A Systematic Approaches for People with Autism to Develop Logical Thinking Process with a Successful Case

Tongpil Min
PonderEd Educaiton, Canada

Abstract

Autism spectrum disorder has been known as developmental disability and they show differences in social interaction, communication, and behaviors. Education is based on communication using language. Since people with autism have challenges in language development, education for the people with autism has not been effective. This paper reports a successful case of a child developed logical thinking process by applying newly developed teaching and learning methods. The methods developed are aligned with developmental stages of the child and school. It started with making connection between language and picture thinking for communication, then expanded to develop logical thinking process. With the teaching and learning methods, the child's performance at school gradually exceeded expectation. The child was recognized as non-verbal at school until grade 3 - 4. Up to grade 10, the child was able to follow schoolwork and activities with some help. Starting from grade 11, the child was fully independent at school and academic performance has been exceptional. Also, the child has achieved very high GPA. As of this paper is being written, the child is in grade 12 and applying for universities. In this paper the development process of teaching and learning methods for children with autism together with a successful case was acknowledged. Therefore, the teaching and learning methods will open a new chapter in education for people with autism.

1. Introduction

The term 'autism spectrum disorder (ASD)' reflects deficit of social and communication skills as well as behaviors due to various factors including genetic component [1], [2]. Since many people with autism do not live independently through their lives, there have been numerous researches to teach and support these individuals to be independent. Some researchers focused on development of teaching methods and programs [3] and some of them focused on finding factors to enhance outcomes of programs [4] or diagnosis [5]. Nonetheless, independent life for people with autism does not seem to be nearing yet.

From my experience as a father of autistic child, finding educational tools to teach a child to be independent was the highest priority. In search of programs, speech language pathology (SLP), occupational therapy and applied behavioral analysis (ABA) were accessible programs. These might be effective for the child to develop social and language skills. However, since the most of the programs were based on behavior or emotions, development of logical thinking process was not highly expected. To live life independently, the most essential skill should be logical thinking process to make logical decision. Without development of logical thinking process, the child should depend on other people's decisions. Since there was no established educational method that tackles development of logical thinking process for children with autism in direct way, new one must be developed.

2. Stage one

Our brain process information in two different ways amongst the five senses. The first one is emotions. Most of cases, human brain interprets information with emotions such as love, comfort, angry, etc. Sometimes emotions were involved in teaching as well. When a child did something that is not acceptable, people teach the child with emotions like facial expression of anger or loud voices with firm tone. This is not only for human. Many animals with brains also teach with emotions. Expressing emotions might be an easy, direct, and effective way of teaching. But emotions rarely contribute the development of logical thinking process because emotions do not require a thinking process. Good or bad is simply either good or bad to accept. The purpose of education is to support learners to develop logical thinking process. To develop logical thinking process, the information from five senses must bypass emotions or redirect from emotions to logical thinking brain parts. This process can also be referred as 'objectification'. When a person is emotionally exited or depressed, it inhibits the brain from thinking logically. In other words, information from sensory systems cannot be processed by emotions and logical thinking at the same time. Thus, the development of teaching and learning methods had to be focused on logical thinking process rather than emotions However, emotions are a part of instincts that all people were born with. Even though people with autism show differences in understanding emotions, they do have emotions. This was the challenge.

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Emotions are inevitable since they are part of instincts. Thus, the decision was to use emotions rather than bypassing them. Since there are positive and negative emotions, positive ones were pursued mainly. This was because the primary goal was communication. When a person suffers from negative emotions, he/she might not be willing to communicate. Thus, providing environment for the child to have positive emotions was the first strategy. This does not mean that negative emotions were completely ignored. They were only restricted to the behaviors that might cause instant danger or injury. The same approach was asked for the people who worked with the child for activities like swimming, skating, and visiting various places so that the child could be open for communication while enjoying the activities. With this approach, the child seemed to be developing listening skills. But active communication skills were not developing yet. Thus, next strategy for communication needed to be considered.

3. Stage two: making connection between language and pictures

One of the biggest challenges in teaching children with autism might be communication. Since the child was not able to describe his thoughts in language, communication was difficult. Communication flows when people's thoughts are visualized clearly. But the child was not able to do so. This was another barrier to overcome. The clue for this challenge was provided by Dr. Temple Grandin's books [6], [7] and TED talk [8]. Dr. Grandin is a person with autism and a scientist. She is the first person with autism who has broken out of the autism. According to her, people with autism think in pictures rather than language. She also described that she picks up smaller details in the pictures. This might be the reason why many autism children focus on an object such a long time. For example, looking at wheels longer than typical children. This behavior might be because to pick up small details from the movement as Dr. Grandin said. Based on the information, following hypotheses were generated.

