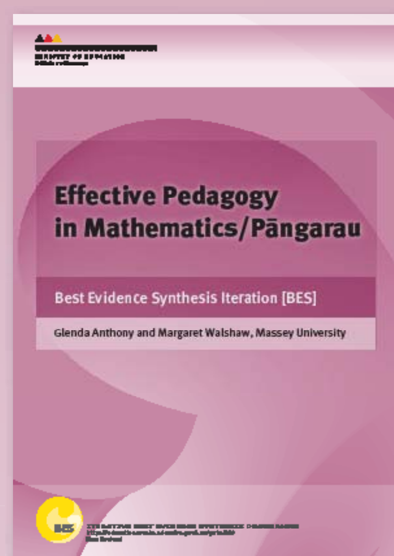
Develop tasks that provide high-level challenge and high-level involvement

This is one of a series of cases that illustrate the findings of the best evidence syntheses (BESs). Each is designed to support the professional learning of educators, leaders and policy makers.



BES
ITERATIVE BEST EVIDENCE SYNTHESIS PROGRAMME
HEI KETE RAUKURA
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New Zealand

MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

BES cases: Insight into what works

The best evidence syntheses (BESs) bring together research evidence about ‘what works’ for diverse (all) learners in education. Recent BESs each include a number of cases that describe actual examples of professional practice and then analyse the findings. These cases support educators to grasp the big ideas behind effective practice at the same time as they provide vivid insight into their application.

Building as they do on the work of researchers and educators, the cases are trustworthy resources for professional learning.

Using the BES cases

The BES cases overview provides a brief introduction to each of the cases. It is designed to help you quickly decide which case or cases could be helpful in terms of your particular improvement priorities.

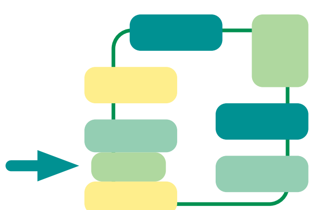
Use the cases with colleagues as catalysts for reflecting on your own professional practice and as starting points for delving into other sources of information, including related sections of the BESs. To request copies of the source studies, use the Research Behind the BES link on the BES website.

The conditions for effective professional learning are described in the Teacher Professional Learning and development BES and condensed into the ten principles found in the associated International Academy of Education summary (Timperley, 2008).

Note that, for the purpose of this series, the cases have been re-titled to more accurately signal their potential usefulness.

Responsiveness to diverse (all) learners

Use the BES cases and the appropriate curriculum documents to design a response that will improve student outcomes



The different BESs consistently find that any educational improvement initiative needs to be responsive to the diverse learners in the specific context. Use the inquiry and knowledge-building cycle tool to design a collaborative approach to improvement that is genuinely responsive to your learners

Develop tasks that provide high-level challenge and high-level involvement

The teacher in this case selects mathematically rich learning activities that are responsive to students’ knowledge and interests, invite exploration and discussion, and develop understanding of fractions.

The case describes how a “pizza fractions” kit provided the impetus for a “fraction flags” activity when the teacher saw a student making a “flag” using pieces from the pizza fractions kit and then exploring fraction-related questions using this different representation.

Challenging tasks with a mathematical focus

As we have seen in chapter 5, high-involvement teachers like Ms. K in CASE 2 typically present challenge as desirable, treat errors as informational, provide feedback on progress, and help students resolve conflicting reasoning. High-involvement classrooms were the focus of Turner and colleagues' (1998) study. A sixth grade teacher in this study, Ms. Adams, took a lesson on fractions and the researchers noted how she regulated the challenge of the task to match her students. Instead of altering the task goal, she adjusted the instructions until her students' skills matched the challenge. For example, to avoid reducing the overall complexity or compromising the integrity of the task, Ms. Adams modelled strategies such as reducing fractions expressed with large numbers to equivalent fractions expressed with smaller numbers. In contrast, when a low-involvement teacher in the same study wanted her students to convert $^{161}/_{184}$ to a percentage, she took over the task: "Most of us don't remember this, but if we want to turn this into a decimal, we would divide 184 into 161."

Students in low-involvement classrooms typically report feelings of boredom and less positive affect, and that their skills exceed the challenges provided. Houssart's (2002) UK study of a class of nine- and ten-year-old 'low attainers' illustrates how task challenge and related mathematical focus can influence students' performance. During a six-week unit on fractions, the children in the research class completed 18 worksheets requiring low-level identification and colouring of fractions of shapes. Houssart's observations of three boys revealed that each attempted, both privately and publicly, to extend ideas introduced by the teacher. For example, in a folding exercise to demonstrate halves, the boys speculated on whether thirds could be made in a similar way. The teacher, however, failed to acknowledge the students' attempts to extend the task. As the unit progressed, the boys commented on the ease of the work and their behaviour became more disruptive and off-task. The teacher's reaction was to express disappointment with the class and focus on structured worksheets. Henceforth, the instructional focus became task completion rather than the development or demonstration of mathematical understanding. As a consequence of the written work being too easy, the boys worked quickly without listening to the teacher, re-reading instructions, or seeking help. The fact that the work was so easy became, according to Houssart, a progressively stronger factor in the boys' apparent failure. By the end of the unit, these boys were failing to complete much of the easy work and they were communicating their dissent publicly.

