NCETM
NATIONAL CENTRE FOR EXCELLENCE
IN THE TEACHING OF MATHEMATICS

Additive Reasoning

This document is part of a set that forms the subject knowledge content audit for Key Stage 1 and Key Stage 2 maths. Each document contains: audit questions with tick boxes that you can select to show how confident you are (1 = not at all confident, 2 = not very confident, 3 = fairly confident, 4 = very confident), exemplifications; explanations; and further support links. At the end of each document, there is space to type notes to capture your learning and implications for practice. The document can then be saved for your records.

Question 1

How confident are you that you understand and can support children to use a part–part–whole model, to explain the structures of aggregation (addition) and partitioning (subtraction)?

1 ☐   2 ☐   3 ☐   4 ☐

How would you respond …?

a. Create your own aggregation and partitioning stories to describe the image.

b. What structure is this word problem? Use a part–part–whole model to represent the relationship.

> There are one hundred and seventy-two books in the book corner. Fifty-three of the books are fiction. How many are non-fiction?

c. If there are more than two parts, how does this affect the structures of aggregation and partitioning?


Responses

Note your responses to the questions here before you engage with the rest of this section:

Did you notice that…?

a. When creating aggregation and partitioning stories, two quantities are combined or separated – it is not an increase or decrease in quantity. For example:

- *'There are six presents, two have bows on them and the rest do not. How many presents do not have bows on them?'*
- *'There are two deflated balloons and six inflated balloons. How many balloons are there altogether?'*

b. This is a subtraction problem where the whole has been separated into two parts so that it has a partitioning structure. A bar model or cherry model could be used to represent the relationship.
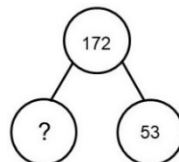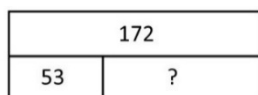
c. The structure of aggregation and partitioning is not affected by there being more than two parts. The whole is split into the required number of parts or more items are combined to make the whole.

Aggregation (addition) and partitioning (subtraction) structures

This section focuses on the structures of aggregation and partitioning as well as the part–part–whole model and how it links to problem solving and calculation, with a focus on language.

Aggregation is the structure of addition in which two quantities are combined and addition is used to determine a sum; no more is added. For example, there are apples and bananas in a fruit bowl, or children standing up and sitting down. In both examples, the quantity does not increase; two parts have been added together to make the whole.

Partitioning is the inverse of aggregation, where the whole has been separated into parts. For example, if there are seven pieces of fruit in the bowl, five of them are bananas and the rest are apples, how many apples are there?

Bar models or cherry models are types of part–part–whole model that can help children to see the mathematical structures. They provide clarity, revealing the maths and the methods needed to solve a problem.

These models can also support the understanding of the relationship between addition and subtraction as they are seen within the same representation. This bar model diagram can be described in the following ways.


$$a = b + c$$
$$a = c + b$$
$$a - b = c$$
$$a - c = b$$

Bar models can be used to transform a real-life problem into a mathematical expression. For example:
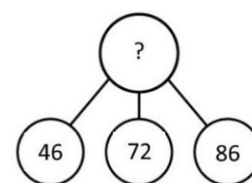
<div align="center">

**Damien has 72 trading cards, Wilf has 46 trading cards and Sally has 86 trading cards.
How many trading cards do they have altogether?**

</div>

In this example, we know the value of the three parts, but we do not know the whole. Representing this question with a bar model exposes the structure of the problem.
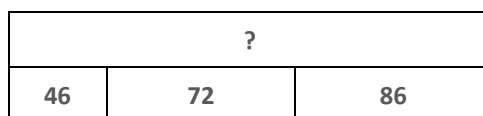
Children need to be taught how to not only represent the mathematics but how this representation enables them to identify the calculations that need to be done. In this example, the addends need to be added together to find the sum.

Children should have opportunities to use different representations, such as the bar model or cherry model, to represent a range of questions in different contexts.

It is important the children understand that aggregation is when two or more parts are put together to make a whole, and that partitioning is when the whole is split into two or more parts. Creating their own stories for the representations given will deepen their understanding of the structures.

Have a go. Can you create a partitioning story for this representation?

80		
16	23	?

Common errors in this area may include:

- children not applying their understanding of structures to different contexts, which may result in the wrong operation being performed
- children confusing the structures of partitioning and reduction, as they tend to be more familiar with the 'take away' structure for subtraction.

What to look for

Can a child:
- link aggregation and partitioning structures to a part–part–whole model?
- use and identify the mathematical language associated with the aggregation structure?
- use and identify the mathematical language associated with the partitioning structure?
- find the inverse calculations?
- create aggregation and partitioning stories?
- identify the structure from a range of word problems?

Links to supporting materials:

NCETM Primary Professional Development materials, Spine 1: Number, Addition and Subtraction:
- Topic 1.5: Additive structures: introduction to aggregation and partitioning
- Topic 1.7: Addition and subtraction: strategies within 10

Notes:

Key learning from support material and self-study:

What I will focus on developing in my classroom practice: