



# Mathematics Learning Design: Measuring the Volume of a Cube Using Unit Cubes for Elementary School

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## ABSTRACT

This study aims to develop an effective learning design to teach the concept of measuring the volume of a cube to students using the unit cube approach. The research method used is qualitative with a development research design approach. Data in this study were collected through class observations, interviews with class teachers, and analysis of existing learning materials. The results of this study indicate that the unit cube approach can improve students' understanding of the concept of measuring the volume of a cube. The use of unit cubes as learning aids helps students to associate abstract concepts with concrete visual representations. In addition, it was found that the interaction between teachers and students played an important role in facilitating student understanding. Teachers need to have an in-depth understanding of the concept of volume cube and the ability to direct class discussions so that students can work in groups, think critically and creatively and ask relevant questions. The use of appropriate questioning strategies also plays an important role in guiding students towards deeper understanding. In conclusion, this learning design provides a practical guide for teachers to teach the concept of measuring the volume of a cube effectively. The unit cube approach encourages students to be actively involved in the learning process and build a solid understanding of the concept. It is hoped that this research can make a positive contribution to the development of more innovative and interactive mathematics learning methods.

**Keywords:** *Learning Design, Cube Volume, Unit Cube.*

## 1. INTRODUCTION

Mathematics education has an important role in shaping students' logical, analytical and creative thinking abilities. One of the fundamental concepts in mathematics is measurement, which includes aspects such as length, area and volume. One of the topics taught in geometric learning in elementary schools is the volume of a cube, before students learn the volume of other geometric shapes. [3] states that the volume of cubes and blocks is an important geometric concept that underlies many aspects of mathematics. The volume of a cube is a measurement concept that has far-reaching implications in everyday life. This is in line with the opinion of [6] which states that the volume of cubes and blocks is related to

According to [2] volume can be measured in two ways, namely by means *filling* and *packing*. *Filling* is by means of space filled with fluid unit iterations. In this method, the unit structure is one dimensions. Whereas *packing* is the way space is packed with the arrangement

of three-dimensional units repeatedly in the third dimension. According to [13] there are two types of units that can be used to measure volume and capacity, namely solid units and container units. Solid units are objects such as wooden cubes that can be used to fill the container being measured. This is in line with [5] who revealed that in volume learning, students need to be given experience to compare fill in the objects that are useful for achieving an understanding of the concept of volume.

However, students' understanding of this concept is often still low. Students' understanding of the concept of measuring the volume of a cube still shows obstacles. A shallow understanding of this concept can hinder students' ability to apply the concept in real situations. This is also in line with the results of research conducted by [12] which states that students still have difficulty understanding the concept of volume of cubes and blocks. In line with [7] who revealed that students still experience difficulties in terms of measurement, namely in measuring the volume of cubes and blocks.

The lack of students' understanding of the concept of volume measurement is one of the contributing factors, namely the way the teacher delivers material that emphasizes mastery of the concept by rote. This is in line with the opinion of [10] which states that teaching teachers only emphasize mastery of concepts that refer to memorization, students can only count and memorize formulas, but cannot explain how these formulas are obtained. The same thing was expressed by [13] that teachers emphasize procedural understanding rather than conceptual understanding. Thus, students do not get the opportunity to explore how to find the concept of the volume of a cube, so they cannot understand the concept and volume formula properly. [8] also stated that mathematics learning regarding the concept of volume focuses learning on procedural calculations with mechanistic learning activities.

Based on the problems above, an effective learning design is needed to help students understand and internalize the concept of measuring the volume of a cube. We need a way to understand the concept of the volume of cubes and blocks that is interesting and meaningful for students so that it becomes motivation for students, both about basic knowledge and understanding of concepts.

This study aims to develop an effective learning design in teaching the concept of measuring the volume of a cube to students, using a unit cube approach or use *packing* method. The researcher used teaching aids in the form of wooden sticks and plasticine to make cubes, and colored paper to make unit cubes that would be made by the students themselves, so that students got meaningful experiences by being actively involved in learning activities. This learning design is expected to increase students' understanding of the concept.

According to [9] PMRI is a learning approach that will lead students to understand mathematical concepts by constructing their own through previous knowledge related to everyday life, like discovering the concept of volume of a cube and cuboid for themselves before they were introduced to numerical calculations or formulas. In this case, can use units to provide a cognitive framework for understanding volume measurements and formulas for determining the volume of cubes and blocks (Battista & Clemens 1998).

In finding mathematical concepts that can be implemented in a context. Use of context as starting point in mathematics learning can increase students' learning motivation [15]. Even [4] found that the use of context can increase the effectiveness of learning for students. [14], states that the context does not have to be a real world problem but can be in the form of a game, the use of props or other situations as long as it is meaningful and can be imagined in the student's mind. The use of visual aids such as room shapes, milk cartons and food cans are

visual media that can be used to foster students' understanding of concepts [11].

This research will focus on learning the concept of measuring the volume of a cube using the unit cube approach. The scope of research includes the stages of developing learning designs, implementation of the design in classroom situations, as well as evaluation of the effectiveness of the learning design.

## 2. METHOD

The research method used is qualitative with a development research design approach. The research subjects were fourth grade students at SDN 1 Donotirto with the number of students involved in this study were 25 students. Data in this study were collected through class observations, interviews with class teachers, and analysis of existing learning materials.

## 3. RESULTS AND DISCUSSION

This learning is designed to produce effective and interesting learning for students in learning volume cube materials using the *packing* method or by using unit cubes. Through this activity, students are expected to be able to discover the concept of volume. Learning activities are carried out in groups, so students can discover concepts collaboratively.

