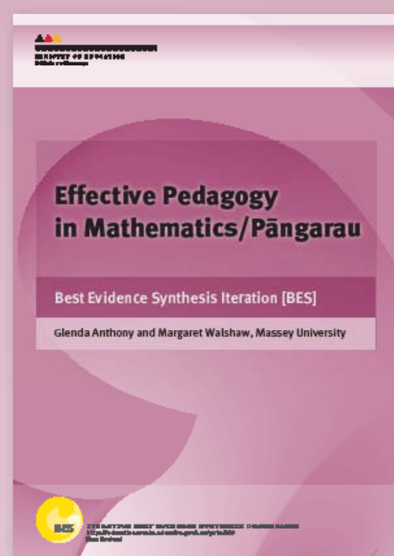
Develop a mathematical community of practice

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 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.

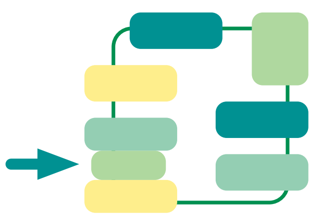
Use the cases with colleagues as catalysts for reflecting on your own professional practice and as starting points for delving into other sources of information, including related sections of the BESs. To request copies of the source studies, use the Research Behind the BES link on the BES website.

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 a mathematical community of practice

In a mathematical community of practice, students learn to articulate their thinking and engage in exchange of ideas in an environment that is both challenging and safe. The safety is particularly important because, to develop mathematical understanding, students need to be able to get things “wrong” and learn from their “mistakes” without being embarrassed or defensive.

This case provides a window into the relationship between a teacher and two students as the teacher challenges one of the students to clarify his explanations.

See also BES Exemplar 1: *Developing communities of mathematical inquiry*.

Belonging to a community of learners

Engaging students in what Wood, Cobb, & Yackel (1991) call "genuine conversations" about mathematics means that teachers take students' ideas seriously in their attempts to support students' understanding. CASE 7 provides a window into a lesson that involves ratios. In addition to featuring the use of multiple connections between percentage, fractions, and measurement, the detailed exchange between the teacher and student illuminates the sense of community and ethic of care that pervade this classroom.

CASE 7: Mixing Drinks

(from Sherin, Mendez, and Louis, 2004)

Mathematics teaching for diverse learners:

- demands an ethic of care;
- involves the respectful exchange of ideas;
- creates a space for the individual and the collective;
- provides opportunities for students to resolve cognitive conflict;
- involves sequencing of tasks and provision of appropriate challenge;
- provides opportunities for students to problematise activities based in realistic contexts;
- involves explicit instructional discourse.

This case is taken from a wider curriculum reform programme, Fostering a Community of Learners (FCL; Brown & Campione, 1996). The goal in the mathematics classroom was the building of a discourse community that focused on students' explanations and discussion of their ideas. In the following example, we see how the FCL principles of activity, reflection, collaboration, and community are realised in David's classroom.

Targeted learning outcomes

Solving ratio problems.

Learning context

The students in this study were from a middle-school classroom involved in an extended reform programme intervention in conjunction with researchers at Stanford University. Data were collected through videotapes of instruction and through discussions of these videotapes with the teacher. The lesson reported on in this case occurred in the second year of the study. Students were given a series of drink mix problems—one of these was as follows:

Juice Mix A contains 2 cups of concentrate and 3 cups of cold water. Assuming that each camper will get ½ cup of juice, how much concentrate and how much water are needed to make juice for 240 campers?

While the students worked on the problem in groups, David, the teacher, circulated through the class.

Student and teacher activity

As David approached Antoine's group, Antoine called him over for help on the last problem. David asked Antoine what he had done so far.

Antoine:	OK. You do 3 out of 5. Three divided by 5 is 60%, times 240 equals 144, divided by 2 is 72. I've got the answer. I've got skills, boy. Yeah.
Teacher:	Can you explain what you just did, what that means?
Antoine:	Yeah, yeah.

Teacher: What's the 3 out of 5 part?

Antoine: Three out of 5 is the number, the number, the cups of water divided by all of the cups put together. And then it equals 60%. And then, times 240 is the number of campers.

Antoine had recognised that for every five cups of juice, three of the cups were water. And it seemed that because $3/5 = 0.6$, Antoine concluded that 60% of the juice mix must be water, no matter how many cups of juice. He then took the total number of campers, 240, and multiplied that by 0.6. Because each camper gets only half a cup of juice, Antoine divided 144 by 2 to get 72 cups of water in the total mix. Later on in the discussion, it became clear that Antoine was unsure of this last part of his calculation.

The report of the teacher's reflections of this episode noted that he was unclear as to why Antoine would multiply 0.6 by 240—the number of campers. Why did Antoine need to know how many 60% of the campers would be? David's own solution involved first calculating the total numbers of cups of juice that were needed, 120 cups and then because 60% of the juice was water, calculating 60% of 120 to conclude that there 72 cups of water. David asked Antoine to elaborate his solution method.

Teacher: So that tells you what, if you do 60% times 240?

Antoine: It tells you how many cups, wait. Times 240. Tells you how many cups are needed.

Teacher: That tells you 60% of the campers.

Antoine: No, tells you 60% of that juice stuff.

Robert: Tells you that 60% of the mix is concentrate.

Antoine: No, it tells you that 60% of water is in the mix altogether.

Robert: Yeah.

Teacher: All right, all right, you've got skills. Let's go.

Antoine: I know I've got skills, you ain't got to tell me. Then this is the part I messed up at. The number of campers, you get. You have to times it, and then what do you get?

In the above episode, we see that Antoine's explanation initially involves 'how many cups' are needed. In response to the teacher probe Antoine becomes a little more precise, explaining that it tells him '60% of that juice stuff'. Robert, another group member, interjects with an incorrect statement, saying that it tells you that '60% of the mix is concentrate'. However, in trying to respond to Robert, Antoine is finally able to explain that 60% of 240 tells him how much 'water is in the mix altogether'.

Quality pedagogy

The researchers analysed factors that facilitated students' success with the ratio problems in terms of four principles of learning: activity, reflection, collaboration, and community.

- Antoine is clearly an active participant in the discussion. He seeks teacher assistance and enthusiastically reviews his solution method with the teacher.
- The interaction supports Antoine to "reflectively turn around on [his] own thought and action and analyse how and why [his] own thinking achieved certain ends or failed to achieve others" (Shulman, 1995, p. 12, cited in Sherin et al., 2004). In reviewing his solution, Antoine clearly wants to resolve his uncertainty as to why he decided to divide 144 by 2.
- Collaboration involves teacher–student and student–student interactions. In the second episode, Robert and Antoine scaffold and support each other's learning in ways that supplement each other's knowledge.
- Sherin, Mendez, and Louis claim that the 'community' principle is more clearly evident in the videotape. From the transcripts, it is apparent that the teacher and Antoine have an established routine that supports effective communication. Teacher questioning occurs in an environment in which Antoine feels safe to

respond. Antoine seeks teacher help, knowing that it is appropriate to question his own solution despite the fact that he already has the answer. The banter between Antoine and the teacher provides evidence of a culture that affords opportunities for students to share their understandings and to know that their opinions are valued.

References

Brown, A., & Campione, J. (1996). Psychological theory and the design of innovative learning environments. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 188-228). New York: Cambridge University Press.

Sherin, M. G., Prentice, M., & Louis, D. (2004). A discipline apart: the challenges of "Fostering a Community of Learners"in a mathematics classroom. *Journal of Curriculum Studies, 36*(2), 207-232.

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