# THE EFFECTIVENESS OF USING CONSTRUCTIVIST TEACHING SEQUENCE (CTS) IN ENHANCING THE VISUAL REPRESENTATION SKILLS OF INTEGERS AMONG STUDENTS AT SMP MUHAMMADIYAH 2 COMAL

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## ABSTRAK

*Constructivist Teaching Sequence* (CTS) merupakan suatu cara dalam mengenali proses pembentukan konsep pada siswa dengan tujuan untuk membentuk pemahaman konsep fisik atau mengembangkan minat dan perilaku siswa dengan lebih mengutamakan pada perilaku siswa untuk berperan aktif. Dari alasan tersebut, maka peneliti tertarik untuk melakukan penelitian tentang Penggunaan CTS untuk Meningkatkan Kemampuan Representasi Visual Bilangan Bulat pada Siswa SMP Muhammadiyah 2 Comal. Tujuan penelitian ini dilakukan untuk menguji bagaimana efektivitas penggunaan model pembelajaran CTS dalam meningkatkan kemampuan representasi visual bilangan bulat pada siswa SMP Muhammadiyah 2 Comal, metode penelitian menggunakan eksperimen dengan desain pre-eksperimental menggunakan *one group pretest-posttest*. Sampel yang digunakan pada penelitian ini sebanyak 53 siswa. Teknik pengumpulan data yang digunakan adalah tes kemampuan representasi visual bilangan bulat dan dokumentasi, kemampuan representasi visual bilangan bulat siswa kelas eksperimen mendapatkan nilai rata-rata *pretest* sebesar 50,13 sedangkan kemampuan representasi visual bilangan bulat siswa kelas eksperimen mendapatkan nilai rata-rata *posttest* sebesar 78,03. Berdasarkan hasil uji hipotesis menggunakan *independent samples t-test* menyatakan bahwa, pada taraf signifikan 5% yaitu $t_t$ = 2,007 diketahui bahwa $t_0$ = 18,80 lebih besar dari pada $t_t$ (18,80 > 2,007). Maka, $H_0$ ditolak dan $H_a$ diterima. Rata-rata skor N-Gain kelas eksperimen adalah 56,2483 atau 56,25% termasuk kategori cukup efektif.

**Kata kunci** : (CTS, Kemampuan Representasi Visual, Bilangan Bulat)

***ABSTRACT***

*The Constructivist Teaching Sequence (CTS) is a method that recognizes students' concept formation processes to develop understanding of physical concepts and foster active participation. Therefore, the researcher is interested in studying the use of CTS to improve students' visual representation skills of integer numbers at SMP Muhammadiyah 2 Comal. This study aims to examine the effectiveness of the CTS teaching model in enhancing students' visual representation skills of integer numbers at SMP Muhammadiyah 2 Comal. The research method employed is experimental, utilizing a pre-experimental design with a one-group pretest-posttest format. The sample used in this study consisted of 53 students. Data collection techniques included tests of visual representation skills of integer numbers and documentation. The visual representation skills of integer numbers in the experimental class had an average pretest score of 50,13, while the average posttest score was 78,03. Based on the hypothesis test results using the independent samples t-test, at a 5% significance level with $t_t$= 2,007, it was found that $t_0$ = 18,80 is greater than $t_t$ (18,80 > 2,007). Therefore, $H_0$ is rejected and $H_a$ is accepted. The average N-Gain score for the experimental class was 56,2483 or 56,25%, which falls into the category of moderately effective.*

***Keywords** : (CTS, Visual Representation Skills, Integers*)

## INTRODUCTION

Mathematics has become a universal science whose presence is crucial in every scientific concept and can enhance students' thinking patterns to prepare them with the skills to think logically, systematically, analytically, critically, and creatively, enabling them to find solutions to everyday problems (Mashuri, 2019). Objects in mathematics are abstract in nature. Due to their abstract nature, it is not uncommon for teachers and students to encounter several challenges in the learning process (Afsari, 2021). The process of learning mathematics in schools is not yet considered an enjoyable activity. However, it cannot be denied that in everyday life, there are human activities related to mathematics. According to Van den Heuvel Panhuizen, as cited by Nanang and Rusgianto, when students learn mathematics separately from their daily experiences, they will quickly forget and be unable to apply mathematics in their lives (Santosa, 2016).

