2018.2.10.

Textbook Development for SDGS:

The case of Japanese Mathematics Textbooks for Elementary school

Shizumi, SHIMIZU
(Teikyo University)

Resources: " Fun with Math for Elementary School ", KEIRINKAN, 2012.7.

(I am chair of editorial board for this textbook)

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1. Recycling activities : 3rd Grade B
2. The garbage processing plant : 4th grade B
3. Healthy life without injuries : 4th Grade B
4. Daily water use : 4th grade B
5. Rice in Japan : 6th grade B
6. Math and Our Planet : 6th Grade B (Option)

Putting your knowledge to work

Reading with math (2)

Recycling activities

The children's club in Higashi town did some recycling activities.

Misaki and her friends participated as a group of third grade students and collected various items to be recycled.

The number of people that participated and collected items are shown below.

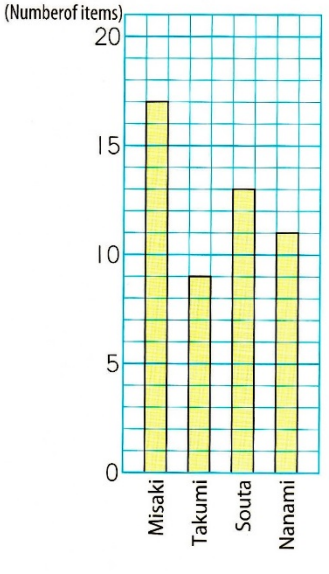
ⓐ **Number of people that participated**

Grade	1st grade	2nd grade	3rd grade	4th grade	5th grade	6th grade
Number of people	3	6	4	10	8	5

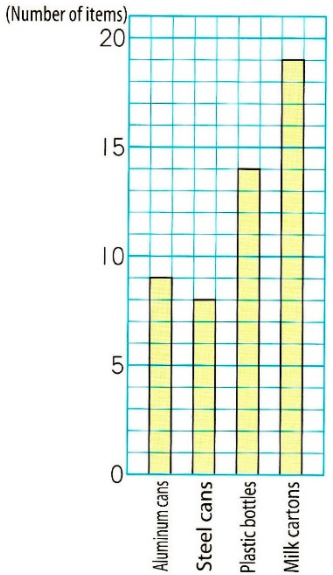
ⓑ **Number of items collected**

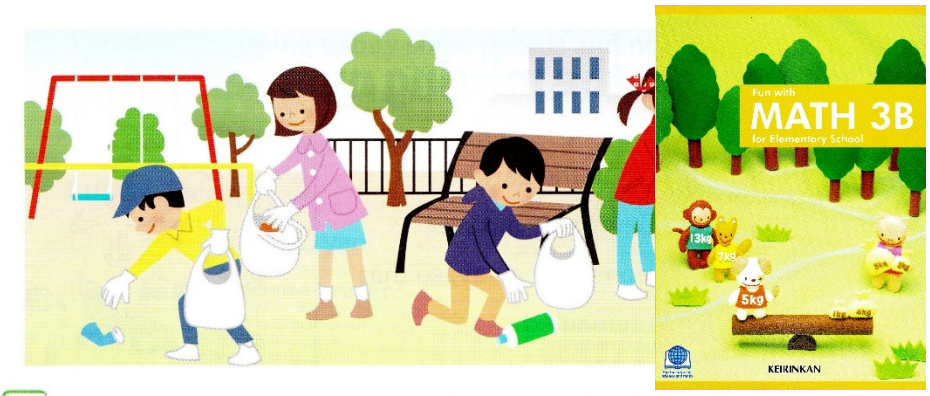
Grade	1st grade	2nd grade	3rd grade	4th grade	5th grade	6th grade
Number of items collected	18	48	50	68	52	42

ⓒ **Number of items collected by the third grade students** (by individual people)



ⓓ **Number of items collected by the third grade students** (by item)





1 Who collected the largest number of recyclables among the groups of third grade students?
What was the number collected?

Ⓐ Which should you look at, ⓐ, ⓑ, ⓒ, or ⓓ?

Ⓑ Solve to find the answers.

2 What item did the third grade students collect the fewest of?
What was the number collected?

3 Find the total number represented by the bar graph at ⓒ.
Find the total number represented by the bar graph at ⓓ.
Explain why the two solutions ended up the same.
You can also find the total number from the table.
Which table should you look at?

4 Make different problems by looking at the table and graph on the left page.

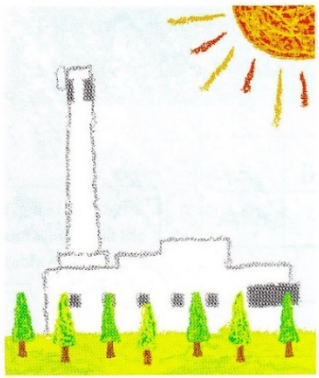
MORE applications Reading with math (2) → Page 116, 117

Putting your knowledge to work

Reading with math (2)

Field trip to the garbage processing plant

On March 4, the seventy-two kids in our Grade Four class rode a bus to the garbage processing plant for a field trip.
The building had a tall smokestack that you could see from far away. When we got to the plant, the building was still very far away from the entrance gate. I was surprised at how much space there was. They said that the area of the site was about four times the size of our elementary school. Garbage trucks kept arriving at the plant one after another and bringing in garbage.
When I acted surprised at the amount of garbage, the man at the plant told me all about it.
He said that they burned enough garbage to fill two hundred and seventy-four two-ton trucks every day. He also said that the site was about three man seven thousand square meters.
If you think about the amount of garbage collected at the plant, each person throws out six hundred seventy-two grams of garbage per day. To process the amount of garbage that each person throws out every day, it costs approximately thirty-one yen.

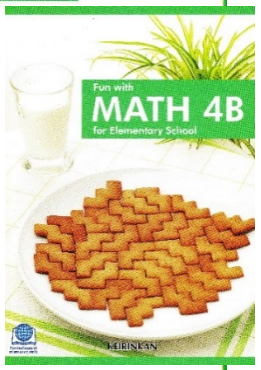


They said that recycling was a good way to reduce the amount of garbage we make, even if it's just a little. I'm going to try to do what I can to start recycling too.

Read what Ayumi wrote on the left and answer the following questions.

1 About how many m² is the area of Ayumi's elementary school?

- Ⓐ How many m² is the plant site?
- Ⓑ About how many times larger is the garbage processing plant than Ayumi's elementary school?
- Ⓒ Find the answer rounded to the first digit.



2 About how many t of garbage is burned at garbage processing plant each day?
Find the answer rounded to the first digit.

3 Tsubasa said that the amount of garbage thrown out by everyone in Grade 4 that went on the field trip was more than 42 kg.
Is he correct? Answer with "correct" or "not correct".
Explain the reason for your choice using words and math sentences.

4 There are a total of 398 children in grades 1 through 6 at Ayumi's elementary school.
About how much does it cost to process the total amount of garbage that all the students at Ayumi's school throw out in one day?
Estimate the answer by rounding to the first digit.

applications Reading with math (2) Page 120, 121

14 How to examine and organize data

The table on the left shows a record of the injuries at Takuya's school over the course of a week.

! Talk about what you'd like to find out from the recorded data.

!! Make a table like the one below.
Then put the injuries in order of frequency.

Ⓐ Where do the most people get injured?

Injury survey (number of people at each location)

Location	Number of people	
Playground	T	
Hallway	—	
Stairway	—	
Classroom		
Courtyard		
Gymnasium		
Total		

Express the numbers using the 正 character.

Injury survey (number of people at each location)

Location	Number of people
Playground	
Courtyard	
Gymnasium	
Stairway	
Other	
Total	

Review
I collected all the ones with low numbers and put them in the "other" category.
Go back

Ⓑ Which injury is the most common?

Injury survey (number of people with each injury)

Injury	Number of people	
Scrape		
Cut		
Sprain		
Jammed finger		
Blow		
Puncture		
Total		

Injury survey (number of people with each injury)

Injury	Number of people
Scrape	
Cut	
Sprain	
Blow	
Other	
Total	

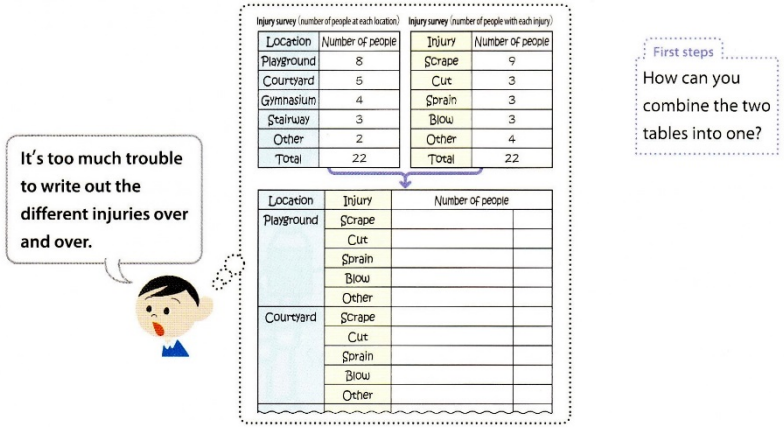
What should we do to find out which injury in what place is most common?

Think about how to organize the data to examine two things at once.

Examining two things at once

1 Look at the record on page 57 to find out which injury is most common in what place.

Ⓐ What kind of table should you make?



