
Title	Using comics to engage students in meaningful learning
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Using comics to engage students in meaningful learning

Cheng Lu Pien, Toh Tin Lam, Lim Lee Hean and Lim Kam Ming
use comics to support effective teaching

Instructional materials, for example, textbooks used in the mathematics classrooms, present varied opportunities for teachers to engage in the teaching and learning of mathematics. In recent years, educators and textbook writers have incorporated comics as part of the instructional material for mathematics to tap into its potential to engage students in classes. However, most of the comics are triggers for a new topic and appear at the beginning of the topic. In this article, we propose that comics, when developed for a whole topic, which we call a *comics package*, can support effective teaching practices by engaging students in deeper mathematical learning.

The comics package

Comics can be referred to as “an approach of conveying ideas” through “a sequence of visual images” (Toh, Chan, Cheng, Lim & Lim, 2018, p. 69). The benefits of using comics include improvement in retention of students’ understanding of complex ideas (Wylie and Neeley 2016). Comics have the potential to increase students’ motivation and interest in learning mathematics (Cho 2012), enhance students’ development of 21st century skills (Toh, Cheng, Jiang & Lim, 2017) and engage students in learning mathematics (Toh et al., 2018). This article describes one part of an ongoing research project on using comics to teach mathematics to students at the primary school level in Singapore. The authors of this paper, also the researchers of this research project, developed the entire comics package. The comics package comprised of three parts. The goals for the mathematics that students are learning for each part of the comic package are as follows:

- Part 1: To recognize and name fractions as parts of sets of objects,
- Part 2: To find the fractional part of a set e.g. $\frac{1}{4}$ of 20, $\frac{1}{5}$ of 25,
- Part 3: To find the fractional part of a set e.g. $\frac{3}{4}$ of 20, $\frac{2}{5}$ of 25, $\frac{3}{5}$ of 25, $\frac{4}{5}$ of 25.

The comics were accessible to the participating teachers and their students online. The comic package was designed such that each part contains examples, problem situations for class discussions and problems for independent practice. It is meant to be all inclusive and to be used as a Replacement Unit (Leong et al. 2016) for the existing textbook and traditional resource.

Figure 1 shows an example from Part 1 of the comics package. The speech bubbles in the comics package were designed to support children’s acquirement of the mathematical language to describe problem situations involving *Fraction of a set* e.g. “a set of 10 planets”, “ $\frac{3}{10}$ of the planets have rings” (Figure 1).



Figure 1: Example from Part 1 comics package.

In this article, we discuss the affordances of comics package applications that engages students in meaningful learning processes. Table 1 summarises key features of the comics package that facilitates students’ engagement. Teachers Toby, Amy and

Table 1 Features of the comics package that engage children’s meaningful learning

Features of Comics	Description
Graphics	Key ideas Connecting representations to deepen understanding
Mathematical task	Variety of tasks for students to learn mathematics

Nathan were three participants in this research from one primary school in Singapore that employed the comics package in their mathematics lessons for 10-year olds. The teachers were encouraged to use the package in ways that they deemed most appropriate for their students. An accompanying instructional guide to the comics package provided the teachers with the key mathematical ideas to be

discussed while using the package. After conducting the lessons on *Fraction of a set*, each teacher was interviewed about their experiences using the comics package. Their lessons using the comics package were video-recorded and the students who experienced the mathematics lessons using the comics package participated in pre and post-tests. Selected students from their classes were

