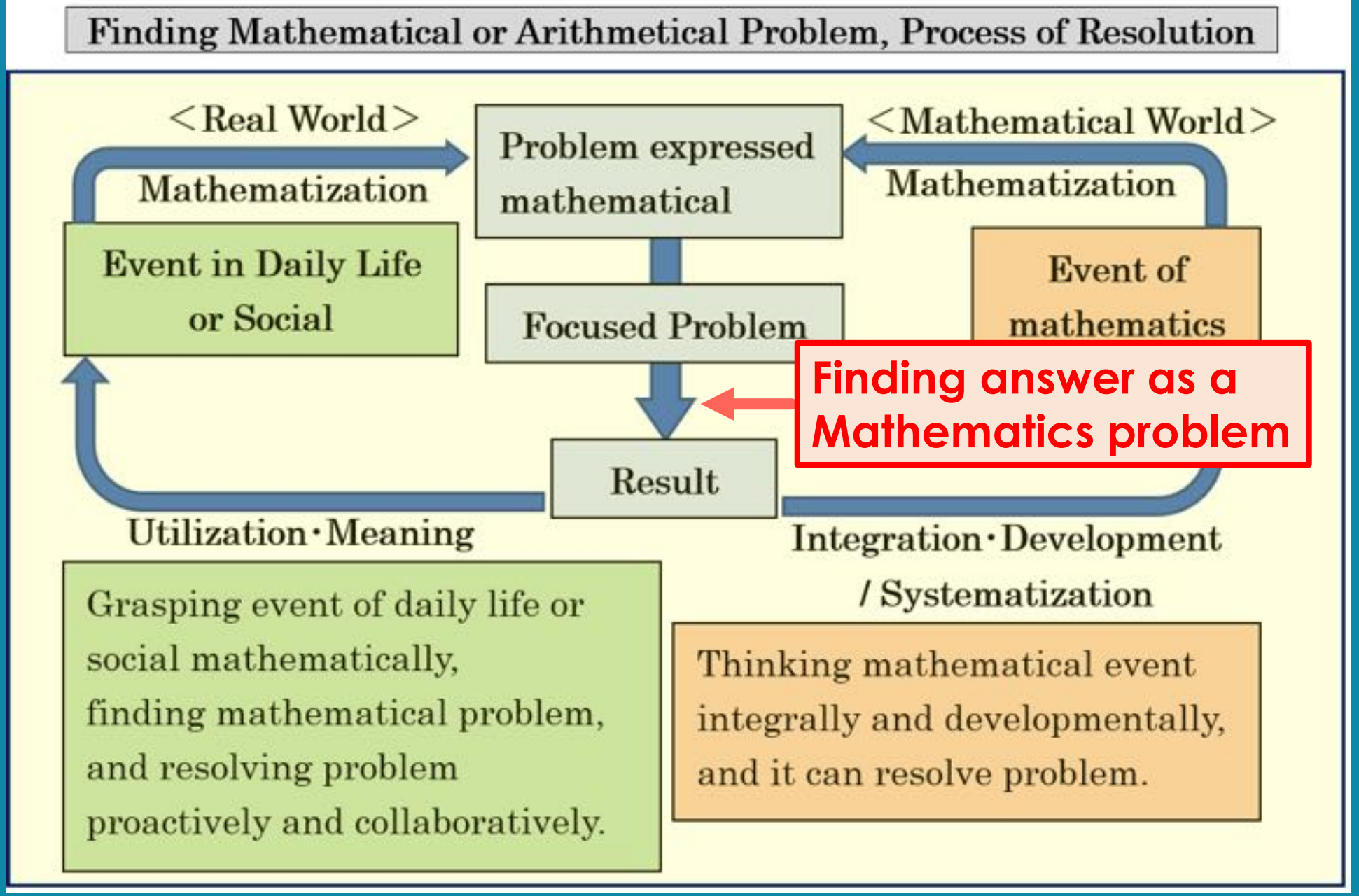


Image of Learning Process of Arithmetic or Mathematics

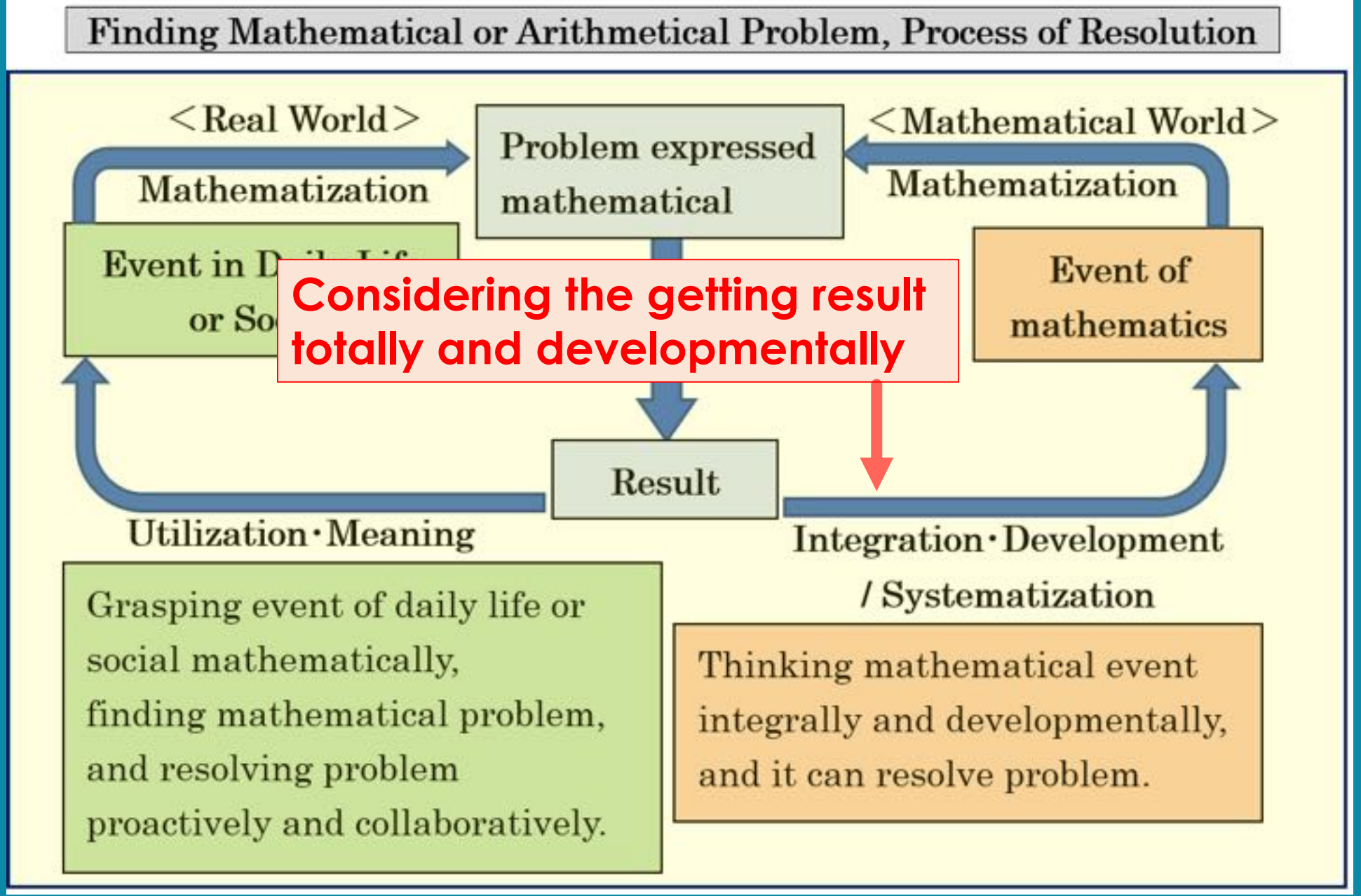


Image of Learning Process of Arithmetic or Mathematics

Finding Mathematical or Arithmetical Problem, Process of Resolution

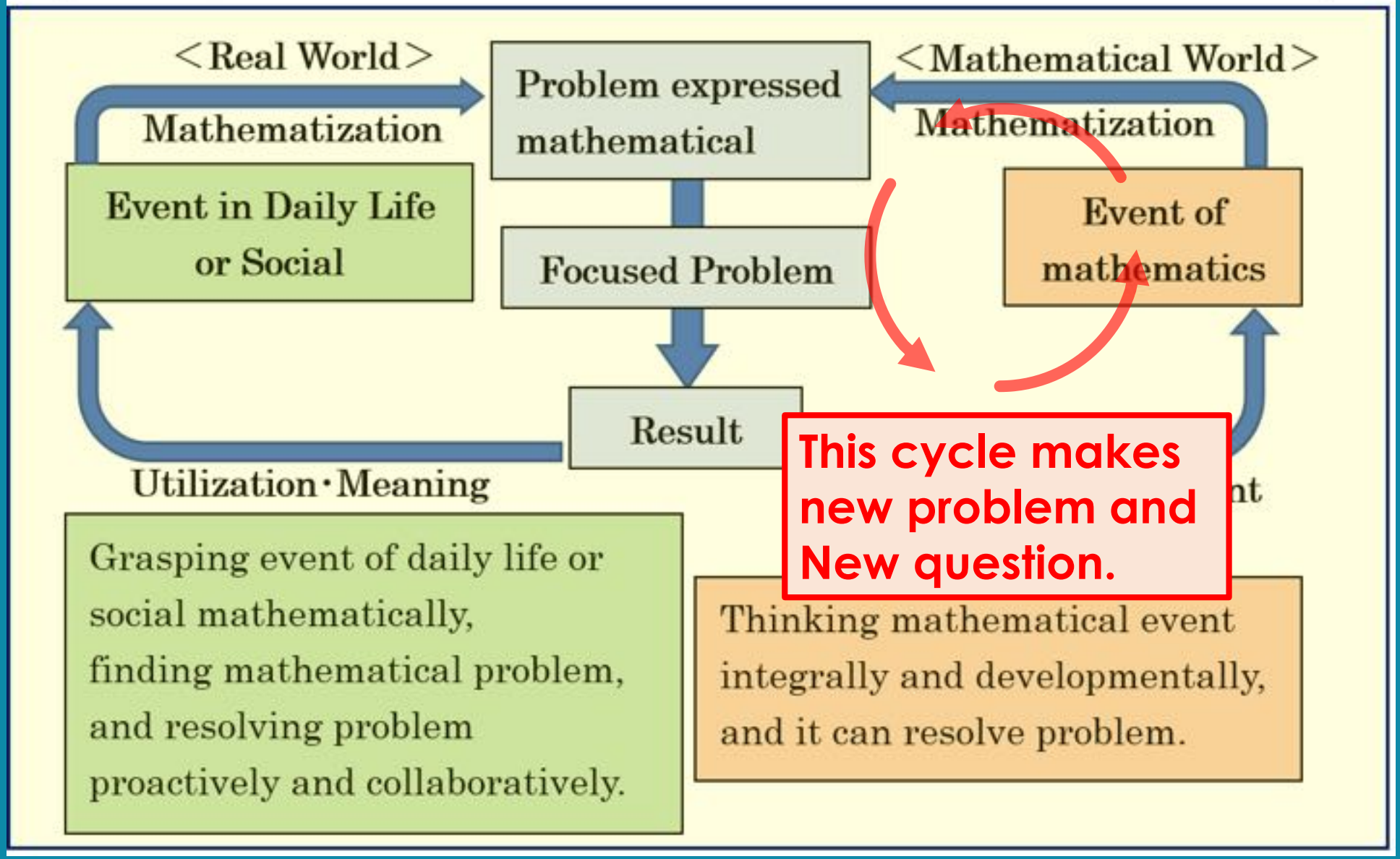
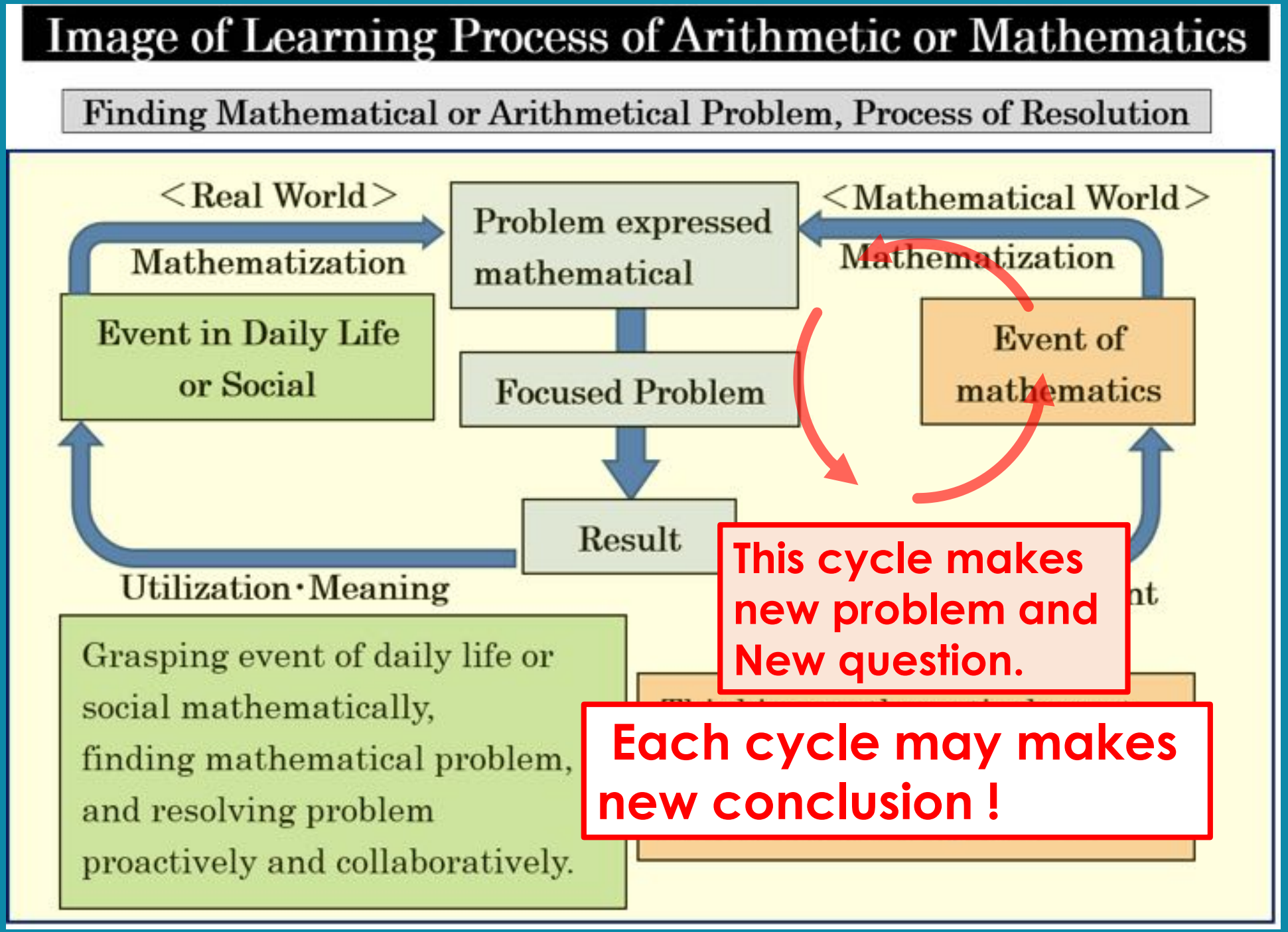


Image of Learning Process of Arithmetic or Mathematics



5． Viewpoint to train power of judgement

For resolving the problems in Real World

- Giving educational material by which students can find new theme.
- Giving educational material by which critical thinking is meaningful and not so difficult.
- Finding new data for researching new theme.
- Considering how to ask students to give questions.

5 items are important.

5． Viewpoint to train power of judgement

For learning statistical sense in mathematical World

- Making data for confirming mathematical feature.
- Mathematical experiment to confirm uncertainty.
- Giving mathematical equipment by which mathematical experiment comes to be possible, for example, computer program or calculator.
- If possible, making computer program code for purpose to confirm mathematical feature or theorem.

4 items are important.

5．Viewpoint to train power of judgement

For remaking the educational material

- Our teachers have to learn methods how to make a good statistical teaching material easily.

For example, remaking the educational material in textbooks, ordinally used in the lesson, to good one by which students would come to be able to do mathematical activity.

If mathematical textbooks will not change, nothing will change.

6． About Statistics

In case of elementary school and junior high school,
The course of study is conscious of PPDAC cycle.

Plan	・Grasping the problem	・Making problem
Problem	・Asumption of data	・Plan of gathering data
Data	・Gathering data	・Arrangement to the table
Analysis	・Making graph	・Grasping feature and tendency
Conclusion	・Making decision	・Looking back

problem that is possible to be resolved statistically

data that should be gathered and the way of gathering
gathering data

Making graph or finding statistics amount

Grasping feature and trend

Getting result

Getting new question or problem

6． About Statistics

In case of elementary school and junior high school,
The course of study is conscious of PPDAC cycle.

