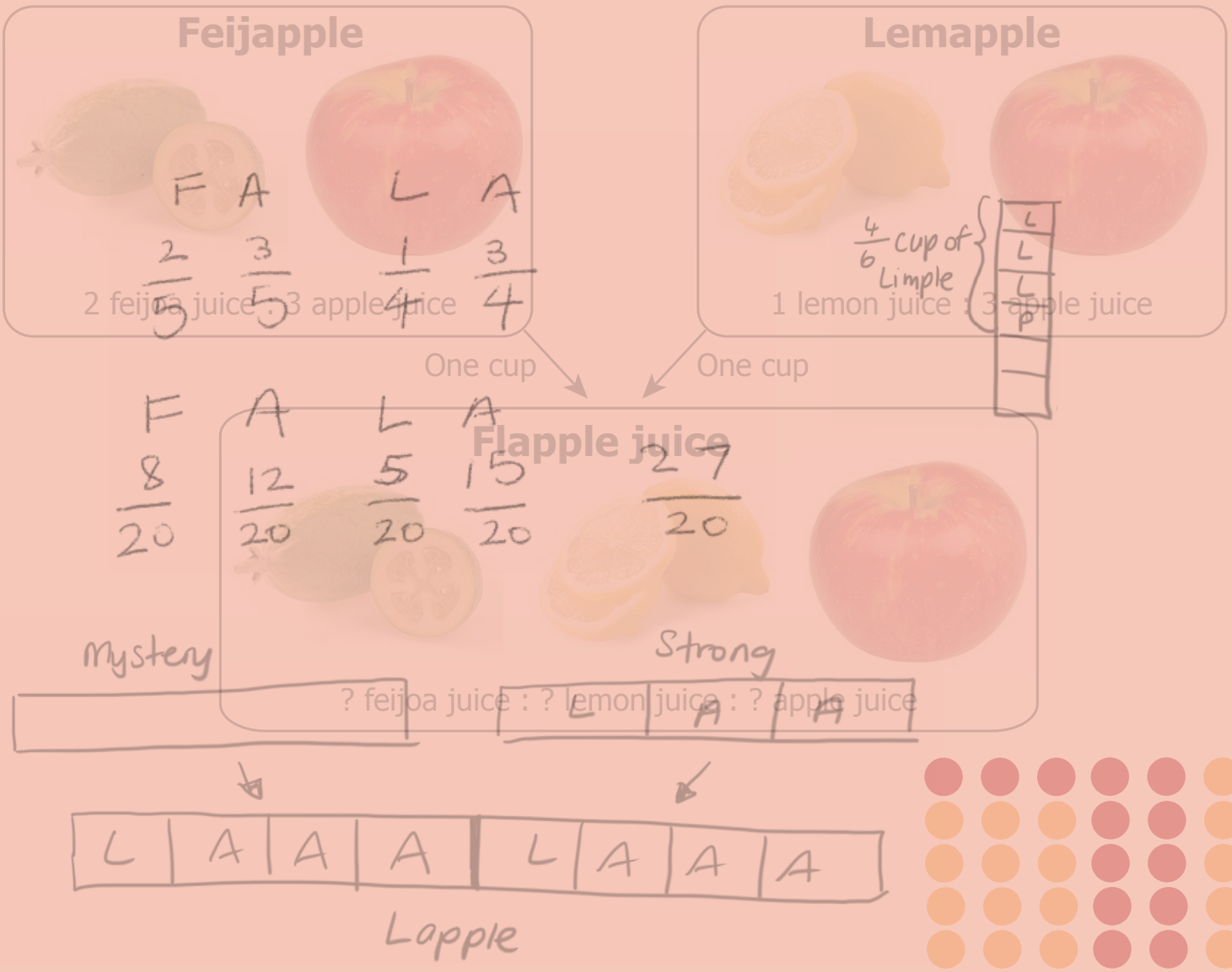
Mixing Ratios

TEACHER MANUAL



By Caroline Yoon, Anne Patel and Nikki Sullivan

2 The LEMMA series:
Learning Encounters with
Meta-Mathematical Activities

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NZCER
Rangahau Mātauranga o Aotearoa

Contents

Introduction

Warm up

Overview: The goal of this warmup is to prepare students for Task 1 by engaging them in the Flapple Juice context and mathematical concepts. It takes 10 minutes, and can be done with the whole class either the day before Task 1 (the Flapple Juice problem), or at the beginning of the class session when Task 1 is implemented. The benefit of doing the warmup the day before is that it will give students more time to work on their written letters for Task 1, and may leave some room for student presentations at the end. However, it also works well if the warmup is presented on the same day as Task 1, as long as the warmup is completed within 10 minutes to leave enough time for the Flapple Juice problem.