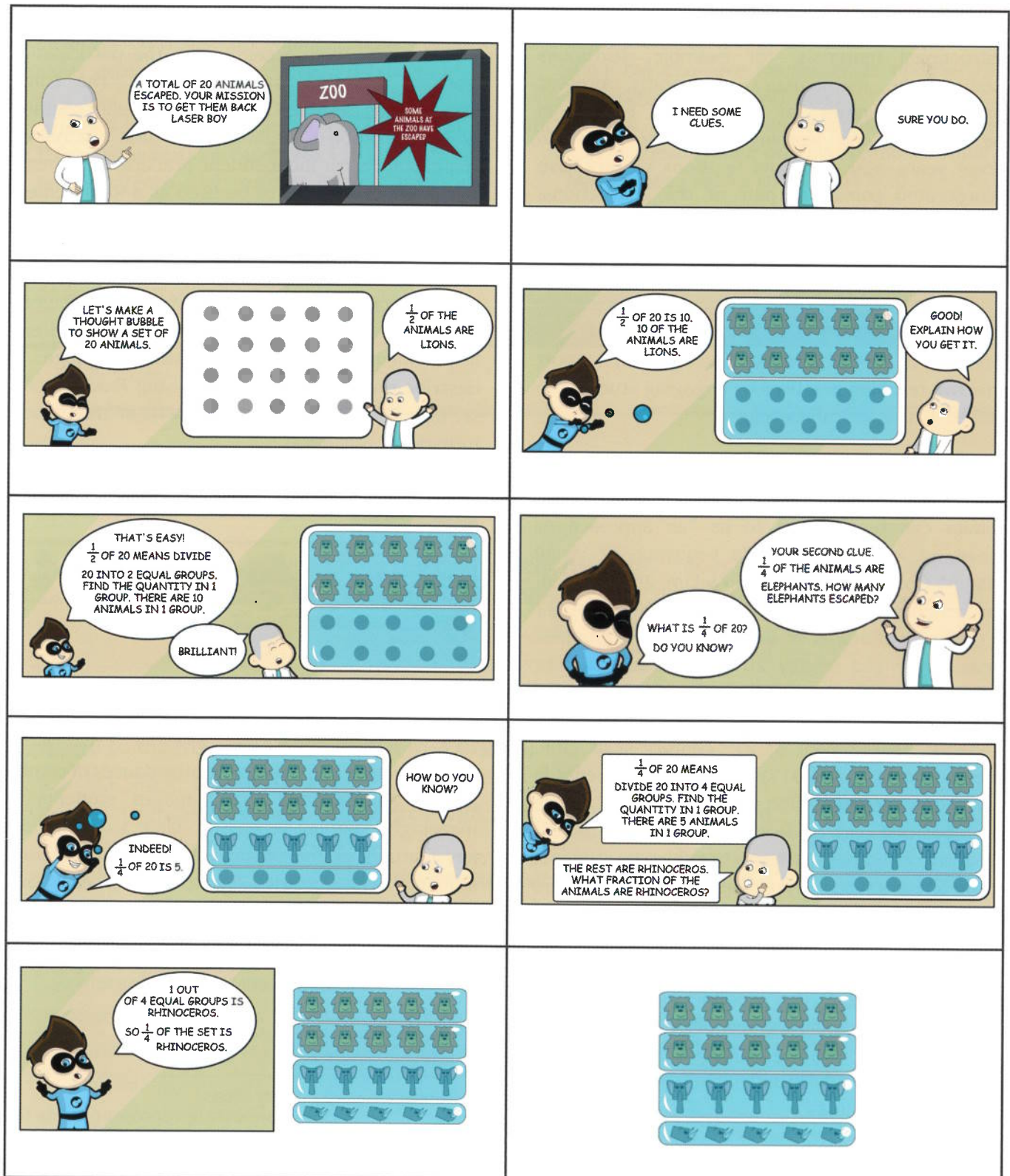


Figure 2: Animals escaping from zoo problem scenario

interviewed about their learning experiences of the package.

Graphics that connect ideas and key representations

Visuals are the language of the 21st century and research has shown the importance of visual mathematics for our brain and learning (Boaler, Chen, Williams & Cordero, 2016). Sousanis (2015) also argues for the importance of visual thinking in teaching and learning. “The new knowledge that we have, showing the visual processing of mathematical ideas, may explain the many research studies indicating that teachers who emphasize visual mathematics and who use well-chosen manipulatives encourage higher achievement for students, not only in elementary school but middle school, high school and college” (Boaler et al., 2016, p. 3).

Part 2 of the comics package started with a problem scenario that required students to find $\frac{1}{2}$ of 20 animals. The set is made up of 20 animals (Figure 2). The comic strips continued by illustrating

the reasoning for $\frac{1}{2}$ of 20. That is, given a set of 20 items, the items can be distributed equally into two equal groups and $\frac{1}{2}$ of 20 requires the students to find the number of items in one group. Students then use the same reasoning for $\frac{1}{4}$ of 20 with the comics illustrating the distribution of 20 items into four equal groups in order to find the number of items in one group.

The comics then represented $\frac{1}{6}$ of 12 and $\frac{5}{8}$ of 16 using model diagrams. Together with the model diagrams, the comics provided clear illustration of the steps to determine their solutions. The well-connected representations (verbalization of Bubble Boy’s reasoning process, the model diagrams and the explicit steps) enabled students to make sense of key ideas of *fraction of a set* and to apply the reasoning to solve the more challenging problems in the package (Figure 4).

