5th ICRIEMS Proceedings
Published by Faculty Of Mathematics And Natural Sciences
Yogyakarta State University, ISBN 978-602-74529-3-0

# Identification of Calculation and Measurement Estimation Strategies Based on Visual-Spatial Intelligence

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**Abstract.** The aim of this paper is to identify calculation and measurement estimation strategies reviewed with visual-spatial intelligence. It is a descriptive study of the qualitative approach. There were 2 subjects explored. Data collected using Multiple Intelligence Survey, Calculation and Measurement Estimation Test, and interview. This study shows that in solving calculation estimation, both subject using reformulation strategy (the process of altering data to another that mentally manageable without changes the problem). Besides using reformulation strategy, the first subject also using translation strategy (changes problem structure into a form that mentally easier to calculate), on the other hand, the second subject did not use others. In accomplishing measurement estimation, subjects using repeat a unit mentally or physically strategy (mentally recalculating a unit by hand or making a mark on an object in order to be easily found). While the first subject also used chunking strategy (cutting off the object into same parts then estimating the size of each part) in this estimation, the second subject using compare to a referent strategy (comparing a reference using standard benchmarks units).

## INTRODUCTION

Estimation is a daily life mathematics application that often encountered [1]. It has been implemented in some countries curriculum for instance Turkey. Turkey has used computer estimation technology. It is very essential in problem-solving by determining a reasonable solution especially using a calculator [2]. In Indonesia, estimation is considered as an important topic of mathematics education. It becomes one of mathematics learning objectives, students have abilities in the estimate and calculate the surface area of irregular solids by implementing basic geometry through the illustration shown [3].

National Examination problem is an example of estimation implementation in Indonesia. Most of it is estimation problem since it consists of 40 multiple choice questions and should be completed in 90 minutes. Consequently, a student which lacks estimation knowledge will find some difficulties to solve them. It happened because the student works on the multiple choice questions in the similar procedure as essay questions that required a lot of time to solve. Anticipating this problem, students need to be provided with estimation knowledge. It is crucial because it can help the students to gain the right answers relatively fast without using the routine procedures [1].

There are three types of estimation; numeracy, measurement and calculation estimation [4]. However, the most common estimation used are calculation and measurement estimation since it is frequently used in junior high school level [5]. Calculation estimation is estimating the answer of a calculation which approximates to the real answer. Meanwhile, measurement estimation is estimating the size of an object without using the measuring instrument, so that the measurement result approximates to the real result [6].

According to Grouws [6], calculation estimation strategy is divided into three, namely *reformulation, translation, and compensation*. *Reformulation* is a process to change a form of a question by rounding the number

known to ease calculation without changing the operation structure in mathematics problem. *Translation* is changing the operation structure in mathematics problem into another form in order to determine the estimated result easily which is close to the real value. *Compensation* is an adjustment from estimate result as doing reformulation and translation to decrease errors during the conclusion.

Walle state, measurement estimation strategy is distinguished into four; they are *compared to a referent, chunking, subdivision, and repeat a unit mentally or physically* [7]. *Compare to a referent* is a strategy of making standard unit benchmark during measurement estimation. *Chunking* is a strategy of making several smaller or shorter parts in the equal size to ease in determining the estimated size of the object. The estimated size of the object can be found by counting the number of parts then multiplies it with the estimated result of one part of the object. The *subdivision* is a strategy of making several smaller or shorter parts which one part has unequal size and shape, thus it will be cut into some smaller parts that have equal size and shape. To establish the estimated size of the object, the procedure is by multiplying the number of big parts with the estimation result of one big part, and then it is added with the multiplication result from the number of small parts with the estimation result of one small part. *Repeat a unit mentally or physically is a strategy* of recalculating the estimated result by using a single unit to determine the size easier.

