

Growing the Imaginative of Mathematical Thinking on Students in Designing a Teaching Aid for CwD

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ABSTRACT

Children with Disabilities (CwD) have the same status, rights, and duties as the normal children for quality and continuing education up to university level. In fact, there is still a gap between the real needs in the Special School (SS) with the facts that exist in the University. This article discusses how to grow the imaginative of mathematical thinking for Mathematics Education students through Extra-Curriculum Training (ECT) to design the teaching aids for CwD. Through qualitative research, in the State SS of Salatiga with results: (1) ECT able to become a place to grow imaginative in mathematical thinking, and (2) created the design of a Teaching Aid for CwD.

Keywords: Teaching Aids, mathematical Imaginative, *ECT*.

1. INTRODUCTION

Children with Disabilities (CwD), have equal positions, rights, and duties with the normal children for quality and sustainable education. Education services for CwD, the Government and Private Sector have set up Special School (SS) for CwD and Inclusive School. CwD who do not have intellectual barriers are encouraged to continue their education to Senior High School, even to Universities. In fact, many of the SS are not ready with the procurement of SS based on subject teachers especially at Secondary School level.

Thus, there is a gap between the real needs in the field and the facts that exist in the college/university. SS requires the math teachers who are professional in the material field, but also master the needs of SS in learning. On the other hand, there is no math teacher ready to teach in SS or an Inclusive School with all the consequences.

Based on the background that have been described above then the formulation of the problem are as follows. (1) How to grow the imaginative of mathematical thinking for Mathematics Education students through ECT activities? (2) How is the student able to design the teaching aids for CwD through activities based on ECT?

The purposes of this study are as follows. (1) Grow the imaginative of mathematical thinking for Mathematics Education students through ECT activities. (2) In order for the student to be able to design the teaching aids for CwD through activities based on ECT.

2. LITERATURE REVIEW

2.1 Special School (SS) for CwD and Inclusive Education

At this time the development of the world of education has grown rapidly, this can be seen from the changing educational paradigm. This paradigm shift is marked by changes in the education curriculum. This change also has an impact on education services for CwD. All citizens have the same rights, not distinguish physical, ethnic, religious, and others to obtain the quality education. Thus, for children with physical, mental, emotional, and social (special-needs children) disabilities, they are entitled to a quality education. Education service system for CwD can be done in segregation and integrated. The segregation education system is an education system separate from the normal child education system. In other words, CwD is provided with educational services to special education institutions for special needs children, such as SS in Primary School Extraordinary (PSE), Junior High School Extraordinary (JHSE), and Senior High School Extraordinary (SHSE).

A form of integrated education service is an education system that provides education services for CwD to learn together with normal children learning in one roof, known as Inclusive Education. Math lessons are often called difficult lessons, especially for children with disabilities (CwD). Therefore, the author as Chairman of the Center for Learning Studies for CwD - FMIPA UNNES want to do research on how to grow the imaginative of mathematical thinking for Mathematics Education students in creating a teaching aid for CwD through activities based on ECT.

2.2 Profile of Mathematical Ability of SS Student

The ability of SS students in the field of mathematics depends not only on the students' own learning needs. They also depend on the attention factor of the parents, the ability of the teachers in serving the SS students, the curriculum, the completeness of school facilities and infrastructure, and even dependent on the completeness of teaching aids for CwD.

Descriptions of the profile of the ability of SS students in the field of mathematics with the results of the National Examination (NE) as a benchmark, focused on State SS students of Salatiga. Thus, the attention factor of parents, teacher ability and their experience in serving to SS students,

curriculum, completeness of school facilities and infrastructure, and completeness of teaching aids are also limited to the scope of State SS students of Salatiga.

2.3 Factor of the Student Parents Attention

Parents of SS students have a dominant role in growing confidence to the CwD from an early age. Based on the results of analysis about the attention of parents to their children who attended school at the State SS of Salatiga obtained the general description as follows. Look at the Table 1 below:

Table 1: The attention of parents to their children

No.	The attention of parents to their children	Tends (in percentage)
1	Very Good	11%
2	Good	63%
3	Enough	17%
4	Less	6%
5	Very Less	3%

2.4 Factor of Facilities and Infrastructure at State SS of Salatiga

Facilities are a moveable learning equipment. While the infrastructure is the basic facilities required to perform the functions of PSE, JHSE, and SHSE. While learning aids or educational tools are tools that are directly used for learning, such as whiteboards, rulers, chalk, markers, LCD, and others. In addition, for the purposes of learning also need educational media for example in the form of teaching aids. Educational media is the equipment used to help communication in learning. Although, Cunningham (2015) wrote that the existence of the teaching aids in school or SS does require the imagination and creativity of teachers.