When asked how the comics package helps them in learning and understanding *Fraction of a set*, Student Lola (pseudonym is used to protect the anonymity of the student) said,

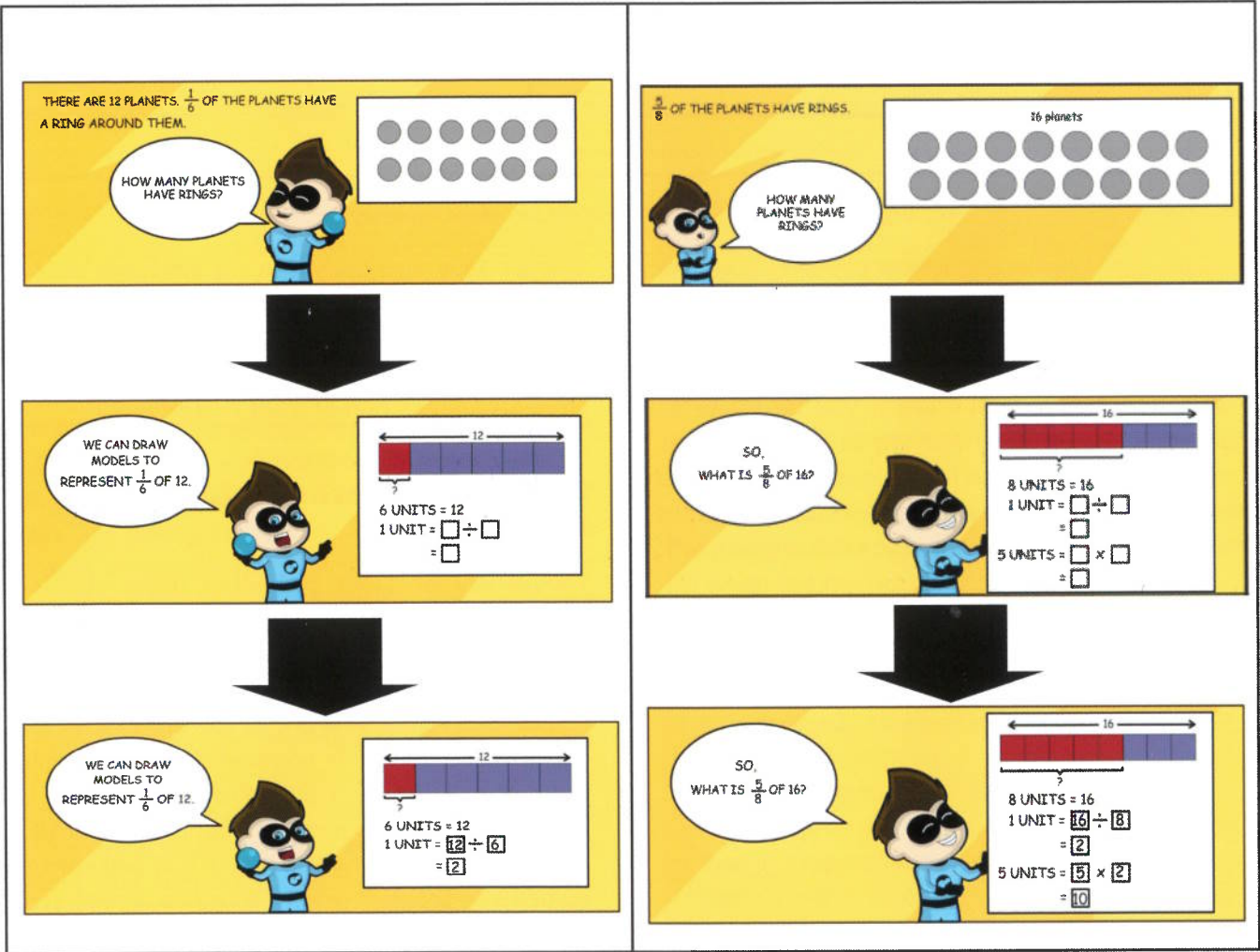


Figure 3: Model diagram in Fraction of a set.

