

Developing Pictorial Ideas in Learning Numbers and Calculations

Tadato Kotagiri

University of the Ryukyus, Japan

kotagiri@edu.u-ryukyu.ac.jp

Pictorial tasks serve three roles in the learning of basic mathematics. First is a function that was observed in children's learning activities, and the second in the teachers' teaching activities. The third function was detected in the teachers' own research and training. These three functions are cited in the examples below. This paper is based on the clinical/remedial research into children with learning difficulties and other special needs. The research has been a longitudinal study over several years and is, even now, still ongoing.

1. The Steps in Teaching/Learning Mathematics and Pictorial Tasks

In my clinical/remedial research into children with difficulties in learning mathematics, I empirically demonstrated the possibility of children overcoming learning difficulties, in other words, securing an adequate level of achievement in learning the four basic operations of arithmetic, by going through four steps in learning. These four steps are the Real World, the Model World, the Schema World and the Mathematical World. During the course of these steps, learners are assigned pictorial tasks in the Model and Schema worlds.

The learning step of the Real World is about cogitation and comprehension in everyday life and is the step where tangible objects are manipulated and thoughts can be advanced. Just because this can be managed in everyday life, it does not imply the actual existence of mathematical understanding and knowledge, but it becomes the basis of the existence of mathematical awareness. The Model World is the step where things that existed in the Real World are put into pictures, and expressions and thoughts are given shape with objects like toys. Playing make-believe is a typical platform in this world where children can be trained to think. The worlds till now have been worlds that have been fabricated by children in their everyday lives. Schema is about being able to define idealized models. The evolution of schematic cogitation is a world of thought that is realized with the intervention of teachers: a world of thought that is secured by going to school. The Mathematics World is a world where thinking is expanded by manipulating numbers and characters, in other words, things of metaphysical being, as though they

were material objects: an intellectual world that is only secure if children attend school.

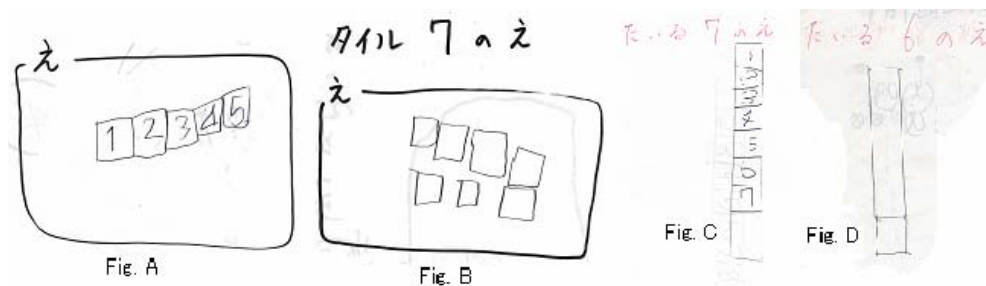
When it comes to the steps to learning, pictorial tasks are indispensable in bridging children's everyday thinking in their real lives with the unreal mathematical thinking. There is a demand to coherently understand the physical existence and the metaphysical existence as a route to grasping mathematical concepts, and I can perhaps explain how we can do this using pictorial-related capabilities.

2. The Two Roles in the Process of Teaching/Learning Basic Mathematics

In the model that is based on operations in the Real World, in other words, pictures and schematics of material things, giving children tasks of manipulating the figurative tiles, encourages them to rehearse the mathematical operations that they have already acquired, make sense of the significance of their learning and encourages them to discover new mathematical ideas and operations. At the same time, by observing the children's pictorial tasks, teachers can observe the children's thinking and evaluate how each child's learning is progressing. Examples are illustrated below of pictorial tasks as methods of observing children thinking, and the process of children's concept-formation through these pictorial tasks.

(1) Teachers' Activities and Pictorial Tasks

In the pictorial task in Fig. A, we can observe child understanding that "7" is made up of seven "1s". In other words, if they count the "1s" one by one the child will get "7". On the other hand, we can observe from the pictorial task in Fig. D that "7" is made up of "5" and "1". In other words it is formed by the manipulation of the concepts of "5" and "1". Fig. B and Fig. C show the process from Fig. A to Fig. D. Seven ones in Fig. C are contained in a 'glass'. Five ones in Fig. D are contained in a 'tin'. These pictures show a process of conceptualization: procedural understanding to conceptual understanding.