Plan	・Grasping the problem	・Making problem
Problem	・Asumption of data	・Plan of gathering data
Data	・Gathering data	・Arrangement to the table
Analysis	・Making graph	・Grasping feature and tendency
Conclusion	・Making decision	・Looking back

Repetition with alteration and improvement is important.

pr
do
gathering data
Making graph or finding statistics amount
Grasping feature and trend
Getting result
Getting new question or problem

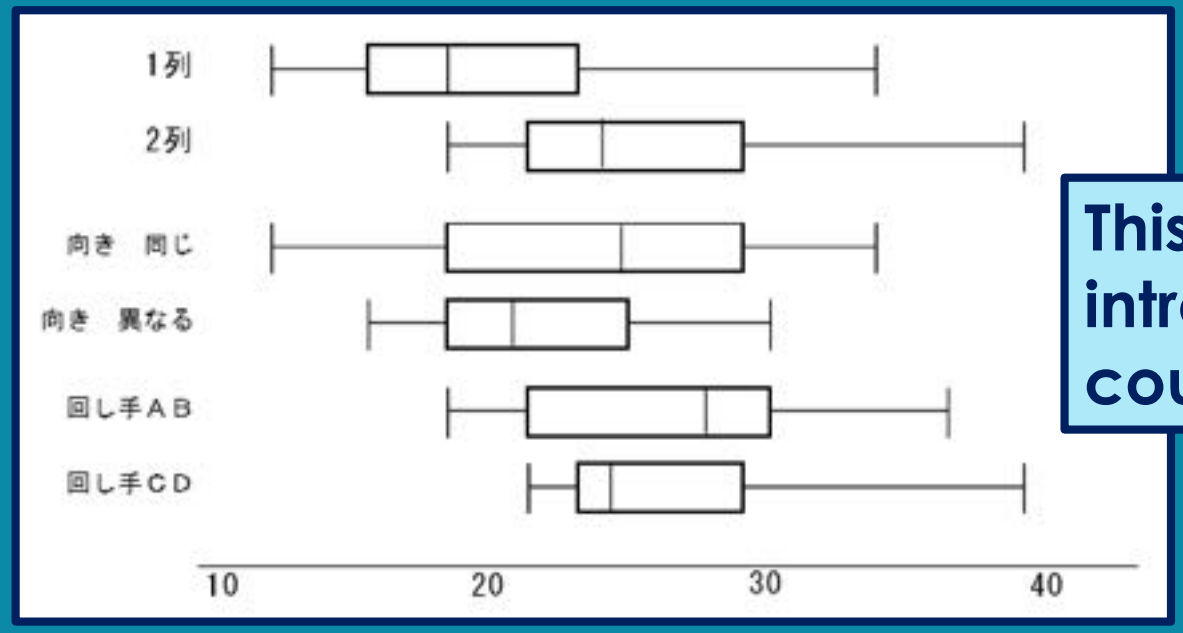
6． About Statistics

This idea is introduced in course of study.

Cause is quality data

Result is quantity data

When compare with some data,
there is a method of box plots positioned parallelly.



This figure is introduced by course of study.

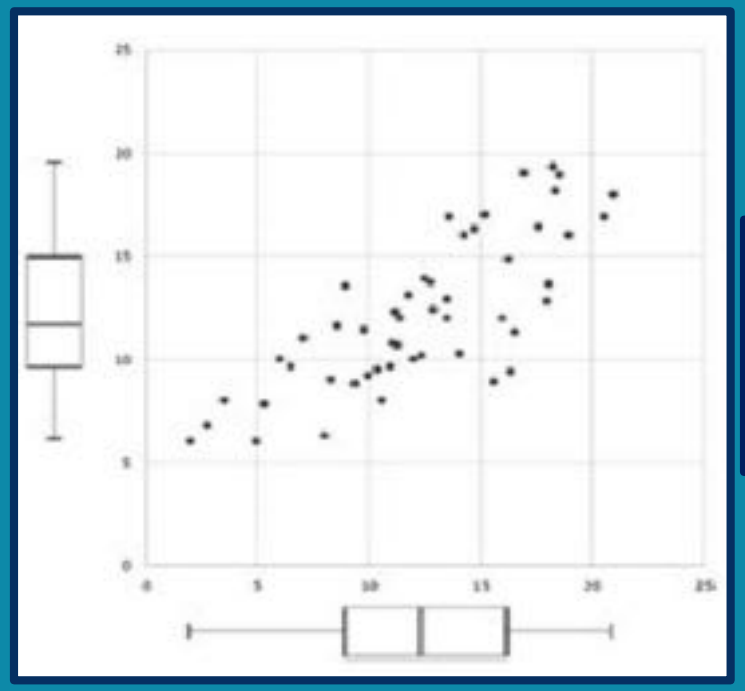
6． About Statistics

This idea is introduced in course of study.

If we want to research relation in the quantity data, •••

Scatter diagram and value of correlation coefficient

Is effective.



This figure is introduced by course of study.

Combinational figure of scatter diagram and box plot

6． About Statistics

Approaching the type of verifying hypotheses

Making hypotheses for the situation of problem

↓

Gathering data

↓

Verifying the hypotheses

Approaching the type of inquiring hypotheses

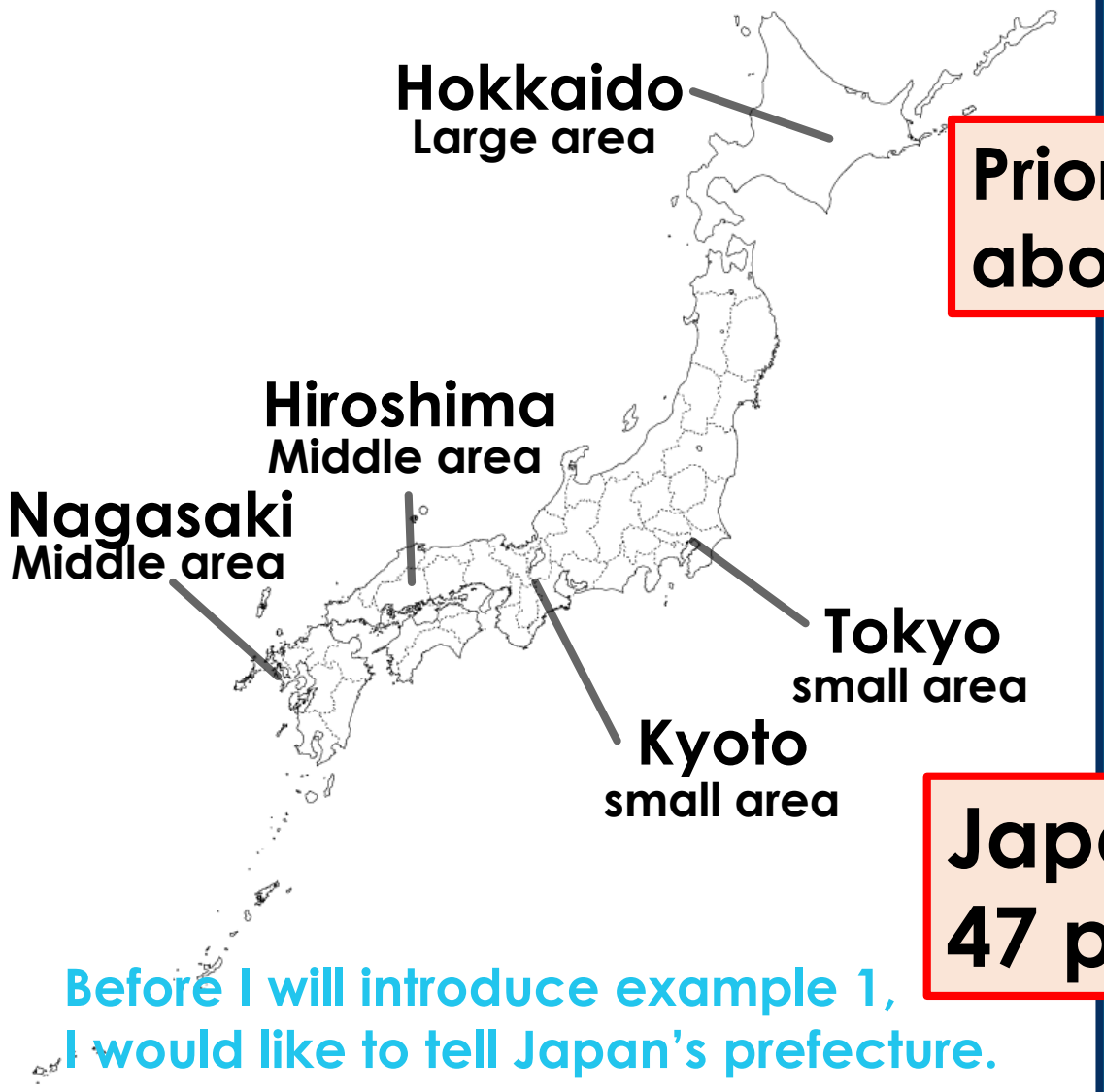
Analysis of data

↓

Discovering a new problem that were not noticed

These two approaches are introduced in course of study.

7． Example of instruction 1
— Educational material of scatter diagram —



Prior knowledge about Japan

Japan is divided 47 prefectures.

Before I will introduce example 1,
I would like to tell Japan's prefecture.