First steps
How can you combine the two tables into one?

Making a table like this one makes it easy to examine two things at once.

Make a mark in the areas that match the two different sets of data.

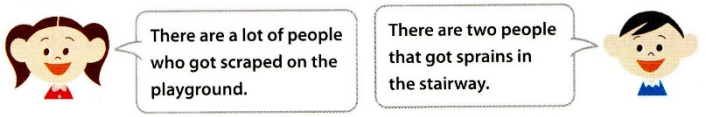
Injury survey by location and type of injury (number of people)

Location \ Injury	Scrape	Cut	Sprain	Blow	Other	Total
Playground	一	一				
Courtyard						
Gymnasium						
Stairway			一			
Other	一					
Total						

Ⓑ Which injury is the most common in what place? Talk about anything else that you noticed.

Injury survey by location and type of injury (number of people)

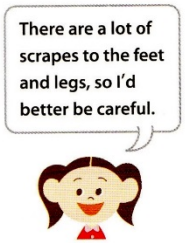
Location \ Injury	Scrape	Cut	Sprain	Blow	Other	Total
Playground	正 6	下 2				8
Courtyard	一 1	一 1		一 1	下 2	5
Gymnasium	一 1		一 1	一 1	一 1	4
Stairway			下 2	一 1		3
Other	一 1				一 1	2
Total	9	3	3	3	4	22



2 Make a table to find out which injury is most common on what body part.

Injury survey by type of injury and body part (number of people)

Injury \ Body part	Leg/foot	Hand	Arm	Face	Total
Scrape					
Cut					
Sprain					
Blow					
Other					
Total					



3 Find out about the injuries at your own school and make a table to organize the data.

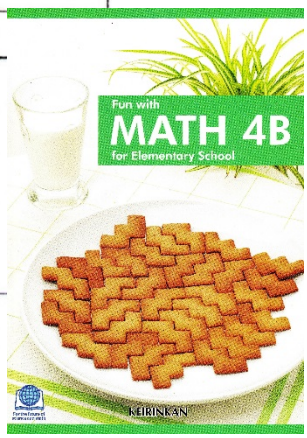
My math dairy
Now I know how to make tables to find out about two things at once.

Extra practice Page 126

One-week injury survey

Date · · No.

DAY	GRADE	CLASS	NAME	LOCATION	BODY PART	INJURY
M	3	1	Tanaka	Playground	Face	Scrape
	4	2	Hayashi	Hallway	Leg	Scrape
	6	4	Omura	Playground	Hand	Cut
	5	1	Takahashi	Stairway	Foot	Sprain
	3	4	Shimada	Playgronnd	Leg	Scrape
T	3	4	Noguchi	Classroom	Hand	Jammed finger
	6	2	Ueno	Stairway	Leg	Blow
	1	3	Yamamoto	Courtyard	Face	Scrape
W	6	4	Tani	Courtyard	Arm	Puncture
	4	2	Yamada	Gymnasium	Foot	Sprain
	4	2	Okawa	Gymnasium	Leg	Blow
	6	4	Nakamura	Playground	Hand	Scrape
T	1	1	Taguchi	Gymnasium	Face	Scrape
	5	2	Morigama	Courtyard	Arm	Cut
	2	2	Furukawa	Playground	Hand	Scrape
	4	4	Minakami	Playground	Leg	Scrape
F	1	3	Kawakami	Gymnasium	Hand	Jammed finger
	2	4	Ohara	Playground	Arm	Cut
	4	1	Kanayama	Stairway	Foot	Sprain
	5	3	Nishikawa	Playground	Leg	Scrape
	2	3	Hirabayashi	Courtyard	Arm	Blow
	3	1	Koyama	Courtyard	Hand	Puncture



More applications

Reading with math (2)

Daily water use

Reading with math (2) Page 100, 101

Sakura wrote this report on the amount of water used in her city in 1 day.

Daily water use

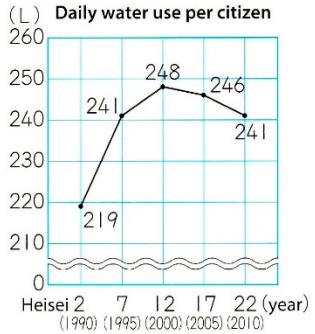
Grade 4 Class 1
Sakura Takahashi

1. Reason for the study

Earth is sometimes called the "water planet", but most of the water on earth is seawater. The amount of water we can use in our daily lives is approximately $\frac{1}{100}$ of all the water on earth. This made me think about how we could conserve the water that is so important to our lives.

2. Water used per person per day

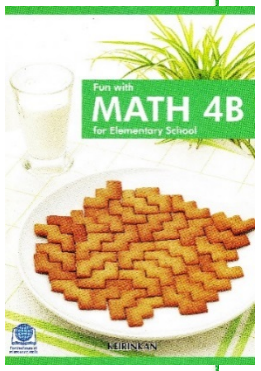
The human body contains a lot of water. To keep this water, a person needs to take in 3 L of water per day. Add the water used in the toilet, bath, cooking, laundry, and more, and 1 person uses between approximately 200 L and 300 L of water each day.



3. Conserving water

It costs 1 yen to process 4 L of municipal water. Running the shower for 1 minute uses 12 L of water. Brushing your teeth using water in a cup instead of leaving the tap running saves 5 L of water, and reusing bathwater to do laundry, for example, can save 180 L each time.

Read Sakura's report and answer the following questions.



(1) People say that you should store 3 days' of drinking water in case there is an earthquake or other disaster. How many L should a family of 4 store?

(2) The population of Sakura's city is 81635 people.

Ⓐ About how many L did 1 person in Sakura's city use for daily life in a year in Heisei 22 (2010)? Use first-digit rounding to estimate.

Ⓑ If everyone in Sakura's city used a cup of water to brush their teeth, about how many yen would they save on water compared to leaving the tap running?

(3) Sakura and her friends were talking about which would save more water, having the whole family use the same bath water, or having each person take a shower.

Sakura said, "my family uses 200 L of water to fill the bath, but if we take showers, we each run the water for 5 minutes. Since there are 4 people in my family, the bath conserves more water." Is she correct?

Answer with "correct" or "not correct".

Explain the reason for your choice using words and math sentences.

Putting your knowledge to work

Using estimates

Rounding up and rounding off

1 Tsubasa and his classmates found out about rice planting.

Ⓐ Approximately 27000 rice plants can grow on a 1-a rice paddy.
Each plant produces approximately 140 grains of rice.
Tsubasa estimated the number of grains of rice that can be produced on a 1-a rice paddy like this.
Explain what he did.

140×27000
Round up, Round up
$200 \times 30000 = 6000000$
Approximately 600 *man* grains

Review
He calculated his estimate by rounding up, so the actual number of grains will be less than 600 *man*.

Ⓑ The seedlings used to plant rice are usually grown in nursery boxes and then planted by machine.
One nursery box can grow enough seedlings to plant approximately 63 m² of rice paddy.
Mirai estimated the number of nursery boxes needed to plant a 1198-m² rice paddy like this. Explain what she did.

$1198 \div 63$
Round up, Round off
$1200 \div 60 = 20$ Approximately 20 boxes

2 There are approximately 479000 grains of rice in a 10-kg bag of rice.
If each rice plant produces approximately 140 grains of rice, about how many rice plants are needed to fill a 10-kg bag?

Figuring out ways to estimate

1 Misai measured her pulse at 73 beats per minute.

Ⓐ Misai estimated the number of heartbeats in a human lifetime like this. She used approximately 70 beats per minute, approximately 20 hours per day, approximately 400 days per year, and approximately 80 years in a lifespan.

Math sentence $70 \times 60 \times 20 \times 400 \times 80$
Estimate
$70 \times 60 = 4200 \rightarrow$ Approximately 4000
$4000 \times 20 = 80000$
8 *man* $\times 400 = 3200$ *man*
$\rightarrow$ Approximately 3000 *man*
3000 *man* $\times 80 = 24$ *oku*
Approximately 24 *oku* beats

Review
We can do easy estimates by calculating with approximate numbers rounded to the first digit.

Explain what she did.

Ⓑ Tsubasa estimated the number of heartbeats in a human lifetime like this. He used approximately 70 beats per minute, approximately 25 hours per day, approximately 400 days per year, and approximately 100 years in a lifespan.

$(70 \times 60) \times (25 \times 400) \times 100 = 4200000000$
Approximately 42 *oku* beats

Review
It's easy to estimate if we calculate with special numbers like 25×400.

Explain what he did.

2 A person takes about 12 breaths a minute.
About how many times does a person breathe in 80 years?

More applications Using estimates ➡ Page 114, 115

Putting your knowledge to work

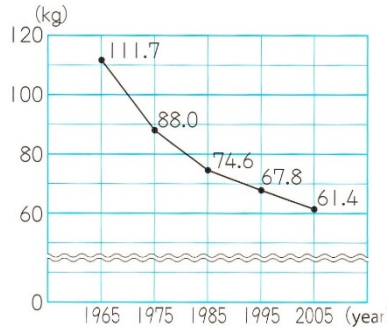
Reading with math (1)

Rice in Japan

The data sources below show information on the harvest and consumption of rice in Japan.