Various strategies should be used in solving a mathematics problem. It depends on the students most dominant intelligence [8]. Yaumi stated that each student has at least nine types of intelligence, namely *logical-mathematical intelligence, interpersonal intelligence, intrapersonal intelligence, environmental intelligence, existential intelligence, linguistic intelligence, musical intelligence, visual-spatial intelligence, and kinesthetic intelligence* [9]. The most related intelligence with mathematics, especially in solids is visual-spatial intelligence. A student with visual-spatial intelligence will solve the problem faster and better since the student is able to observe an object that has space in it accurately and transform it into a visual image, and present the new spatial idea precisely [10].

Based on the statements above, this paper aim is to identify students' calculation and measurement estimation strategy in terms of visual-spatial intelligence.

## METHOD

This is a descriptive study using a qualitative approach. The study was conducted at class VIII-2 SMPN 5 Sidoarjo. Data was collected on June 5 to 13 2017. Subjects were two students with visual-spatial intelligence. The subjects' selected by Multiple Intelligences Questionnaire result and teacher's recommendation. Both subjects were given the problems of Calculation and Measurement Estimation Test and then interviewed. The data was analyzed based on the data analysis techniques which consisted of data reduction, data display, and conclusion.

## RESULT AND DISCUSSION

The identification of students' calculation and mathematical measurement estimation strategy in terms of visual-spatial intelligence could be pointed out by both students' answers on Calculation and Measurement Estimation Test and their responsibilities in an interview. When identifying calculation estimation, both subjects looked at, observed, and understood the problem. Then, they made the plans to solve the problem. As shown in figure 1 and 2 below, the subjects did not write down what was known and asked in the worksheet, yet they worked on the problem immediately by connecting what was known and asked, along with some formulas that could be used to solve the problem. The answer to the first subject is presented in figure 1:

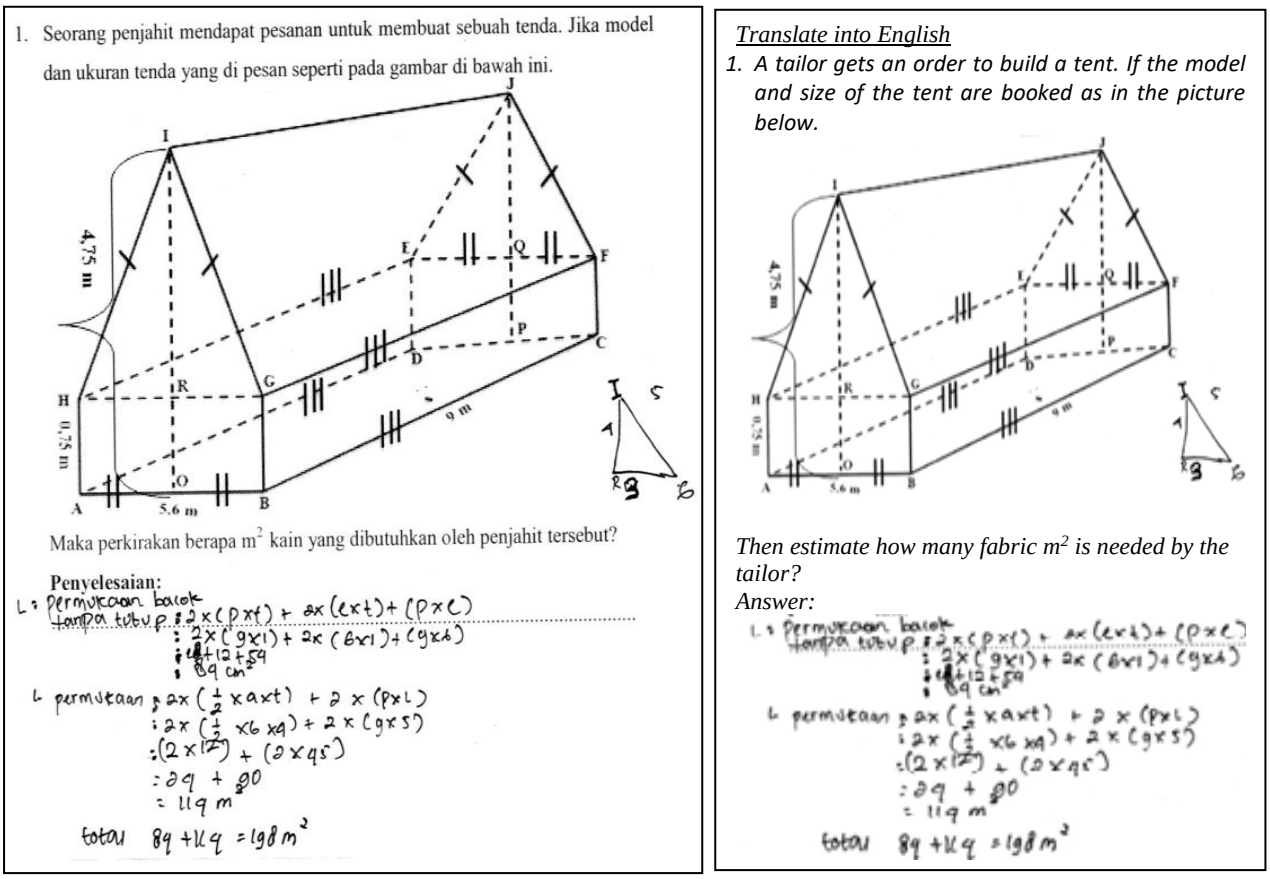



**FIGURE 1.** Subject 1's answer to problem number 1

Based on the picture above, calculation estimation strategies used by this subject are reformulation and translation. Reformulation strategy appeared on the process of changing the form of the problem by rounding the number known to be easily calculated without having to change the operating structure in the mathematics problem, for example, 0,75 was rounded to 1 and 5,6 is rounded to 6. Meanwhile, translation strategy was shown when the subject changed the operation structure of the problem into another form in order to determine the real estimation easily. For instance, the first subject looked for the surface area of uncovering bar by operating the formula $2 \times (p \times l) + 2 \times (l \times t) + p \times t$. The formula was derived from two figures that had equal shape and same size, which are ABGH with CDEF and BCFG and ADEH. For this reasons, the surface area could be obtained by multiplying the number of equal shapes. This is consistent with the opinion of Grouws who says that the reformulation strategy can be seen when process to change a form of a question by rounding the number known to ease calculation without changing the operation structure in mathematics problem [6].

Figure 2 shows that calculation estimation strategy used by the second object is a reformulation. It appeared on the process of changing the form of the problem by rounding the number known to be easily calculated without having to change the operating structure in the mathematics problem, for example, 0,75 was rounded to 1, 5,6 is rounded to 6 and 4,75 is rounded to 5.

The first two figures show that both subjects using reformulation. It was showed that booth subjects rounding the decimal into integers. If the number after the point was less than 5, it will be rounded down. While, if it was more than 5, it will be rounded up. This is consistent with Boz and Bulut statement that rounding numbers is the easiest way to use when making calculation estimates so that rounding of these numbers is often taught in the classroom [2].