1. Read the conversation below then answer the questions that follow.

Gemma	yvonne, are you sick? why weren't you at school?	3:51 PM
Yvonne	hi hi, yes, i'm sooo sick. i caught a cold from marcus, the little s#*@. i was going to call you but it hurts too much to talk	3:52 PM
Gemma	drink honey and lemon tea	3:52 PM
Annabelle	yeah, get marcus to make it for u	3:53 PM
Yvonne	lol! ouch, that hurts	3:53 PM
Gemma	and add some grated ginger, that's really good for your stomach	3:54 PM
Annabelle	yeah, and some garlic	3:54 PM
Gemma	eww!	3:54 PM
Yvonne	um, gross?	3:54 PM
Annabelle	no u should try it. hte garlic kills the bacteria. just cut up the garlic into small bits so u don't have to chew it. that way u won't get bad breath	3:55 PM
Yvonne	mmm no thanks	3:55 PM
Annabelle	don't believe me if you don't want to, but i never lie	3:56 PM

Note: These questions are designed to check that students have engaged in the context of the problem. Since these are meant to be brief questions, it is efficient to go through these questions as part of a whole class discussion, rather than having students write their answers individually.

(a) What are the three ingredients Gemma suggests using?

Answer: Lemon, honey and ginger

(b) What ingredient does Annabelle add to Gemma's tea?

Answer: Garlic

(c) What cold remedies do you use? Any weird remedies?

Note: Students may give a variety of answers. The important thing here is to engage students in the context. You may want to ask students to name the weirdest cold remedy they know.

Sample answer: e.g. sleep and chicken soup

2. Gemma decided to make honey and lemon tea. She added 1 teaspoon of honey and 1 teaspoon of lemon to some hot water. What is the ratio of honey to lemon?

Note: These questions familiarise students with the mathematical concept of ratios, which is necessary for task 1.

Anwer: 1 : 1

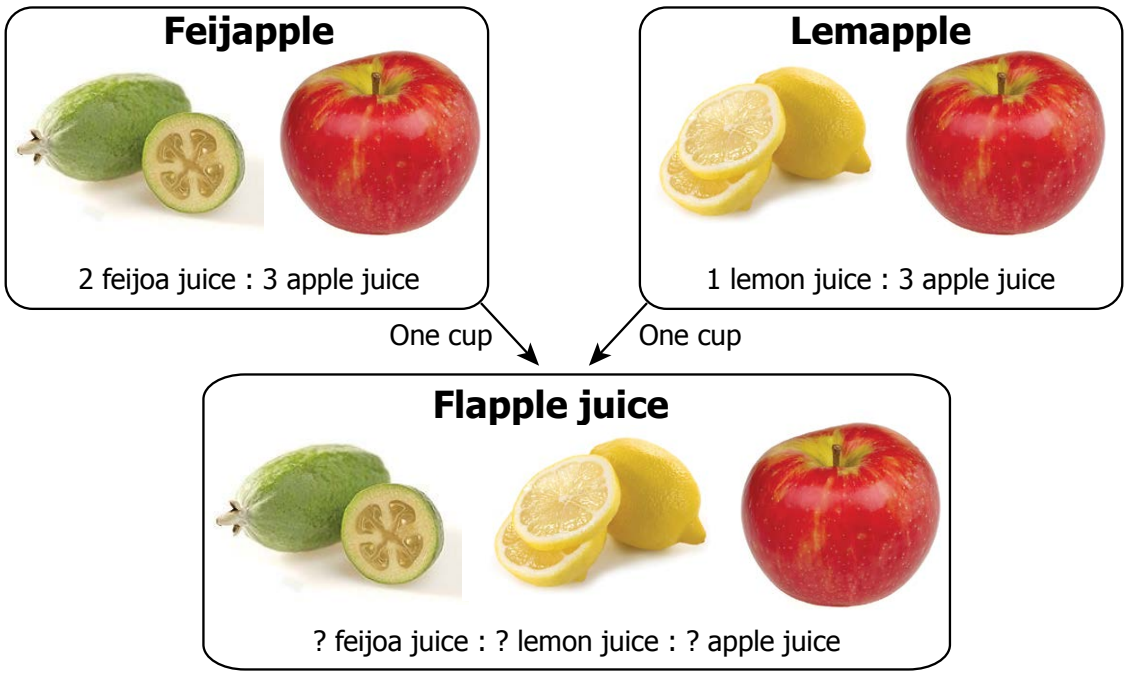
3. Gemma decided her tea was too sour, so added half a teaspoon of honey to the mixture. What is the new ratio of honey to lemon? Express your ratio in whole numbers.