Niigata Prefecture

a Annual per-person rice consumption



b Rice harvest by year

Year	1965	1975	1985	1995	2005
Harvest (*man* t)	1241	1317	1166	1075	907

c Rice harvest by region

Region	Harvest (%)
Tohoku	27.6
Kanto/Tosan	18.8
Hokuriku	12.8
Kyushu/Okinawa	10.6
Hokkaido	7.5
Chugoku	6.9
Kinki	6.6
Tokai	6.0
Shikoku	3.2

(Tosan includes Yamanashi and Nagano prefectures)

d Rice harvest by crop

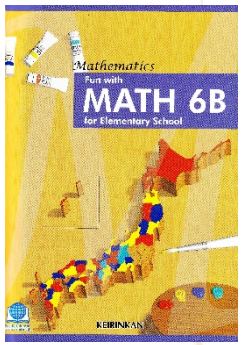
Crop	Harvest (%)
Koshi-hikari	37.1
Hitome-bore	10.0
Hino-hikari	9.2
Akita-komachi	8.8
Hae-nuki	3.3
Kirara 397	3.2
Kinu-hikari	3.2
Other	25.2

(2005 Ministry of Agriculture, Forestry, and Fisheries)

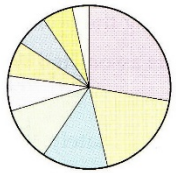
1 About what % of the per-person rice consumption in 1965 was consumption in 2005?

- **A** Which data source should you use?
- **B** Select the information you need from the data source(s) and explain how you will get the answer.
- **C** Find the answer rounded to the ones place.

2 About what % of the rice harvest in 1965 was the rice harvest in 2005?
Find the answer rounded to the ones place.



3 The pie chart on the right shows information from data source **c** or **d**.
Tsubasa said that it shows data source **c**.
Is he right?
Answer with "correct" or "not correct". Explain the reason for your choice using words and math sentences.



4 Use the data sources above to make various questions of your own.

MORE applications Reading with math (1) ➡ Page 116, 117

6. Math and Our Planet : 6th Grade B (pp83-99: Option)

This section presents practical problems designed to spark children's curiosity and interest (it is not necessary for all children to learn in exactly the same way).

1. Temperature and carbon dioxide
2. Rising ocean temperature
3. Melting polar ice caps
4. Rising sea levels
5. Life and carbon dioxide
6. The function of forests
7. Plans to reduce carbon dioxide emissions
8. Ways to live harmony with nature

From the main reform policies in mathematics: Current COS (2008 revised)

 # It is important that we motivate students to learn mathematics, and students should experience the meaning of learning and utility of what was learned. For this reason, the following objectives are emphasized:

- To help students understand numbers, quantities, and geometrical figures through learning activities which serve as a basis for understanding their meanings.
- To help students feel progress in learning, such as a depth and broadening of understanding through repeated learning (spiral) that is designed according to the developmental stage and grade level of each student.
- **To help students apply what has been learned to activities in daily life, to the study of other subjects, and to learning more advanced mathematics.**

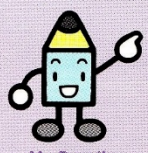
 # Mathematical activities play an important role in helping students acquire fundamental and basic knowledge and skills, in increasing students' ability to think and express mathematically, and **in enabling students to feel a joy and purpose in learning mathematics**. To enrich the teaching of mathematics through mathematical activities — with experiential activities and an emphasis on language— concrete examples of mathematical activities should be provided in the curriculum for elementary and lower secondary schools; and in upper secondary schools, project-based learning is introduced in the required subjects and in more popular elective courses.

The objectives of mathematics for Elementary school: Current COS (2008 revised)

Through mathematical activities, to help pupils acquire basic and fundamental knowledge and skills regarding numbers, quantities and geometrical figures, to foster their ability to think and express with good perspectives and logically on matters of everyday life, **to help pupils find pleasure in mathematical activities and appreciate the value of mathematical approaches, and to foster an attitude to willingly make use of mathematics in their daily lives** as well as in their learning.

Math and Our Planet

This section presents practical problems designed to spark children's curiosity and interest (it is not necessary for all children to learn in exactly the same way).


Mr. Pencil


Mirai


Tsubasa

Mr. Pencil Were you able to do all the problems in the Grade 6 Summary?

Mirai Almost. I went back to the ones I missed and did them again.

Tsubasa I did all of them. I was amazed at how much we've learned!

Mr. Pencil Did you notice the parts at the bottom that said "The history of the earth and its people"?

Mirai It was like a timetable of pictures that started with the birth of space, right?

Tsubasa It started more than 100 *oku* years ago, and every time we turned the page, it showed $\frac{1}{10}$ the years on the pervious page.

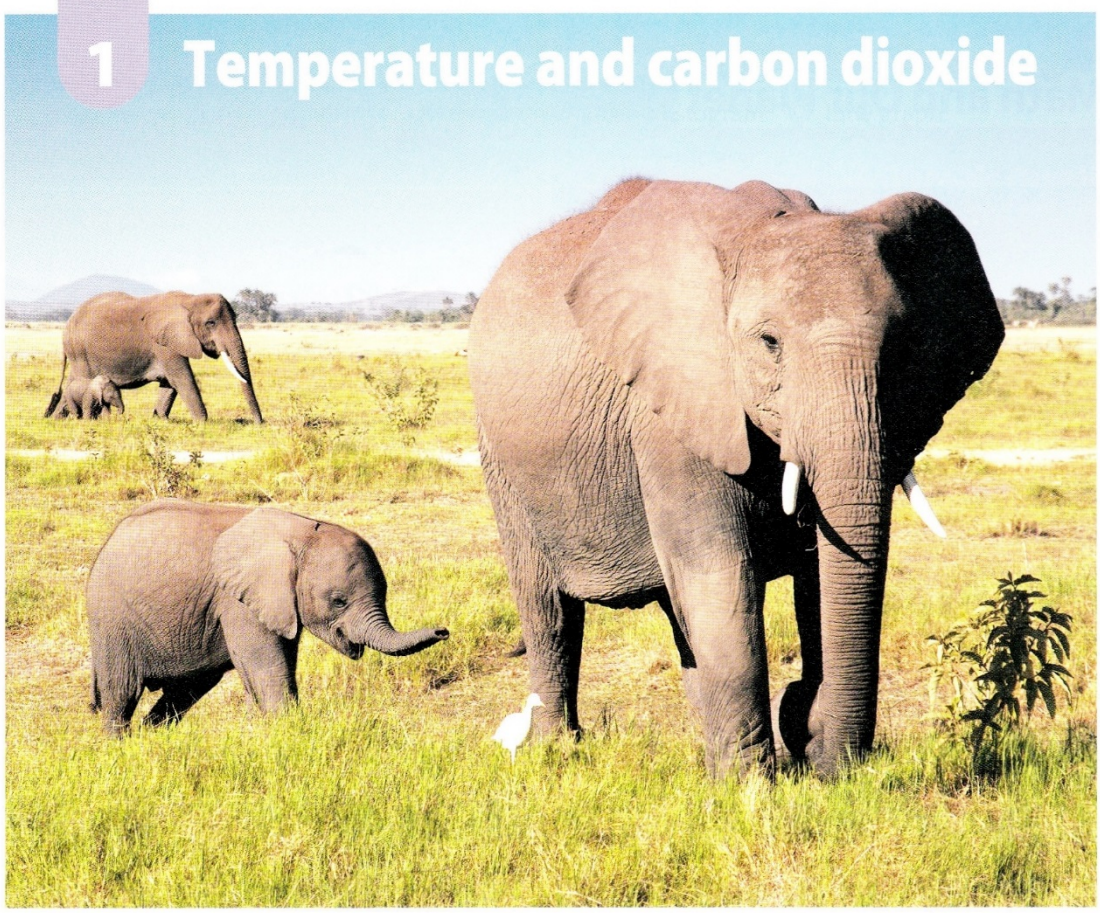
Mr. Pencil That's right. At the end it showed the present day. Humans have made so many discoveries and our lives have become very convenient, but we are also destroying nature and the planet is facing a lot of problems.

Mirai What's wrong with the planet?

Tsubasa Is it because we only thought about convenience?

Mr. Pencil Let's look at it more closely. Then I think you'll understand what the problems are, what we can do, and how math can help us do it.

1 Temperature and carbon dioxide



Mr. Pencil Have you heard of global warming?

Tsubasa That's where the earth keeps getting warmer, causing all kinds of problems.

Mr. Pencil That's right. We're getting more carbon dioxide and other things in our atmosphere, so heat is not being released into space. Scientists are saying that our planet will just keep getting hotter.

Mirai Is it really that much of a problem? I bet African elephants like the heat.

Mr. Pencil Look at the data on the right. It shows average global temperature between 1950 and 2005 along with carbon dioxide emissions converted into carbon amounts.

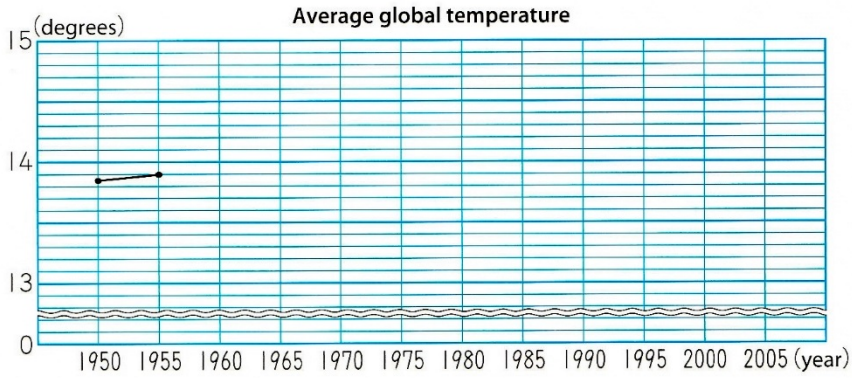
Tsubasa The amount of carbon emissions is increasing, but it doesn't look like the temperature is increasing that much. We might be able to understand it better if we showed this information on a graph.

