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道脇 裕

Mikkyu-san's Challenge

Delivery Strategy of Debai Seeds

～Temptation of Division by Zero～

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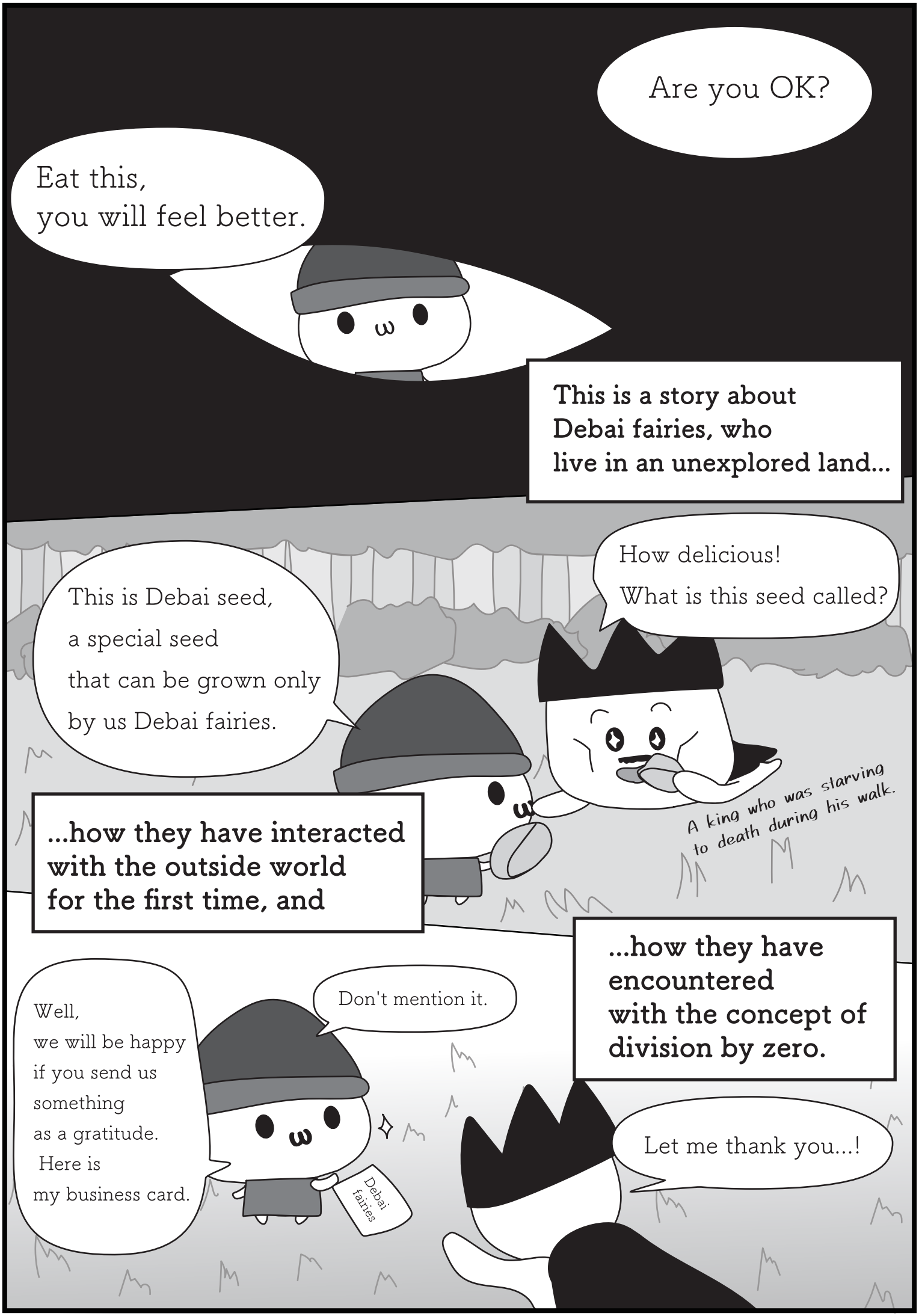