7．Example of instruction 1
— Educational material of scatter diagram —

Statistic Problem of Scatter Diagram

If you made a new company, and you want to make new convenience stores, how are you going to decide the number of stores in each prefectures?

Students will soon begin to think some relations between numbers of store and other kinds of data.

And I think that they will easily predict there is a good relation between number of stores and population of each prefecture.

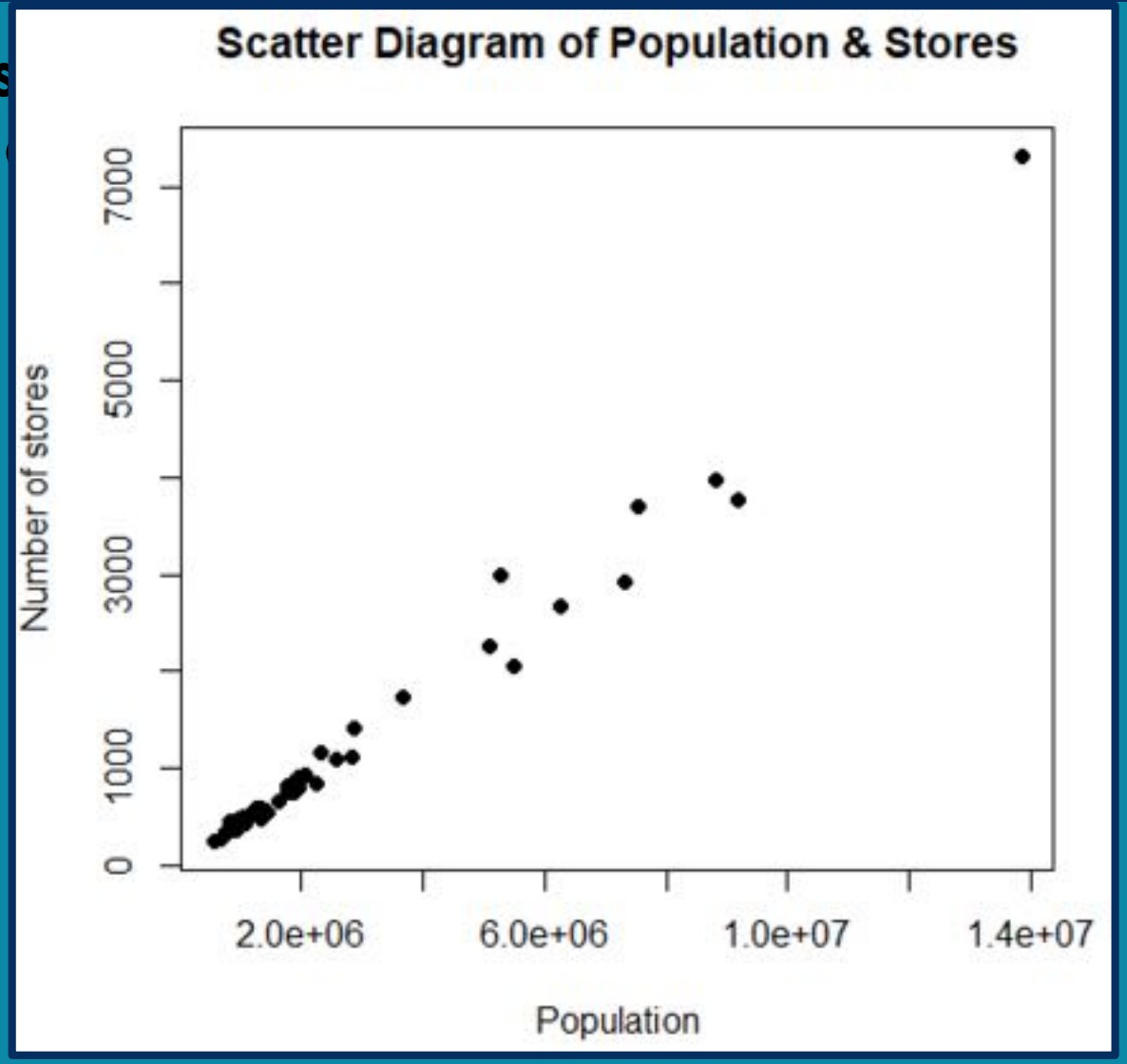
Students will soon focus on population and number of stores.

7．Example of instruction 1
— Educational material of scatter diagram —

Students will be able to find each prefecture's population data and number of stores by using internet.

7． Example of instruction 1
— Educational material of scatter diagram —

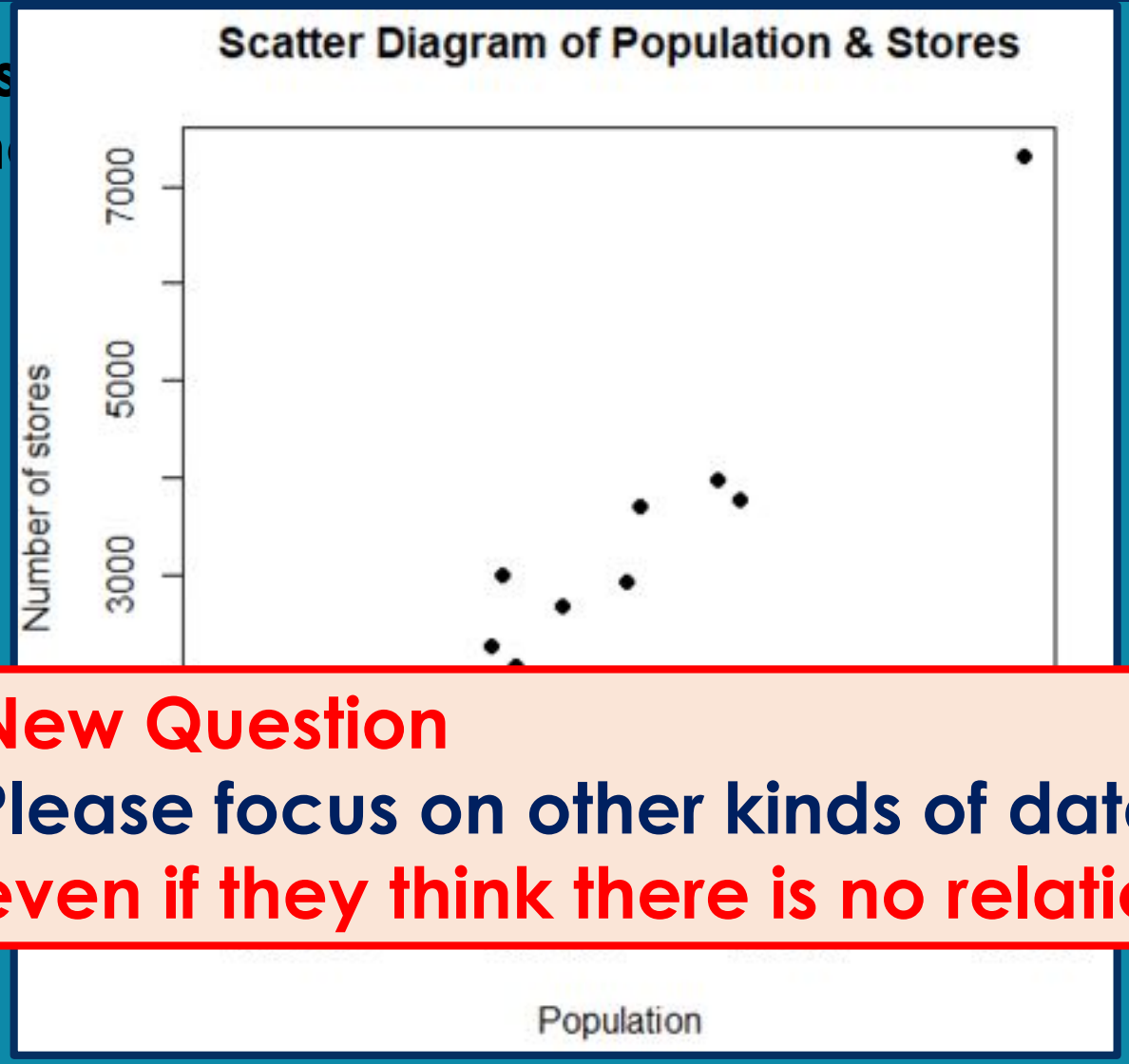
Students **population**
data an



There is a strong positive relation.