Make a line graph showing the temperatures between 1950 and 2005.

Average global temperature and carbon emissions

Year	Average temperature (degrees)	Carbon emissions (*oku* t)
1950	13.85	16.1
1955	13.90	20.1
1960	13.99	25.3
1965	13.89	30.9
1970	14.03	40.0
1975	13.95	45.2
1980	14.18	52.1
1985	14.06	53.0
1990	14.38	59.9
1995	14.38	62.1
2000	14.33	64.5
2005	14.63	75.6

(Vital Signs 2007–8)




Tsubasa

The data give numbers every 5 years, so let's make the horizontal scale in 5-year increments.


Mirai

We should make the vertical scale go from 13 degrees to 15 degrees.

Tsubasa It's hard to see it by just looking at the table, but when you graph it you can see that overall the temperature keeps going up, even though there are some small decreases.

Mirai But it's not increasing that much.

Mr. Pencil Did you know that more parts of the world are having droughts, and swamps and lakes are drying up? These changes are affecting the African elephants too.

Tsubasa Are you saying that lakes in Africa are disappearing just with these small increases in temperature?

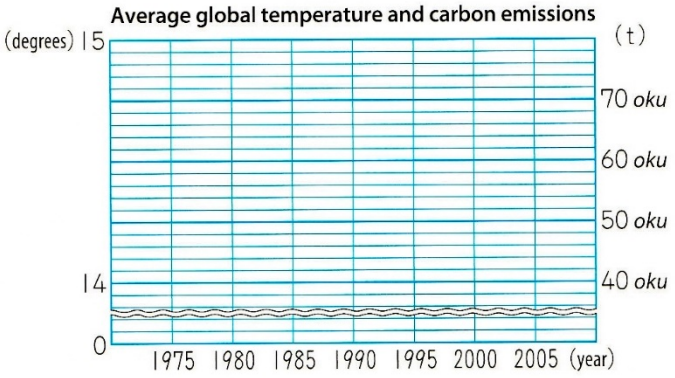
Mirai That's terrible! The elephants won't be able to live there anymore.

Tsubasa I wonder why the increases in temperature have been higher lately.

Mr. Pencil Why don't you look at the amount of carbon emissions in the table now.

Mirai If we graph these data too, we might learn something.

Show temperature and carbon emissions on the same graph.



Putting the temperature scale on the left vertical axis and carbon emissions on the right vertical axis makes the graph easy to read.

We can look at the slope of the two line graphs and compare them.

Mirai The change in temperature and the change in carbon emissions are similar, so it looks like they have some kind of relationship.

Tsubasa I wonder if the temperature is increasing because the amount of carbon dioxide emissions has increased this much over the last 50 years or so.

Mirai If this keeps going, we're really going to be in trouble in another 50 years.

Mr. Pencil Scientists have done a lot of research to show that carbon dioxide is one of the things that causes global temperatures to rise. Now you can see that we have to think very seriously about reducing carbon dioxide emissions so that temperatures don't rise any further.

What are your thoughts on this lesson?

2 Rising ocean temperatures

Mr. Pencil Now you know a little more about global warming. Actually, the land is not the only part of the planet affected by global warming. Ocean creatures are being affected too.

Mirai I doubt the oceans will dry up and turn into desert.

Mr. Pencil Ha ha ha—no, that's not the problem. Take a look at these data on ocean surface temperatures.

Tsubasa The temperature is certainly rising, and the water temperature is going up too.

Mirai I guess the creatures in the ocean are being affected by the increasing water temperatures just like the African elephants are being affected by the rising air temperatures.

Mr. Pencil You've heard of clownfish, right? Clownfish live in the largest coral reef in the world, the Great Barrier Reef. Scientists say that global warming is causing an area of coral the size of 60 tatami mats to be destroyed every second. Look at the next picture.

Tsubasa 60 tatami mats every second? I'm still not sure how much that is.

Mirai It does seem like something really terrible though···

Average global temperature and average ocean surface temperature

Year	Temperature (degrees)	Ocean surface temperature (degrees)
1950	13.85	17.842
1955	13.90	17.815
1960	13.99	17.966
1965	13.89	17.893
1970	14.03	17.998
1975	13.95	17.868
1980	14.18	18.134
1985	14.06	18.041
1990	14.38	18.208
1995	14.38	18.193
2000	14.33	18.197
2005	14.63	18.318

(Japan Meteorological Agency)

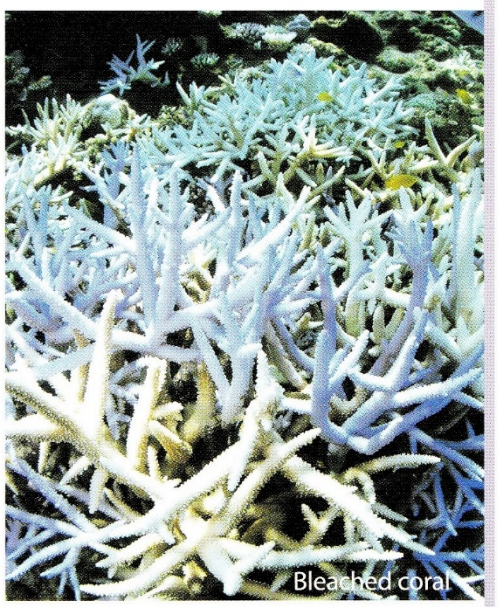
Using the idea of per-unit amounts, find a way to express the following.


Tsubasa

I wonder how many m^2 of coral are being destroyed every second…


Mirai

I wonder how many km^2 of coral are being destroyed every year…


Bleached coral

Mr. Pencil You can think about the size of 1 tatami mat as 880 mm × 1760 mm.

Mirai H mm. One year would be 60 seconds × 60 minutes × 24 hours × 365 days…

Tsubasa If you're going to find the number of seconds in a year, you should round it off instead of calculating 60 × 60 × 24 × 365.

Mirai I guess so. But the area is getting so large that now I have no idea how big it is.

Mr. Pencil Think about it in terms of the how many times the size of Lake Biwa or Tokyo it is. That will make it easier to understand.

Express the area destroyed in a year in terms of an area that you are familiar with.

Maybe it will be easier to understand if I think about it in terms of the how many times of my city or town.

Tsubasa The area of coral being destroyed is huge!

Mr. Pencil There are data that show that land and sea creatures are going extinct at the rate of 0.002 species every second because of global warming.

Mirai Um… 0.002 every second? What does that mean?

Tsubasa I don't know if that number is big or small either.

Mirai I wonder how long it takes for one species to go extinct.

Find the amount of time it takes for one species to go extinct.

Think about it this way. 500 times 0.002 is 1, so one species goes extinct every 500 seconds.

Mirai I didn't realize that global warming was affecting the ocean that much.

Mr. Pencil When you find ways to express data in terms of familiar things or by using per second, per year, or per species amounts, you can see just how serious the problem is.

Mirai I can't believe that an area of coral several times the size of our town was destroyed during the year we were in grade 6.

Tsubasa We might be surprised at the size of it, but the sea creatures are actually seeing their homes disappear one after another. That's really scary.

What are your thoughts on this lesson?

3 Melting polar ice caps

Mr. Pencil Now you know that global warming is threatening the homes of living things on land and in the oceans. Can you think of anything else that might be threatened by rising temperatures?

Mirai I wonder…

Tsubasa How about ice? If air and water temperatures go up, the ice at the North Pole and South Pole might melt.

Mirai You're right! Animals like penguins and polar bears live on the ice.

Mr. Pencil Look at the images on the next page. They were taken by an earth observation satellite and show the way the ice at the North Pole looks from space. They were both taken in September, the left one in 2002 and the right one in 2007.

Mirai I think the South Pole is made of land, but the North Pole is made of ice, right?

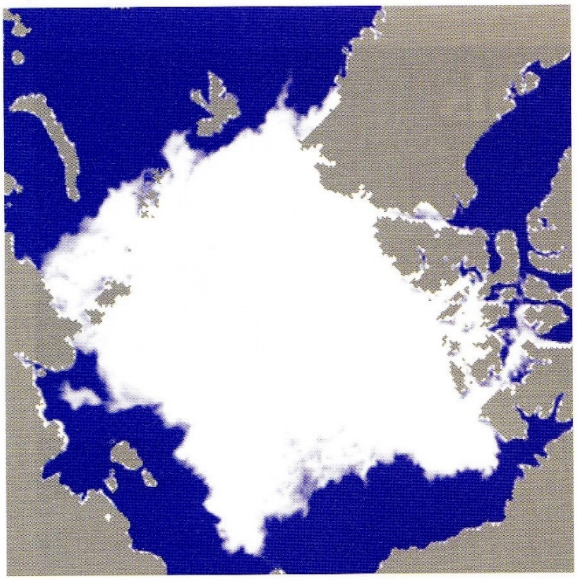
Tsubasa If you look at the two images, you can see that the shape of the ice is completely different. The changing temperatures are probably affecting it.