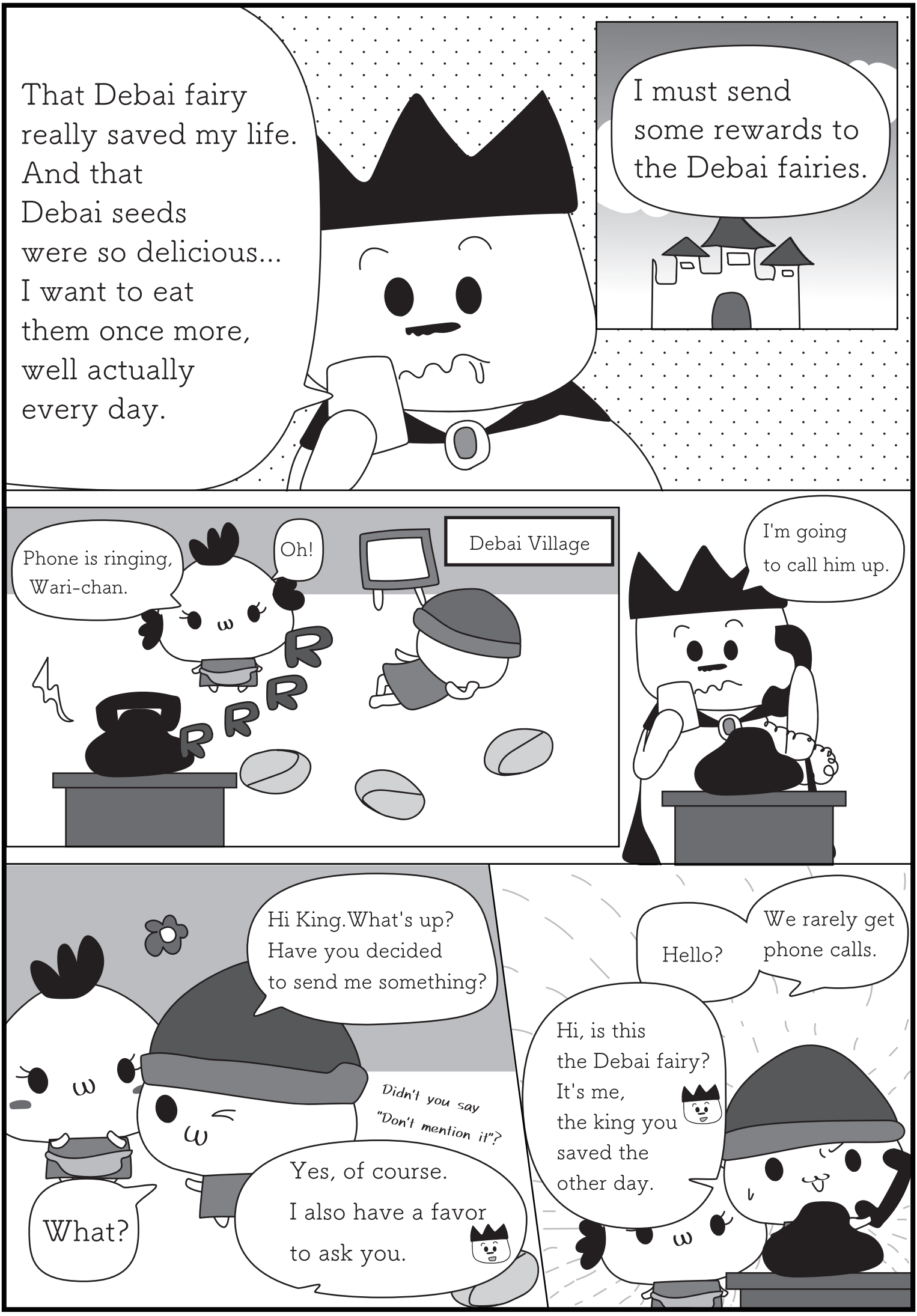
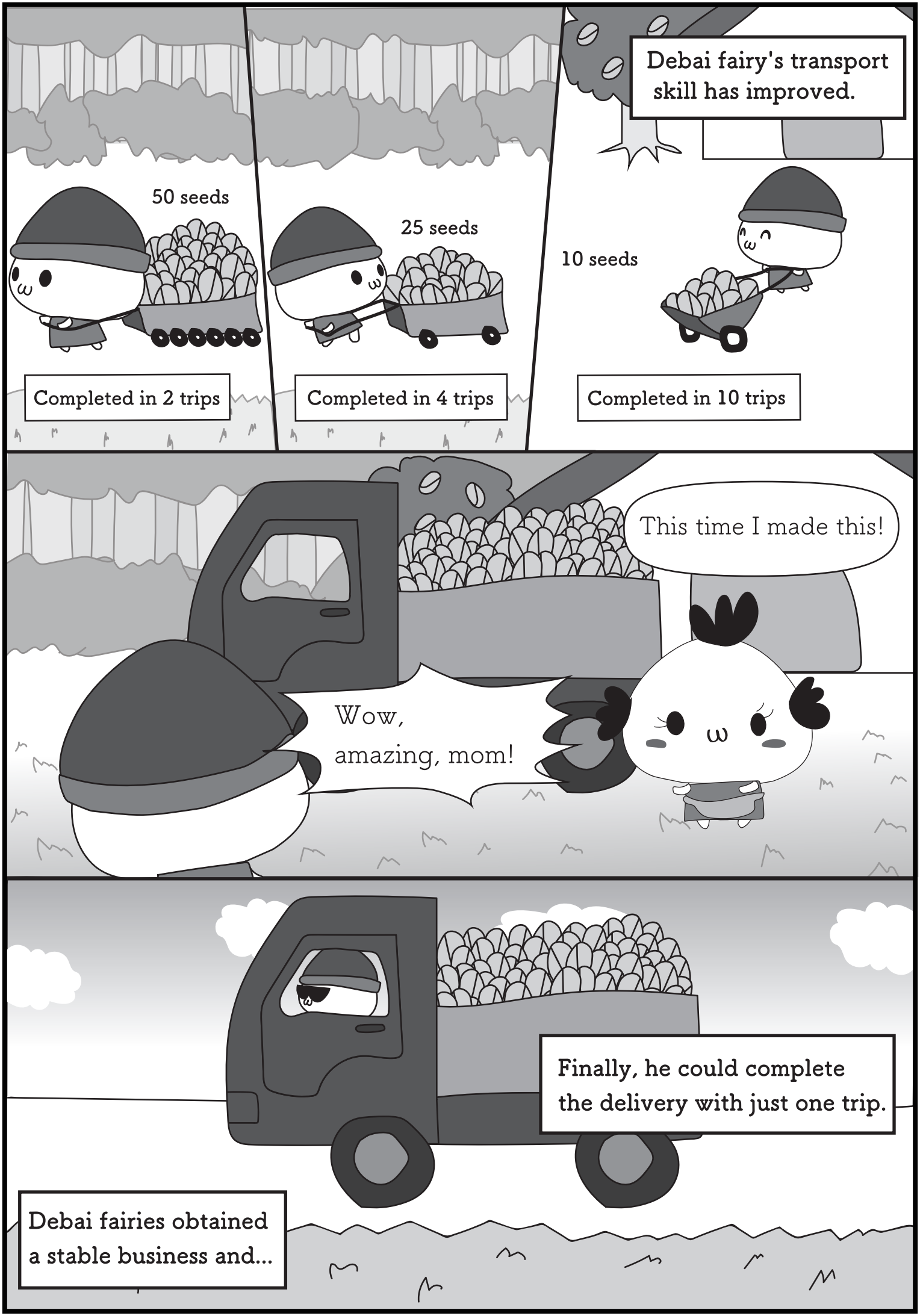
Drawing by Onitsuka Jiro


