

# Practical Test Result of Visuanlized Exercises of Number Symbol for Children with Autism Spectrum Disorder Aged 5-6 Years Old in Specialized Settings

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**Abstract** The paper indicated the results of using data visualization to form number symbol (NS) for two children with Autism Spectrum Disorder (ADS). Based on the strength of visual thinking of children with ASD, we have designed a set of symbol exercises from easy to difficult arrangement for pre-schoolers. In addition, exercises are developed in specific and detailed procedures, combining visual and writing instructions to make children easily manipulate and comprehend. After conducting experiment by 02 children with ASD at 5-6 years old, there has been a remarkable improvement in forming number symbol and the concentration to do these exercises. Case 1: The concentration was reported to increase from 12,5% to 50%; The number symbol formation was reported to increase from 22,75% to 71,87%. Case 2: The Concentration was reported to increase from 0% to 37,5%; Number symbol was reported to increase from 36% to 64%. Thus, the data visualization exercises have showed many positive effects for the process of forming children's number symbol.

**Keywords:** number symbol, data visualization, Autism Spectrum Disorder

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## 1. Introduction

Number symbol are images about quantity of assemblies which previously perceived by people that remained and reproduced in our mind when the assemblies are no longer perceived directly by us, no longer acting on our senses as before [1,2,3]. In order to form the basic knowledge for children entering elementary class, we need to give them the concept of number symbols, let them get acquainted, recognize numbers from 1 -10, provide concepts about add and subtract [4,5].

Most of children with ASD often have difficulties in counting in order, adding or subtracting numbers, generalizing the quantity, and taking much time in the process of forming number symbol. Therefore, when having a transition to primary school, they are often overwhelmed due to too difficult knowledge for them and they can not keep up with the educational program. In some cases, children with high function ASD have little difficulty in learning math and forming number symbol but still facing many difficulties in communication and social interaction. There were some international typical studies on forming number symbol for children with ASD such as: Janet Preis "The Effect of Picture Communication

Symbol on the Verbal Comprehension of Commands by Young Children With Autism" [6]; Kathleen A. Quill "Instructional Considerations for Young Children with Autism: The Rationale for Visually Cued Instruction" [7] and "Visually Cued Instruction for Children with Autism and Pervasive Developmental Disorders" [8]; Melissa E. Libertus, Lisa Feiqenson, Justin Halberda "Preschool acuity of the approximate number system correlates with school math ability" [9]; Meijke E. Kolkman, Evelyn H. Kroesbergen, Paul P. M. Leseman "Early numerical development and the role of non-symbolic and symbolic skills" [10]; Virpi Vellonena, Eija Kärnäa, Marjo Virnesb "Communication of Children with Autism in a Technology-Enhanced Learning Environment" [11]; Su, Hui Fang Haung; Lai, Leanne; Rivera, Herminia Janet "Effective mathematics strategies for pre-school children with autism" [12]. Studies have proved the importance of the data visualization in the formation of number symbol, on that basis, then designed exercises to develop math skills for children. In Vietnam, Hien Nguyen Thi, Thao Do Thi carried out a research on "Applying TEACCH method to design and use some exercises to help 5-6 year old children with ASD to form number symbol" [13].

This paper provided the practical results of using data visualization to form on two 5-6 year old children with ASD in specialized schools.

## 2. Content

### 2.1. Introduction on Visualized Exercises of Number Symbols

#### 2.1.1. Why Should We Use Visualized Exercises of Number Symbols?

Data visualization has an important meaning in the forming number symbol for children with ASD, especially children who are going to enter grade one. Building a set of exercises with independent and practical assessment criteria will help children to grasp information better to flexibly apply and generalize in their life. Therefore, a set of visualized exercises of number symbol has a number of significant goals as follows: (1) Attracting and maintaining the child's attention; (2) Helping children to process information quickly, accurately and effectively; (3) Engaging children into activities actively; (4) Standardizing information, stability and consistency during teaching process [3,5].

