

Educational instruction in a mathematics class for elementary school children with autism and emotional disorders: The method of instruction for multiplication with calculation writing computation on paper

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Abstract

This study explored a teaching method of instruction for multiplication with calculation by writing computation on paper. The purpose of this study was to focus on teaching methods in a mathematics class for children with autism and emotion disorder to improve present educational instruction. A mathematics lesson was opened to teachers by the new teacher at a public elementary school in Tokyo, in which six children in third grade with autism and emotional disorders learned multiplication calculation.

The result revealed all the six children could reach to the correct answer in the mathematics class successfully. The teacher's instruction method to ask children to be a mini teacher for their classmates was efficient to explain their own ideas to their friends individually. This study implicated that a mini teacher method is fruitful for children with developmental disorders with low self-efficacy and self-confidence.

Keywords: autism, emotional disorders, mathematics, elementary school, multiplication calculation

1. Introduction

Across the country, states are reporting increases in the number of children with autism enrolled in the education system. Autism is a complex neurological disorder which impairs one's ability to socialize, communicate, process sensory information, and experience the full range of interests common to most people. In addition to the severe nature of the disorder, the prevalence of autism is increasing. Recently, effective intervention programs for teachers to implement evidence-based practices for students with autism spectrum disorder (ASD) are a pressing need. Teachers and prospective teachers need effective training to improve their implementation of interventions for students with disabilities.

Japanese governmental educational organization, *Ministry of Education, Culture, Sports, Science and Technology (MEXT)* predicts that children and students who will study Japanese, mathematics, and English in classes with special supports inside public elementary and junior high schools for Neurotypical (NT) schools will increase twice in 2020 in compare to 2009. Accordingly, Tokyo Metropolitan Board of Education (2010) promotes *the third special support education promotion plan* for children and students with autism, Learning Disabilities (LD), and (ADHD). In Tokyo in near future 'special support classes' will be absolutely set at all the public elementary and junior high school in Tokyo by Tokyo Metropolitan Board of Education. To fulfill increasing needs for children and students with developmental disorders, teacher training for instruction and methods for such learners have been reinforced since 2012. In 2012 *the model project for special support classrooms* began, and then in 2015 the guideline for the project has been made public. At public elementary schools in Tokyo this project has been launched from 2016.

Besides, when DSM-5 has been revised after 19 years blanks in 2013, the definition of developmental disorders has also dramatically revised. DSM-5 proposes to subsume CDD under the single category of autism spectrum disorder (ASD) together with three other DSM-IV PDDs (AD, Asperger's disorder and pervasive developmental disorder not otherwise specified (PDD-NOS)), with Rett's disorder (RD) excluded. To this end, in the current study, I focus on teaching methods in a mathematics class for children with autism and emotion disorder to improve present educational instruction.

2. Instruction method for Multiplication Calculation

2.1. Instruction using Concrete Materials: Array figure

Children and students often find multiplication tasks complicated to achieve in mathematics classrooms (Wong & Evans, 2007). Sometimes they try to use inefficient and inaccurate counting methods and encounter difficulties in counting with fingers and memorizing numbers (Geary, 2004; Kilpatrick, Swafford, & Findell, 2001; Koscinski & Gast, 1993). Especially for elementary school children, to accomplish multiplication calculation tasks by writing computation on paper is so complicated to master by themselves in mathematics classrooms. However, if basic multiplication facts are not acquired during the primary school years, it is enormously difficult to acquire multiplication in a structured manner in junior high school (Steel & Funnell, 2001). Not only for NT learners, but this phenomenon is also typical for children and students with developmental disabilities.

Then how educators and teachers could improve their instruction and teaching methods in mathematics classrooms for developmental disorders? Recently, in mathematics education, use of concrete materials and discussion deepen children's understanding through exploration and discovery (Wong and Evans, 2007).

In mathematics education in Japan, especially to impair learners' imagination in multiplication, *array figure* is frequently used (Figure 1). *Array figure* consists of dots. *Array* means standing in lines or arranging in order. This figure model is used because it can be adapted to all kinds of multiplication. Its concept stands on quantity of separation and is efficient to promote children and students' imagination in multiplication. If learners combine array figure to a rectangle area, then they can adapt it to multiplication of continuous volume. If they use array figure, they can recognize multiple meaning and mechanism visually. In the current study, a mathematics classroom using this array figure to instruct children with autism and emotional disorders how to calculate multiplication was observed.

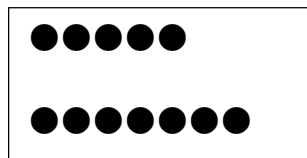


Figure 1. Array figure

2.2. Instruction using Multiplication Law

Mulligan and Mitchelmore (1997) investigated 60 children in Year 2 and Year 3 for two years longitudinally and identified children's strategies to solve a range of multiplication problems. In the latter part of two years research,

'commutative law' and 'distributive law' have been observed among children's solution. They defined commutative law as 'changing the order of two numbers in a multiplication equation does not change the answer (e.g., $7 \times 9 = 9 \times 7$)'. In contrast, distributive law is ' $a \times (b + c) = a \times b + a \times c$ or vice versa (e.g., "9 times 14" is $9 \times (7 + 7) = 9 \times 7 + 9 \times 7$)'. In mathematics classroom generally, these laws are stressed and confirmed before children learn multiplication calculation.