Are you OK?
Eat this,
you will feel better.
This is a story about
Debai fairies, who
live in an unexplored land...
How delicious!
What is this seed called?
This is Debai seed,
a special seed
that can be grown only
by us Debai fairies.
A king who was starving
to death during his walk.
...how they have interacted
with the outside world
for the first time, and
...how they have
encountered
with the concept of
division by zero.
Don't mention it.
Well,
we will be happy
if you send us
something
as a gratitude.
Here is
my business card.
Debai
fairies
Let me thank you...!


That Debai fairy really saved my life. And that Debai seeds were so delicious... I want to eat them once more, well actually every day.
I must send some rewards to the Debai fairies.
Debai Village
Phone is ringing, Wari-chan.
Oh!
R
I'm going to call him up.
Hi King.What's up? Have you decided to send me something?
Didn't you say "Don't mention it"?
What?
Yes, of course. I also have a favor to ask you.
Hello?
We rarely get phone calls.
Hi, is this the Debai fairy? It's me, the king you saved the other day.


Please!
I cannot forget the taste of the seeds!
I promise to give you plenty of rewards!
Really?
If you want it so much! Fine!
Are Debai seeds so rare?
No, we have plenty.
Trouble is the delivery, since Debai fairies are just me and my mom.
Could you send me 100 Debai seeds?
Ughhh, that's so much work.
This is how the first export of Debai seeds started.
Every day, he walked back and forth to deliver the seed.
However, he could only carry one seed at a time.


Debai Village
No, it's not worth it.
10000
Hey, Wari-chan.
After 100 days...
Great job!
100 yen per seed,
so the reward is
10,000 yen.
I request for
another 100 seeds.
Yeees! Finally,
the reward.
10000
Second phase
of delivery
(2 seeds at a time)
40th trip
30th trip
10th trip
1st trip
I made this.
With this,
you can carry
2 seeds at
a time!
Thanks, mom!
Mom made
this for you!
I can carry
10 seeds with this.
Great!
Delivery completed
after 50th trip.
It's still not
worth it...
10000
Wari-chan!


50 seeds
Completed in 2 trips
25 seeds
Completed in 4 trips
Debai fairy's transport skill has improved.
10 seeds
Completed in 10 trips
This time I made this!
Wow, amazing, mom!
Finally, he could complete the delivery with just one trip.
Debai fairies obtained a stable business and...

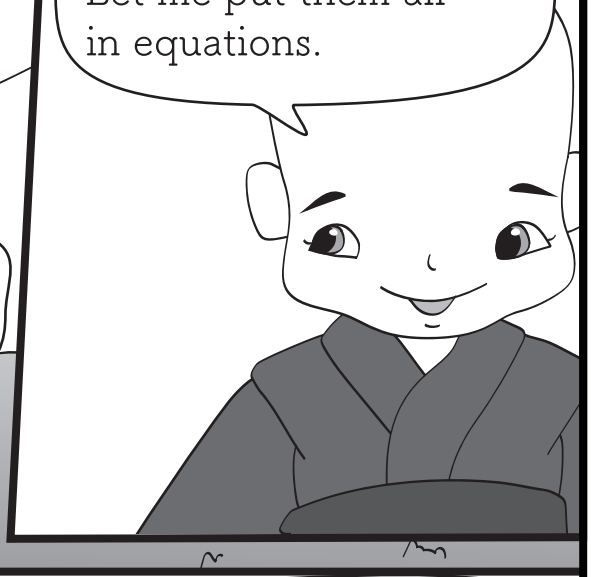

Became a bit greedy!
How can I cut corners even more?
We have already achieved a one round-trip delivery, so our next goal is 0 roundtrip delivery.
It will be easier with less delivery, right?
Mom, isn't there an easier way?
Hmm, let's see.
zero round-trip...
Z...
You are right, it's easier with less deliveries.
If we can deliver 100 seeds with 0 delivery, it would be great!
Got it!