Furthermore, Slameto (2003) wrote that in the education process, the quality of education needs to be supported by the facilities and infrastructure that become the school standard or related educational institution. In SS, facilities and infrastructure greatly affect students' ability in learning. This shows that the role of facilities and infrastructure is very important in supporting the quality of student learning. For example, the SS located in the city that already has computer lab. facilities, the students can directly learn the computer while the school in the village does not have the facility and do not know how to use the computer unless they take courses at the outside school.

Facilities and infrastructure in SS need to be managed properly for optimal utilization. Management is intended to use the facilities and infrastructure in schools/SS can run effectively and efficiently. Management of facilities and infrastructure is a very important activity in SS, because

its existence will greatly support the success of the learning process in school/SS. In managing the facilities and infrastructure in schools required a process as contained in the existing management in general, ie from planning, organizing, mobilization, maintenance, and supervision. What is needed by SS needs to be carefully planned with regard to facilities and infrastructure that support all learning process in SS.

Rudiyati (2002) wrote that every subject in a particular class of disabilities has a different character from that of the other class. Thus, each subject also requires different learning suggestions. In conducting the learning, the teacher definitely needs a tool that can support its performance so that learning can take place with interesting and fun. With the support of adequate learning facilities, teachers not only deliver the material orally, but also by writing and demonstration in accordance with the facilities and infrastructure that have been prepared by teacher.

Based on observations at State SS of Salatiga, the teachers have been sufficient experience in teaching and serving CwD students. However, good teachers need the learning tools to support their learning activities. In addition to the ability of teachers in organizing learning activities, support from learning facilities is very important in helping teachers in SS. The more complete and adequate means of learning owned by a SS will facilitate the teachers in carrying out their duties as an educator. Similarly, the atmosphere during the learning activities. Learning facilities should be developed in order to support the learning process. Some of the things that need to be developed in supporting the learning process in SS are: 1) library, 2) supporting facilities for curriculum activities, and 3) infrastructure and facilities of extracurricular activities and local content.

With reference to Article 2 Permendiknas Number 33 Year 2008, then based on observation and interview the results can be summarized as follows. Notice Table 2 below.

Table2: Completeness of Facilities and Infrastructure

No.	Type	Category
1	Condition of Classroom	5
2	Condition of Teacher Room and Principal	5
3	Library	3
4	Bathroom and Toilet	4
5	School Cleaning	4
6	Learning Tools	4
7	Mathematical Teaching Aids	3

Category: 5 means Very Good; 4 means Good; 3 means Enough; 2 means Less; 1 means Very Less.

Judging from the existence of the Mathematical Teaching Aids, then the Teaching Aids for mathematics learning needs to be added.

2.5 SS Student Capability Profile in Mathematics Lesson

The profile of SS students' ability in math lesson in Central Java will be reviewed and will also review the ability of SS students in the mathematics lesson at State SS of Salatiga as the other comparison. The benchmark is the result of the National Examination of mathematics. Note the following on Table 3.

Tabel 3: SS Student Capability Profile in Mathematics Lesson

No.	Type	From the 40 items, the results of the mathematics score is lower than the national average score	Category
1	SS student at Central Java	28	Disappointing
2	SS student at State SS of Salatiga	24	Disappointing

Category:

- 5: Very Good, if from 40 items, the results of the mathematics score is lower than the average of national score is in the range of 1 to 5.
- 4: Good, if from 40 item, the result of the mathematics score is lower than the average of national score is in the range of 6 to 10.
- 3: Enough, if from 40 items, the results of the mathematics score is lower than the average of national score is in the range of 11 to 19.
- 2: Disappointing, if from 40 items, the results of the mathematics score is lower than the average of national score is in the range of 20 to 30.
- 1: Very Disappointing, if from 40 items, the results of the mathematics score is lower than the average of national score is in the range of 31 to 40.

While the results of the National Examination (NE) of mathematics profile of State SS of Salatiga on 2017, presented in Table 4 below.

Table4: The results of NE of mathematics profile of State SS of Salatiga on 2017

No.	Target	NE Score of Mathematics	Category
1	National	50,34	Less
2	JHS at Central Java	50,91	Less
3	JHS atSalatiga City	65,20	Enough
4	State JHSEof Salatiga	69,17	Enough

Thus, the training and assistance to create the teaching aids for CwD through activities based on ECT to Mathematics Education students of FMIPA UNNES this needs to be implemented. Furthermore, the imaginative growth in mathematical thinking for Mathematics Education students in creating a teaching aids for CwD through activities based on ECT should be examined.

