Shirouzu Data Set[1]

This data set consists of **video data of a fifty-minute class** of Japanese 6th graders and their **written reports five months after the class**. As this school is very remote, there were only SIX children as a whole in the class, the size of which enabled me to transcribe **all talks and actions of all the children**.

Participants

Participants were six 6th graders: two females G and K and four males F, N, O, and Y (pseudo-initials), seated as in Fig.1. I (Shirouzu) visited the class and conducted the lesson as a teacher. The lesson was thus detached from the regular course and curriculum.

Fig.1. Blackboard at the end of the lesson

Tasks and Learning Objectives

The first task was to make 3/4 of 2/3 of colored paper (origami paper) using provided colored paper and scissors. The second one was to discuss whether various answers to the first task were the same or not. The first task was solvable in many ways from external-resource driven (e.g. fold and cut the paper) to internal-resource driven (e.g. 2/3 multiplied by 3/4 equals 1/2), the features of which let us observe the details of intra- and inter-mental interactions. The learning objective for pupils was to connect their hands-on experience to algorithmic knowledge in order to deepen their prior understanding of fraction multiplication.

[1] Slightly adapted from Shirouzu (in press) by Kristine Lund for the purposes of the *école thématique IR Vidéo* in Brest, 2013.

Phases of the Lesson

The lesson could be roughly divided into two phases, corresponding to the two tasks above. In Phase 1, two children (N and G) volunteered to do the task, and then all six children did it. Everyone used external resources, i.e., origami paper, but their ways had rich variety as shown in Fig.2. In Phase 2, they discussed whether those answers were the same, through which awareness to the algorithmic solution emerged. Time spent in Phase 1 was about 30 minutes and that in Phase 2 was 15 min. Let me describe the lesson in detail, tying it to the transcription file. Having origami paper at hand helps your interpretation.