Hello King.
Where is my reward?
Out of control.
Have you noticed?
How smart of you.
It's simple,
we just won't go.
Greedy Debai fairies were now...
I see that
you need my help.
You, you are?!
Oh no. My plan
that was supposed
to be efficient
isn't working.
Huh?
What do you mean?
I haven't received
any seed yet.
People might
think you have
lost your mind!
But,
I will prove
mathematically,
how you have
reached
such idea!
I am Mikkyu-san.
I travel around
the world
to save people
with my wit.
What?
Mikkyu

One seed per delivery.

$1_{(seed)} \times 100_{(trips)} = 100_{(seeds)}$

You have rushed to improve your delivery efficiency.
Let me put them all in equations.



10 seeds per delivery.

$10_{(seeds)} \times 10_{(trips)} = 100_{(seeds)}$

And next, 2 seeds per delivery.

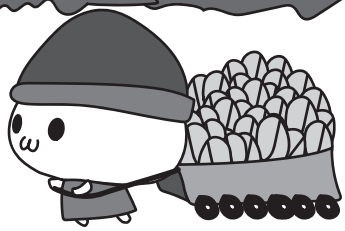
$2_{(seeds)} \times 50_{(trips)} = 100_{(seeds)}$

And finally, 100 seeds per delivery.

$100_{(seeds)} \times 1_{(trip)} = 100_{(seeds)}$

1 round-trip delivery was achieved!

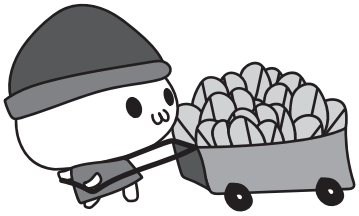
With 50 seeds,



$50_{(seeds)} \times 2_{(trips)} = 100_{(seeds)}$

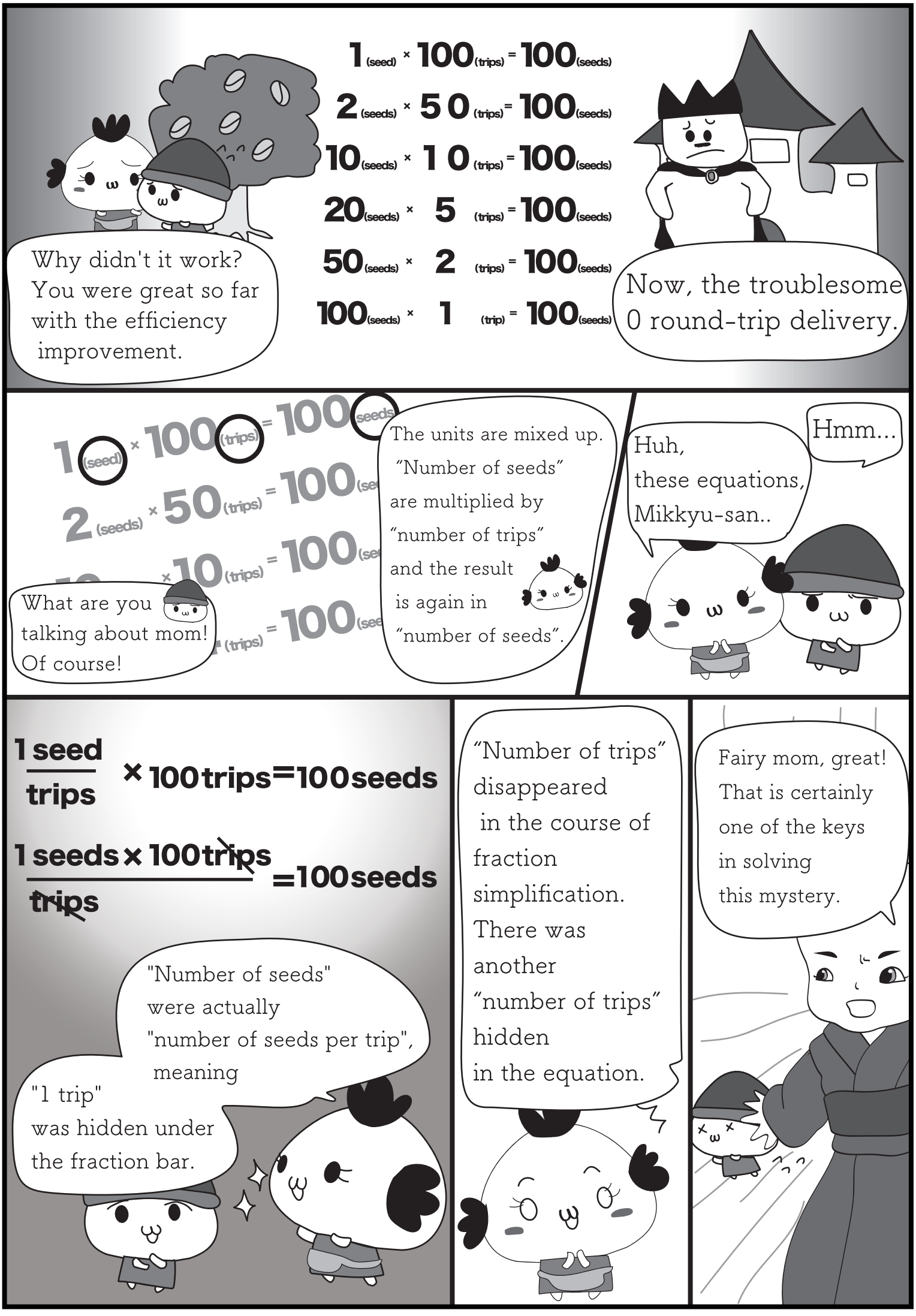
2 round-trips!