2.6 Growing the Imaginative in Mathematical Thinking

Without a imagination,too difficult to conceptualize of geometry, mathematical learning, or other science. According to Afiff (2013), without imagination, the Egyptians would not be able to build pyramids. With the imagination of the persons like of Bill Gates and Steve Jobs, who can imagine that someday there will be computers/laptops in every home, and has now manifested unimaginable by most people at that time. Obviously, imagination and knowledge can not be separated.

Afiff (2013) further wrote that imagination is a cognitive process that is a complex of mental activity in which elements in the mental activity are out of sensory sensations. Imagination involves integrating aspects of memory, memories, or experiences into a mental construct different from the past and becoming a new reality of the present, or even the anticipation of reality in the future. Imagination is generally regarded as one of the "higher mental functions," and can also be associated with fantasies, dreams, or problem-solving forms originally different from the ordinary.

If this imagination is associated with mathematical thinking, then the nature of this imagination is called the imaginative of mathematical thinking. There are well-known words from Albert Einstein, an expert in Mathematics and Physics. According to Eistein, an imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and ever there will be to know and understand.

Cunningham (2015) wrote that the emergence of imagination requires creativity. Imagination and creativity are needed in the future, including the demand for labor such as teachers. To elicit an imaginative in this mathematical thinking, there are some expert opinions that peel it. Are as follows.

- 1) Goman (1999), wrote that to elicit the imaginative of mathematical thinking, the indicator needs to be ideas that are: (1) *fluency*, that is, the ability to generate many ideas; (2) *flexibility*, that is, the ability to solve problems with various approaches; (3) *originality*, ie the ability to express ideas of itself and in its own way; (4) *elaboration* (complete), ie the ability to explain something in detail; (5) *redefinition*, ie the ability to see a problem based on a different angle to what others have found.
- 2) Silver (1997) wrote that in order to elicit the imaginative of mathematical thinking, the indicator needs to be ideas that are: (1) *flexibility*, in solving problems that have many different strategies in the solution, (2) *fluency*, able to produce correct answers different, (3) *novelty*, which has a new work.

Based on the description above, the researcher chose to use the combination of Gomon (1999) and Silver (1997) above with modified according to the purposes of this research. To raise the imaginative of mathematical thinking to create the teaching aids for CwDbased on ECT, the indicators:

- (1) Appears an imagination or idea that is characterized by the production of teaching aids that are different from what others have found.
- (2) *Fluency*, ie the ability to produce a teaching aids that can be utilized to describe several different materials.
- (3) *Flexibility*, ie the ability to produce some teaching aids that can be used to describe a material.
- (4) *Originality*, the ability to produce a teaching aids as self-supporting works.

2.7 Mathematical Teaching Aids Models that Suitable for CwD

The following is presented the product of manipulative teaching aids for CwD which is expected to be a modeling for teaching aidswho designed and made by students. These teaching aids can be trained face-to-face through activities based on ECT(learning that looks easy and fun).

This research activity will give analysis result for the growth of imagination which is innovation and creative in Mathematics Education Student of UNNES to develop of Learning Teaching Aids for CwD which is suitable with children needs and environmentally friendly.

Example 1. In the book of SS students there is Geometry material as in figure 1 below.

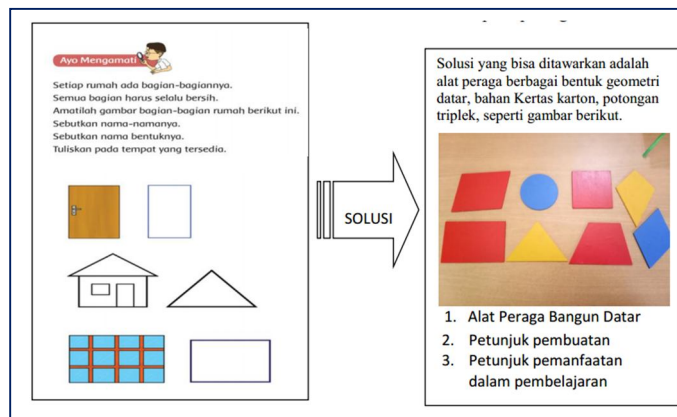


Figure 1: Learning Process

Example 2: In the fourth grade book of the Mentally Disabled at page 91 there is a problem as shown in Figure 2 below.