"Relating learning materials to their everyday experiences and encouraging collaboration are some constructivist principles that can be applied to enhance daily learning. One learning model that applies constructivist concepts is the Constructivist Teaching Sequence (CTS) model (Amiruddin, 2020). In the Constructivist Teaching Sequence (CTS) learning model, teachers can apply visual representations to encourage students to form mathematical concepts according to their own abilities and experiences. The CTS model has its own characteristics, including: (a) being based on constructivist views, (b) the learning process refers to students playing an active role in shaping their knowledge, (c) students carrying out actions and developing their thought processes, and (d) students utilizing the environment as a reference in learning (Faridah, 2022).

The National Council of Teachers of Mathematics (NCTM), as cited by Masjaya, states that there are five components of mathematical abilities that students must possess. These include the skills to solve problems or problem-solving, the skills to make connections or connection, the skills to communicate or communication, the skills to reason or reasoning, and the skills to represent or representation. Based on this statement, the skills of representation is one of the mathematical skills that students need to master, which will assist them in solving mathematical problems as well as in everyday life (Wardono, 2018). It can be

concluded that representational skills is the capskills to re-express mathematical ideas or concepts visualized in other forms such as symbols, graphs, diagrams, pictures, or written words. This skill needs to be developed because mathematics is an abstract science that must be represented in order to be easily understood by students.

Based on the interview results obtained by the researchers, it was found that at SMP Muhammadiyah 2 Comal, the teaching methods tend to be verbal, which leads to a lack of student participation in the classroom. One of the subjects that seventh-grade students find difficult to understand is integers. In the teaching process of integers, the teacher first provides a review to recall the material from elementary school. However, some students do not remember it and are still confused about representing it on a number line. Additionally, students are often given illustrations in the form of borrowing or debt concepts to make it easier to understand. The issue arises because the students' visual representation skills are still low, causing them to be unable to grasp the concept of integers even though it has been taught at the previous level.

The relevant previous research related to this study was conducted by Hinda Faridah, titled “Penerapan Model Pembelajaran *Constructivist Teaching Sequence* (CTS) untuk Mengubah Konsepsi dan Meningkatkan Keteramplan Proses Sains Siswa Sekolah Dasar” and the research conducted by Nur Hidayah et al., titled “Analisis Kemampuan Representasi Visual melalui Model Pembelajaran TPS”. The novelty of this research compared to previous studies lies in the different variables, namely enhancing the skills of visual representation of integers, applied to seventh-grade students of junior high school, and utilizing a different research method as well. The research problem formulated is "How effective is the use of the Constructivist Teaching Sequence (CTS) learning model in improving the visual representation skills of integer numbers for students at SMP Muhammadiyah 2 Comal?" Meanwhile, the researcher is interested in studying the use of CTS to improve students' visual representation skills of integer numbers at SMP Muhammadiyah 2 Comal.

This type of research is an experimental study with a Pre-Experimental design using a one-group pretest-posttest. This study employs a quantitative research

approach by applying an experimental method. The population of this study consists of all seventh-grade students at SMP Muhammadiyah 2 Comal with a total of 112 students. Meanwhile, the sample used is 53 students based on Slovin's calculation formula with a 10% range. The sample in this study is the experimental class selected using Simple Random Sampling technique. The reason for using this technique is that, in this method, every individual in the population has an equal chance of being selected as a research subject (Nuryadi, 2017). Data collection techniques are conducted through two methods: a pretest and posttest of integer representation skills and documentation. Data analysis technique involves testing normality using the Lilliefors test with the proposed hypothesis: H0: The sample has a normal distribution and Ha: The sample does not have a normal distribution. Hypothesis testing methods used are Independent Sample T-Test and Normalized N-Gain Test.

## DISCUSSION

### Mathematics

Mathematics is part of abstract and systematically structured knowledge, also serving as a logical science. Problems related to numbers in mathematics assist in articulating concepts and conclusions (Siagian, 2016). Mathematics possesses a consistently structured and logical framework. Mathematical concepts are arranged in a structured and well-organized manner. For instance, axioms in geometry form the foundations of a coherent system. This structure enables the application of consistent rules and procedures in developing mathematical arguments and ensuring logical validity in problem-solving. Mathematics, being an artificial language, refers to its nature with symbols, notations, and specific communication rules. It provides a symbolic system used to describe, represent, and communicate mathematical concepts (Yosi, 2019).