7．Example of instruction 1
— Educational material of scatter diagram —

Students population data an



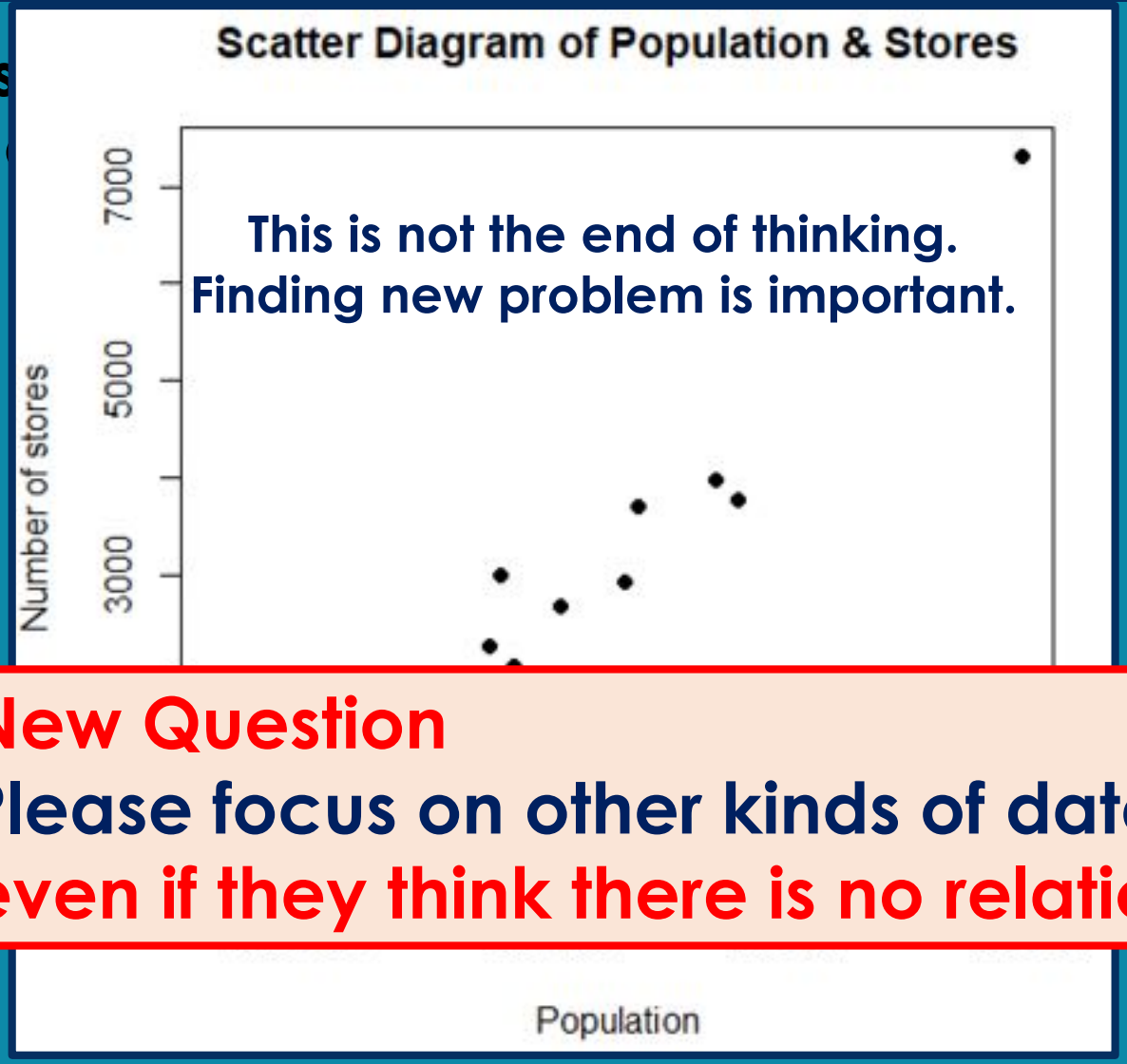
There is a strong positive relation.

New Question

Please focus on other kinds of data even if they think there is no relation.

7．Example of instruction 1
— Educational material of scatter diagram —

Students … population data an…



There is a strong positive relation.

New Question

Please focus on other kinds of data even if they think there is no relation.

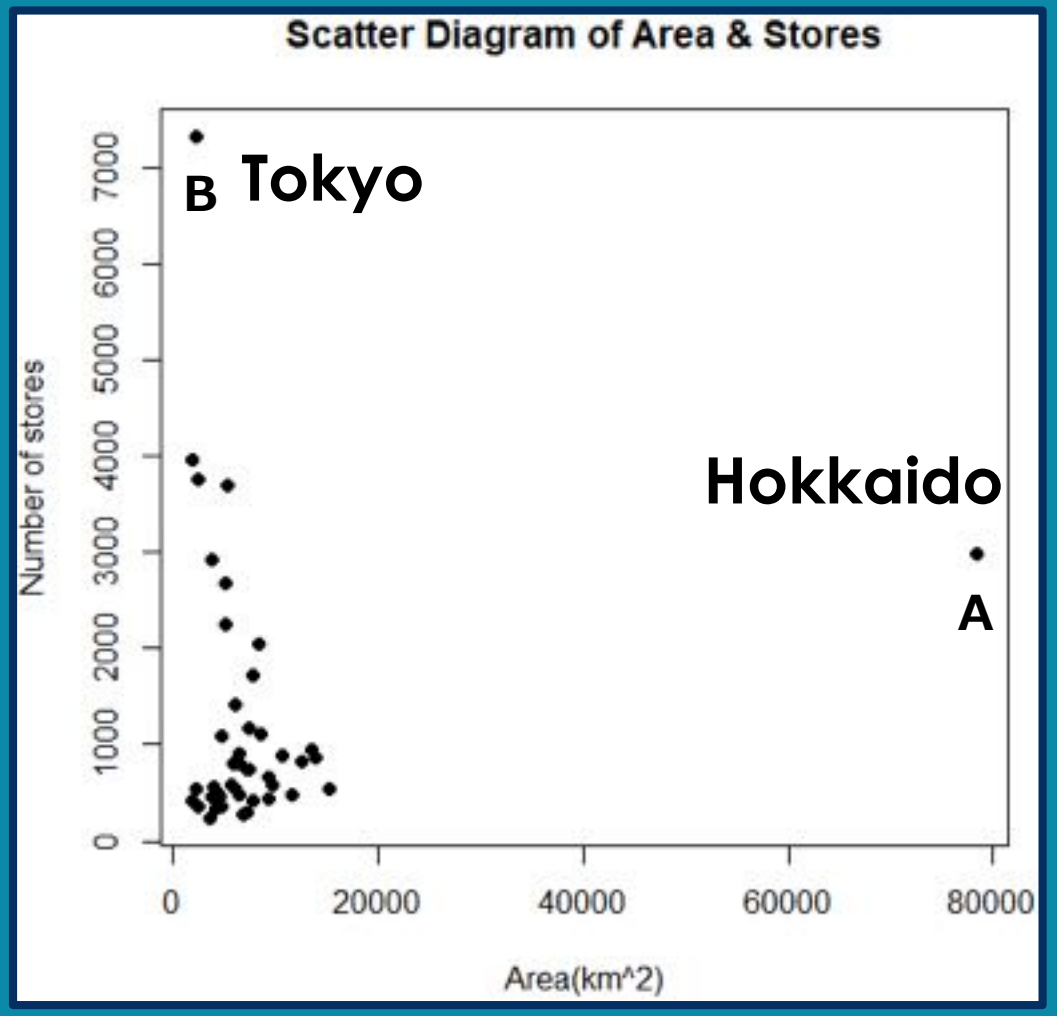
7． Example of instruction 1
— Educational material of scatter diagram —