#### 2.1.2. Visualized Exercises of Number Symbol

We designed a set of visualized exercises include eight exercises (1) Sort by general signal; (2) Number recognition; (3) Count and define the quantity; (4) Compare groups of subjects to each others; (5) Separate a group of subjects into two groups; (6) Mix two groups of subjects into one group; (7) Add to create new quantity; (8) Subtraction to create new quantity [3,4,5]. Each of the above practice tests arranged from easy items to difficult items which could be easily comprehensible about number symbol by children and they manipulate on A4 paper and a processing board for each attached specific exercise as follows:

Practice test named Sort by general signal included eleven items: (1) Attach the mango to the tree; (2) Put green and red apples in the right basket; (3) Classify vehicle; (4) Match similar pictures; (5) Tick the same images; (6) Odd one picture out; (7) Find picture with the same pattern; (8) Connect pictures with equal size;

(9) Order the right picture; (11) Choose the correct answer; (12) Find the missing piece of the picture.

Number recognition practice test included nine items: (1) Number recognition; (2) Match the same number; (3) Choose the correct answer; (4) Matching 4 pieces to complete the number; (5) Counting down; (6) Stacking train carriages; (7) Find the missing number of the down sequence; (8) Match from 1 to 5 to complete the picture; (9) Find the missing number of the inverse sequence.

Count and determine numbers practice test included seven items: (1) Attach a number to the object; (2) Choose the correct answer; (3) Get the required quantity; (4) Choose the number and corresponding quantity; (5) Match the number with the corresponding quantity; (6) Find pictures with number corresponding to the original number; (7) Complete mindmap diagram.

Comparing groups of subjects to each others included five items: (1) Bigger - Smaller; (2) Taller - Shorter; (3) Longer - Shorter; (4) More - Less; (5) is more than - is less than.

Split a group of subjects into two groups includes six exercises: (1) Split the same numbers; (2) Split the same numbers and stick to the right place; (3) Split the different numbers; (4) Separate different numbers and stick to the right place; (5) Choose the correct answer; (6) Observe pictures and count objects.

Mix two groups of subjects into one group includes four exercises: (1) Add number; (2) add and label number symbol; (3) Choose the correct answer; (4) add groups of objects

Add groups of objects includes six items: (1) Count the same type, stick the number; (2) Count different types, stick the number; (3) Count the number in each group, stick the number; (4) Choose the correct answer; (5) Add to get the required number; (6) Choose total number.

Subtract objects includes six items: (1) Cover required number; (2) Cross out objects; (3) Choose the correct one; (4) Choose the correct number; (5) Cross out numbers; (6) Add or remove each row to get the required number (see Table 1, Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, Figure 7 and Figure 8).

Table 1. Some sample exercises

<p>Excercise1: Sort by general signal  <i>Preparation:</i> Workbooks,  <i>Steps:</i> Teacher face to face with students, then, explain tasks to them. Let them do step by step. Ask the child to take the same object with sample.  <i>Assessment procedure:</i> Classify objects correctly according to the sample. Students will get 10 points when they completed exercise. Maximum score is 110 points.</p>	
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Figure 1. Sort by general signal

*Excercise2: Number recognition*  
*Preparation:* Workbooks, perform and end tray, performing process strip  
*Steps:* Teacher face to face with students, then explain tasks to them. Let them do step by step. Ask children to point, give, and take the number correctly.  
*Assessment procedure:* take, point, give the number correctly following the sample. Completing an exercise correctly, the child will get 10 points. Maximum score is 90 points.

