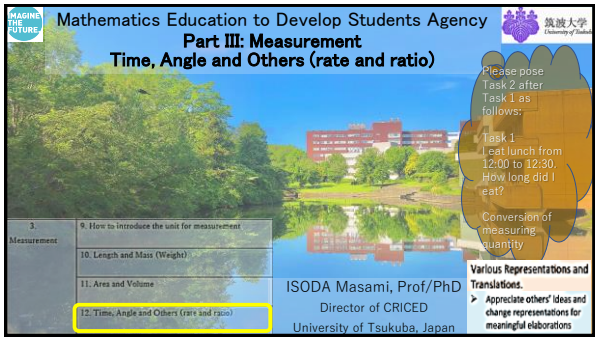
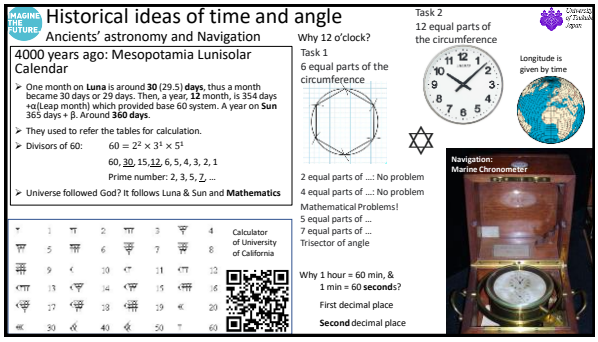
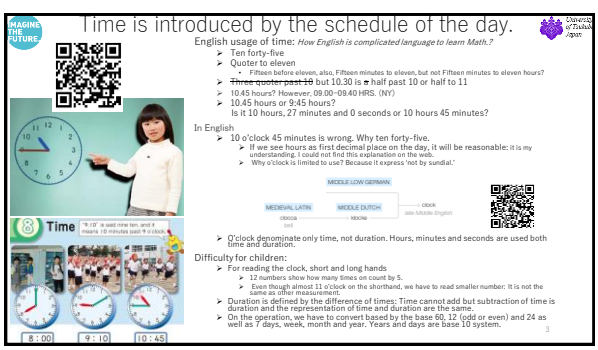
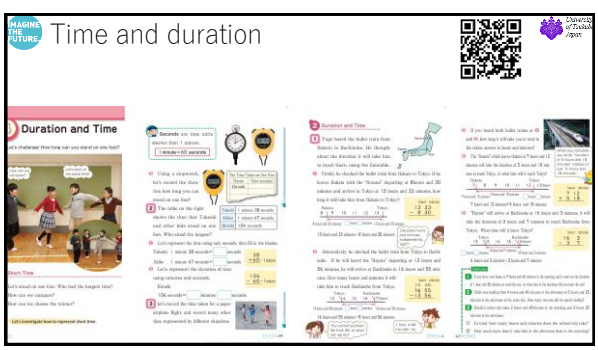
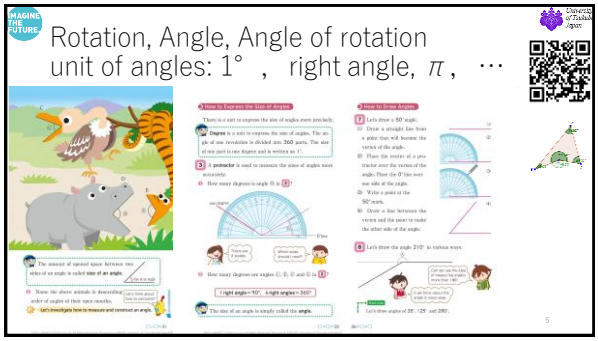
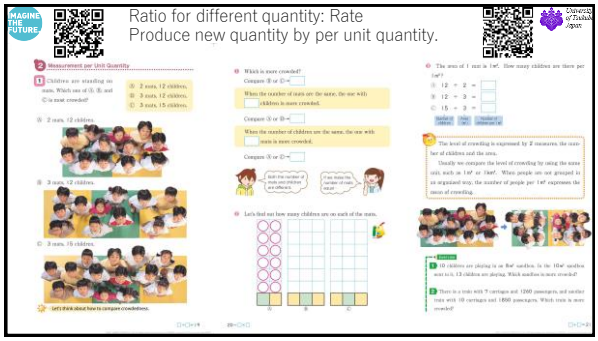

Mathematics Education to Develop Students Agency
Part III: Measurement
Time, Angle and Others (rate and ratio)
筑波大学
University of Tsukuba
Please pose Task 2 after Task 1 as follows:
Task 1
I eat lunch from 12:00 to 12:30. How long did I eat?
Conversion of measuring quantity
3. Measurement
9. How to introduce the unit for measurement
10. Length and Mass (Weight)
11. Area and Volume
12. Time, Angle and Others (rate and ratio)
ISODA Masami, Prof/PhD
Director of CRICED
University of Tsukuba, Japan
Various Representations and Translations.
Appreciate others' Ideas and change representations for meaningful elaborations