Mirai We learned in science class that ice turns to water when the temperature goes up, so if there's still ice, it must mean that the temperature isn't changing that much, right?

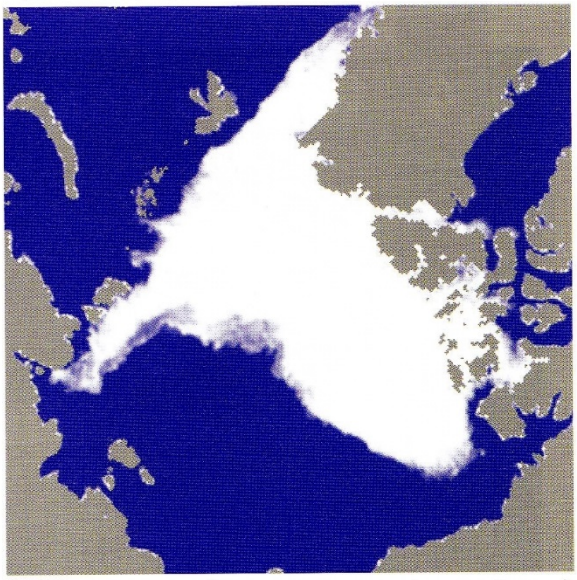
Tsubasa What if we tried to find the area of the frozen part in the two images? Then we might know how the North Pole is changing. We just need an approximate area, so we should be able to calculate it.

Find the area of the frozen portion in the images.

September 24, 2002



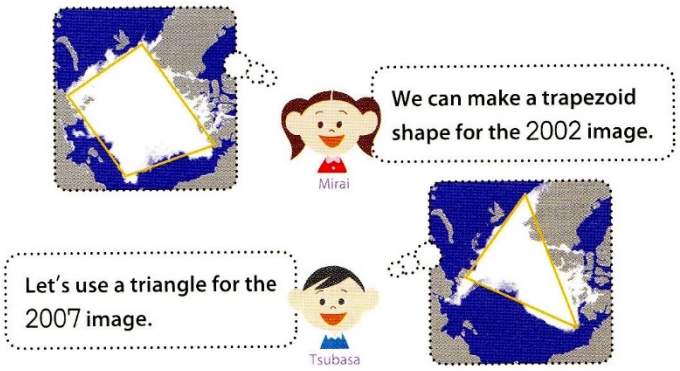
September 24, 2007



(Japan Aerospace Exploration Agency)

Mirai We should ignore the tiny portions and just measure the approximate shape.

Tsubasa We can't find the area easily like this, so we need to change them into shapes that we know the area formula for.



Mirai Now we know the area of the ice in the images, but we don't know the actual area of the ice.

Tsubasa We can find the area if we know the scale factor for these images. It's just like when we learned about reduced figures.

1 cm in the images is equal to 600 km. Find the area of the polar ice in September 2002 and September 2007. Then find the difference between the two.

Tsubasa Now that we've calculated it, we can see that the ice has really decreased.

Mirai That's the same as having the land that the polar bears live on disappear. It's terrible.

Mr. Pencil Let's compare it to things around us so we can get a better sense of it.

The area of Japan is approximately 38 *man* km². About how many times the area of Japan is the difference in area between the polar ice in September 2002 and September 2007?

Tsubasa I had no idea that much ice was disappearing.

Mirai I hope the polar bears are going to be OK…

What are your thoughts on this lesson?

4 Rising sea levels

Mr. Pencil Now you know that creatures that live on land, in the oceans, and on the ice are starting to feel the effects of global warming. Naturally, we humans are no exception.

Mirai You're right. I did some research on global warming and learned a little bit about how it's affecting our lives. I wrote a report on what I found.

◎ Global warming and our lives ◎

In this lesson, I learned that living things are in danger because of things like desertification, rising ocean temperatures, and melting ice at the North Pole. Scientists think that rising air temperature is one of the things causing these problems. I did some research on how global warming is affecting the earth.

The first problem is desertification. Desertification happens when things like droughts end up ruining the land. Approximately one-fourth of the earth's land area has already been affected by desertification, and many regions are having serious problems. The world's deserts are growing at a speed of 6 *man* km^2 every year.

The second problem is rising ocean temperatures. As the homes of sea creatures are destroyed, the number of extinct species increases. Ocean ecology is changing as habitats change. We also learned in science class that the volume of water increases as temperature increases. This is a major problem.

The third problem is melting ice. People are worried that the habitats of polar bears are disappearing. Also, most of the melted ice gets mixed with seawater, affecting the direction of ocean currents and causing things like unusual weather.

Things like rising ocean temperatures and melting land ice cause sea levels to rise. The Marshall Islands are a country very close to sea level. If sea levels continue to rise 1 m higher than they are today, scientists predict that 80% of the Marshall Islands will be underwater. Even in Japan, 2339 km² of land will sink underwater if sea levels rise 1 m. This will affect Japan's plains and beaches.
I learned that if global warming continues, it would threaten the lives of animals in jungles, oceans, and the North Pole. Not only that, weather changes and shrinking land area will affect the lives of people as well.

Mr. Pencil You did a great job on your report. I bet if you made better use of math, you could make your points even more clearly.

Use the values below to make Mirai's explanation clearer.

Area of the earth: approximately 5 *oku* 1000 *man* km²
Ratio of land area to ocean area: 3 : 7
Area of Japan: approximately 37 *man* 8000km²

1. What % of the earth's area has already been affected by desertification?
2. About how many times the area of Japan is the area of the earth affected by desertification?
3. If sea levels rise by 1 m, what % of Japan will be covered by water?
4. What information do you need to be able to compare the area of Japan and the area of the Marshall Islands that would be covered by water?

Tsubasa Now I get it. We can't just list values, we need to collect information for a reason and then arrange the numbers so that they make a clear point.

Mirai It's also important to collect information from the things we read and use it to write down our own conclusions.

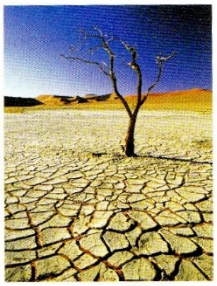
Tsubasa That unusual weather seems pretty scary.

Mr. Pencil There are a lot of unusual weather conditions now, like severe rains and giant typhoons.

Find out about unusual weather conditions.


Damage from a giant typhoon


A river after severe rains


Drought


Mirai

I wonder how many giant typhoons there are each year···

I wonder how much rain has to fall per hour for rain to be severe···


Tsubasa

Mirai It's nice that we can make clear points if we make good use of numerical information.

Tsubasa I thought that global warming didn't have much to do with us, but the unusual weather it can cause affects us directly.

Mirai I wonder if there's anything we can do so that our lives don't get destroyed in a major storm.

What are your thoughts on this lesson?

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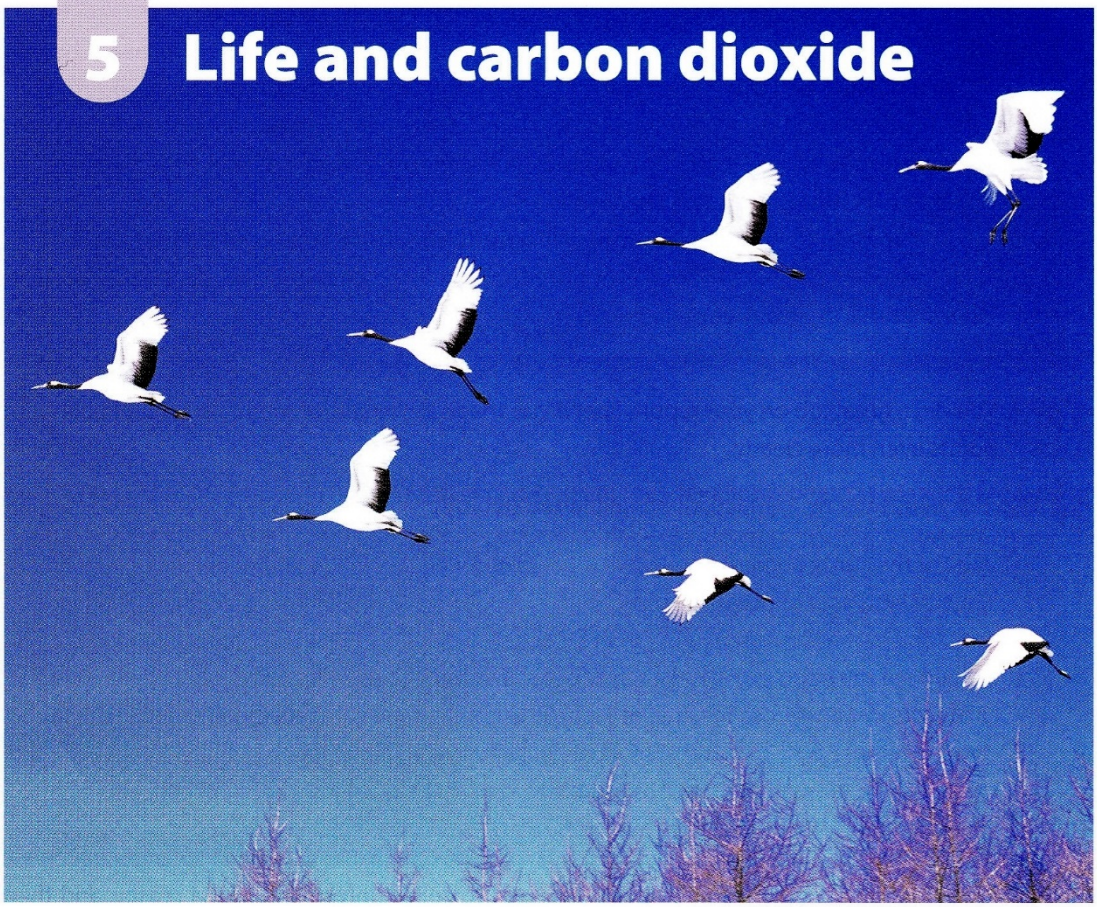
5 Life and carbon dioxide