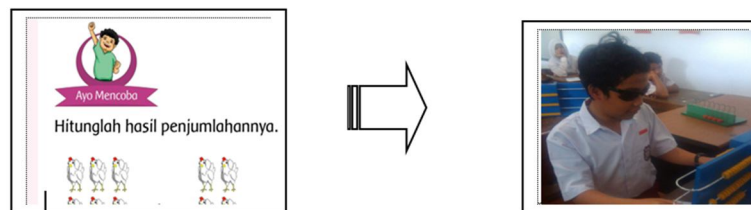


Figure 2: Using Teaching Aids in Mathematics Learning

2.8 Extra-Curriculum Training (ECT) Activity

ECT activity is a semi-lecturing activity that conducted outside the formal lecturing activities scheduled. Because of its implementation outside of the formal lecturing activities scheduled, this activity can be referred to as extra-curricular training. Salmi and Thuneberg (2015) wrote that learning activities from informal sources occurring in extra-curricular training or in out-of-study environments have proven to be effective and able to motivate participants.

Furthermore, Resnick (1987) suggested that out-of-studying can make a learning environments will be particularly useful for students, either because of the manipulation-oriented tool approach and contextualized reasoning. Not associated with mere thought or mere symbols of manipulation.

Harwell (2003), Kramarz (2008), and Burns (2011) are experts who like to write articles about teacher training or teachers candidate. They wrote that training is necessary for teachers or teachers candidate to have the ability to develop professions and have high quality in the learning process needed for students. While Doyran (2011), stated that the training materials should be very useful for teachers and students faced and must be in accordance with current needs. If what is encountered is CwD then the material related to learning CwD is feasible to be studied and trained.

In this research, ECT training activities are filled with intensive materials and training such as the characteristics of CwD, how to write and read the letters and numbers of Braille, to teach school mathematics using Braille symbols, to create mathematical teaching aids to be used for CwD who study in SS. With these teaching aids, it is expected that mathematics subject matter becomes easy and fun (Joyful Learning) for CwD. Associated with Joyful Learning, Wei (2011) wrote that Joy, according to Oxford English Dictionary, is described as an emotion or a feeling of joy. The adjective of joy is fun that also describes a kind of feeling, expressing and causing pleasure. This means that the mathematical learning process for CwD that utilizes visual aids takes place "in a pleasant atmosphere and math becomes easy." The learning process or learning experience can make the SS students or inclusion schools feel happy. Wei (2011) and Conklin (2014) also observed that a pleasant learning perception has a positive effect on students' learning motivation.

3. METHODS

3.1 Research Approach

In this research used research method with qualitative approach. Qualitative approaches have natural characteristics with data retrieval through direct, descriptive, and process data sources are preferred to obtain accurate research results in accordance with the problems and objectives of the study.

3.2 Focus of Research

The subject of this research was conducted by taking 6 students of Mathematics Education Study Program of FMIPA UNNES of Academic Year 2017/2018 who are interested to follow training activities based on Extra-Curriculum Training. To these students:

- (1) are given a training with a pattern based on the Imaginative appearance in Mathematical Thinking,

- (2) given briefing and reading of letters and numbers of Braille, and its utilization in learning mathematics,
- (3) provided mathematical modeling of the teaching aids suitable for CwD,
- (4) ECT activities are provided by designing of mathematical teaching aids suitable for CwD, and
- (5) is studied in depth in an imaginative appearance in mathematical thinking of Mathematics Education students in creating the teaching aids for CwD based on ECT through:
 - a) Inspection/assessment of the teaching aids design products.
 - b) Interview intensively on the subject of research.
 - c) Triangulation.

3.3 Data and Research Data Sources

This qualitative research data source are some students of Mathematics Education Study Program of FMIPA UNNES of Academic Year 2017/2018 who are interested to follow training activity based on ECT, and was selected as research subject. The data is the result of the design of teaching aids CwD creation of students who will be analyzed/studied of Imaginative in Mathematical Thinking, creativity, behavior, and activities.

3.4 Data Collection Techniques

In this qualitative research, the data collecting instrument is the researcher himself. On the other hand, researchers have limitations in determining the data to be collected. Thus, researchers need tools in the form of instruments making teaching aids, guidance assessment guides, interview guides, observation guides, diaries, and document study so that the collection of research data can be focused and focused on the problems to be solved.

3.5 Data Validity Techniques

The data collected needs to be tested for validity in order to obtain objective data and in accordance with the purposes of this study. Some data validity testing techniques such as extension of time/research period, improved research persistence study, review on research subjects, additional interviews, and triangulation. The triangulation consists of (1) theory triangulation, (2) source triangulation, (3) method triangulation, and (4) triangulation of the researcher.