3. Methods

In the current study, a mathematics classroom for children with autism and emotional disorders was observed at a public elementary school in the suburb of Tokyo in 2016. The teacher was a new female teacher who has just graduated university. The members of the class were six children in third grade. Usually a supporter stands by the class during all lessons, but when I participated in the lesson, it was open for the lesson study among teachers from several public elementary schools in the area. So only the teacher instructed all six children multiplication calculation by herself during the open lesson. After the lesson, I participated in the study group for children with developmental disorders as an advisor to improve her lesson. It takes for an hour to discuss and exchange opinions to each other with 40 teachers. Two principals of the study group for children with developmental disorders attended on the study group as gatekeeper and leader.

To instruct multiplication calculation to children, the teacher tried to keep in mind the disposition of multiplication calculation and rules. She planned the following teaching method beforehand and distributed it to all the participants in the lesson.

a) The instruction method of multiplication calculation

'At the case of 16×4 , children learn ① 4×6 at first, then they accomplish ② 4×1 , because they can calculate by using numbers 0 – 9. If they calculate multiplication by these single numbers, it is easy for them to calculate numbers carried in the second position. Further, when they have learned addition and subtraction, they used single numbers. Therefore, it is likely for them to learn in the same method when they calculate multiplication. If they learn second and third position numbers, it should be inconvenient for them to calculate from large positions.'

b) Writing numbers which carried in the next position

'There are various methods to write supporting numbers, e.g. to write on the upper side of lines or to make a circle around numbers and so on. It is confusing for children in this mathematics class to use several solutions, so I teach them an integrated method. In addition, for children who have difficulties to understand general multiplication, I

prepare a multiplication with each part of multiplications.

c) Character of children with autism and emotional disorders

‘In this class, children find difficulties to accomplish problem-solving by themselves. For this reason, basically teacher-oriented method will be main style when I teach multiplication.’

4. Results

The teacher instructed how to calculate multiplication to six children in the mathematics class. In next section, the mathematics activity teaching plan and children’s responses during the classes are provided (Table 1; T: teacher, C: children).

Table 1
The mathematics activity teaching plan and children's responses

Time Table	Learning activities	Points and evaluation
Innovation (5 min.)	<p>1. To understand today's task</p> <p>T : A thief Mary who a jewelry sent you a quiz. Please calculate 386×2 and guess the room number at the hotel.</p> <p>Quiz: Dear guests, I'm in a room at a hotel. Please guess my room number. The hint is 386×2.</p> <p>T : Does anybody know how to solve 386×2?</p> <p>C : To use multiplication calculation by writing computation on paper.</p> <p>C : To use array figure is efficient.</p> <p>T : Which is easy for you, to use array figure or writing computation on paper?</p> <p>C : Writing numbers on paper.</p> <p>T : If you use array figures with 386 dots, then it takes time surprisingly. Today, we want to use calculation by writing computation on paper. Now, today's goal is:</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p>To learn how to calculate 386×2 and exercise multiple calculation together.</p> </div>	

Plan for problem-solving (5 min.)	<p>2. Plan problem-solving</p> <p>T : How have you learned to calculate multiplication?</p> <p>C : From a single number I calculated multiplication.</p> <p>C : When I calculate carrying numbers in second position, I wrote small numbers carried in next position.</p>	
Individual problem-solving (15 min.)	<p>3. Individual problem-solving</p> <p>T : Let's calculate multiplication by yourself based on your ideas. Please hang your hand up if you find some difficulties.</p> <p>a) Multiplication for each positions</p> $\begin{array}{r} 386 \\ \times 2 \\ \hline 12(6 \times 2) \\ 160(80 \times 2) \\ \underline{600}(300 \times 2) \\ 772 \end{array}$ <p>b) Multiplication using small numbers which are carried in second and third positions</p> $\begin{array}{r} 386 \\ \times 112 \\ \hline 772 \end{array}$	<p>○If the teacher find children who have difficulties to solve the task by themselves, instruction method will be flexible to review notebooks and teach them individually with a work-sheet to fill blanks.</p> <p>○If some children finish quickly, then they are able to be a mini teacher for classmates to teach tasks.</p>

After all six children solved the task by themselves, they could answer the correct number '772' finally. Why in this class all the children with autism and emotional disorders could understand such complicated multiple calculation writing computation on papers? The point is hidden in the teacher's instruction method. In general, in plenty of researches children with developmental disorders such as autism, LD, and ADHD have been found being not good at communicating with other people. However, in this class the teacher taught children to be a mini teacher for friends. The teacher said, 'Children are not willingly to suppress their own ideas or opinions in front of blackboard or in the classroom, especially in mathematics lesson. But I suggested them to tell their ideas to other people so as to understand multiplication calculation easily.' This 'mini teacher method' is fruitful for children with low self-efficacy and self-confidence for their developmental disorders.

Conclusion

The purpose of the current study was to investigate what kind of teaching method is efficient for children with developmental disorders, when they learn multiplication calculation. In the first step, using concrete materials such as array figure, they can understand the notion how to separate large numbers and positions to each other. Such concrete materials are sometimes helpful because it promotes children's visual deep imagination. The goal of the lesson was to accomplish multiplication calculation individually and it seems to be achieved after they experienced a role of mini teacher for friends.

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