> Superficially, this could be seen merely as bad behaviour and failure to cooperate. However, the crucial point is that the behaviour was a result of shifting classroom norms and practices. Non-challenging mathematics produced challenging behaviours. In terms of performance on formal written tasks it also produced failure, though oral response provided contrary indications. (Houssart, 2002, p. 210)

The study raises two significant issues for pedagogical practice. First, when gathering evidence about student learning, teachers need to consider evidence from a range of tasks, both written and oral. And second, more significantly, with regard to task challenge, Houssart's work contests the view that task simplification and repetition is appropriate for low attainers.

In contrast, tasks that present higher-level demands use procedures but in a way that build connections to the mathematical meaning (Stein et al., 1996). CASE 3 presents an example of a challenging task that arose spontaneously during a class activity. The mathematically rich activity invited student exploration and challenge at a range of levels appropriate to all students in the class.

CASE 3: Flags

(from Kieren, Davis, and Mason, 1996)

Mathematics teaching for diverse learners:

- involves explicit instructional discourse;
- creates a space for the individual and the collective;
- demands teacher content and pedagogical content knowledge and reflecting-in-action;
- provides opportunities for cognitive engagement and a press for understanding;
- utilises tools as learning supports.

This case describes students' exploration of fraction concepts using a student-generated activity, 'fraction flags'. The case is framed from the perspective that students benefit from engaging in mathematically rich activity—activity that invites exploration and conjecture. In addition, the teacher selects classroom learning activities that are responsive to students' knowledge and interests.

Targeted learning outcomes

Learners view fractions as representing additive quantities and as showing multiplicative relationships.

Learning context

This activity is derived from an exploration by two 12-year-old students, Tanya and Ellen, of the pieces from a 'pizza fractions' kit. The six-week unit that gave rise to the 'flags' activity was developed around various paper-manipulating activities: folding, cutting, comparing, rearranging, and assembling. The tools used to support learning included physical manipulation of units and fractional sub-units built from paper, mental actions on the images of fractions constructed by students, and the verbal and symbolic expressions of actions, observations, and justification.

Task and student activity

The fractions unit centred on providing opportunities for students to build their own ideas of fractions. A key representation for investigating multiplicative notions involved folding units (standard pieces of paper) and sub-units into various numbers of parts. For example, by exploration, repeated folding could generate thirty-twoths. Another representation, the 'pizza fractions' kit, (assorted rectangular fractional pieces including wholes, halves, thirds, fourths, sixths, eights, twelfths, and twenty-fourths, as in figure 7.1) offers students the opportunity to develop an additive, quantitative sense of rational numbers.

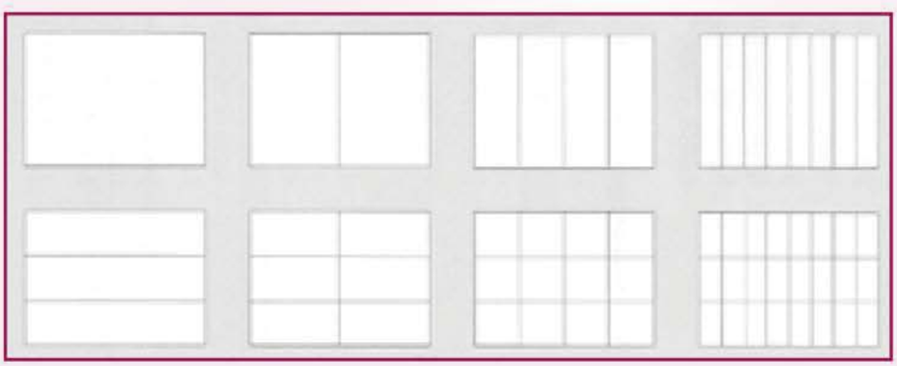


Fig. 7.1. The 'pizza fractions' kit

Activities based around the pizza kit included student-generated pizza orders, such as $^3/_4 + {}^2/_3 + {}^5/_{12}$. Students' arrangement of the pieces supported the development of images and understandings. Several strategies were used by students to present their results, including drawing pictures, writing out fraction phrases and sentences, and reproducing summary charts.

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Within this context, Kurt, playing with some pieces from the kit while waiting for the teacher, created a flag (fig. 7.2). Prompted by another student's enquiry as to how much of the paper was left uncovered, the teacher structured a new setting for further fraction problems.