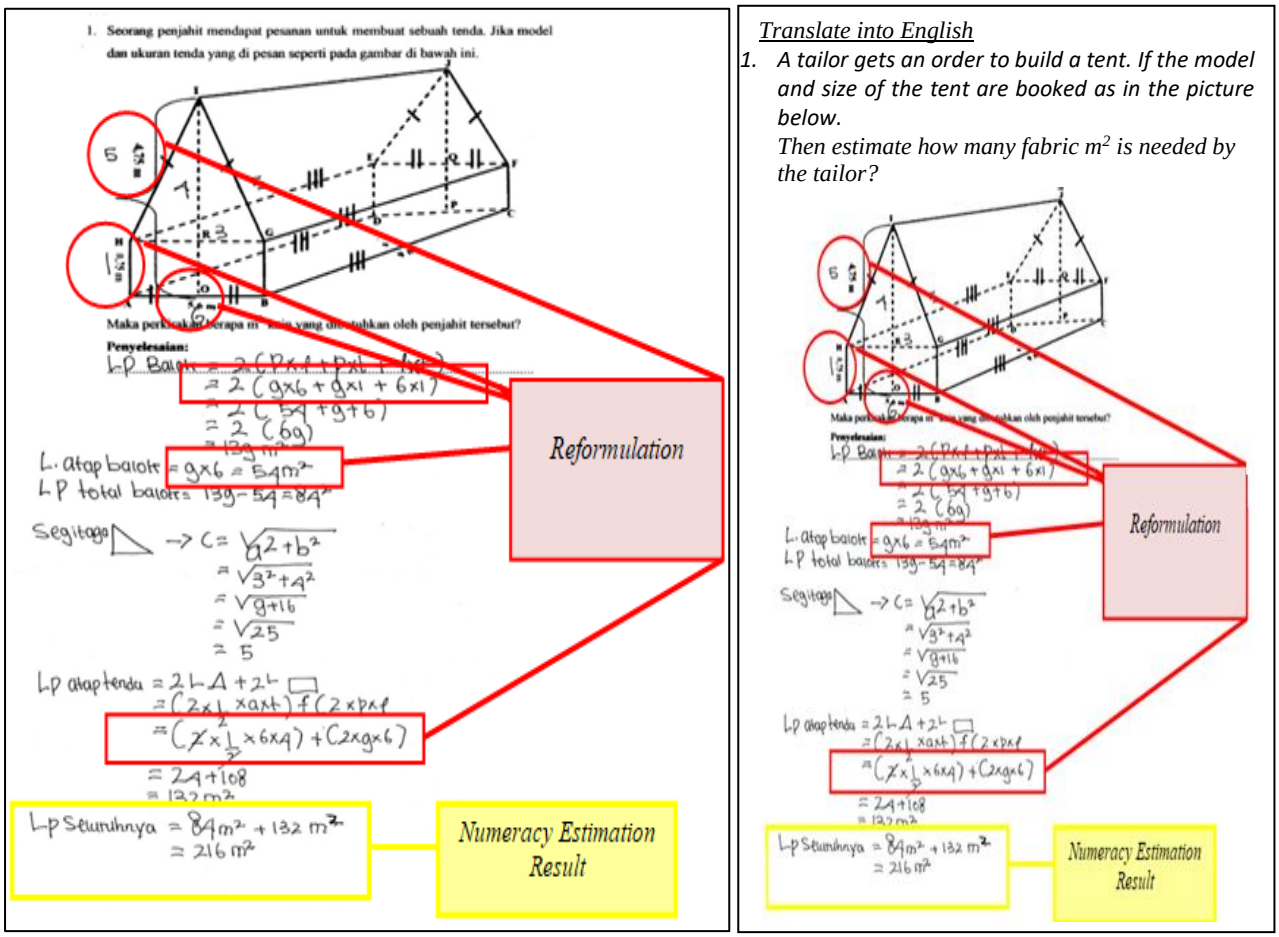