### 3.1. Create a Unit Cube

The activity begins with students cutting patterns or cube nets. This activity can introduce students to cube nets and cubic shapes. Each group is given a cube pattern sheet with a different color. This aims to create student interest, and facilitate students who have a visual learning style, so they are interested in colorful things. The activity is continued by forming the pieces of the cube nets into unit cubes. Following the process of making unit cubes can be seen in Figure 1.



Figure 1. Unit Cube Production Process

Based on Figure 1. it can be seen that the students in figure (a) cut the unit cube pattern, after the pattern was cut the students formed unit cubes by gluing each end as shown in figures (b) and (c). The unit cubes that have been formed are collected as shown in figure (d). Through these activities students can also recognize cube nets.

After the unit cubes were made, the activity continued with each group making a cube frame using skewers and plasticine. Each group is given a Student Worksheet as a work step guide. Through this activity students can get to know about the edges and vertices of a cube. Following the process of making a cube framework can be seen in Figure 2.



(a)



(b)



(c)

**Figure 2.** The process of making a Cube Frame

Based on Figure 2. Students follow the work steps according to the Student Worksheet distributed as shown in figure (a). Students then in groups arrange the cube framework according to the picture using wooden sticks and plasticine as shown in pictures (b) and (c). Through these learning steps students can get to know the parts. The parts of the cube are the length of the edges and the number of vertices.

**3.3 Assembling the Unit Cubes on the Cube Framework**

After the cube framework is formed, students are asked to fill in the cube framework by arranging unit cubes until they are completely filled. Following the process of preparing unit cubes can be seen in Figure 3.



(a)



(b)

**Figure 3.** The Process of Filling the Cube Using Unit Cubes

Students are seen assembling unit cubes one by one on the cube framework as shown in figure (a). The unit cubes are arranged until the cube framework is completely filled as shown in figure (b). Through this activity students can also calculate the number of unit cubes needed to fill the cube frame to the brim.

**3.4 Filling in Student Worksheets Calculating the Volume of a Cube**

After each group has finished filling in the cube framework using unit cubes, each group continues to fill out the Student Worksheet. Through the Student Worksheet, students are asked to observe the unit cube on each side. Next, students are asked to count the number of unit cubes on each side, namely length, width, and height. After finishing the calculations, each group can draw conclusions by writing down the formula and calculating the volume of a cube based on the unit cube they have observed. The following is the process of completing the Student Worksheet, which can be seen in Figure 4.



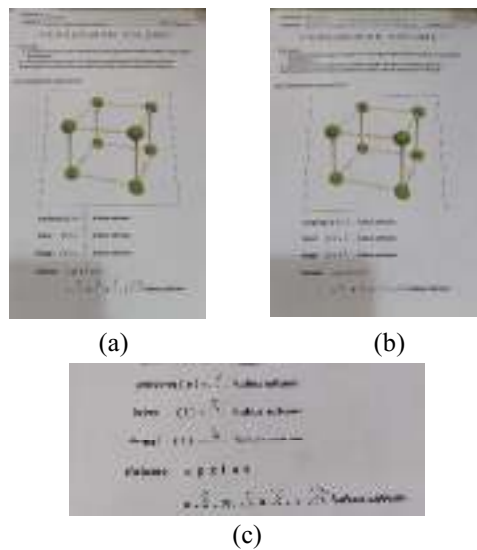
(a)



(b)

**Figure 4.** The Process of Filling in the Student Worksheet Calculating the Volume of a Cube

An example of the results of answers from students in groups to find the formula for the volume of a cube can be seen in Figure 5.



**Figure 5.** Student Work Finding the Volume of a Cube Formula

Based on Figure 5, an example of student work, it can be concluded that students already understand the concept of volume cube. Students are able to find the volume of a cube independently through practice.

Based on these learning activities it can be seen that each group has been able to conclude the concept of measuring the volume of a cube, students can find the formula for the volume of a cube. Through activities using *packing* method namely using unit cubes, it can be concluded that this method can help students to understand the concept of measuring the volume of a cube. This is in line with the opinion of [2] which states that the volume of cubes and blocks can be used in two ways, namely *filling* and *packing*.

Through volume measurement learning activities using unit cubes, students also get experience comparing the contents of objects with other objects to gain an understanding of concepts. This is in line with the opinion of [5] who revealed that in volume learning, students need to be given experience in comparing the contents of objects that are useful for achieving an understanding of the concept of volume.

Based on the learning activities that have been carried out, students in the volume cube learning process have had the opportunity to learn. Students are actively involved with the teacher's guidance to find formulas and measure the volume of cubes using wooden sticks, plasticine, and unit cubes. In addition, these learning activities also bridge students to help associate abstract concepts with concrete visual representations. This is in accordance with the stage of development of elementary school students, namely concrete operations. Thus,

students will get meaningful experiences and easy to understand material concepts.

The observation results also show that students are more actively involved in learning and show greater interest in the concept of measuring the volume of a cube. Interviews with teachers also revealed that instructional designs provide clear guidance and assist students in building better understanding.

#### 4. CONCLUSION

The results of this study indicate that the learning design with the unit cube approach is effective in increasing students' understanding of the concept of measuring the volume of a cube. The unit cube approach encourages students to be actively involved in the learning process and build a solid understanding of the concept. The application of this learning design makes a positive contribution to learning mathematics which is more interactive and fun. This learning design also provides a practical guide for teachers to teach the concept of measuring the volume of a cube effectively. It is hoped that this research can make a positive contribution to the development of more innovative and interactive mathematics learning methods.

#### AUTHORS' CONTRIBUTIONS

The first author contributed to the writing of all parts of the article. Then, the second author contributed to checking the research result as a whole. All authors read and approved the final manuscript.

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