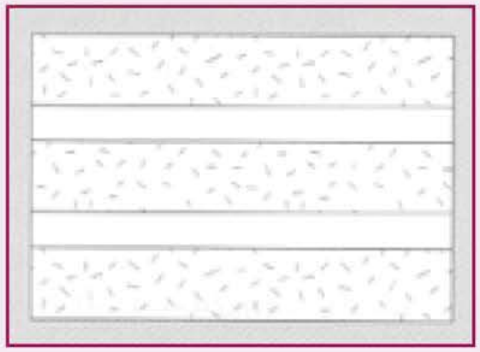

Fig. 7.2. Kurt's flag

The 'fraction flags' activity was introduced to the class in this way:

Take a half piece, a twelfth piece, and two eighth pieces from your kit and make this flag (see fig. 7.3). Show it to your partner and make up some fraction questions about the flag. For example, is more of the base covered or uncovered? How much more? Use pieces from your kit to make up your own flag. Once you have done this, make up some fraction questions about it. Try to have your partners or other students in class answer your questions. All members of your group should be ready to discuss your flags and questions with the rest of the class. Remember, try to make interesting flags, but also make flags so that you can ask good fraction questions about them.

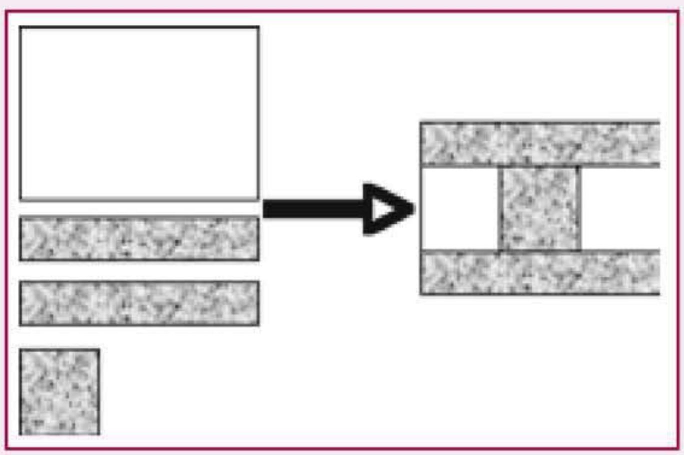

Fig. 7.3. 'Fraction flag' questions

Student outcomes

When left to design their own questions within contexts that were of interest, students developed situations that were personally challenging. For example, Tanya and Ellen made a fraction flag (fig. 7.4) by taking a half-sheet of paper and arranging smaller pieces on it, then worked out how much of the whole sheet of paper was covered.

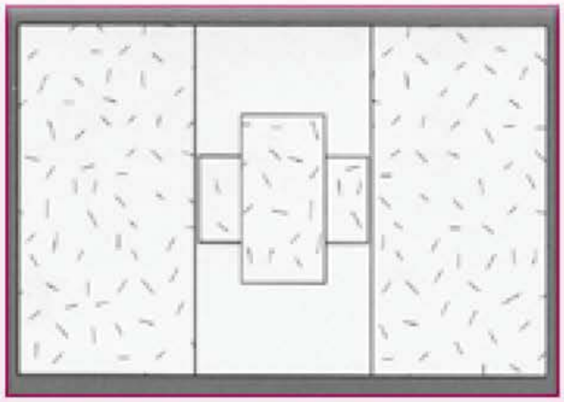

Fig. 7.4. Tanya and Ellen's fraction flag

Ellen: The edge parts are easy—that's just two-sixths [of a whole sheet]—but the middle part is hard.

Tanya: That's because it's a twenty-fourth on top of a twenty-fourth.

Ellen: I can see the twenty-fourth in the middle, but I don't get the two little pieces on its sides.

Tanya: [Sliding over the top twenty-fourth piece] Oh, I get it. Those two side parts make a half of a twenty-fourth together, and that's a forty-eighth.

Ellen: Okay! So the total covered on the flag is two-sixths plus one twenty-fourth plus half a twenty-fourth.

Tanya: Right! So that's four, eight, nine-and-a half twenty-fourths. What's that in forty-eighths?

The two girls solved the coverage problem by rearranging the pieces so that they could "see" the amounts involved. Although the calculation was informal, it amounted to $^{2}/_{6} + {}^{1}/_{24} + {}^{1}/_{2}({}^{1}/_{24}) = {}^{9.5}/_{24} = {}^{n}/_{48}$—a significantly challenging task for students considered to be average achievers in mathematics.

The flag activity gave students an opportunity both to develop calculation skills and to invent situations that required more flexible strategies.

Students were positioned as mathematical doers and thinkers: "It's good. It's a little challenging; It's not boring to do" [Ellen]; "A way of asking questions about the world" [Greg].

Quality pedagogy

Enactment of the flag activity highlights factors that supported productive learning:

- Task design was premised on a combination of a predetermined learning trajectory based on teacher knowledge of fractions and significant milestones.
- The teacher responded flexibly to students' interest and learning needs. The introduction of the flag activity was a direct result of the teacher attending to the learners—learning from them—to structure responsively a more effective learning environment.
- The flag activity is a mathematically rich activity that invited exploration and conjecture while offering opportunities for personal and aesthetic expression.
- The flag setting allowed students to interact with one another, with the teacher, and with the objects in their world. The resulting conversations enabled the teacher to observe and respect the diversity in students' fractional thinking and in their expression.
- Class discussion supported the introduction and encouragement of the use of standard fraction language and symbols.

- Students were able to create problems for themselves that were appropriate to their own levels of understanding.

These pedagogic strategies involve "not simply helping students to learn but, more fundamentally, learning from the learners" (p. 19).

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