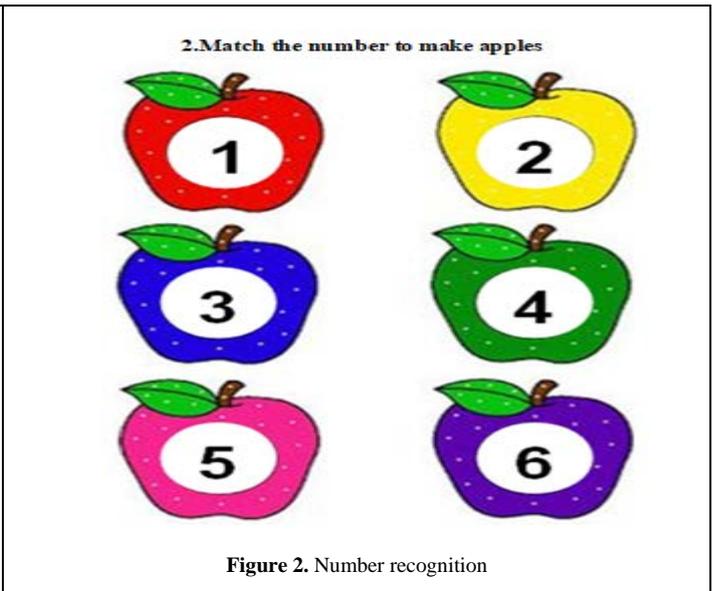


Figure 2. Number recognition

*Excercise 3: Count and determine numbers*  
*Preparation:* Workbooks, perform and end tray, performing process strip  
*Steps:* Teacher face to face with students, then explain tasks to them. Let them do step by step. Ask the children to count, recognize total are there, and choose the right number.  
*Assessment procedure:* Count and generalize the quantity correctly, determine the correct number. Completing an exercise correctly, the child will get 10 points. Maximum score is 70 points.

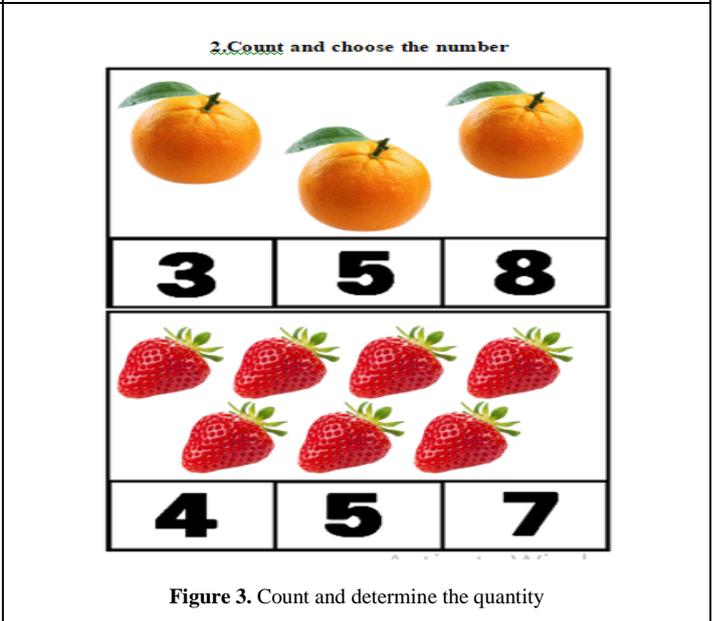


Figure 3. Count and determine the quantity

*Excercise 4: Compare groups of subjects* *Preparation:* Workbooks, perform and end tray, performing process strip  
*Steps:* The teacher sits face to face with the child, letting them know their tasks. Instruct the child to step-by-step perform the exercises according to the given process strip. Ask children to observe and determine which object are: Less- more; Big-small; High and short; Long- short.  
*Assessment procedure:* Compare correctly. Completing an exercise correctly, the child will get 10 points. Maximum score is 100 points.

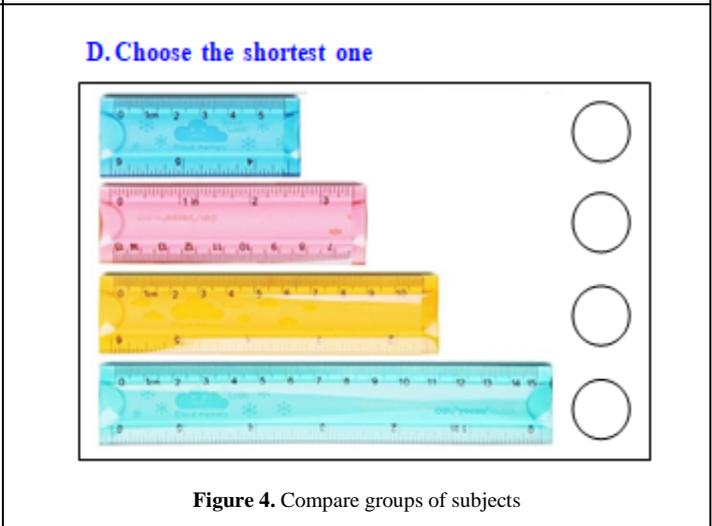


Figure 4. Compare groups of subjects

*Excercise5: Split a group of subjects into two groups*  
*Preparation: Workbooks, perform and end tray, performing process strip*  
*Steps: Teacher face to face with students, then explain tasks to them. Let them do step by step. Ask children to observe and separate given groups of subjects in different ways to get two different groups.*  
*Assessment procedure: Split correctly. Completing an exercise correctly, the child will get 10 points. Maximum score is 60 points.*