- The child might think in pictures like Dr. Grandin.
- If the child thinks in pictures, providing verbal description of what he is observing could connect the picture to the language.
- If the child picks up details from what he is observing, the verbal description should be in details so that both language and picture can be linked.

Thus, the strategy was to describe what the child was observing in detail as much as possible. At this stage, the emotions were minimized. Emotions are interpretation of something that is already observed. In other words, emotions can be compared to processed food. Because all the ingredients were already processed, it is hard to find what was included from the beginning. In addition to the invisibility of ingredients, the interpretation of the same emotion could be different from a person to a person. To make strong connection, the topic should be agreeable for both sides. In this way, mismatch between language and the picture can be minimized. Therefore, natural phenomena and objects were primary targets for this approach.

The practical approach was 'describe what the child touches, sees, hears, tastes, and smells in detail'. For example, if it is an apple the child was eating, the color, thickness of skin, sourness, and sweetness were described while eating apples together. With the latter approach, the child started to pick up the words and short sentences. But there was limitation. The targets were limited because the child's interests were in narrow range of subjects. Thus, new strategy to broaden subjects was needed.

4. Stage three: Connecting concepts to expand the child's viewpoints

Jumping to different topics was not successful when the child's interest was still fixed on one thing. For example, if the child's interest was on a fish, changing topics to different animals like elephants caused instant resistance. This could be because there are still smaller details left for the child to pick up. Since the child needed to follow various activities and subjects in school, developing ability to change topics was essential. However, as mentioned earlier, jumping from one topic to another was not ideal approaches as the child resisted. This approach even jeopardized communication. Thus, new strategy had to be developed. The hypotheses behind the development were as follows.

- The child could express his thoughts in brief (a few words) at this stage. This indicated that thinking process of making connections between pictures and language had been initiated.
- Since the child seemed to be able to understand somewhat what was described, the child might be able to move to different topics if they were linked.

The plan was gradually moving from a topic to different ones by making connections. At this stage, the connections between language and pictures were still weak. Explaining the different topic in language would not be expected to work even if they were linked together. Still the process had to be done by language. The goal of making connection was for the child to develop skills of changing subjects by following the link. It would be easier for the child to

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follow topics linked already rather than making new ones. Thus, topics that were linked by experiences would be the best choice. The reason for this was twofold. With experiences, the child could understand verbal description easier. Also, the pictures should be connected in his brain already. This could make the child to follow the link spontaneously. For this purpose, natural phenomena that the child had experienced were the best choice.

The topic of choice was salmon in rivers for spawning. Since the child had been fishing for salmon as a hobby in past years, he experienced the salmon life in rivers. With the experiences, all the pictures like spawning, changes in body structures and colors, death, and decomposition process should have stored in his brain. Also, the connections were already made since the events were sequential. It was matter of making connections by language so that the child could follow the link to change topics. But the challenge was 'how to promote the child's brain to make connections among pictures by language'. Even for the people thinking in language, making connections among different topics are challenging. For example, to connect digestive system to respiratory system, extensive concept building and connection is required. This is because the thinking process to make connection is not clearly known. Thus, the key factor of making connections had to be discovered.

To discover the thinking process of making connections, a set of simulation using two different concepts were carried out. Since the topic was salmon, the changes of body shape and color was selected to make connections to spawning. Prior to simulation, two observations were described and listed. One was changes of shapes and colors. The other was spawning. Descriptions were as follows.

Step 1. Salmon changed their colors and body structures as they move up to a river.

Step 2. Once in a river, they spawn.

Using the above two descriptions, the thinking process of making connections had to be identified. The approach was putting them in sequential order first then analyze. Since these two descriptions are consecutive, one should be the reason or cause of another. In this case, changes in color and body shape must be the reason for spawning. Thus, questions to reason must be the thinking process that connects these two different phenomena. For example, questions to reason like 'why are color and body structure of a salmon changed for spawning?' were identified as the thinking process for making connections among concepts. In the process of generating questions to make connections, many different questions were tested. However, after analyzing those questions, the questions were categorized into two different groups. Questions in one group could promote brain to make connections among the concepts and the others mostly inhibited thinking process. The questions that seemed to promote connections were curiosity questions that start with 'why' or 'how' based on observation and comparisons. For example, questions like 'A cup filled with ice water is very cold. Why are water molecules in the air condensed around this cold cup?' promotes brains to identify and connect factors for the condensation. On the other hand, questions that seek for knowledge from other people or literatures like 'Who (or where) might be able to explain condensation concept to me?' mostly inhibited brain to build concepts to connect independently. Thus, the questions to make connections among concepts have to be questions to reason or to look for cause based on observation and comparison.

Even though the thinking process for concept connection had been identified, the effectiveness on child who thinks in pictures was uncertain. The only way to confirm was to experiment. After a series of simulations, a scenario was written for experiments. The following script is one of the actual conversations based on the scenario from the simulations:

Father:
We are fishing for salmon in this river. You see, there is a school of salmon. Why do you think salmon is migrating to rivers?