We can observe in Fig. E & F, counting one by one, and in Fig. I, working out sums by manipulating the concepts of numbers. Teachers can observe child's

learning progression in Fig. E, F, G, H, and I.

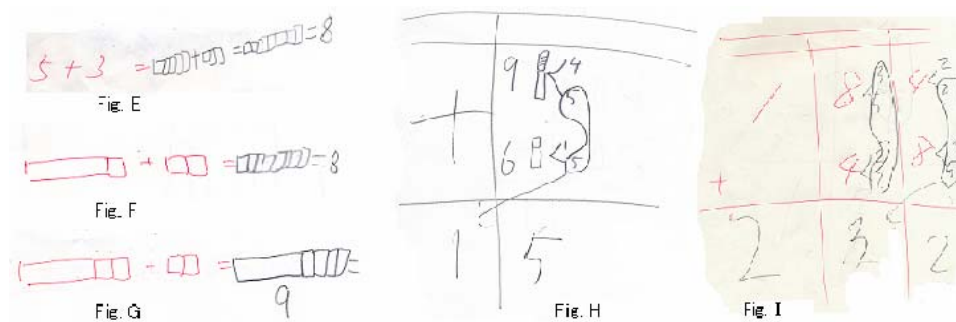
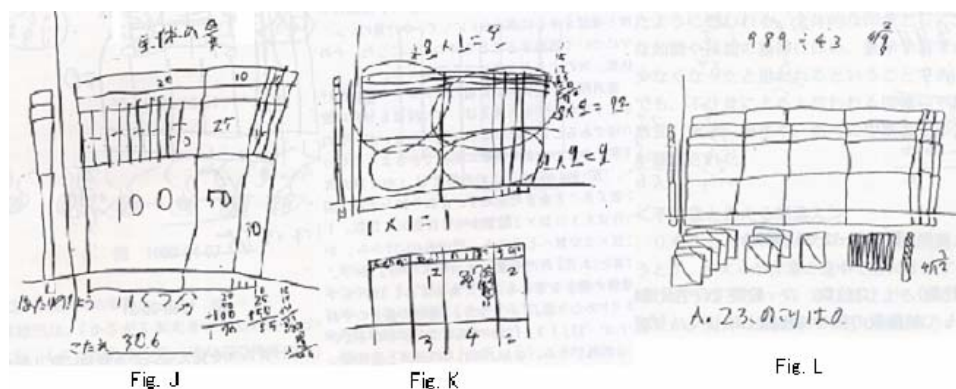


Fig. J, K, and L show us how children similarly think about multiplication and division.



(2) Learning Proficiency and Pictorial Tasks

Fig. A-L above clearly demonstrates the differences in acquiring skills in each of the learning scenarios. Just answering with the answer will not progress one's learning. Putting it another way, we can interpret that the learning proficiencies of each of the learning scenarios, will not just allow progression to the next stage, but is in fact a criterion for progressing to that next stage.

The learning proficiency in each of the teaching/learning stages will increase the learning quality of the learner. In layman's terms, learners deepen their understanding: they change and improve their knowledge and learning. Fig. J and K show the progress in the learning of multiplication, from the addition of partial sums, to the addition of partial products. Through the process of learning in Fig. M, learning, which is based on the understandability of everyday, transcends to the metaphysical mathematical world.



The child, who drew Fig. N, needed to learn about the decimal notation although he had memorized multi-digit numbers and read them. Fig. O gives us the same message as Fig. N. Fig. P shows us that the child had started to grasp the decimal notation, but he didn't understand the place-value notation at all. He just memorized Arabic numerals.

7 8 9 22 23

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	

Fig. N

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16				

Fig. O

11	12	13	14
15			

Fig. P

3. Database on the Progression of Learning

The practical educational materials mentioned earlier have an objective relationship to teacher's teaching activities and secure the solidarity of the teacher population, which will improve their individual teaching experiences. At present, I am working on building a database of the learning processes of many children who have one of the mounting special needs. The database will be browsable on the Internet, and as it will be on a non-commercial website, its release will be restricted to relevant teachers and researchers.

References

Kotagiri, Tadato: 2002, 'A Child with a "Trait" of LD in Mathematics – A Case Study (V) – Learning Possibilities and Some Problems', The Research and Clinical Center for Handicapped Children, Faculty of Education, Uni., of the Ryukyus No.4, 51-70