### Constructivist Teaching Sequence (CTS)

Learning models refer to methods or frameworks that can be used to design curricula, organize learning resources, and guide the learning process both inside and outside the classroom over an extended period. Utilizing learning models as a reference enables teachers to select suitable and effective learning models to achieve their educational goals (Mirdad, 2020). By employing learning models,

teachers can support students in acquiring information, developing skills, enhancing thinking abilities, and assisting them in visualizing their ideas. One example of a learning model that adopts a constructivist approach in teaching implementation is the Constructivist Teaching Sequences (CTS) learning model. The CTS learning model is a highly beneficial way to recognize the process of concept formation in students aimed at shaping understanding of physical concepts or developing student interest and behavior (Amiruddin, 2020). Ari Widodo in his research, explains that the CTS model can be implemented in 5 syntaxes are (Widodo, 2004).

1. Introduction: It identifies efforts to prepare students for the topic, to promote students' readiness and to generate students' interest in the lesson.
2. Exploring students' prior knowledge: It identifies teachers' efforts to explore students' prior knowledge related to the topic.
3. Restructuring students' conceptions: It identifies attempts to facilitate conceptual change.
4. Applying the newly constructed ideas: It identifies attempts to apply the concepts learned to other contexts or to real life..
5. Reviewing the new ideas: It identifies attempts to encourage students to compare the newly achieved and the previous conceptions..

**Visual Representation Skills**

Representation is a configuration that can depict, symbolize, or represent a concept through a certain means. For example, a word can describe an actual object or a number can represent a position on a number line (Sabirin, 2014). The skills of representation can be defined as the skills to explain concepts or ideas demonstrated by students when they express a problem in different forms, such as words, pictures, or mathematical symbols, to solve problems in a way that clarifies their meaning. Mathematical representation skills is divided into 3 indicators, namely visual representation skills, symbolic representation skills, and verbal representation skills.

Visual representation can be used to convey concepts, ideas, or to illustrate problem-solving outcomes. The results of visualized ideas can take the form of images, diagrams, animations, or graphic maps (Hendra. K, 2019). The following

are indicators of the skills of visual representation of integers, including (Rila, 2019).

1. Skills to identify absolute value: the skills to recognize and understand the absolute value of integers in a visual context. For example, recognizing that the number 5 has a greater value than the number 3.
2. Understanding number scales: the skills to understand number scales on a number line or measuring bar. This involves understanding the relationship between integers and their positions on the scale.
3. Representation with dots and lines: the skills to use dots and lines as visual representations of integers. For example, showing the number 7 with seven dots or lines on a diagram or scale.
4. Understanding arithmetic operations: the skills to visualize arithmetic operations on integers, such as addition, subtraction, multiplication, and division. For example, understanding that adding two positive numbers will result in a larger number.

Based on the statements that have been presented, it can be concluded that visual representation skills is the capskills to present information using media such as pictures, sketches, graphics, to facilitate students in finding solutions to a problem and presenting an illustration of the relationships between concepts within a system through visual forms.

**The Use of Constructivist Teaching Sequence (CTS)**

1. Introduction

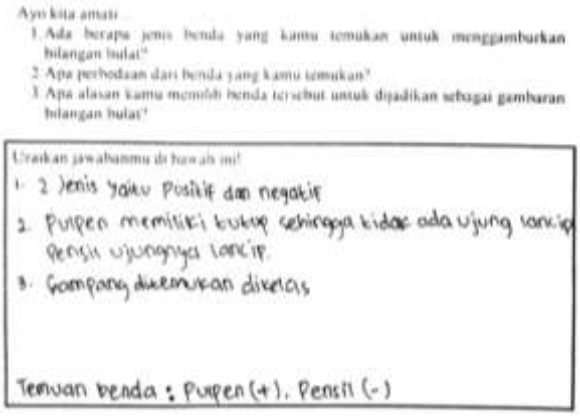
   Before conducting the learning process, the researcher initiated with prayer, attendance, and providing learning motivation. The researcher conducted an apperception regarding whole numbers that had been taught in elementary school to enhance students' memory of the material. The researcher introduced the topic of whole numbers and explained the material in general.