Table of Area and Number of Stores in Each Prefecture

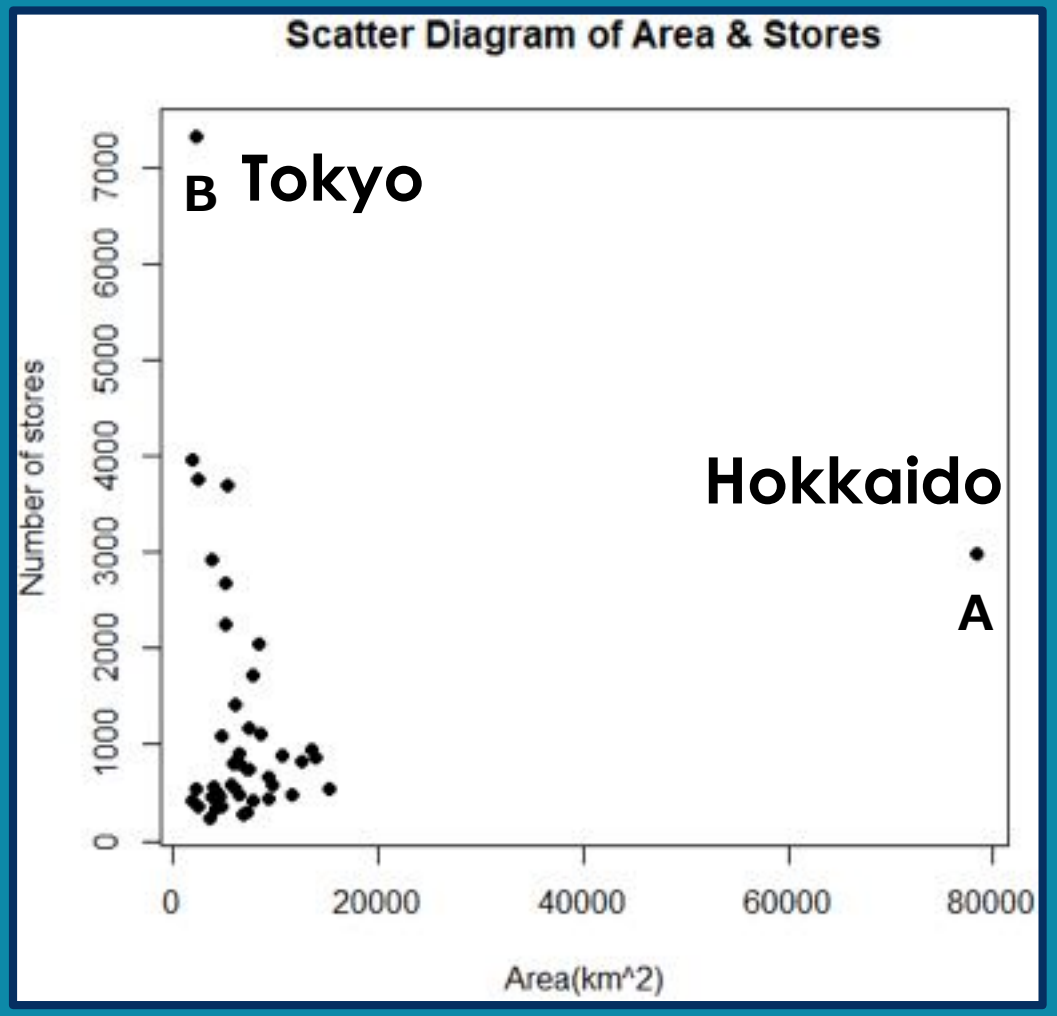
No.	Prefecture	Area	Stores	No.	Prefecture	Area	Stores	No.	Prefecture	Area	Stores
1	Hokkaido	78420.8	2981	17	Ishikawa	4186.1	511	33	Okayama	7114.3	748
2	Aomori	9645.7	588	18	Fukui	4190.5	346	34	Hiroshima	8479.6	1108
3	Iwate	15275.0	539	19	Yamanashi	4465.3	457	35	Yamaguchi	6112.5	537
4	Miyagi	7282.2	1162	20	Nagano	13561.6	939	36	Tokushima	4146.8	334
5	Akita	11637.5	472	21	Gifu	10621.3	884	37	Kagawa	1876.8	419
6	Yamagata	9323.2	446	22	Shizuoka	7777.4	1730	38	Ehime	5676.2	590
7	Fukushima	13783.9	865	23	Aichi	5173.0	3705	39	Kochi	7103.6	286
8	Ibaraki	6097.3	1421	24	Mie	5774.4	812	40	Fukuoka	4986.5	2256
9	Tochigi	6408.1	910	25	Shiga	4017.4	561	41	Saga	2440.7	366
10	Gumma	6362.3	796	26	Kyoto	4612.2	1086	42	Nagasaki	4130.9	504
11	Saitama	3797.8	2913	27	Osaka	1905.3	3963	43	Kumamoto	7409.5	742
12	Chiba	5157.6	2675	28	Hyogo	8401.0	2041	44	Oita	6340.7	486
13	Tokyo	2194.0	7320	29	Nara	3690.9	465	45	Miyazaki	7735.3	423
14	Kanagawa	2416.2	3768	30	Wakayama	4724.7	363	46	Kagoshima	9187.0	666
15	Niigata	12584.2	834	31	Tottori	3507.1	241	47	Okinawa	2281.1	549
16	Toyama	4247.6	501	32	Shimane	6708.3	267				

Students may focus on area and number of stores.

7． Example of instruction 1
— Educational material of scatter diagram —

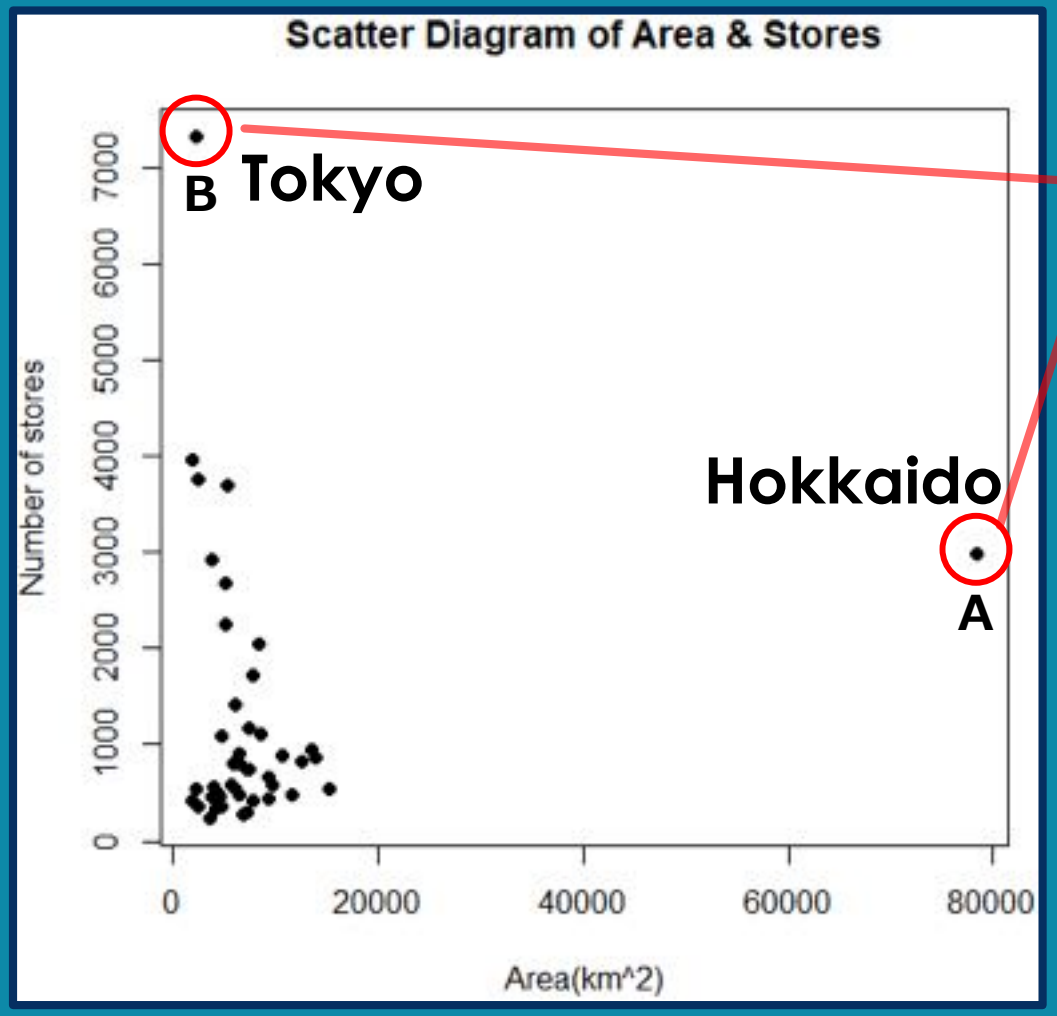


7．Example of instruction 1
— Educational material of scatter diagram —



Students can find
a new problem.