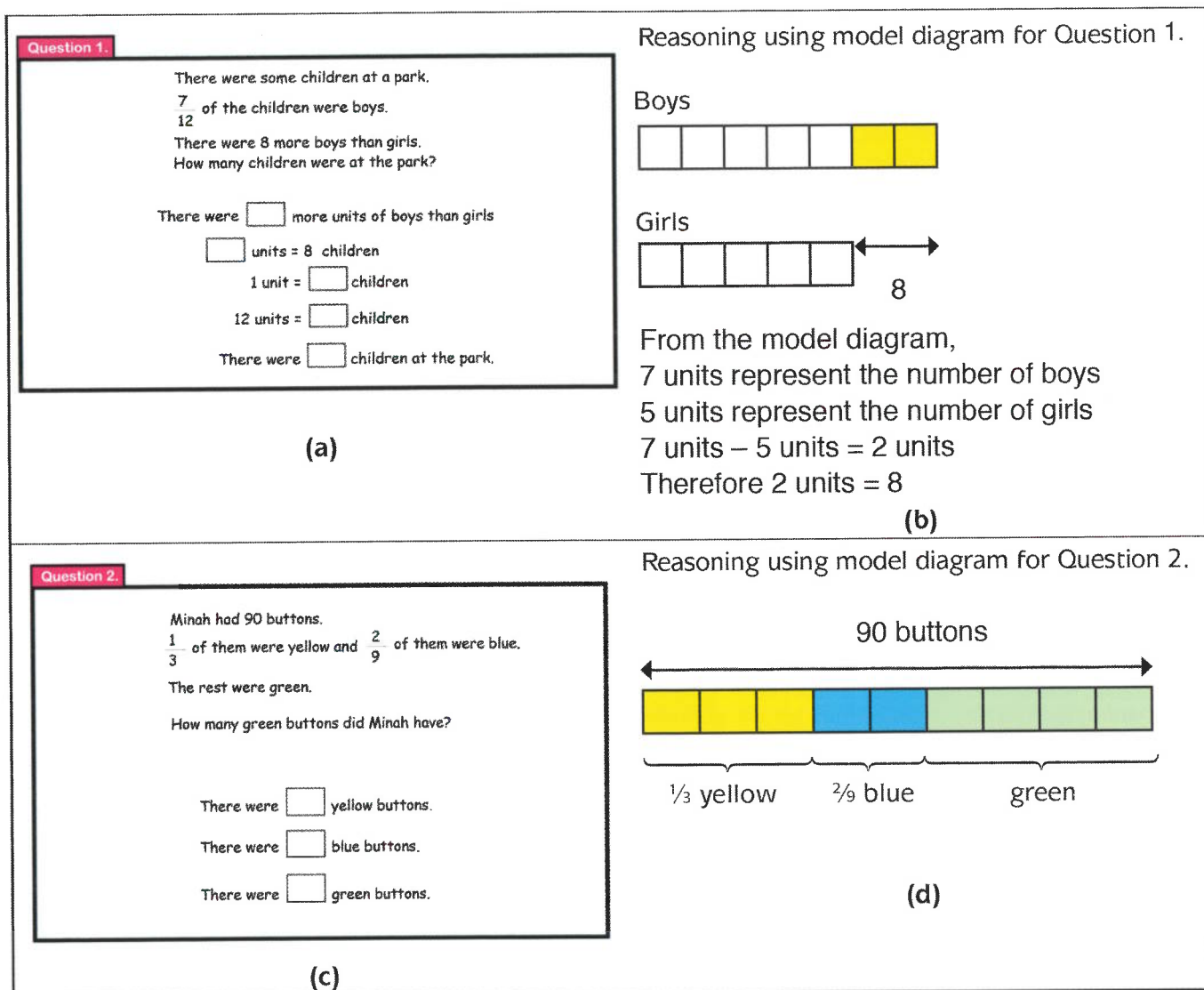


Figure 4: Examples of problems in the comics package.

“... It's like show us about how to regroup, ... like because if we don't understand it, we have the image [pictures] to guide us, so and it's also some ... questions so that we will really know how to do it”. Lola added, “It's like it will be easier to understand instead of like words 'cause I'm not really understanding so like – I need something to explain to me, and there's a picture of the comics so I, some sort of explain to me what is going on”.

Another student Tim also said in his interview that the story and the visuals in the comics package help him understand fractions better.

“I'm not very good at fractions. So yeah, it'll be quite hard for me to understand but, the comic um, make- *it's clear*. And like if I read the story and how they do and the graph [picture], *then I will understand* it... my teacher talks about it and um teach us and *explain more about it*, like further.”