2. Exploring

   Researchers provide students with the opportunity to explore the concept of visual representation of integers. Students are challenged to find objects in the classroom to be used as visual representations of integers. The researchers divide the groups consisting of 2-4 people to discuss problem-solving in the

worksheet. The results of the students' exploration can be seen in the following picture.

Image 1. Student Exploration Results



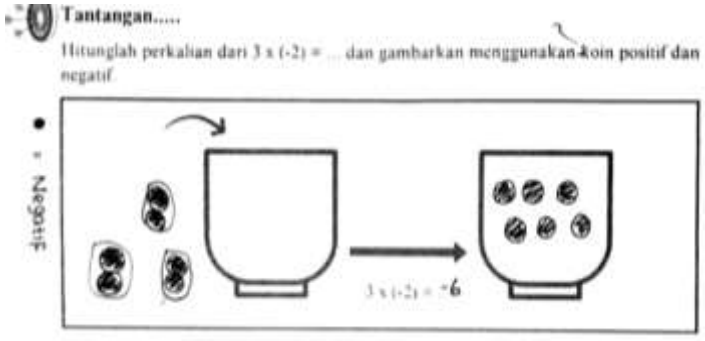

3. Restructuring

After conducting exploration, students are guided to develop their understanding of integers through conceptualization stages. They are directed to explain the exploration results based on their understanding of integers using number lines or positive and negative coins.

4. Applying

Students are given the opportunity to provide examples of the concept of representing integers visually in everyday life. Researchers guide students to apply these examples in problems related to the skills to represent integers visually. The results of the students' applications can be seen in the following picture.

Image 2. Student Aplication Results



5. Reviewing

The final stage conducted by the researchers is to provide students with the opportunity to reflect and draw conclusions from the learning that has been undertaken. Students may raise their hands to explain the conclusions they have drawn and share interesting experiences as well as challenges they faced during the exploration. The learning concludes with providing appreciation and motivation to students to be more active in their learning.

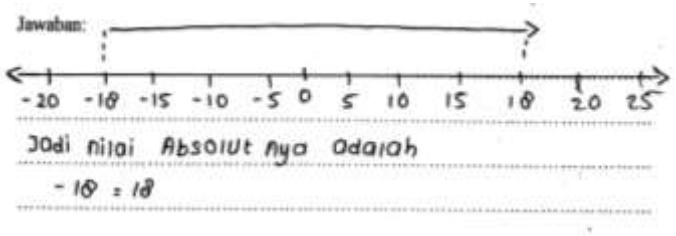
**The Visual Representation Skills of Experimental Class Students**

The skills of experimental class students in visual representation can be seen from the results of pretests and posttests. The following is an elaboration of the visual representation skills of the experimental class based on its indicators.

1. Skills to identify absolute value

Students are able to recognize and understand the absolute values of integers in visual contexts. For example, in the following question, students are able to answer that the absolute value of -18 is 18.

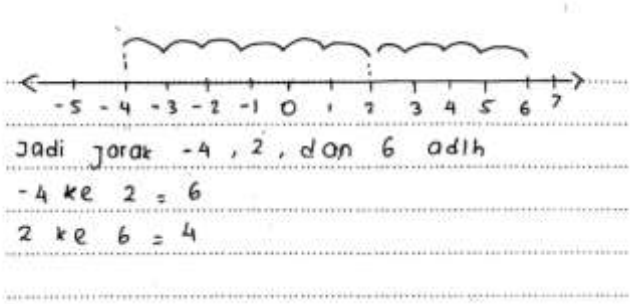
Image 3. The result of Indicator 1 Test




2. Understanding number scales

The students are able to comprehend the number scale on the number line and can demonstrate the relationship between integers and their positions on the scale. For example, in the following problem, students can explain that the distance from -4 to 2 is 6 units.