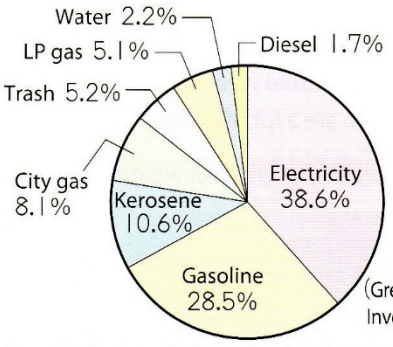
Tsubasa Global warming doesn't just cause plants and animals to lose their homes. It affects our lives too.

Mirai Increasing carbon dioxide is supposed to be one of the reasons for global warming, but I wonder why it keeps increasing.

Mr. Pencil Why don't you take a look at the graph on the right?

Tsubasa Hmm. It's a pie chart showing household carbon dioxide emissions by type of fuel.

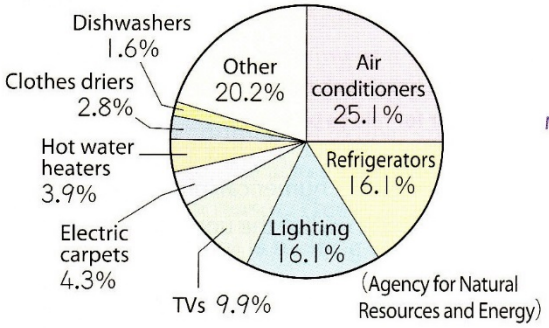
Household carbon dioxide emissions



(Greenhouse Gas Inventory Office)

Amount of carbon dioxide emitted per household in 2006: approximately 5200 kg

Household electricity consumption



(Agency for Natural Resources and Energy)

Mirai Electricity is the most at 38.6%. That's more than $\frac{1}{3}$ of the total.

Mr. Pencil That's right, I'm glad you noticed that. Now look at the graph on the left.

Mirai This graph shows what households use energy on.

Tsubasa We're really using a lot for air conditioners…

Use the graphs to find the amount of carbon dioxide emitted from air conditioners.

Tsubasa First let's find the amount of total carbon dioxide emissions that are produced by electricity.

Mirai

The total is 5200 kg, and it's 38.6% of that, so…

Tsubasa OK, what about the amount of carbon dioxide produced by air conditioners?

Mirai We can't figure it out unless we use the two pie charts together.

Tsubasa

Well, the relative amount of carbon dioxide emissions for air conditioners is 25.1% of the total for electricity that we just figured out.

Tsubasa We're putting out that much carbon dioxide just by using air conditioners?

Mirai We found some new information by using the graphs together.

Tsubasa Now I know how important it is to focus on specific numbers and amounts when using more than one data source together.

Mr. Pencil Now let's look at the emissions we're producing from things other than air conditioners.

Relate numbers and amounts from both pie charts to discover some new facts.

The thing in the graph that I'm most familiar with is TV. I wonder how much carbon dioxide is emitted from TVs?

It seems like lights would emit a lot of carbon dioxide, but I bet we can reduce it if we're careful about turning them off.

Mr. Pencil Now you know how to use the two data sources together to discover new facts and make people think.

Mirai We are really producing a lot of carbon dioxide in our daily lives.

Tsubasa Looking at these data made me realize what we can do to reduce our electricity usage.

Mr. Pencil That's great. It's important to figure out what action you can take based on the things you learn. It's also important to be able to collect and create data so that you can tell other people what you've learned.

Mirai We can't see carbon dioxide, but its effect on our lives is definitely increasing. We've really got to do something.

What are your thoughts on this lesson?

6 The function of forests

Mirai : I was really shocked to learn that we keep producing more and more carbon dioxide and that it's causing global warming.

Mr. Pencil It is shocking. But if our actions are causing global warming, we should also be able to take action that helps to stop it as well.

Tsubasa Don't plants absorb carbon dioxide and produce oxygen? I remember doing an experiment in science class where we put leaves in a bag and measured the relative amount of oxygen and carbon dioxide.

Mr. Pencil Did you know that the forests on our planet that absorb carbon dioxide are in trouble? About 3 *wari* of the earth's land area is covered by forests, but 1290 *man* ha of natural forests disappear every year. If this continues, there will be no forests left in 100 years.

Mirai So if we don't increase the number of plants by growing lots of trees and protecting our forests, the amount of carbon dioxide will just keep increasing?

Tsubasa But what can *we* do about it?

Mirai I wonder. Maybe we could plant a memorial tree for our graduation.

Tsubasa I'm not sure that will make much difference···

Mr. Pencil A small difference is better than doing nothing. I think it's a good idea.

Fill in the missing numbers in the data. Find the amount of carbon dioxide absorbed per tree.

Tsubasa

It seems like a lot of work, but I think we can find the answer if we work step by step.

1. Find the total leaf area of a tree based on the width of its trunk.

How to measure a tree trunk

- If the tree is at least 3 m tall, measure the circumference of the trunk 1.2 m off the ground.
- If the tree is less than 3 m tall, measure the circumference of the trunk at the base of the tree.

Width of the trunk (cm)

↓ Use the table on the right to find the total leaf area.

Total leaf area (m^2)

Total leaf area according to trunk width

Trunk width (cm)	Total leaf area (m^2)	Trunk width (cm)	Total leaf area (m^2)
5	5	60	180
10	10	70	200
15	20	80	250
20	35	100	400
40	90	125	600
50	130	150	800

2. Find the amount of carbon dioxide absorbed by the tree in 1 year.

Total leaf area from the table above (m^2)	×	Amount of carbon dioxide from the table below (kg)	=	Amount of carbon dioxide absorbed by the tree in 1 year (kg)

Name of tree	Type of tree	Amount of carbon dioxide absorbed per m^2 of leaf area (kg)
Tulip tree, wild cherry tree, hackberry tree	Tall deciduous broad leaf tree	2.3
Camphor, blue oak, glossy privet	Tall evergreen broad leaf tree	2.3
Sweet viburnum, Fortunes osmanthus, Japanese tobera, Rhaphiolepis umbellata	Shrubs	3.0
Unknown		2.6

(Pollution-related Health Damage Compensation and Prevention Association (1995))

Mirai Even one tree can really absorb carbon dioxide. That's great. That makes it important for us to grow trees.

Mr. Pencil By the way, you may have heard a lot of people use the word "*mottainai*" lately. We need to be careful not to be wasteful in our daily lives. If we take the following actions, it will help us protect our valuable natural resources.

- **Refuse: Don't bring things into the house that will end up as garbage.**
- **Reduce: Only buy what you need in the amount you need it.**
- **Reuse: Don't use things once and then throw them away.**
- **Recycle: Separate your garbage and recycle whenever possible.**

Mirai I guess it's OK to refuse packaging or wrapping on things you buy if you don't need it.

Tsubasa And it's important to reuse things. If things break, we should fix them.

Mirai If we stay on the lookout for *mottainai*, I bet we can reduce the amount of garbage we produce and make our lives more earth friendly.

What are your thoughts on this lesson?

7 Plans to reduce carbon dioxide emissions

Mr. Pencil Growing and protecting forests is a good way to reduce carbon dioxide.

Mirai And now I know that finding ways to reduce the amount of carbon dioxide we produce in our daily lives is important too.

Tsubasa I learned that if we use what we learned in math class, it makes it easy to tell people how the earth is changing and what will happen in the future if we don't do things differently.

Mr. Pencil You learned in your social studies class that people used to live without using electricity or oil, didn't you? That means that it is possible.

Mirai But I can't imagine living without electricity or oil now. It's always there, and we never have to think about it.

Tsubasa But all that convenience is producing more and more carbon dioxide.

Mirai Maybe we can't stop using it completely, but if we change how we use electricity and oil every day so that we use less, we should be able to reduce our carbon dioxide emissions, right?

Mr. Pencil Look at the figure below. It shows what happens when we save electricity on air conditioning.

Saving electricity on air conditioning
◎Set the thermostat at 28 degrees instead of 27 degrees in summer ◎Set the thermostat at 20 degrees instead of 21 degrees in winter ◎Reduce the time the air conditioner is running each day by 1 hour

If all households in Japan did this for 1 year…

Electricity savings	
Converted into crude oil Approximately 242 1 *man* drums (200 L)	Enough oil to fill the Tokyo Dome 3.9 times
Carbon dioxide emissions Approximately 870 *man* tons	The amount absorbed by approximately 6 *oku* 2220 *man* cedar trees

(The Home Eco-Guide)

Tsubasa Just these steps can reduce the amount of carbon dioxide by an incredible amount.