Teacher Toby also shared in his interview that the visuals in the comics aid student learning. He said, “with the examples given and being very pictorial... so it catered to some students and helped some students see fraction of a set better”.

Variety of mathematical task types

The variety of tasks presented, from simple to complex tasks, in the package allowed students to develop deep understanding of the topic. Besides tasks that emphasised procedural fluency, problem posing (See Figure 5) is one of the task types in the comics package and is considered a high cognitive demand task (Doyle, 1983). Problem posing is also a fundamental component of mathematical thinking (Cai, Moyer, Wang, Hwang, Nie, 2013) and engaging students in problem posing activities is reported to have a positive impact on students' learning (Cai & Hwang, 2002).

Question 4

Using the same diagram.
Ask 2 questions related to fractions of a set.
Here's a hint.
Think of "boys" and "girls"



Here are my 2 questions and answers

Question 1:

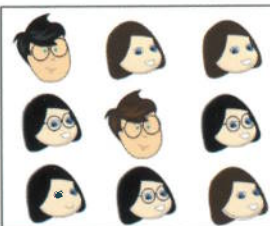
Answer:

Question 2:

Answer:

Question 4

Using the same diagram.
Ask 2 questions related to fractions of a set.
Here's a hint.
Think of "boys" and "girls"

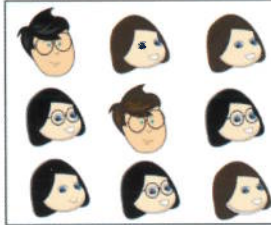


Here are my 2 questions and answers

What fraction of the girls wear glasses?
Students Answer should be 3 out of 7

Question 4

Using the same diagram.
Ask 2 questions related to fractions of a set.
Here's a hint.
Think of "boys" and "girls"



Here are my 2 questions and answers

What fractions of the girls have black hair?
Students Answer should be 4 out of 7.

Figure 5: Problem posing task in comic package.

In this study, the problem posing task elicited students' thinking and provided evidence of students' thinking (Figure 5b). This information allowed the teachers to access students' understanding of mathematics, identify and address misconceptions that surfaced from the problem-solving tasks. For example, teachers could use the question posed by the students, "What fraction of the girls wear glasses?" (Figure 5b) to deepen students' understanding of 'a set' by distinguishing the differences between the sets when the question asks, "What fraction of children wear glasses?" Similarly, teachers could use students' responses "What fraction of the girls have black hair?" and "What fraction of children have black hair?" to draw out differences between the two sets and ensure that students are very clear and specific about the set they were referring to. By doing so, teachers could "assess progress toward mathematical understanding" and adjust instruction in ways that support and extend learning progress (NCTM 2014, p. 10).

Another task-type in the comics package required students to reflect on the mathematical ideas for the

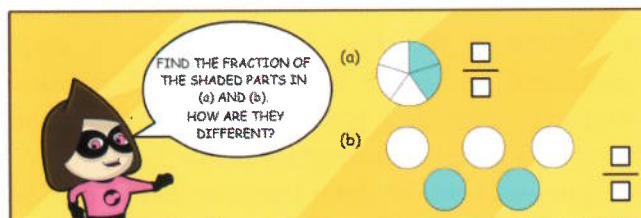


Figure 6: Reflecting on mathematical ideas.

topic. For example, the tasks in Figure 6 required the students to reason out any differences in (a) and (b) when the fraction is $\frac{2}{5}$ in both situations.

Tasks that "promote mathematical reasoning and problem solving and allow multiple entry points and



Figure 7: Multiple methods.