Son: *To spawn.*

Father: *What did you see after spawning?*

Son: *They die or being eaten by other animals.*

Father: *What is your observation of the dead bodies?*

Son: *They get decomposed.*

Father: *Yes, they get decomposed by bacteria and fungi. What do you think will happen once the bodies are decomposed?*

Son: *Plants grow.*

Father: *You see all the trees and plants growing here. Where do you think the food for all these plants are from?*

Son: *I think the salmon.*

The connection between salmon and terrestrial animals and plants in British Columbia, Canada was published in 2002 [9]. With the questions, the child could connect each stage of salmon life in rivers and even could expand to nutrients. After this, the child's interests widen to other animals, fungi, bacteria, and nutrients that are related to salmon. The child's answers were short. However, the answers indicated that the child already had connections between

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pictures and language since he understood the descriptions and questions. What lacked was ability of describing the pictures in language by himself. And the conversation showed that the questions to reason could be used not only making connections but also providing examples of language for the child to learn. With this method, child's description skills had improved significantly over a few years. But he was still not able to change topics proactively by himself.

5. Stage four: Training to become independent learner with building concepts and connecting concepts methods

Until grade 3 and 4, the child's interests had broadened significantly. But changing topics were still dependent to the questions asked. To become independent thinker, the child needed to develop skills to change topics by himself. Thus, new strategy had to be developed.

A thinking process starts from observation. However, in general, people have tendency to ignore details from observation. Even though people with autism focus on details, it seemed to be only for the topics that they are interested in. Thus, the strategy was to develop learning methods for the child to initiate thinking process on his own starting from observation.

In this development, the key was making the child to observe in detail regardless of his interests. Thus, a way to force the child's brain to observe any given topics in detail had to be developed. To force the child's brain to observe in details, the development had to be carried out by going backward. In general, thinking process moves forward from observation. For example, observe, describe, and compare. However, development of methods to prompt observation required illumination of the thinking process before observation. To investigate the triggering factor for brain to observe, first step is to describe in details. For example, 'apple' as a topic, thickness of skin, color, texture, etc. were described and written. Then, they were analyzed to identify the factor that triggered observation. The thinking process found was also questions. But this time the questions were 'questions to observe' like 'what color is the apple?'

The questions to observe did not make differences in topics that the child had interests. Because the child already had interest, the observation started spontaneously. However, the questions to observe started to show effect on the topics that the child was not interested in. The observation skills were extended to broad topics by these questions gradually. At this point, the main goal had to be changed from 'developing observation skills' to 'developing questioning skills to start observation'. Then, other thinking processes such as comparison were followed by. Now, the whole thinking process was 'questions to observe', 'observe', 'describe what was observed', and 'questions based on description'. The entire think process was named as 'building concepts' and has been published in PonderEd education website [10].

In addition to the concept building skills, concept connections to expand topics also had to be added so that the child can develop skills to explore various topics on his own. This was the reason to develop learning methods of concept connection [11]. With these two 'thought process-based learning and teaching' methods, the child started to build and connect concepts on his own.

6. Stage five: Aligning the thinking process with schoolwork

Until grade 10, the child had been trained with concept building and connecting methods. However, these methods were not aligned with schoolwork. At school, the child received learning support. Since the child would like to study marine animals in a university in the future, all the methods had to be refined to align with schoolwork. This was done by replacing topics with learning materials from the school. At the same time, various knowledge had to be digested for academic achievements. Thus, another learning method had to be developed for school learning.

The first step of development was motivation. One of the most effective ways of motivating students is curiosity. Curiosity promotes students to engage in learning actively. However, people ask curiosity questions when they are interested in the topics. The child was not showing interests for all topics. Thus, a way to motivate the child to have interests for those topics had to be developed. To motivate the child to have interests in various topics, the child was asked to generate curiosity questions around the topics before each class as a pre-study. In this way, the child's brain was forced to become interested.

The second strategy was to enhance the child's understanding of knowledge. Learning difficulties are mostly from lack of concepts. For example, a student might know the word 'apple' as knowledge. But he/she might not have concepts of 'apple' which is physical characteristics such as texture, color, etc. In addition to the concept, terminologies were another challenge due to autism. Thus, the child needed to learn to build concepts using terminologies. And this required another learning method to be developed.

To develop conceptualization of terminology, the child was asked to read a paragraph or a page from textbooks and extract key words. Once the key words extracted, the child was asked to conceptualize the key words, especially that were strongly connected to figures or photos since the child thinks in pictures. By observing figures or photos, the child was asked to

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build concepts of the terminologies. For example, if a terminology is 'condensation', the child was asked to build concept of condensation by observing a cup filled with ice water. This was a modified version of concept building [10]. Then, the child was trained to connect concepts using the terminologies which is modified version of connecting concepts [11]. In this way, the child could follow subjects dealt at school more efficiently.