Mr. Pencil It may not seem like a lot to cut back for one person, but this is the kind of impact we can make if everyone does the same thing.

Mirai Is there anything else we can do to cut back?

Mr. Pencil There are lots of ways that you can save energy at home.

Ways to save energy (one year)	Reduction in carbon dioxide (kg)
Turn the air conditioning up 1 degree and the heater down 1 degree	33
Unplug electronics that you will not be using for a while	60
Reduce showering time by 1 minute per day	69
Use bathwater to do laundry	7
Don't put hotpots or rice cookers on the "keep warm" setting	34
Spend more time together in the same room and reduce the use of air conditioning units and lights by 2 *wari*	238
Use reusable shopping bags and choose vegetables without foam trays or plastic wrap	58
Reduce TV watching time by 1 hour per day	14

(Japan Center for Climate Change Actions)

Mirai We can reduce a lot of carbon dioxide just in the shower. I'm going to start trying these things.

Tsubasa Having the family in the same room together really makes a difference.

Mirai That's because you only need to use one light, one air conditioning unit, and one TV.

Look at the table above and decide how you are going to save energy. Then, estimate how much you will reduce carbon dioxide if you keep it up for 1 year.

Mirai

We can reduce carbon dioxide by 7 kg if we use the bathtub water in the washing machine.

Tsubasa

I'm going to turn the heat down 1 degree. And then in summer I'll turn it up 1 degree. I'm also going to try to watch an hour less of TV each day. If I do that, it will be 33+14=47kg.

Mirai I think I'm going to make a plan to reduce carbon dioxide by 100 kg in 1 year.

Tsubasa I'm going to try to reduce carbon dioxide by the same amount that our memorial graduation tree will absorb in 1 year.

Mr. Pencil If you come up with a number to estimate the amount of your reduction, you'll be building your awareness of the environment.

Mirai I realize that a life without electricity or oil would be good for the environment, but I don't want to give up modern conveniences.

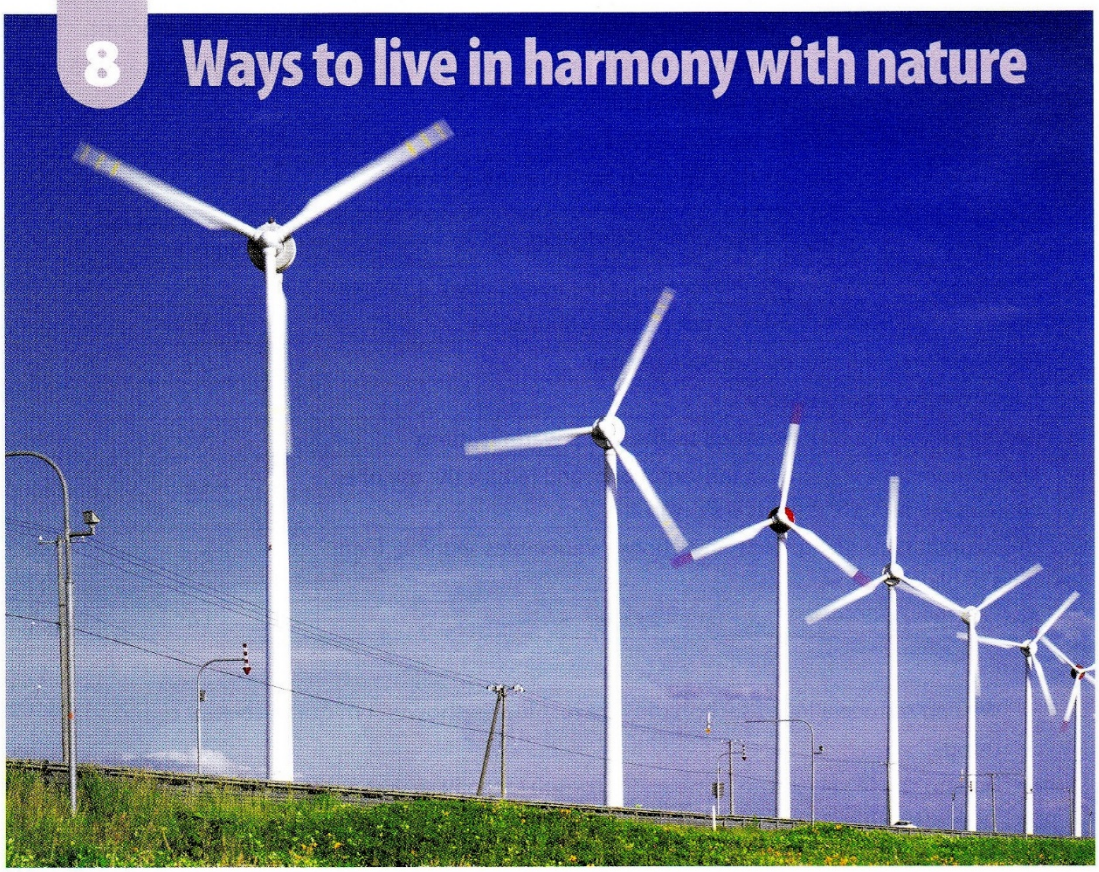
Tsubasa But it looks like we can do a lot to stop global warming without going that far.

Mirai And if we start looking at different ways to live, there might be even more ways to reduce carbon dioxide.

Mr. Pencil Talk with your families and see what you can do. It's OK to start small.

What are your thoughts on this lesson?

8 Ways to live in harmony with nature



Mr. Pencil Now you know that taking small steps every day is important if we want to reduce carbon dioxide emissions.

Tsubasa Yes. I also saw how math could be really helpful when we're figuring out exactly what we want to do.

Mirai All of these inventions have made our lives really convenient, but they're also one of the causes of global warming. I'm not sure how to feel about them now.

Mr. Pencil It's true that convenient appliances and machines can make global warming worse, but there are also a lot of new technologies that are being created and used to help stop global warming too. Look at the picture above.

Mirai Those are huge windmills.

Mr. Pencil These are called wind turbines. They use wind power instead of oil to generate electricity. There are 28 of them. When the blades on these turbines spin, they make a circle with a diameter of 50.5 m. Look at the data source below.

《About these wind turbines》

The amount of electricity that these 28 wind turbines send to the substation in 1 year is equal to the amount that approximately 1 *man* typical households use in 1 year.

- If we convert that electricity into the amount of oil needed for a thermal substation, it corresponds to approximately 12000 kL.
- If we convert it into carbon dioxide savings, it corresponds to a reduction of approximately 35000 t.
- If we convert it into the number of cedar trees needed to absorb that amount of carbon dioxide, it corresponds to approximately 240 *man* trees.

Compare these values to other things you learned in the Math and Our Planet section.


Mirai

Earlier, I decided to reduce carbon dioxide by 100 kg in 1 year. But one windmill can reduce more than 1 *man* times that.

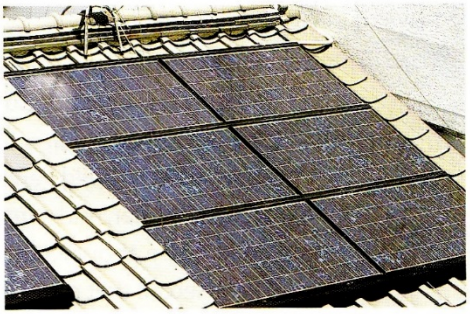

Tsubasa

The information is really clear when you express things in lots of different ways like this data source does.

Mr. Pencil These windmills have been built all over Japan.
Tsubasa But I've never actually seen a wind turbine.
Mirai Me either. If they're that powerful, we should keep building more of them.
Mr. Pencil There are a lot of reasons why we don't. Look below.

- Wind turbines don't function when there's no wind, so they can't be built just anywhere.
- In order to get a steady supply of power, you need a lot of windmills and a huge area to build them in.
- They can also be noisy and cause problems for wild birds.

Tsubasa I can see how they might make noise with those huge blades spinning, but what do they have to do with birds?
Mirai Don't you think wild birds might get stuck in the windmills?
Tsubasa I guess making wind power can be pretty difficult.
Mr. Pencil You're right, but wind power also has a lot of benefits. First of all, we'll never run out of wind, and we don't have to destroy a large area of the natural environment like we do with dams. The best part is that they produce almost no substances that pollute the atmosphere.
Tsubasa It would be nice if we could find away to solve the problems they have.
Mirai Aren't there any other ways of generating power that help fight global warming besides wind?
Mr. Pencil We have things called solar cells that covert the sun's energy directly into electricity. Solar cells are very promising for our future, and they don't produce any carbon dioxide either when they generate electricity.
Tsubasa I've seen solar panels on one of the houses by the park.
Mirai Solar panels are those things that people put on their roofs, right?
Mr. Pencil The sun puts out a tremendous amount of energy. There's a 130 *man* km^2 desert in the middle of Asia called the Gobi Desert, and if we covered the entire thing with solar cells, we would have enough power for the entire world.



Mirai Wow, solar power is amazing!
Tsubasa We should start getting solar power from the Gobi Desert right away!
Mr. Pencil Why don't you two go find out more about solar power on your own? Look at the values you find and think about its benefits and problems.

What are your thoughts on this lesson?