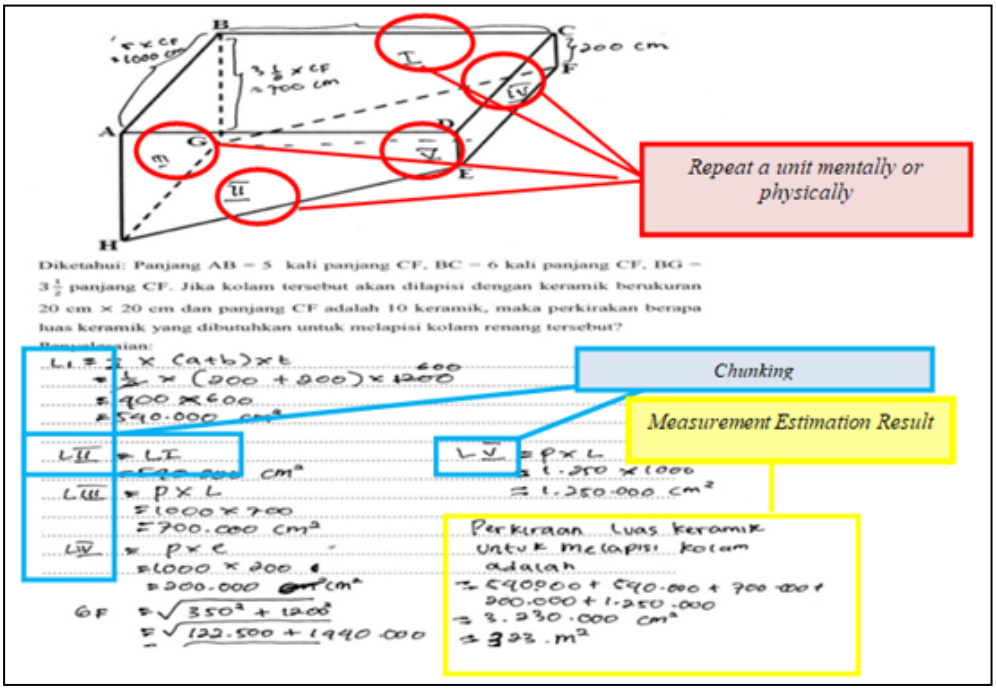