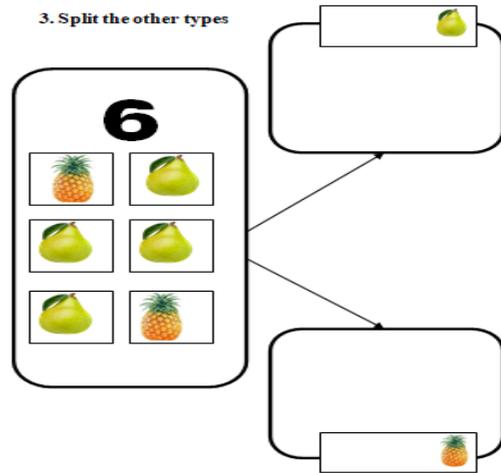


Figure 5. Split a group of subjects into two groups

*Excercise 6: Combine two groups of subjects into one group*  
*Preparation: Workbooks, perform and end tray, performing process strip*  
*Steps: Teacher face to face with students, then explain tasks to them. Let them do step by step. Ask children to observe, combine two given groups of subjects into one group and make generalize.*  
*Assessment procedure: Completing an exercise correctly, the child will get 20 points. Maximum score is 80 points.*

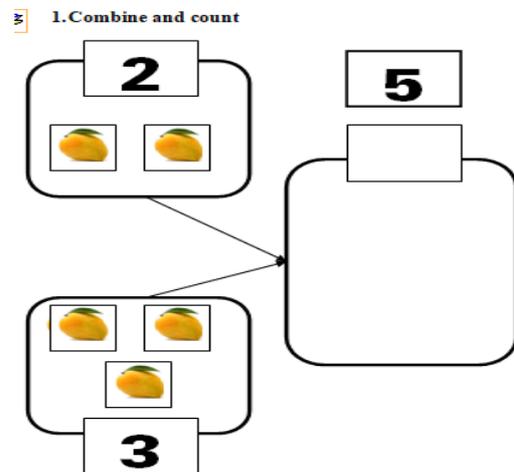


Figure 6. Combine two groups of subjects into one group

*Excercise 7: Add groups of objects*  
*Preparation: Workbooks, perform and end tray, performing process strip*  
*Steps: Teacher face to face with students, then explain tasks to them. Let them do step by step. Give a random number with objects, ask the child to add objects to match the required number.*  
*Assessment procedure: Completing an exercise correctly, the child will get 10 points. Maximum score is 60 points.*

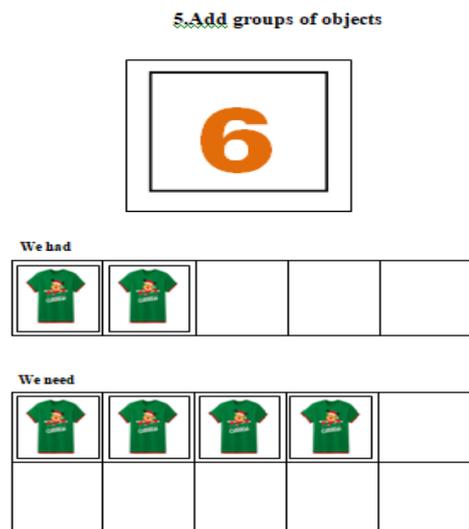


Figure 7. Add groups of objects to create new quantity

**Excercise8:Substract groups of**  
**Preparation:** Workbooks, perform and end tray, performing process strip  
**Steps:** Teacher face to face with students, then explain tasks to them. Let them do step by step. Teacher gives 10 objects and a random number, ask children to subtract the number of objects to match the corresponding number.  
**Assessment procedure:** Completing an exercise correctly, the child will get 10 points. Maximum score is 60 points.