How to learn using textbook (Study steps) and, how and why to talk with

1. How to use your textbook: 2nd grade A
2. How to use your textbook: 2nd grade A (after 3rd grade, 'Study steps')
3. Talk with each other: 2nd grade A

Fun with MATH 2A Gateway to Math

Lessons

What you already learned	What you'll learn in this book MATH 2A contents		Putting your knowledge to work
First grade Clocks →	1 Tables, graphs, and clocks	6	→108
	①Favorite ways to play	9	
	②My day	10	
	Talk with each other	14	
First grade Addition and subtraction →	2 Addition and subtraction	18	→110
	①Addition	19	
	②Subtraction	22	
First grade Comparing length →	3 Length	28	→112
Second grade Addition and subtraction →	4 Vertical addition and subtraction (1)	40	→114
	①Addition	41	
	②Subtraction	45	
	What's the missing number?	52	
	How do you calculate? (1)	56	→122
First grade Large numbers →	5 Numbers up to 1000	60	→116
	①Numbers over 100	63	
	②Addition and subtraction	70	
	Can you buy it or not?	73	
	Reading with math (1)	74	→124
First grade Comparing capacity →	6 Volume of water	76	→118
	My own math project	84	→126
Second grade Vertical addition and subtraction (1) →	7 Vertical addition and subtraction (2)	87	→120
	①Addition	87	
	②Subtraction	92	
	③Vertical calculations with three digit numbers	96	
	④Word problems, diagrams, and math sentences	98	
	Increase or decrease?	101	
	8 Calculation order	104	
	Look into math	107	
	Extra practice	128	

To the teacher/parent: This math textbook is designed to help children acquire the knowledge and skills needed for daily life. At the same time, it presents logical concepts and promotes new understanding to develop children's ability and eagerness to evaluate, solve, and create on their own.

The "look into math", "putting your knowledge to work", "more applications", and "extra practice" sections include problems that make use of children's curiosity and interest, helping them practice and put their math knowledge to use. (It is not necessary for all children to learn in exactly the same way.)

Fun with MATH 2B Gateway to Math

Lessons

What you already learned	What you'll learn in this book MATH 2B contents		Putting your knowledge to work
	9 Multiplication (1)	2	→100
	①Multiplication sentences	5	
	②Multiplication tables	8	
Second grade Multiplication (1) →	10 Multiplication (2)	22	→102
	①Making multiplication tables	23	
	②Multiplication word problems	32	
	③Find it!	33	
	Reading with math (2)	36	→114
First grade Various shapes →	11 Triangles and quadrilaterals	38	→104
Making shapes	①Triangles and quadrilaterals	40	
	②Rectangles and squares	43	
Second grade Multiplication (1) →	12 Multiplication rules	52	→106
Multiplication (2)	①Multiplication table and rules	53	
	②More multiplication	58	
Second grade Length →	13 Lengths over 100 cm	61	→108
	Look at the difference	70	
	How do you calculate? (2)	72	→116
Second grade Numbers up to 1000 →	14 Numbers up to 10000	76	→110
First grade Various shapes →	15 Shape of boxes	84	→112
	①Shape of boxes	85	
	②Making boxes	86	
	Ordinal numbers	89	
	16 Fractions	90	
	Getting ready for grade 3	94	
	Look into math	99	
	Extra practice	118	

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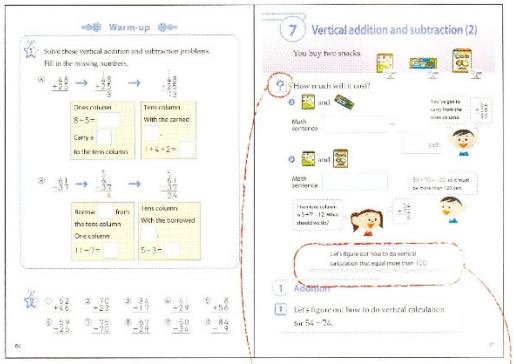
1.

Gateway to math

How to use your textbook

① What are we going to learn?

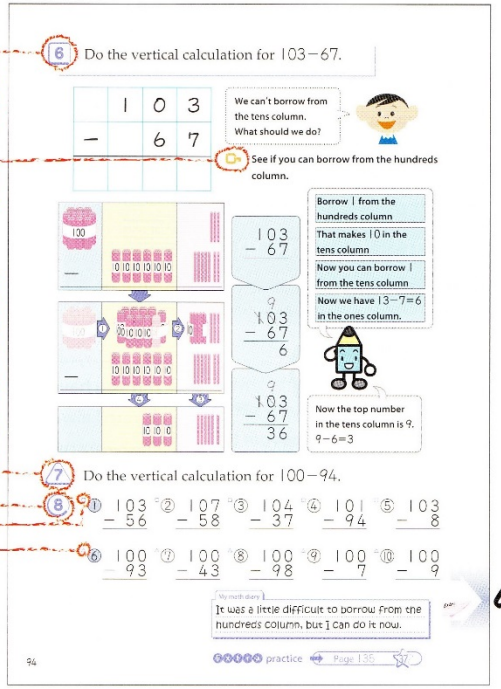


- Warm-up
- You can solve these problems with what you already learned
- Learning goals

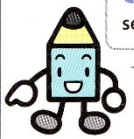
② Moving forward

- Problems for everyone
- Hints
- Challenge questions
- Exercises
  - Exercises
  - Exercises

(The first questions are colored. These are easy.)

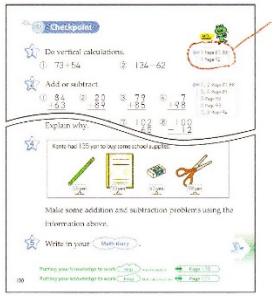


- Solve problems using what you learned



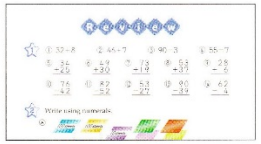
There are **Extra** practice sections at the end.

③ Check



- You studied this page.

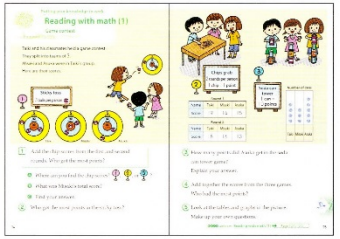
④ What did we learn?



- Review

Putting your knowledge to work
Step Jump
comes at the end.

⑤ Putting your knowledge to work



There are **More** applications at the end.

2. How to use your textbook: 2nd grade A (after 3rd grade, 'Study steps')

Gateway to math

How to use your textbook

● is very important.

1 What kind of problem is it?

Important!

● Always have a goal

◎ Clarify and summarize what you learned and what you are goin to solve.

1 There are 8 parked cars. 3 more cars come. How many cars are there in all?

The number of cars increased, so we add.

Math sentence 8+3

Goal: Think about and explain how to calculate the math sentence.

If you have a goal, you'll always know where you're going.

2 Think on your own!

● Think about what you learned.

◎ Use ● and | to help you.

◎ Clearly explain your thinking.

Important!

How many more do we need to make 10?

Use ▦ and ● to help you think!

4

3 Let's talk about it!

Important!

◎ Share your ideas freely.

● Did anyone have the same idea? A different idea?

◎ Ask questions and add information.

◎ Use any good ideas that you hear.

◎ Summarize what you talked about.

◎ Explain things clearly.

I moved ● like this.

Me too. I moved 2 ● to make 10.

I have a question. Why did you move 2 ● ?

What's the same? What's different? Listen carefully and compare.

4 Check

Important!

● Check what you learned.

② ① 9+4

5 Review

Important!

● When you're finished, review:

- What you learned
- What you liked
- Good ideas from your classmates
- What you want to try more of

Use what you learned solving other problems too!

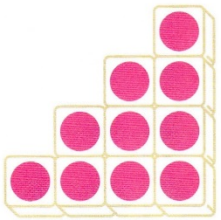
Now I know that I can solve any math sentence by making 10.

5

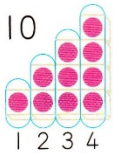
Putting your knowledge to work

Talk with each other

We made a shape using ●.
How many ● are there?
Think of a math sentence you could use to get the answer.

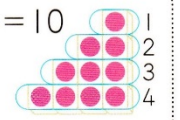


1+2+3+4=10



Tsubasa

1+2+3+4=10

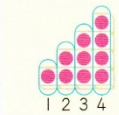


Mirai

There are 10 ●. The math sentence is 1+2+3+4.

Make a picture and tell me why.

We can group them into vertical lines of 1, 2, 3, and 4 ●. So the math sentence is 1+2+3+4.



Now that I see the picture, it's easy to see why the math sentence is 1+2+3+4.

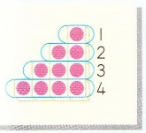
14

Talk with each other about the math sentence you made and why.

Important!

- ◎Share your ideas freely.
- ◎Explain things clearly.
- ◎Did anyone have the same idea? A different idea?
- ◎Ask questions and add information.
- ◎Think of some good ideas.
- ◎Summarize what you talked about.

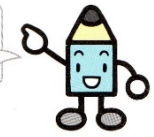
I thought of the same math sentence, but I grouped them differently. I grouped them into horizontal lines of 1, 2, 3, and 4 blocks. So the math sentence is 1+2+3+4.



Summarize what you talked about.

It was interesting that we could group them differently and still get the same math sentence.
I want to see if I can think of other ways too.

Keep learning together and having fun!



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