**FIGURE 2.** Subject 2's answer to problem number 1

When identifying measurement estimation strategy, both subjects looked at, observed, and understood the problem. Figure 3 and 4 show that both subjects did not write down what is known and asked on the worksheet, yet they worked on the problem immediately. Figure 3 shows the first subject answer for the second problem.



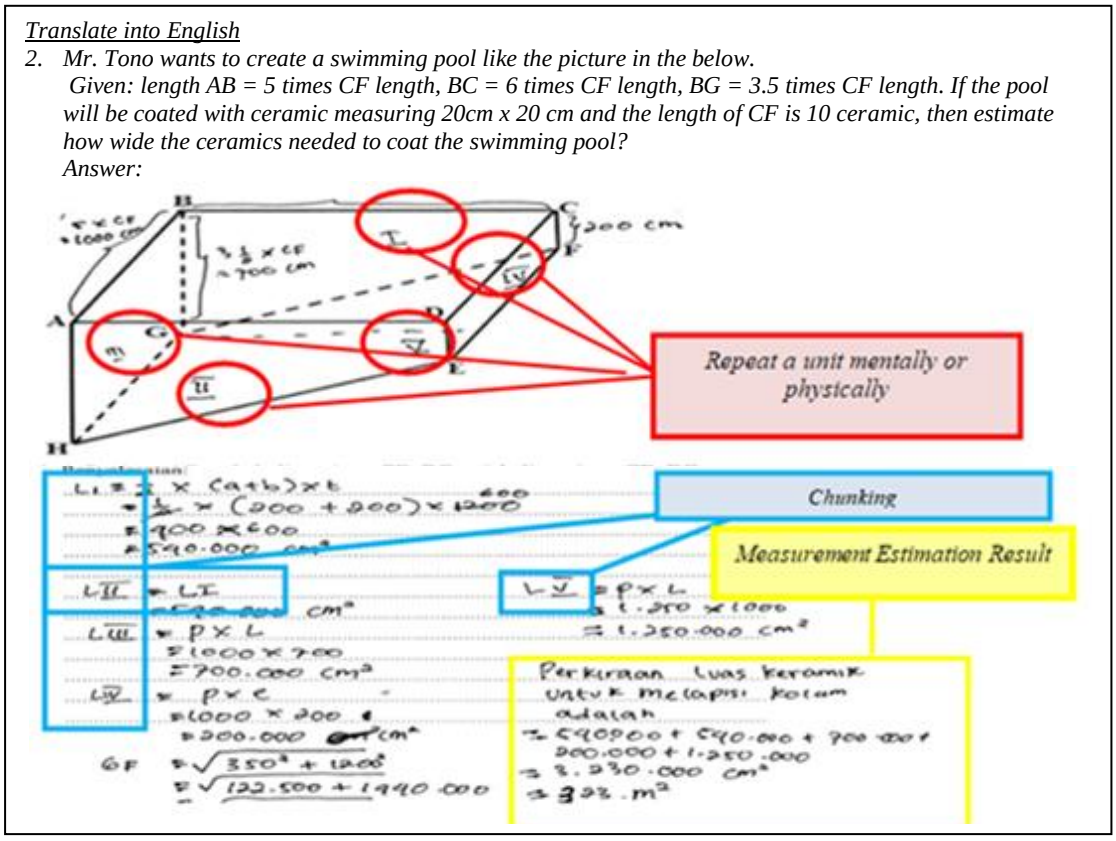
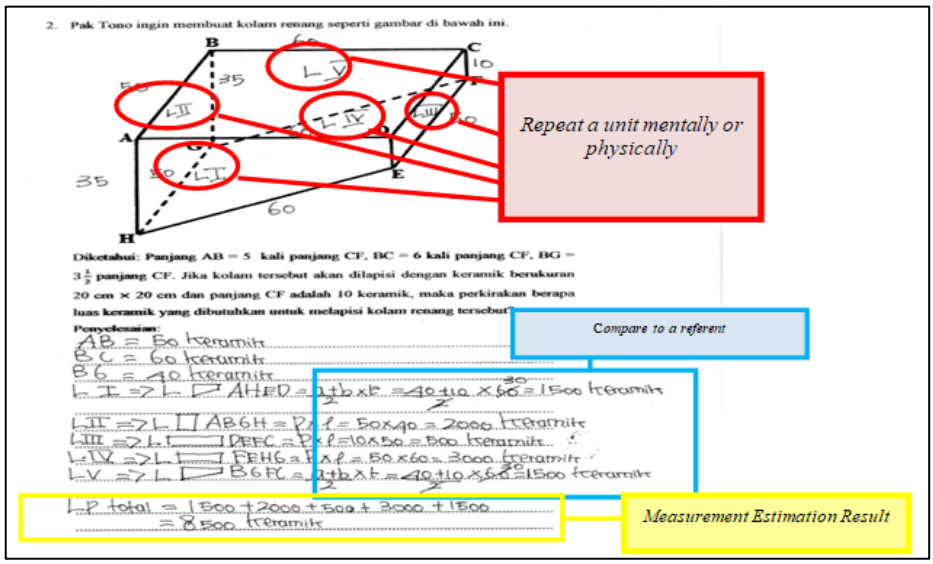