3.6 Data Analysis Techniques and Interpretation

The data analysis in this study is based on Matthew B. Miles & A. Michael Huberman. Miles and Huberman (2014) theory, Miles and Huberman translated by Rohidi

(1992), and Moleong (2010), principally argued that activity in data analysis qualitative done interactively and lasted continuously until complete Thoroughness of data is marked by not getting any new data or information. Activities in data analysis include: data reduction, display data, data interpretation, and conclusion/verification.

3.7 Indicators of the Imaginative in Mathematical Thinking Appearance

As described in the literature review above, the researchers chose to use a combination of Gomon (1999) and Silver (1997) theories modified, in accordance with the purposes of this study to determine the indicator of the imaginative of mathematical thinking. To bring up the imaginative of mathematical thinking is marked by the successful participant of ECT in designing teaching aids for CwD, the indicators are as follows.

- (1) Growing of imagination or ideas that characterized by the design of teaching aids that are different from those found by others, which are:
 - a) *fluency*, that is, the ability to design a teaching aids that can be exploited to describe several different materials, or
 - b) *flexibility*, ie the ability to design some teaching aids that can be utilized to describe a material.
- (2) *Originality*, the ability to produce the design of teaching aids as self-supporting works.

After the teaching aids design is examined/ assessed, an in-depth interview is conducted, then triangulation (comparing the findings when assessing and during the interview) the imaginative of mathematical thinking is characterized by the design of teaching aids for CWD produced. The qualitative weight of the student's teaching aids design is divided into 5 categories, namely: very good, good, enough, less, and very less. The determination of this category depends on the subjectivity of the researcher as a key instrument, interview guide, and the results of its triangulation.

4. RESULTS AND DISCUSSION

The results achieved are as follows. First, through ECT activity has grown the imaginative in mathematical thinking which is marked by the production of the different teaching aids designs that have been found by others, which are: (1) fluency, ie students now have the ability to design a teaching aid for CwD that can be utilized to explain some different material, or (2) flexibility, ie the student now has the ability to design some teaching aids that

can be utilized to explain a material. In addition, the student is also the ability to produce the teaching aids as his/her own self-contained or originality work. Notice Table 7 below:

TABLE7

RECAPITULATION OF RESULT AFTER TRIANGULATION

No	The category of imaginative emergence in mathematical thinking is characterized by designing props for CwD towards Joyful Learning.	Able to design props for APD in the direction of Joyful Learnings as a form of imaginative appearance in mathematical thinking of students:		The number of research subjects, after completion of the assessment process, interviews, and triangulation
		<i>Fluency</i> imagination	<i>Flexibility</i> imagination	
1.	Growing, Very Good	There are 3 or more materials.	There are 3 or more the teaching aids.	1
2.	Growing, Good	There are 2 materials.	There are 2 the teaching aids.	2
3.	Growing, Enough	There is 1 material.	There is 1 the teaching aid.	1
4.	Growing, Less	There is 1 material and less appropriate to use.	There is 1 teaching aid and less appropriate to use.	2
5.	Growing, Very Less	Fail.	Fail.	0

Secondly, ECT students have succeeded in designing a teaching aids for CwD that are different from those already found by others. Student design of the teaching aids have started to have properties: (1) fluency, (2) flexibility, and (3) originality.

Discussion. Although through ECT activity has grown the imajinative of mathematical thinking which is marked with the result of design of the teaching aids different from those that have been found by others, which are: (1) fluency, (2) flexibility, and (3) originality, but on research subject there is only one student who has the category Very Good. There are two students who have the category Very Good, others are in the Medium or Less category. Look at Figure 5 below which contains 2 photos. Photo 1, bustle of students is designing and making a teaching aids as a form of imaginative growth of mathematical. Photo 2, some of the students' works make the teaching aids for CwD.



Figure 5: Example of the teaching aids of student work

5. CONCLUSIONS AND SUGGESTIONS

From the description above it can be concluded as follows. (1) Through this ECT activity, it is very effective to cultivate the imaginative of mathematical thinking for Mathematics Education student. The students have a place to develop imaginative power in mathematical thinking. (2) Students participating in ECT are able to design the teaching aids for CwD which is expected to be the learning process as a form the students' imaginative growth in mathematical thinking.

The suggestions: (1) It is necessary to design, create and apply the teaching aids of math learning for CwD who are school in SS, especially in State SS of Salatiga. (2) Required a suitable learning model to be applied in the SS so that math lessons become fun (joyful learning) and the results are effective.

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