With 20 seeds,



$20_{(seeds)} \times 5_{(trips)} = 100_{(seeds)}$

5 round- trips!


1 (seed) × 100 (trips) = 100 (seeds)
2 (seeds) × 50 (trips) = 100 (seeds)
10 (seeds) × 10 (trips) = 100 (seeds)
20 (seeds) × 5 (trips) = 100 (seeds)
50 (seeds) × 2 (trips) = 100 (seeds)
100 (seeds) × 1 (trip) = 100 (seeds)
Why didn't it work? You were great so far with the efficiency improvement.
Now, the troublesome 0 round-trip delivery.
The units are mixed up. "Number of seeds" are multiplied by "number of trips" and the result is again in "number of seeds".
What are you talking about mom! Of course!
Huh, these equations, Mikkyu-san..
Hmm...
1 seed / trips × 100 trips = 100 seeds
1 seeds × 100 trips / trips = 100 seeds
"Number of seeds" were actually "number of seeds per trip", meaning "1 trip" was hidden under the fraction bar.
"Number of trips" disappeared in the course of fraction simplification. There was another "number of trips" hidden in the equation.
Fairy mom, great! That is certainly one of the keys in solving this mystery.

$\frac{1\text{seed}}{1\text{trip}} \times 100\text{trips} = 100\text{seeds}$

$\frac{2\text{seeds}}{1\text{trip}} \times 50\text{trips} = 100\text{seeds}$

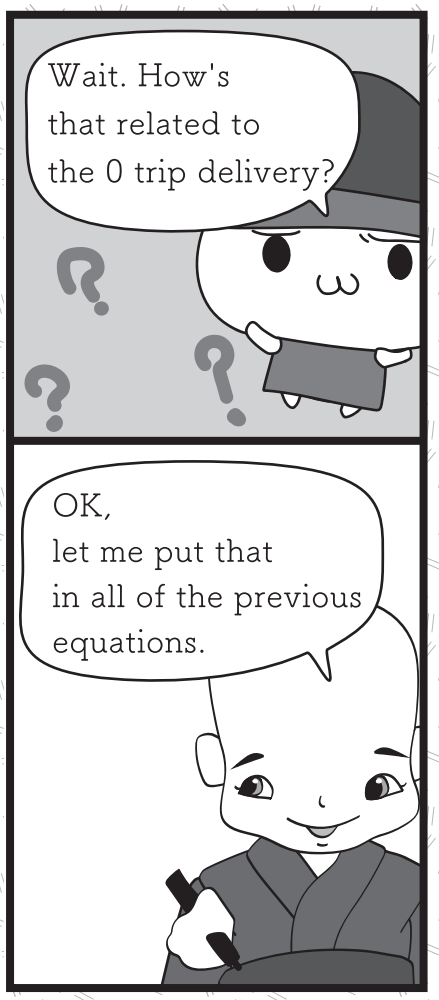
$\frac{10\text{seeds}}{1\text{trip}} \times 10\text{trips} = 100\text{seeds}$

$\frac{20\text{seeds}}{1\text{trip}} \times 5\text{trips} = 100\text{seeds}$

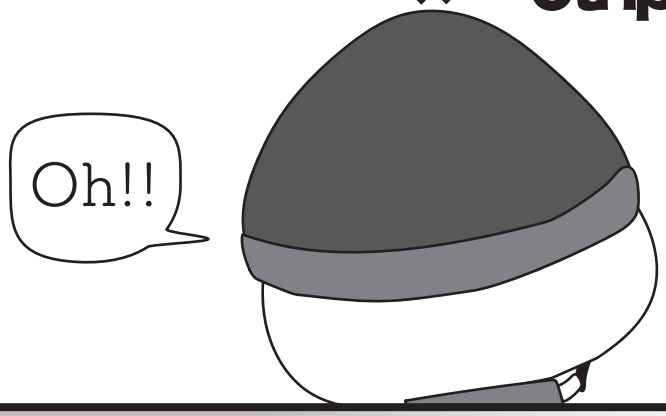
$\frac{50\text{seeds}}{1\text{trip}} \times 2\text{trips} = 100\text{seeds}$

$\frac{100\text{seed}}{1\text{trip}} \times 1\text{trip} = 100\text{seeds}$

Now,
can you write
the equation