Answer: 1.5 : 1, which converts to 3 : 2

Task 1: The Flapple Problem

Overview: This open-ended task forms the basis for the rest of the booklet, and should not be skipped. Students should work in teams of three for 30 minutes to create a team solution. If there is time available, teams can present their methods to the rest of the class. Facilitate mathematical questioning from the audience, and enjoy the diversity of ideas students bring to the problem.

Neti, a food scientist, is working on new flavour combinations for juices and smoothies. While experimenting, he mixes one cup of *Feijapple juice* (made out of 2 parts feijoa juice to 3 parts apple juice) with one cup of *Lemapple juice* (1 part lemon juice to 3 parts apple juice) to create a new flavour, which he calls *Flapple juice*:



High-fives go round the lab as the other scientists taste flapple juice and agree it is a winner – just the right amount of aromatic feijoa offset by plenty of crisp apple juice and zesty lemon. Neti's boss asks him to figure out the exact proportions of feijoa, lemon and apple juice so they can mass produce flapple juice and sell it to customers. Thinking it is easy, Neti adds the ratios for Feijapple and Lemapple juice, and tells him flapple juice is *2 feijoa juice : 1 lemon juice : 6 apple juice.*

Neti mixes a new batch of flapple juice using these proportions, but it doesn't taste quite the same. He knows he measured carefully, so Neti figures there's something wrong with his method.

Neti needs your help!

Your task is to come up with a method Neti can use to figure out the proportions of feijoa, lemon and apple juice that make up Flapple juice. Write a letter to Neti, explaining your method. Include an explanation of why Neti's method of adding the ratios together doesn't work. Explain how Neti can use your method to figure out the proportions in any mix of fruit juice made from different initial juice blends.

Note: As the problem statement is quite long, it works well to have one or two students read it out loud, as students are more likely to pay attention when they know they might be called upon to read part of the problem statement.

Before students start working, ask the class three questions to check they know what they are being asked to do:

(1) Question: Who's your client?

Answer: Neti

(2) Question: What is Neti's problem?

Answer: He wants to work out the correct ratio of feijoa juice, lemon juice and apple juice in Flapple juice.

(3) Question: What does she want you to give her?"

Answer: A ***letter*** that describes a ***method*** for figuring out the ratio of juices in Flapple juice, and ***any other juice blends***. The letter also needs to ***explain why Neti's method of adding together the ratios didn't work***.

Here are some frequently asked questions about implementing these open-ended tasks

1. Should I provide resources (e.g. calculators, counters, etc.) for the students? How should I provide them?

- After launching the problem statement, say to the class: "You can use anything you have with you, anything you can find in the class, or you can ask me for equipment and I will see what I can find"
- Try not to prioritise one piece of equipment at the beginning, as students might think they have to use it to find the "correct" answer.
- You can put resources on group tables at the beginning of the task, but emphasise that these are just a selection of tools they might find useful, they don't have to use them, and they can use other tools if they wish.
- Alternatively, you could have a collection of resources on a common table at the front of the class, with the same caveat.

2. What if a group of students don't talk to each other?

- Use 1-minute of thinking time for the whole class before starting the task. After launching the problem statement, say to the class: "Take 1 minute to think about this problem in silence". This will give students an opportunity to come up with ideas before they are forced to share them.
- When interacting with small groups that aren't talking, ask them to share what they are thinking with the other students in the group, not just with you. E.g., say "Sam, please tell Julia and Tina what ideas you've had about this problem", not "Sam, tell me what you're thinking". Then encourage the other team mates to respond to each others' ideas: "Julia, what do you think of Sam's suggestion?"
- Observe nonverbal clues and make them explicit to start discussion. E.g., "Benny, you're frowning. What does that mean? Tell the others in your team what you're thinking".