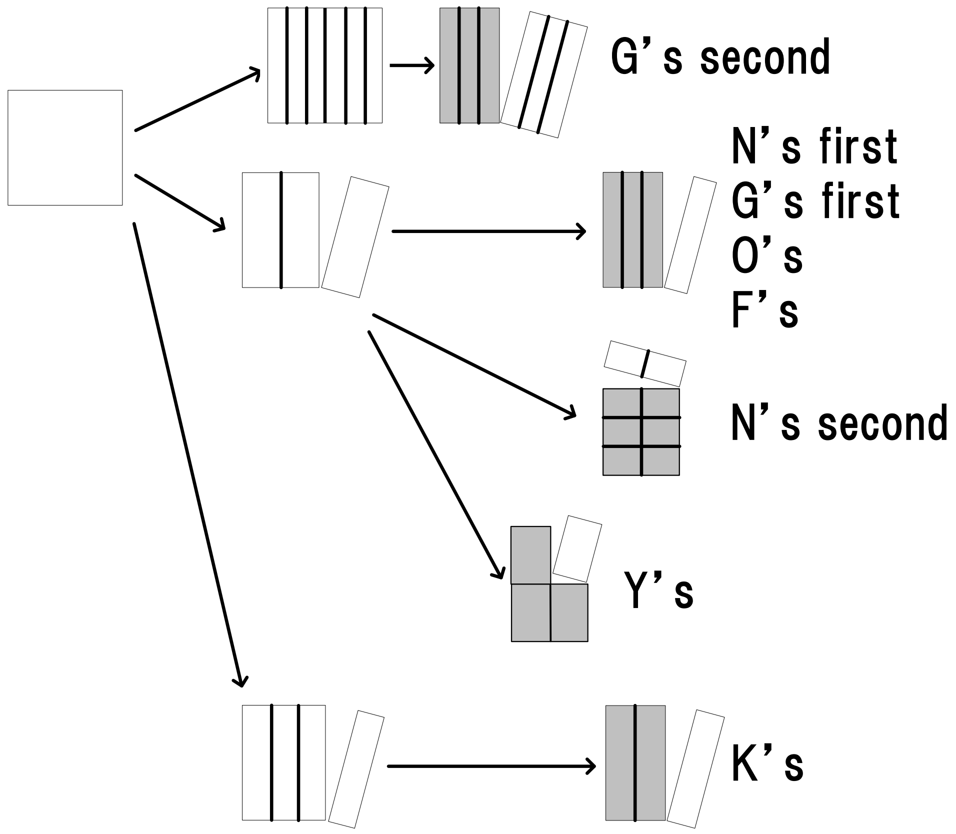

Fig.2. Solution Processes

For example, N's first solution is represented in "N's first" path from an original square at the leftmost column, to the midpoint where some parts are cut out and lastly to the resultant state represented by shading ('One' in the transcription means the original square, but sometimes this middle 'rectangle.') Folds are shown by bold lines. The length of arrow roughly means the efficiency of solution steps.

Phase 1: Lesson from the start to thirty minutes

Lines 1 to 42. Children were instructed to solve the problem of "obtaining 3/4 of 2/3 of colored paper (origami paper)" using provided colored paper and scissors. N and G reacted to this instruction. Their solutions happened to be the same as shown in Fig.2.

Lines 43 to 127. The teacher asked N (and then G) to explain his/her solution to others, displaying it by new sheets of paper and some notations on the blackboard as shown in Fig.3.

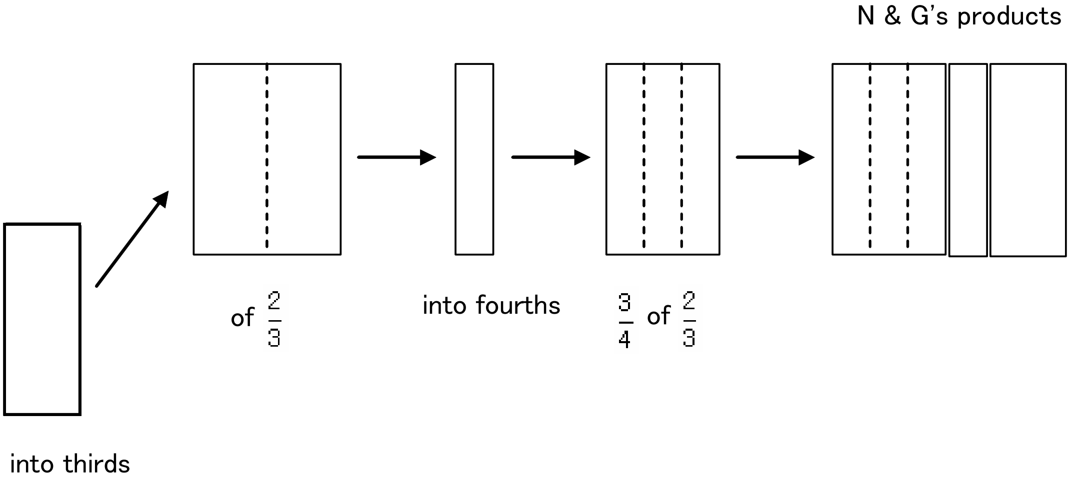

Fig.3. Blackboard at line 127: Display of N and G's solutions

Lines 128 to 201. Then, the teacher encouraged all children to tackle with the task, by saying "there is no correct solution. Although N and G solved the problem in this way, there may be other solutions" (lines 130-137). Children did it in various ways as shown in Fig.2. N and G changed their ways from the first trials. K changed the order of fractions, but had some confusion and completed the task helped by a teacher in charge. Also, F first failed, but completed it supported by other children. Y had planned to solve the task in the same way as N's second solution, but happened to notice at the midpoint that he did not have to fold the "2/3 rectangle" into fourths and instead only had to fold it into halves to take the 3/4 of 2/3 area.

Lines 202 to 405. The teacher asked the all to explain each own solution. A total of eight answers of five types were posted on the blackboard with their solution processes as shown in Fig.1 and Fig.4. The answers differed from each other in shape or production method, providing the class with sources for further discussions.