**FIGURE 3.** Subject 1's answer to problem number 2

Figure 3 shows that the first subject used chunking and repeat a unit mentally or physically measurement estimation strategy. Chunking strategy could be pointed out when the subject made several smaller or shorter parts in the equal size to ease in determining the estimated size of the object. The example was cutting off solids ABCD EFGH into several shapes namely ABGH, ADEH, CDEF, and EFGH. but. This is consistent with Walle statement that the chunking is a strategy of making several smaller or shorter parts in the equal size to ease in determining the estimated size of the object [7]. Repeat a unit mentally or physically strategy was known as the student marked I, II, III, IV, and IV on each shape. The mark I, II, III, IV, and V symbolized the area of each side in the pool. Those marks were used to help the student calculating the estimated area of each side of the pool. This is consistent with Walle 's statement that the repeat a unit mentally or physically is a strategy of recalculating the estimated result by using a single unit to determine the size easier [7].



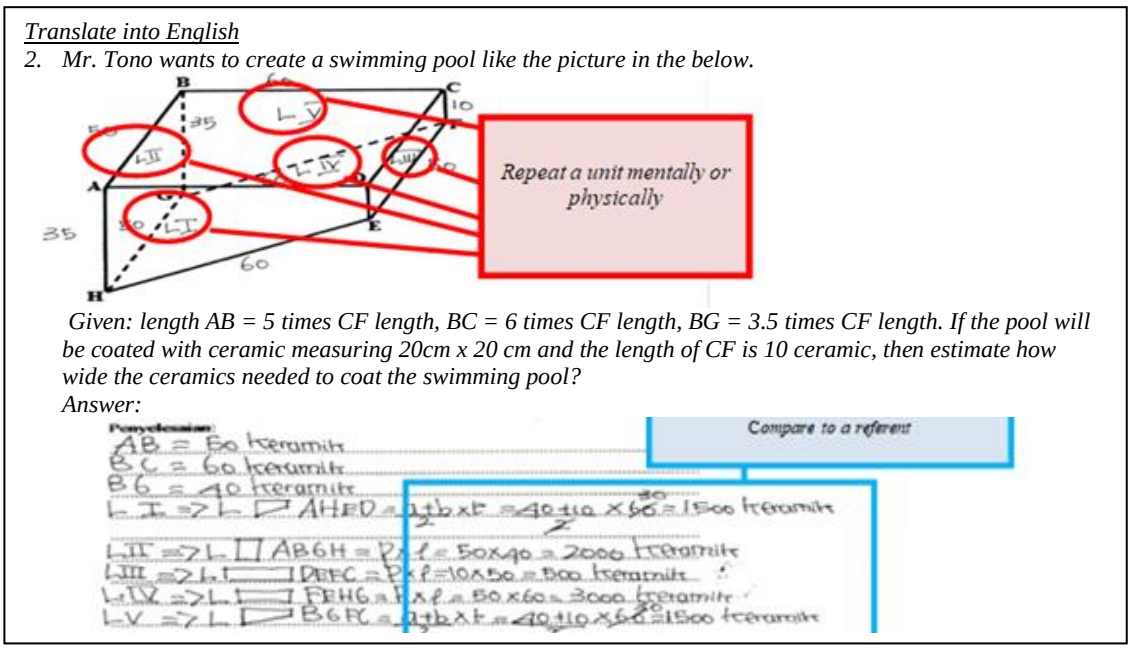



**FIGURE 4.** Subject 2's answer to problem number 2

Figure 4 shows that the second subject used estimation strategy compare to a referent and repeat a unit mentally or physically. Compare to a referent strategy was found when the second subject made standard unit benchmark during measurement estimation by using ceramics unit. While having the estimated area of ceramics, the subject changed the ceramics unit into $m^2$. Meanwhile, repeat a unit mentally or physically was known as the subject marked LI, LII, LIII, LIV, and LV on each shape. The mark L symbolized the area whereas the mark I, II, III, IV, and V symbolized each side of the pool. The mark was used by the student to calculate the estimate each area easier. This is consistent with Walle's statement that the compare to a referent is a strategy of making standard unit benchmark during measurement estimation [7].

Based on the last two figures, both subjects have a similar strategy. Both used repeat a unit mentally or physically strategy by marking to calculate the estimated area of each side of the pool easier.

Calculation and measurement estimation strategy by visual-spatial intelligence students' in solving Calculation and Measurement Estimation Test used same strategy. This is consistent with Novitasari statement that the visual-spatial intelligence students' are able to observe and understand a form of objects or images have space accurately and can transform into visualization and can generate new spatial ideas appropriately [10]. Epriliyanti says that the visual-spatial intelligence subjects' are able to translate the form or image that is in his mind into a two or three dimensional form [11]. Ilma also says that visual mention known and asked by picture, modelize problem by picture, use any different strategy, and conclude by picture [12]. It can be easily shown in the table 1 below.

**TABLE 1.** Calculation and measurement estimation strategies

| Types of Estimation | Estimation Strategy | |
|---|---|---|
| | **The First Subject** | **The Second Subject** |
| **Calculation Estimation** | -Reformulation<br>-Translation | -Reformulation |
| **Measurement Estimation** | -Chunking<br>-Repeat a unit mentally or physically | -Compare to a referent<br>-Repeat a unit mentally or physically |

## CONCLUSION

Based on the findings and discussion in above shows that visual-spatial intelligence students' have calculation estimation and measurement estimation. The first subject used reformulation and translation in calculation estimation strategy when solving the problem, while the second subject only used reformulation in calculation estimation strategy when solving the problem. In the measurement estimation, the first subject used chunking and repeat a unit mentally or physically strategy, while the second subject used compare to a referent and repeat a unit mentally or physically strategy. Finally, it could be conclude that the visual-spatial intelligence

students' have same estimation strategy when the solving this problem. In calculation estimation, visual-spatial intelligence students' used the reformulation strategy. In measurement estimation, visual-spatial intelligence students' used the repeat a unit mentally or physically.

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