- Make it clear that it's ok to disagree with each other. Tell them they should challenge each other, because that's how their ideas will get better.

3. What if a group of students finish before the rest of the class?

- Ask if they have written their letter.
- If they have, ask if their letter is clear enough for the client to follow without needing to ask for help.
- If their letter is clear, and their solution is sound, invite them to present their solution to the rest of the class once everyone's finished. Let them spend the remaining time preparing their presentation while the rest of the class finish writing their letters.

4. What if some students are stuck or on the wrong track, mathematically?

- Remember that it's OK for students to experience being stuck. Sometimes it's a necessary phase before a breakthrough.
- Try not to give them explicit solutions or hints. Instead, get them to test their method on some examples that will reveal the method's flaws.

Instead of telling them the answer, you could suggest they use a resource that will help see the problem in a new way. For example, you could say, "have you thought about using counters?"

5. What if one student wants to do it all?

- In some cases, one or two students may take charge to the extent that they take over the problem. As a consequence, other team members may lose interest as they feel their contributions are not important. When this happens, remind the team that they all need to agree on the final method.
- Ask other team members whether they agree with the student's method, and whether they have other suggestions.
- Ask the team member(s) who have not contributed much to write up the final method.
- Tell the team they all need to be comfortable with explaining their method to the rest of the class.

6. What if some students are off task?

- Sometimes, taking a break can be a useful part of the modelling process. After a short break, students often return to the problem with fresh eyes, which can lead to a new way of interpreting the data.
- Are they off task because of communication issues, or because they have already finished, or because they are stuck?
- Remind the students they are responsible for producing a group letter.
- Remember that it's OK if some groups don't finish the task as well as you hoped. By struggling on the problem, they will be better prepared to appreciate good solutions that other groups present.

7. What if some students won't write a letter?

Getting students to write can always be a challenge. Some ways to scaffold this process are:

- Encourage them to write step-by-step instructions
- Encourage them to draw diagrams.
- Provide a writing frame like the one shown below:

> Dear Neti,
> Your method didn't work because…
>
> To figure out the ratio of juices in Flapple juice, follow these steps:
> Step 1:
> Step 2:
>
> Draw a diagram to explain your method
>
> Demonstrate your method with a different juice blend.
>
> Yours sincerely,

8. How do I mark the written communication of the letter?

Students may not have had much practice explaining mathematical methods in everyday English in the form of a letter. Some of the follow up tasks will be useful for enhancing students' written mathematical communication (e.g. Tasks 4, 5, and 6), and the communication assessment task (Task 8) is an opportunity for students to demonstrate how their written mathematical communication has developed. Guidelines on how to assess the written mathematical communication of Task 8 are given at the end of this booklet, and can certainly be applied to the Flapple problem (Task 1) if you wish. However, it may be more productive to focus on strengthening students' written mathematical communication first through the follow up tasks (2-7) before assessing their written communication, which is why we have not included the assessment guide in this task.

Note: The sample answer provided is just one of many possible correct methods. Students are likely to come up with a variety of alternative methods, some of which may yield different (although equivalent) ratios as a result. For example, see Liam, Mason and Elliot's method in Task 5.

Answer: Neti's method is incorrect because he adds different sized ratio parts together. He needs to make sure the parts are the same size before adding them. Here is one method for solving the problem.

Step 1: Add together the terms in each ratio to find the total number of parts in each ratio.

E.g. 2F : 3A has 2 + 3 = 5 parts

1L : 3A has 1 + 3 = 4 parts

Step 2: Find the lowest common multiple for the total number of parts for each ratio

E.g. 20 is the LCM for 5 and 4.

Step 3: Convert the original ratios so they both have the same total number of parts, using the answer to step 2.

E.g. 2F : 3A is equivalent to 8F : 12A
1L : 3A is equivalent to 5L : 15A
} These each have 20 parts in total

Step 4: Now you can add the common terms because the parts are all the same size.

E.g. 8F : 5L : 27A