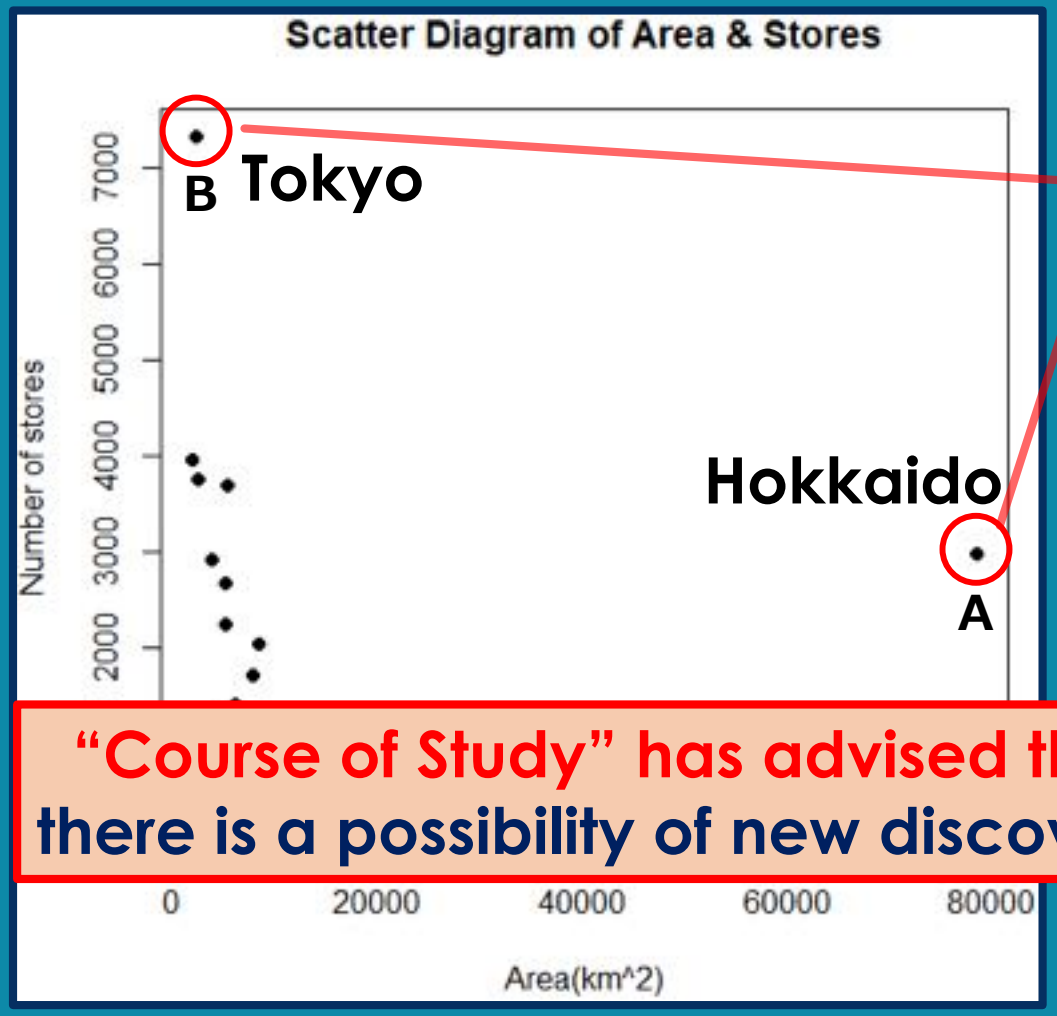
7． Example of instruction 1
— Educational material of scatter diagram —



Outlier ?

Students can find
a new problem.

7． Example of instruction 1
— Educational material of scatter diagram —

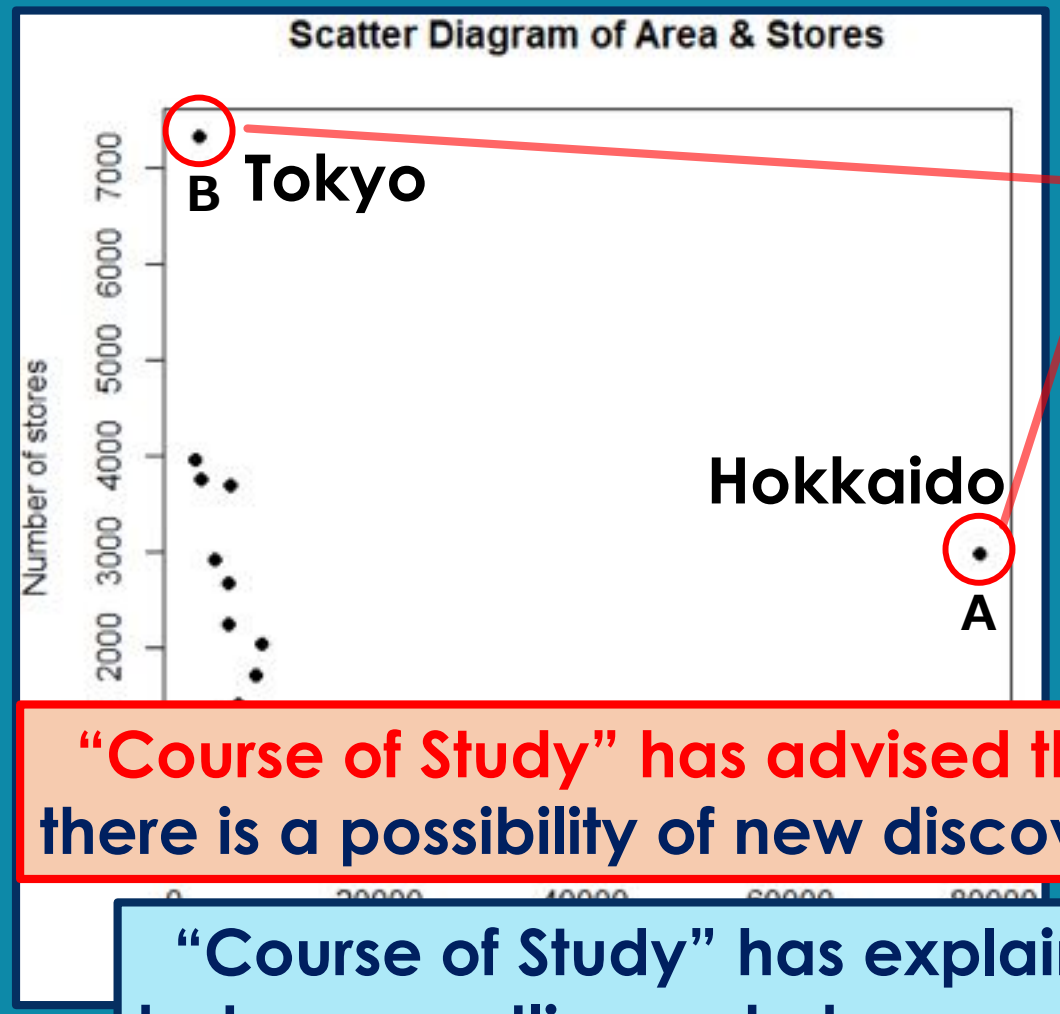


Outlier ?

Students can find a new problem.

"Course of Study" has advised that if outlier exists, there is a possibility of new discovery.

7． Example of instruction 1
— Educational material of scatter diagram —



Outlier ?

Students can find a new problem.

"Course of Study" has advised that if outlier exists, there is a possibility of new discovery.

"Course of Study" has explained the difference between outlier and abnormal value.

8． Example of instruction 2
— Educational material of interval estimation —

Statistic Problem of Interval Estimation

Suppose you chose nine samples that values are 3, 6, -3, 18, -1, -9, -8, 5, 7 from some population. The variance of the population has known 36, but real mean value isn't known.

Then let's estimate the real value of mean by the interval estimation with confidence coefficient 95%.

After choosing nine samples, students have to estimate mean value.

8． Example of instruction 2
— Educational material of interval estimation —

Mean of sample values is 2.
It is easily calculated the confidence interval of confidence coefficient 95% about mean.

It is easy for students because they only use the theorem.

8． Example of instruction 2
— Educational material of interval estimation —

Mean of sample values is 2.
It is easily calculated the confidence interval of confidence coefficient 95% about mean.

Formula $$\bar{x}-1.96\times\frac{\sigma}{\sqrt{n}}<\mu<\bar{x}+1.96\times\frac{\sigma}{\sqrt{n}}$$

It is easy for students because they only use the theorem.

8． Example of instruction 2
— Educational material of interval estimation —

Mean of sample values is 2.
It is easily calculated the confidence interval of confidence coefficient 95% about mean.

Formula $\bar{x}-1.96\times\frac{\sigma}{\sqrt{n}}<\mu<\bar{x}+1.96\times\frac{\sigma}{\sqrt{n}}$

Substitute $2-1.96\times\frac{6}{\sqrt{9}}<\mu<2+1.96\times\frac{6}{\sqrt{9}}$

It is easy for students because they only use the theorem.

8． Example of instruction 2
— Educational material of interval estimation —

Mean of sample values is 2.
It is easily calculated the confidence interval of confidence coefficient 95% about mean.

Formula $\bar{x}-1.96\times\frac{\sigma}{\sqrt{n}}<\mu<\bar{x}+1.96\times\frac{\sigma}{\sqrt{n}}$

Substitute $2-1.96\times\frac{6}{\sqrt{9}}<\mu<2+1.96\times\frac{6}{\sqrt{9}}$

Answer $-2.92<\mu<4.92$

It is easy for students because they only use the theorem.

8． Example of instruction 2
— Educational material of interval estimation —

Mean of sample values is 2.
It is easily calculated the confidence interval of confidence coefficient 95% about mean.

Formula $\bar{x}-1.96\times\frac{\sigma}{\sqrt{n}}<\mu<\bar{x}+1.96\times\frac{\sigma}{\sqrt{n}}$

Substitute $2-1.96\times\frac{6}{\sqrt{9}}<\mu<2+1.96\times\frac{6}{\sqrt{9}}$

Answer $-2.92<\mu<4.92$ **Good !**

It is easy for students because they only use the theorem.

8． Example of instruction 2
— Educational material of interval estimation —

Mean of sample values is 2.
It is easily calculated the confidence interval of confidence coefficient 95% about mean.