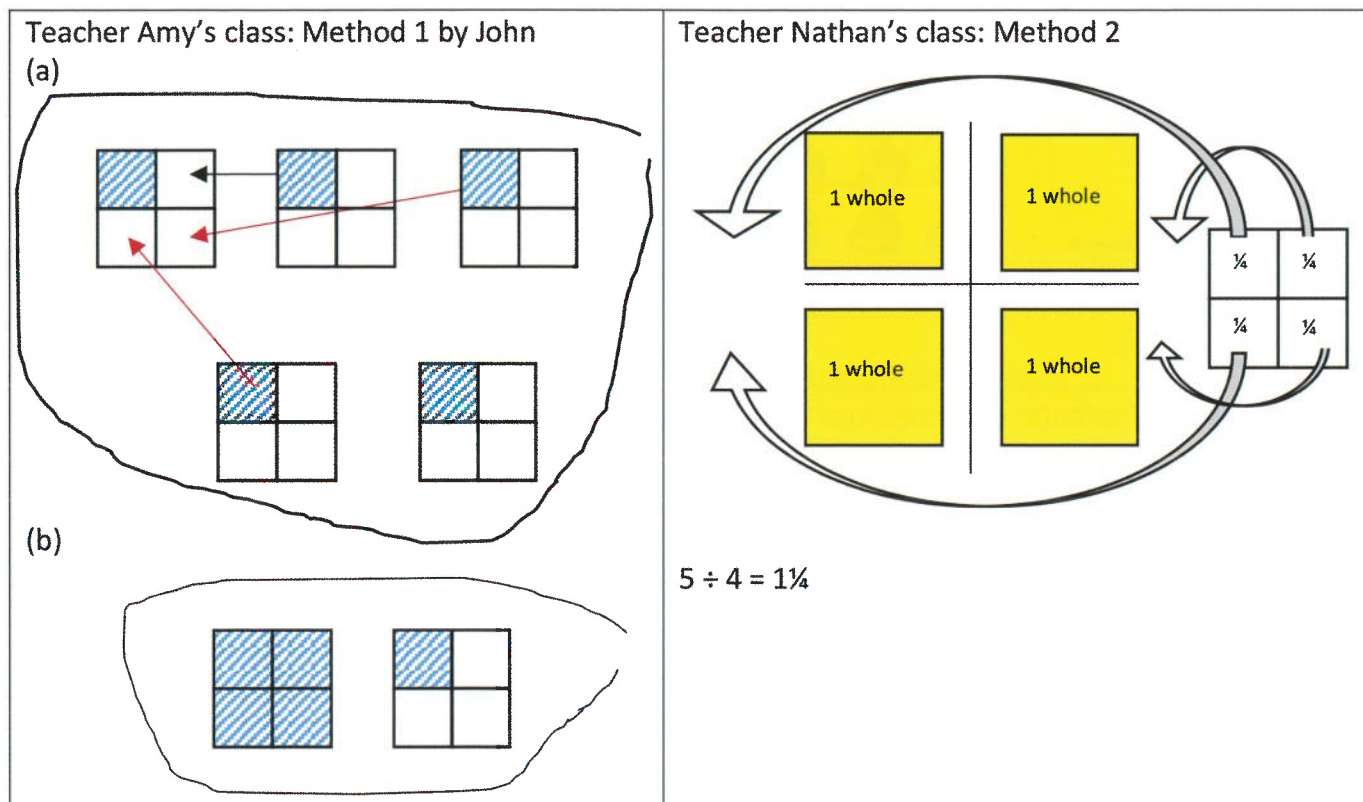


Figure 8: Students' methods to find $\frac{1}{4}$ of 5.

varied solution strategies" (NCTM 2014, p. 10) were also included in the package. For example, the tasks in Figure 7 afforded opportunities for students to think about multiple approaches to the problem. Two methods for this task are presented in Figure 8.

John, a student in Teacher Amy's class explained his method to his class. He shaded $\frac{1}{4}$ of each square, and he said "I take the other 3 [shaded parts] and bring over [gestured how he will shift the other 3 parts]. John explained that by doing so, that gives us 1 whole. John then concluded that $\frac{1}{4}$ of 5 or the shaded part will be 5 quarters or 1 and $\frac{1}{4}$ (Figure 8b). In Teacher Nathan's class, $\frac{1}{4}$ of 5 was interpreted as 5 objects to be shared equally among 4 children and hence the equivalence of the expressions $\frac{1}{4} \times 5 = 5 \div 4$. Five squares were drawn to represent the 5 objects. The first 4 squares were equally shared among 4 children leaving the fifth square to be shared equally among 4 children. The fifth square is cut into 4 equal parts. Hence, each child has 1 square and $\frac{1}{4}$ of a square.

Conclusion

This paper discusses possibilities for using the comics package to engage students in meaningful learning. Two key features of the comics, visuals and variety of task types are highlighted in this paper.

Specifically, comics are the expedient use of visual representations to convey messages, in a manner that is more interesting to most students compared with the usual textbook messages. We believe that when primary school teachers use the comics package meaningfully, they ride on the affordance of these features of comics. In this way, we argue that the use of comics can engage students learning of mathematics.

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5 on the Clock



On a digital clock showing 24-hour time, over a whole day, how many times does a 5 appear?

Is it the same number for a 12-hour clock over a whole day?

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