For example, the process of conceptualization of 'condensation' started from 'a cup filled with ice water' which is data. From the data, elements to conceptualize the terminology like 'temperature of ice water', 'a cup', 'moisture in the air', and 'temperature of surrounding air' were to be extracted. Then, they were categorized based on the similarity and differences to compare.

The strategy of conceptualization of terminology was extended further for the child to learn theories. Theories are explanations with reasoning and data. Instead of simple understanding and memorization of a theory as knowledge, the child was trained to conceptualize the theory by processing data in the same way. For example, there was an article about evolution of elephants due to poaching pressure [12]. This article starts with a photo that depicts elephants without tusks to show how poaching pressure forced them to evolve without tusks. By extracting and comparing number of elephants without tusks in the data which is the photo, students can build reasoning why population of elephants without tusks has increased. This is a process of theorization. Only difference from actual theorization process from research is that the process is based on simulation in the brain.

Combining the 'conceptualization of terminology' and the 'simulation of theorization', the whole process was named as 'conceptualization of knowledge' [13]. The child was taught to adopt these learning methods to digest terminologies and theories from school. From this moment, the child's learning at school has been accelerated.

Starting from grade 11, the child was able to carry out schoolwork without learning support. The grades and academic performance were improved significantly for all the subjects including language. And the teachers' comments showed that the child's capability in schoolwork. It is clear that all the strategies developed and applied worked for him. As of this paper is being prepared, the child is applying for universities.

7. The future

The academic performance of the child shows that he has developed logical thinking process and it increased learning efficiency at school. However, this is not enough for the child's future.

The world is competitive. The source of human competition is from a new knowledge. For example, if it was not Steve Jobs, a founder of the apple company, the competition over smartphone might not exist yet. Because Jobs introduced brand new smartphone concept, the competition over smartphone is severe in these days. This means that for human, competition starts from a new concept that was either discovered or created by pioneers. To survive in competitions, building and connecting concepts are not enough because they are to digest knowledge. Each society moves forward by creating new features, new strategies, or new concepts. This means that creative thinking to either discover or develop new concepts are critical for the future life. Unfortunately, education sector cannot deal with process of development because it is not proven yet. Only theories can be dealt in educational institutes. This is the biggest gap between education and the future. Students learn to know theories that had been confirmed. But the entire society is under process of developing new strategies, technologies, and unknown concepts. This requires creative thinking that current education system cannot provide.

Creative thinking is another level of thinking process. It does not only create competitions. It also shows the world directions to move as seen from Isaac Newton's artificial satellite concept and Albert Einstein's relativity theory. Only problem with creative thinking is that the thinking process had not been known. Einstein and Newton could provoke the creative thinking process, but they were not able to teach others how to think like them. This means that even known geniuses were not able to describe how the creative thinking was being processed in their brains. However, for the first time in human history, Min has discovered the systematic thinking process of the creative thinking [14]. The future plan is to train the child to develop creative thinking process by following these methods.

8. Conclusion

People with autism may show differences in social interaction, communication, and behaviors. Some of them might be recognized as gifted in a specific area. This does not mean that this is the most out of them. Their brains can also be train to develop logical thinking process. Since language is primary tool that is being used in education sector, people with autism have been left behind. Learning and teaching strategies from picture thinkers' viewpoints were limited. Because of this, provoking logical thinking process was left for individuals with autism. This might be the reason why people like Dr. Grandin are very rare. He is the first person who unveiled the thinking process of the people with autism and introduced to the world. The systematic teaching and learning methods that have been discussed in this

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paper are based on Dr. Grandin's explanation of thinking in pictures. The child discussion in this paper also confirmed that he thinks in pictures, and he can simulate the pictures like movies in his brain.

The teaching and learning methods for each stage are not only for people with autism. It can be applied to anybody who would like to develop logical thinking process. Only approaches to make connections between picture thinking and language are directly related to the people with autism. As discussed in this paper, once the connections made, development of thinking process could be the same as other people. This is the beginning step. It was successful but took over 10 years. In addition, these strategies are still based on language point of view. Thus, research to improve by analyzing the process of thinking in pictures should be followed.

Social interaction and behaviors are not discussed in depth in this paper since the focus is logical thinking process. In short, behavior like jumping and hitting body parts are mostly from either excitement or stalled thinking process, according to the child. This could be compared with behavior like 'pulling hair'. They simply react with different behaviors. As more people with autism provoke logical thinking process, world of autism could be unveiled further. Then, more advanced educational strategies including behaviors and social interactions could be developed further.

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