**2.Eliminate groups of objects**



**Figure 8.** Eliminate groups of objects to create new quantity

## 2.2. Practical Test Results

### 2.2.1. Organize the Practical Test

*a. Purpose:* Conducting practical test for trialusing a set of exercises forming number symbol in order to confirm the feasibility; at the same time evaluate the effectiveness of exercises for children aged 5-6 years old.

*b. Content:* 2 case studies using a set of exercises, aiming to form number symbol were 2 children with autism spectrum disorders during 6 months.

*c. Hypothesis:* Building a system of visualized exercises to form number symbol, consistent with the specific characteristics of children with ASD contributes to skill of recognize number symbol easier and more convenient.

*d. Subjects:* 02 children with mild and moderate ASD 5-6 years old in a specialized settings

*e. Steps to conduct:* (1) Collect information and develop a plan to form number symbol for children; (2) Select teachers to participate in the test; (3) Carry out the exercises in the built-in system; (4) Evaluate the results. (5) Data processing of trial results.

*f. Criteria and rating scale for practical test results*

After every 2 months practicing with each excercise, we measured the results based on the established criteria as presented in Table 2.

*g. Processing and analyzing the results:* The child's performance level is evaluated according to the established criteria of interest level, attention focus and number symbol formation (Table 3).

**Table 2. Criteria for evaluating the child's concentration**

Level	Criteria
High attention	Children listened and observed the teacher to model and performed all assigned exercises
Low attention	Children did not really pay attention and easily were distracted, teacher had to remind them for their attention, but could be able to complete the assigned tasks when being encouraged.
No attention	Children didnot care and pay attention to exercises even when getting prompts and encouragement.

**Table 3. The scale criteria of scoring about ability of number symbol recognition**

Group content	Number of exercises	Total score	Score rating scale				
			Weak	Below Average	Average	Good	Excellent
Sort by general signs	11	110	<22 points	23-44 points	45-66 points	67-88 points	89-110 points
Number recognition	9	90	<18 points	19-36 points	37-54 points	55-72 points	73-90 points
Count determines number	7	70	<14 points	15-28 points	29-42 points	43-56 points	57-70 points
Split a group of objects into 2 groups	6	60	<12 points	13-24 points	25-36 points	37-48 points	49-60 points
Addobjects in 2 groups into one	4	80	<16 points	17-32 points	33-48 points	49-64 points	65-80 points
Add group of objects to form new amounts	6	60	<12 points	13-24 points	25-36 points	37-48 points	49-60 points
Substract objects to create new amounts	6	60	<12 points	13-24 points	25-36 points	37-48 points	49-60 points
Compare groups of objects	5	100	<20 points	21-40 points	41-60 points	61-80 points	81-100 points
<b>Total score</b>	<b>54</b>	<b>630</b>	<b>≤126 points</b>	<b>127-252 points</b>	<b>253-378 points</b>	<b>379-504 points</b>	<b>505-630 points</b>

## 2.2.2. Results in 2 Children

### A. Describe the current function of 02 children with ASD

#### CASE 1

Name: N.V.K	Gender: Male
DOB: 12- 2- 2015	Severity of ASD: Moderate

**a. General information about the child:** K's family has 4 people. His father is a worker at Sam Sung Company, Bac Ninh province. His mother works as an accountant at Van Tri Golf Stadium. K is the oldest brother in the family who lives with his parents and his 3-year-old brother, who is studying preschool at Time way Tien Duong, Dong Anh, Hanoi. During pregnancy, the mother's health was normal. Before 18 months, the family did not detect any abnormal signs. By 26 months, the child still had no language with limited cognition. Thus, his family brought him to assess at the Pediatrics Hospital and he was diagnosed by the doctors as ASD. Then, he was sent to intervene at the Children's Hospital, and Van Noi kindergarten after that, and joined class at CHIC center in June 2019. K's parents and family concerned him a lot and were ready to be involved into taking care and education for their child under guidance of teachers.