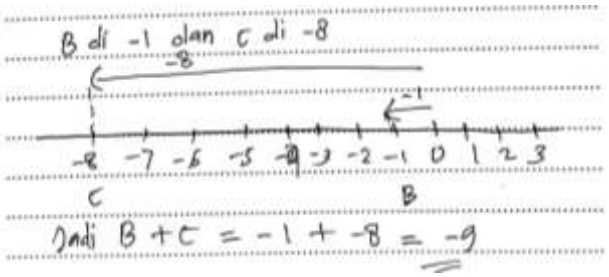
Image 4. The result of Indicator 2 Test




3. Representation with dots and lines

Students are able to use points and lines as visual representations of integers. For example, students can represent the number -8 with eight points or lines on a diagram or scale. If the number is negative, the arrow points to the left, and if it is positive, it points to the right.

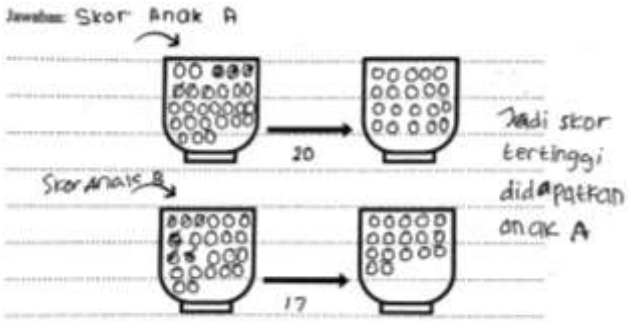
Image 5. The result of Indicator 3 Test




4. Understanding arithmetic operations

The students are able to visualize arithmetic operations on integers, such as addition, subtraction, multiplication, and division.

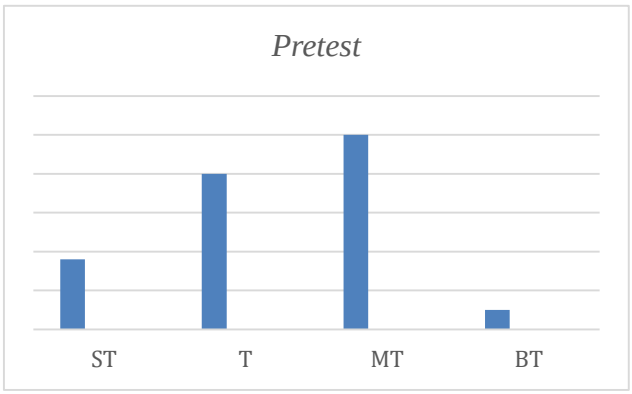
Image 6. The result of Indicator 4 Test



**Pretest Data on Students' Visual Representation Skills**

Based on a sample size of 53 students, there is 1 student who reached the ST (Already Skilled) category with a percentage of 1,89%, there are 22 students who reached the T (Skilled) category with a percentage of 41,50%, there are 24 students who reached the MT (Starting Skilled) category with a percentage of 45,29%, and there are 6 students who reached the BT (Not Skilled) category with a percentage of 11,32%. The graphical representation can be seen in the following image.

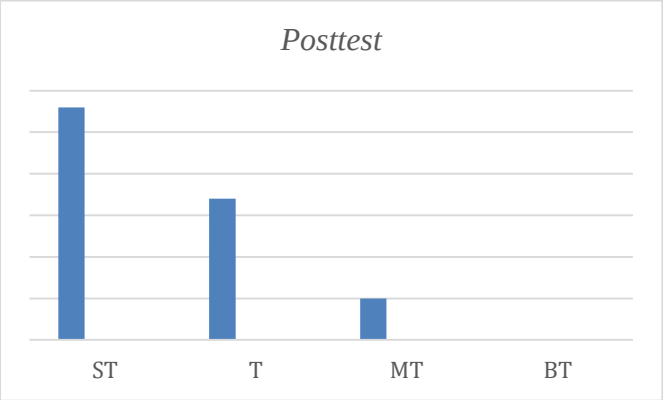
Image 7. Pretest Value Percentage Graph




**Posttest Data on Students' Visual Representation Skills**

Based on a research sample of 53 students, there were 27 students who reached the ST (Highly Skilled) category with a percentage of 51%, there were 24 students who reached the T (Skilled) category with a percentage of 45,29%, there were 2 students who reached the MT (Moderately Skilled) category with a percentage of 3,78%, and there were no students who reached the BT (Not Skilled) category. As for the graphical representation, it can be seen in the following image.