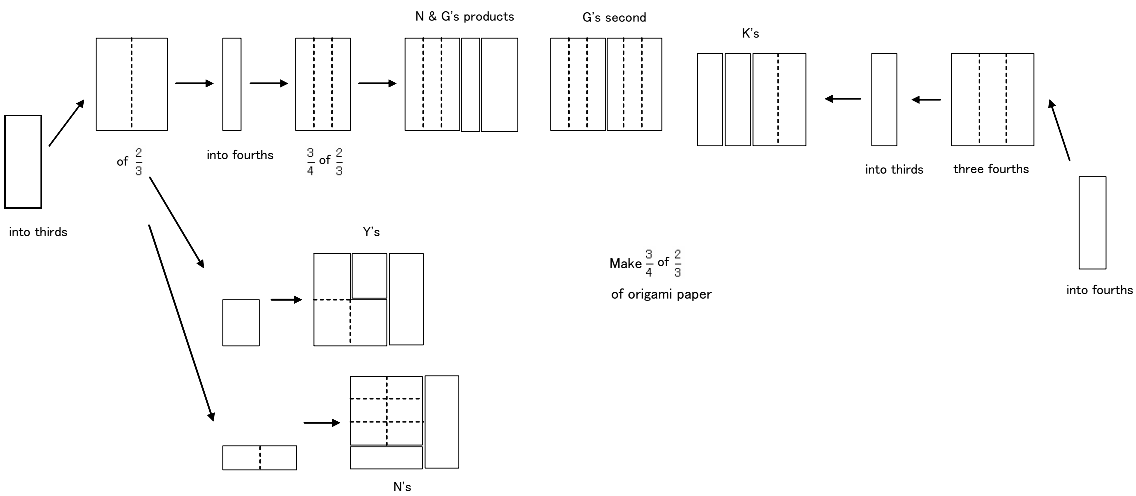

Fig.4. Blackboard at line 405: Display of all pupils' solutions

Phase 2: Lesson from thirty minutes to the end

Lines 406 to 499. The teacher asked the pupils to discuss whether the answers were all the same, but their responses were dull and no clear answer was obtained. The teacher changed the questioning approach to letting them compare every two pieces of colored paper like N's first solution and G's second one, and repeated paired comparisons five times in total as follows ("AND" indicates comparison; see Fig. 2 for the solution shapes). This scaffold enabled the pupils to compare the variations and see commonalities among them shown in double quotations.

Child N's first solution AND G's first solution: "The same." (Lines 448)
Child N's first solution AND G's second solution: "Although the production methods differ, the shape is the same." (Lines 457-459)
Child N's first solution AND N's second solution: "Though areas are equal, the shape and production method differ." (Lines 473-476)
Child N's first solution AND K's solution: "Although the shapes are the same, the production methods differ." (Lines 481-482)
Child N's first solution AND Y's solution: "Although the areas are the same, the shapes and production methods differ." (Lines 488)

As you noticed, the abstract commonality "area" appeared at the third comparison, to which Y referred sooner than any other children (Line 473). The girl G also said "the areas are the same" immediately following this verbalization, which succeeded in confirming the existence of a new dimension "area" to the class, supporting child Y at the same time (Line 474).

By this point, the teacher had visualized the results of their comparisons and wrote commonalities on the blackboard (Fig.5). On his asking, "What among these is constant?" (Line 495), pupils said first quietly but then loudly, "the area" (Lines 496-497).