**b. Evaluate the recognition level of K's number symbol** (Table 4).

Table 4. K's recognition level of number symbol

Types of exercise	Before the trial		
	Number of points achieved	Scale (%)	Evaluate
Sort by general signs	48	43,6	Average
Number recognition	55	61,1	Good
Count determines quantity	31	42,8	Average
Split a group of objects into 2 groups	12	20	Below Average
Combine two groups of objects into one group	18	22,5	Weak
Add groups of objects to form new amounts	8	35,8	Below Average
Subtract groups of objects	7	11,7	Below Average
Compare groups of objects	3	3	Below Average
Total score of exercises	182	28,9	Below Average

#### c. Attention ability

K had difficulty in concentrating on a particular activity and easily distracted by any triggers such as whistles, voices, etc. Or he didn't finish his tasks. Sometimes he was not interested in the prompting or support of others to try to perform a task.

#### CASE 2

Name: N.T.S	Gender: Male
DOB: 20-09- 2011	Severity of ASD: mild

**a. General information about children:** S's parents are working in Japan. S is the second child in his family. He has an older sister, 8 years old, who is in grade 2, and her 4-year-old brother is in preschool. All three S's siblings are living with their grandparents. During his mother's

pregnancy, she had a fever and had to take medicine and antibiotics for 10 days. At age 2,5, he still did not have verbal language. He likely looked at spinning ceiling fan, and play horizontally arranged toys, and also enjoy spinning toy car wheels. When he was 38 months, seeing that he had many irritable manifestations, throwing toys, his family took him to the Pediatric Hospital for examination and was diagnosed by doctors as having ASD.

**b. Number symbol formation level** (Table 5)

Table 5. S level symbol formation amount

Types of exercise	Before the practical test		
	Number of points achieved	Scale (%)	Evaluate
Sort by general signs	65	59,1	Average
Number recognition	43	47,8	Average
Count determines quantity	38	54,3	Average
Split a group of objects into 2 groups	41	68,3	Good
Combine two groups of objects into one group	35	43,7	Average
Add groups of objects to form new amounts	28	46,7	Average
Eliminate groups of objects to create new amounts	19	31,7	Below Average
Compare groups of objects	7	7	Weak
Total score of exercises	288	45,7	Average

#### c. Concentration ability

S. could do some activities that she enjoyed with the teacher's support and prompting. He easily got distracted but more easily returns attention to activities when encouraged or prompted. However, S still had difficulty in performing all requests related to symbol formation, requiring prompting from others to return to focus attention (Table 5).

### B. The results after using the trial practical exercises of 2 children with ASD

After the 6-months of practical tests, we reassessed 3 times (every 2 months according to the criteria), the results of forming number symbols of 2 children were quite positive. It presents in Table 6.

#### a. Case 1: N.V.K

**About the formation level of number symbol** (Table 6): Almost all exercises related to the formation of the child's number symbol after experimentation by using visualized exercise increased significantly. It was increased from one to two levels in the evaluation criteria, as follows: Part of classified by general signs was reported from 43.6% to 81.8% reached the average level to a good level. Exercise part of number recognition increased from 61.1% to 84.4%, achieving excellent level. The quantitative determination increased from 42.8% to 97.1%, achieving excellent level. Split - add or add - remove objects all reached the weak and poor threshold to the fair and average. This was a great effort on the part of the teachers at school, parents at home as well as the children themselves. Thanks to the coordination of the school and the family's positive, after 6 months of experimentation, has reached the upper level of the fair level, but the content was still less target groups and the comparison of subgroups was average. This showed that in the coming

time, its took much efforts to form and develop number symbol. The evidence proved that visualized exercise was very effective in the process of forming number symbols in children.

*Regarding the level of attention to complete exercises during trial:* Through 3 phases of evaluation and comparison table above (Table 6), we realized clearly the active focus of K’s attention, especially exercises of content classified according to common signs; digit recognition; count determines the quantity. Although with some types of difficult exercises that required a multi-step procedure, K was still easily distracted from her need to remind her to continue doing it. Therefore, in the future, in order for children to continued to focus on absorbing and applying exercises on QS formation, teachers had to observe and pay attention to give appropriate rewards for their children.