Image 8. Pretest Value Percentage Graph




**Independent Sample T-Test**

Based on the calculation results obtained, the value of $t_0$ = 18,80 and the value of t listed at the 5% significance level is $t_t$ = 2,007, thus it can be known that $t_0$ is greater than $t_t$, namely 18,80 > 2,007. Therefore, the null hypothesis ($H_0$) proposed is rejected, meaning that there is a difference in visual representation skills scores among students between the pretest data and the posttest data using the experimental method. Therefore, the alternative hypothesis ($H_a$) is accepted, and the null hypothesis ($H_0$) is rejected. So, it can be concluded that the use of Constructivist Teaching Sequence (CTS) is effective in improving students' visual representation skills.

**Normalized N-Gain Test**

Tabel 1. Deskripsi Hasil Uji N-Gain

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Ngain_skor | 53 | .26 | .94 | .5625 | .17281 |
| Ngain_persen | 53 | 26.47 | 93.75 | 56.2483 | 17.28118 |
| Valid N (listwise) | 53 | | | | |

Based on the results of the N-Gain test calculation above, it shows that the average N-Gain score of the experimental class is 56,2483 or 56,25%, which falls into the category of moderately effective. The minimum N-Gain value is 26,47% and the maximum is 93,75%. Therefore, it can be concluded that the use of Constructivist Teaching Sequence (CTS) is quite effective in improving the visual

representation skills of integers in the seventh-grade students at SMP Muhammadiyah 2 Comal.

The use of Constructivist Teaching Sequence (CTS) can enhance students' skills to visually represent integers because in learning, Constructivist Teaching Sequence (CTS) involves students' activity to play a crucial role in learning and students are taught to form their own understanding of integer concepts. Furthermore, the use of objects in the surrounding environment to perform integer operations is also crucial, making it easier for students to understand the material being learned.

In line with the research by Nunggal and Janet, it is asserted that learners require mathematical representation skills to discover and devise a tool or method of thinking in communicating mathematical ideas from abstract to concrete, thus making it easier to comprehend. (Nunggal Pramudita. M, 2016). The perceived complex and intricate problem can become simpler when the strategy and utilization of mathematical representations used are appropriate for the case. (Effendi, 2021). This study is also in line with research conducted by Hinda Faridah, which found that the use of the CTS learning model in heat and temperature-sensitive subjects is one of the strategies to assist students in developing their scientific method skills. (Faridah, 2022). This research is also supported by the findings of a study conducted by Elissanriani Nuinik Ardiana and Muhammad Syahril Harahap, which also concluded that students who were provided with treatment in the form of using constructivist learning models showed greater improvement in their skills to solve mathematical problems. (Elissanriani. N. K, 2020).

**CONCLUSION**

Based on the results of research and analysis conducted on the effectiveness of using Constructivist Teaching Sequence (CTS) to enhance the skills of visual representation of integers in students at SMP Muhammadiyah 2 Comal, it can be concluded that there is a significant improvement inferentially with the use of Constructivist Teaching Sequence (CTS) to enhance students' skills in visual representation of integers. This can be observed by comparing the magnitude of the t-value obtained by the researcher, $t_0 = 18.80$, and the critical t-value listed as $t_t =$

2,007 (18,80 > 2,007). Therefore, the use of Constructivist Teaching Sequence (CTS) can be employed to enhance students' skills in visual representation of integers with a significance level of 5%. Thus, it can be analyzed that $t_0$ is greater than $t_t$ ($t_0 > t_t$), thus rejecting $H_0$ and accepting $H_a$, indicating that the use of Constructivist Teaching Sequence (CTS) is effective in enhancing the skills of visual representation of integers in students at SMP Muhammadiyah 2 Comal. The level of effectiveness of using CTS can be seen from the calculation of the N-Gain value, which obtained a minimum value of 26,47%, while the maximum value obtained was 93,75%, with an average N-Gain score of 56,2468 or 56,25%. Therefore, it can be concluded that the use of Constructivist Teaching Sequence (CTS) is quite effective in enhancing the skills of visual representation of integers in seventh-grade students at SMP Muhammadiyah 2 Comal.

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