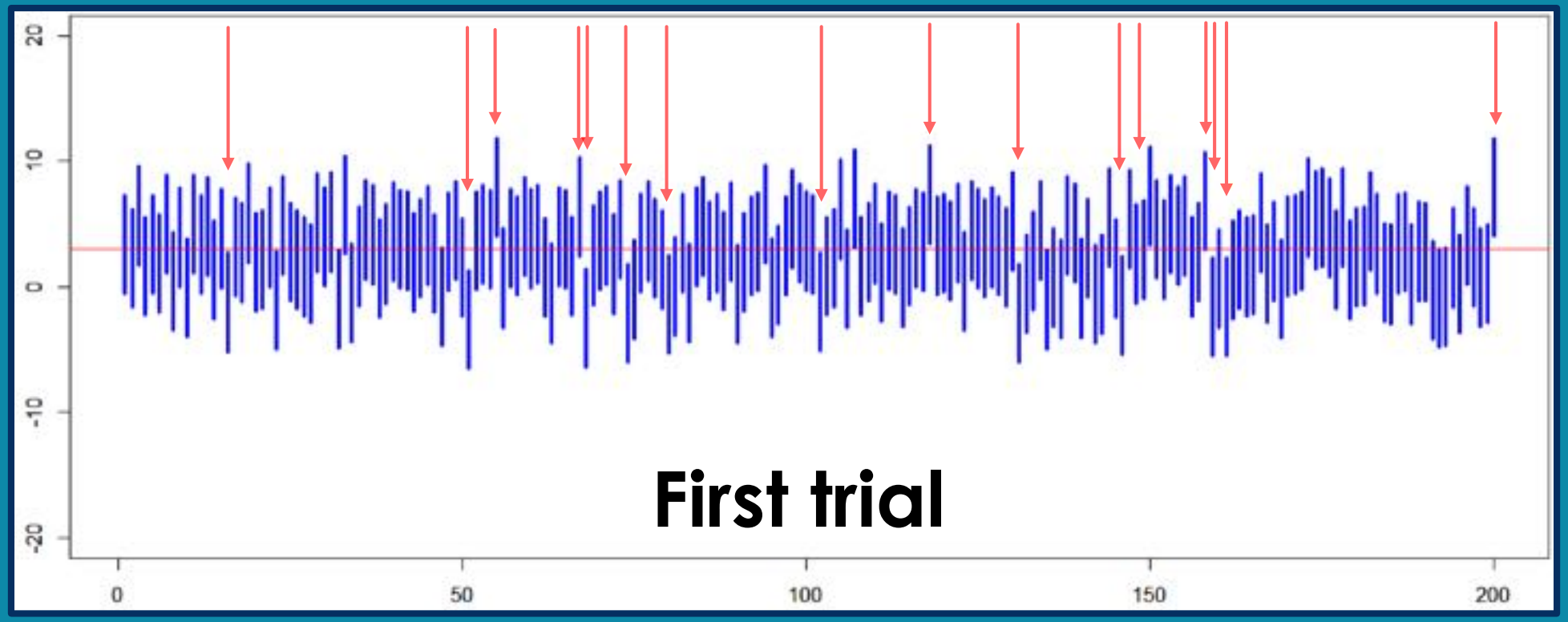
– Desirable Question –

What is the meaning of the confidence interval of confidence coefficient 95%?
What this answer "-2.92 < μ < 4.92" mean?
Please tell me the meaning of 95%.

Answer $-2.92 < \mu < 4.92$ **Good !**

It is easy for students because they only use the theorem.

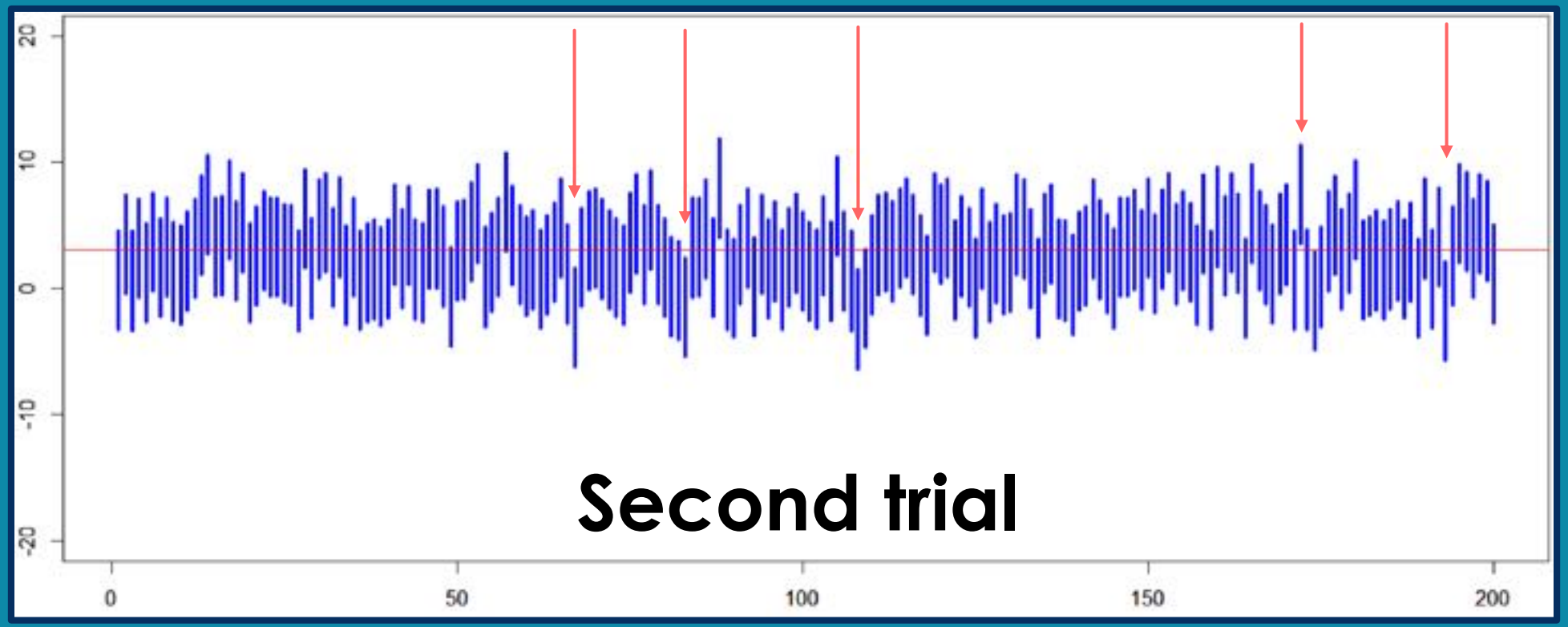
8． Example of instruction 2
— Educational material of interval estimation —



Red arrow → means that sixteen estimated interval doesn't include a real mean value.

Students themselves using computer is meaningful, they can learn the image of confidence coefficient.

8． Example of instruction 2
— Educational material of interval estimation —



Red arrow ⟶ means that five estimated interval doesn't include a real mean value.

Computer helps students to understand statistical image.

9． Future Tasks

Students, Teachers, Teaching methods, and Teaching material.

Future Tasks about Students

Sharing Ideas Collaboratively

Language activities

It is necessary to get used to the style of sharing ideas collaboratively through language activities.

Device of how to learn

Proactively learning

Device of how to learn for proactively learning

But before now, students have not so many times to experience this type of mathematics lesson.

9． Future Tasks

Future Tasks about Teachers Themselves

Necessity for Teachers to Study
Basic Knowledge of Statistics

Many teachers didn't learn statistics
in their age of students.

In Japan, many teachers did not learn not so many statistics at school age.

Necessity for Teachers to participate in
Workshop of Statistics

Not only studying knowledge
But also the idea of statistics

Teachers have not be accustomed to teach the idea of statistics.

9． Future Tasks

Future Tasks about Teaching Methods

- Importance of how to finding new problem
- Teaching method that enable statistical experiment
- Plan to teaching methods used critical thinking

Invention of question

They are conducted Collaboratively

Concrete methods of teaching to find new problem,
enable statistical experiment and critical thinking.

9． Future Tasks

Thank you for your attention.

Future Tasks about Teaching Materials

Developing Teaching Material

To enable students to find new problem.
To develop statistic material enable students to do statistical thinking

It is desirable to change the style of contents treated in mathematics textbook.

Developing Equipment for Numerical Experiment

For confirming statistical feature or theorem (For example, computer program.)

Students not only know the result of statistic feature but also have to confirm the result themselves by the equipment. Using computer is effective.

Reference

1. Manual of Course of Study (Elementary School)
   Ministry of education in Japan

2. Manual of Course of Study (Junior High School)
   Ministry of education in Japan

3. Manual of Course of Study (Senior High School)
   Ministry of education in Japan