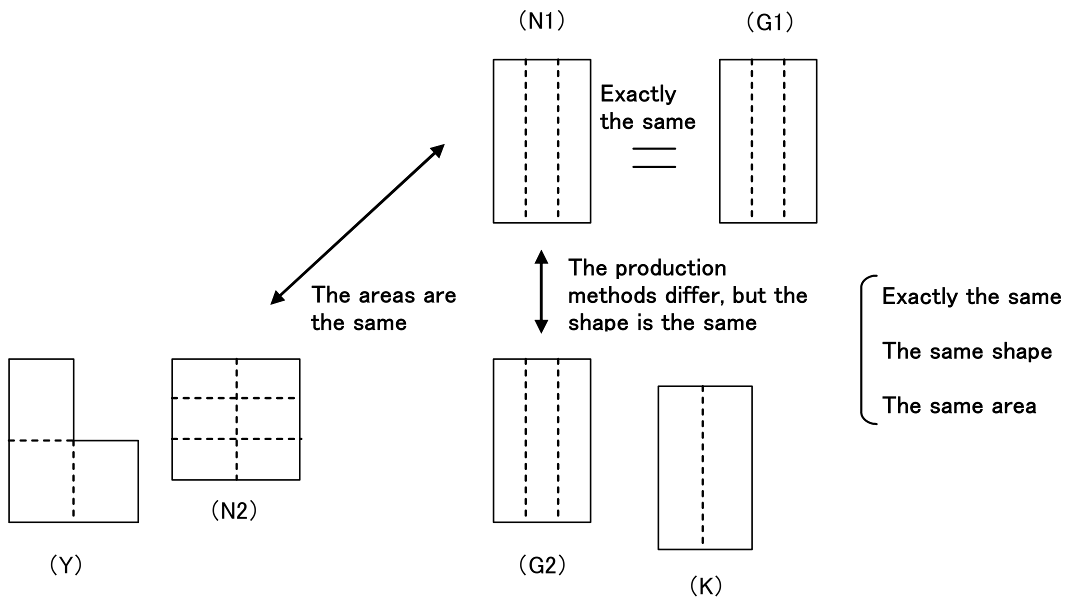

Fig.5. Blackboard at line 495

Lines 500 to 548. When asked "How large is the area?" by the teacher, Y clearly answered "2-bun-no-1 (algorithmic expression of one half)" and attempted to explain it by mating the portion of colored paper representing the answer (G's second one) to the rest portion, but he withdrew that idea (Lines 500-519). G supported this explanation too (Line 520). Finally, Y explained that all answers are 1/2 by the following calculation (Lines 536-546):

"Another (explanation) is, when these two (fractions) are multiplied, I think that the ratio (of the answer) to the whole can be obtained. When 2/3 is multiplied by 3/4, the product is 6/12 and it is equal to 1/2 after being reduced, all (answers) are 1/2 of the whole."

He took the floor from the teacher and asked the other pupils, “What do you all think?”(Line 547). The others answered, “OK” (Line 548).

Lines 549 to 584. The teacher resisted their jump from externally-driven reasoning to an algorithmic one. He aimed at, for example, letting them back up their own explanation by using "a core square" of 1/12 area to show every shape has six of them.

Reports Five Months after the Class

Although the boy Y’s explanation was approved by all members and the class appeared to have converged to a certain understanding, differences between them were revealed in descriptions of the lesson contents written five months later. Table 1 shows their reports to the teacher's question, "what do you remember about the last lesson?" Y's report included the calculation (2/3 x 3/4) and its answer (1/2), which was not common among all the pupils. Instead, the others like Child G referred to the “shapes,” indicating that they did not necessarily consider the lesson from the mathematical point of view.

Table 1. Contents of Reports

Y	We made 3/4 of 2/3 using origami paper. Then the 2/3 x 3/4 made 1/2 and we thought why it resulted in 1/2.
K	Various shapes of 1/2 of origami paper were made. We thought why 2/3 x 3/4 equals 1/2.
G	3/4 of 2/3 of origami paper was expressed by shapes.
N	What is the shape of 3/4 of 2/3 of colored paper? Do various shapes produced have the same area?
O	To solve the problem of dividing a piece of origami paper into 3/4 of 2/3, we folded it into 2/3 and then 3/4 of 2/3. Various shapes were obtained.
F	Origami paper was used and folded to find 2/3 and 3/4.

Key Questions for the Workshop

What do you see as “pivotal” in this lesson, either in terms of learning or in terms of collaboration? How do you define “pivotal”? Why did you choose those particular moments? What are the assumptions you are making, either about learning or about collaboration?