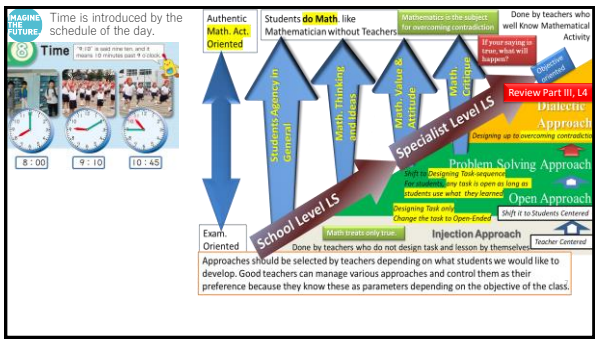

Historical ideas of time and angle
Ancients' astronomy and Navigation
4000 years ago: Mesopotamia Lunisolar Calendar
One month on Luna is around 30 (29.5) days, thus a month became 30 days or 29 days. Then, a year, 12 month, is 354 days +α(Leap month) which provided base 60 system. A year on Sun 365 days + β. Around 360 days.
They used to refer the tables for calculation.
Divisors of 60: 60 = 2² × 3¹ × 5¹
60, 30, 15,12, 6, 5, 4, 3, 2, 1
Prime number: 2, 3, 5, 7, ...
Universe followed God? It follows Luna & Sun and Mathematics
Calculator of University of California
Why 12 o'clock?
Task 1
6 equal parts of the circumference
2 equal parts of ...: No problem
4 equal parts of ...: No problem
Mathematical Problems!
5 equal parts of ...
7 equal parts of ...
Trisector of angle
Why 1 hour = 60 min, & 1 min = 60 seconds?
First decimal place
Second decimal place
Task 2
12 equal parts of the circumference
Longitude is given by time
Navigation: Marine Chronometer

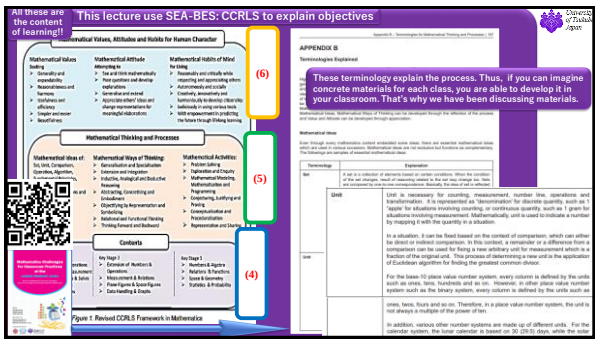

Time is introduced by the schedule of the day.
English usage of time: How English is complicated language to learn Math.?
Ten forty-five
Quoter to eleven
Fifteen before eleven, also, Fifteen minutes to eleven, but not Fifteen minutes to eleven hours?
Three quoter past 10 but 10.30 is half past 10 or half to 11
10.45 hours? However, 09.00–09.40 HRS. (NY)
10.45 hours or 9:45 hours?
Is it 10 hours, 27 minutes and 0 seconds or 10 hours 45 minutes?
In English
10 o'clock 45 minutes is wrong. Why ten forty-five.
If we see hours as first decimal place on the day, it will be reasonable: it is my understanding. I could not find this explanation on the web.
Why o'clock is limited to use? Because it express 'not by sundial.'
MIDDLE LOW GERMAN
MEDIEVAL LATIN
MIDDLE DUTCH
clock
late Middle English
clocca
bell
klocke
O'clock denominate only time, not duration. Hours, minutes and seconds are used both time and duration.
Difficulty for children:
For reading the clock, short and long hands
12 numbers show how many times on count by 5.
Even though almost 11 o'clock on the shorthand, we have to read smaller number: It is not the same as other measurement.
Duration is defined by the difference of times: Time cannot add but subtraction of time is duration and the representation of time and duration are the same.
On the operation, we have to convert based by the base 60, 12 (odd or even) and 24 as well as 7 days, week, month and year. Years and days are base 10 system.
Time
8:00
9:10
10:45
3


Time and duration
Duration and Time


Rotation, Angle, Angle of rotation
unit of angles: 1° , right angle, π , …


Ratio for different quantity: Rate
Produce new quantity by per unit quantity.


Time is introduced by the schedule of the day.
Time
8:00
9:10
10:45
Authentic Math. Act. Oriented
Students do Math. like Mathematician without Teachers
Done by teachers who well know Mathematical Activity
Mathematics is the subject for overcoming contradiction
If your saying is true, what will happen?
Objective oriented
Review Part III, L4
Dialectic Approach
Students Agency in General
Math. Thinking and Ideas
Math. Value & Attitude
Math. Critique
Specialist Level LS
Designing up to overcoming contradiction
Problem Solving Approach
Shift to Designing Task-sequence
Open Approach
Students use what they learned
Designing Task and Change the task to Open-Ended
Shift it to Students Centered
School Level LS
Math treats only true.
Injection Approach
Teacher Centered
Exam. Oriented
Done by teachers who do not design task and lesson by themselves
Approaches should be selected by teachers depending on what students we would like to develop. Good teachers can manage various approaches and control them as their preference because they know these as parameters depending on the objective of the class.


All these are the content of learning!!
This lecture use SEA-BES: CCRLS to explain objectives
(6)
(5)
(4)
APPENDIX B
Terminologies Explained
These terminology explain the process. Thus, if you can imagine concrete materials for each class, you are able to develop it in your classroom. That's why we have been discussing materials.