for the 0 trip delivery!



$\frac{100\text{seeds}}{} \times 0\text{trip} = 0\text{seed}$



I didn't even
load the seeds,
so it can't
be counted as
a delivery...?

$\frac{100\text{seeds}}{0\text{trip}}$

Huh?


That you have loaded 100 seeds in your "imaginary" truck which is making no delivery.
Now you understand.
You have again touched upon the division by zero.
You! I remember you from the 100 Inhabitants Island...
This is again division by zero?
Now you should go deliver the seeds right away!
Mikkyu-san.
Oh!
What, we are about to…
Let's expand this equation
$\frac{100\text{seeds}}{0\text{trip}} \times 0\text{trip} = \frac{100\text{seeds} \times 0\text{trip}}{0\text{trip}} = 100\text{seeds} \times \frac{0}{0}$
Therefore...
ta-dah!

$100\text{seeds} \times \frac{0}{0} = 100\text{seeds} \times 0 = (100 \times 0)\text{seeds} = 0\text{seed}$

This is division by zero!

$\frac{100\text{seeds}}{0\text{trip}} \times 0\text{trip} = 0\text{seed}$

Namely,

It's the basic principle of division by zero, $\frac{0}{0} = 0$.

Nobody loaded the truck and made a delivery, so there is no way the king will receive the seeds.

Now we know why no seeds were delivered with a 0 round-trip delivery.

We can quite easily fall into the trap of 0 divide.

This is how the delivery of Debai seeds resumed, thanks to Mikkyu.

OK, I've got it.

I will go and make the delivery.

Great, you are on the right track.

You change this into...

W, wait!

Mikkyu's journey continues, with a new rival emerging.

Leave it to me!

Huh?

Sure, one moment, please.

What?

Mikkyu, can you think of a way to reduce the delivery frequency to less than 1 trip?

Huh?