**b. CASE 2: N.T.S**

*About the formation level number symbol (Table 7):* S showed more stability in both of cognitive and number symbol. There were no exercises after the experiment that the child could not achieve. Accordingly, the content with the most increase in score was number recognition (up from 47.8% to 90%, equivalent to an increase of 42.4%); classified according to general signs (up from 59.1% to 86.4%, equivalent to an increase of 34.5%); comparison of target groups (up 36%); add groups of objects to create

new amounts increased by 20%; reducing target groups to create new ones increased by 13.3%; separating a group of subjects into 2 groups increased 11.7%; The number of determinants increased 7.1% and the least increased content that combined the two groups into one group increased by 6.3%. Thus, S from the average threshold of the average level, after 6 months of experimenting, only reached the average threshold of the fair level. Compared to case 1, S has not really formed the number symbol, even though it achieved the set target but at the low threshold. This is explained by the reason that in the experimental process, S had little attention from parents to practice reinforcement for their children at home. So S only performed when participating in activities with teachers at school. Therefore, it needs to continue to teach S and follow the system of exercises to form number symbol.

*The level of paying attention to complete exercises during experiments:* Through the 3 stages of evaluation and comparison table above (Table 7), we found that S had certain active focus of attention. He could return to his attention when prompted or encouraged. However, there were exercises that S coulddo but he unfinished, or required to change other activities, which was one of the typical problems of Children with disabilities. Therefore, teacher needs to set time for each activity to inform their students.

**Table 6. Compare the number symbol formation level before and after the experiment**

Types of exercise	Before the experiment			After the experiment		
	Number of points achieved	Scale (%)	Evaluate	Number of points achieved	Scale (%)	Evaluate
Sort by general signs	48	43,6	Average	91	81,8	Excellent
Number recognition	55	61,1	Good	76	84,4	Excellent
Count determines quantity	31	42,8	Average	68	97,1	Excellent
Split a group of objects into 2 groups	12	20	Weak	39	65	Good
Combine two groups of objects into one group	18	22,5	Below Average	50	62,5	Good
Add groups of objects to form new amounts	8	35,8	Weak	38	63,3	Good
Subtract groups of objects to create new amounts	7	11,7	Weak	30	50	Average
Compare groups of objects	3	3	Weak	43	43	Average
<b>Total score</b>	<b>182</b>	<b>28,9</b>	<b>Below Average</b>	<b>435</b>	<b>69</b>	<b>Good</b>

**Table 7. The level of number symbol formation before and after the experiment**

Typesof exercise	Before the experiment			After the experiment		
	Number of points achieved	Scale (%)	Evaluate	Number of points achieved	Scale (%)	Evaluate
Sort by general signs	65	59,1	Average	95	86,4	Excellent
Number recognition	43	47,8	Average	81	90	Excellent
Count determines quantity	38	54,3	Average	43	61,4	Good
Split a group of objects into 2 groups	41	68,3	Good	48	80	Good
Combine two groups of objects into one group	35	43,7	Average	50	62,5	Good
Add groups of objects to form new amounts	28	46,7	Average	40	66,7	Good
Subtract groups of objects to create new amounts	19	31,7	Below Average	27	45	Average
Compare groups of objects	7	7	Weak	43	43	Average
<b>Total score of exercises</b>	<b>288</b>	<b>45,7</b>	<b>Average</b>	<b>420</b>	<b>66,7</b>	<b>Good</b>

### 3. Conclusion

Forming number symbol for children with ASD aged 5-6 years old needs patient and persistence to support for cognitive development. Building a prompted exercises with clear visualization would help children with ASD to overcome their core difficulties. Through the two typical experimental cases above, it is initially possible to confirm that the set of visualized exercises are appropriate and effective. It not only helps children to form number symbols but also enhance their concentration and excitement in doing exercises. The practical test results in this paper once again reaffirm that we are on the right track when proposing measures to form number symbol for children with ASD through visualization. That means "Developing thinking by visual - Action important thinking - image and progress to developing logical thinking, conceptual thinking for children. According to the curriculum framework of the Ministry of Education and Training - as well as the exercises that we built are feasible and it achieved positive results and contributed to improve the level of number symbol formation for children with ASD aged 5-6 years old.

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