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Testing through the Mann-Whitney Method and the Wilcoxon Signed Level on Learning Cube and Perfect Cube Roots

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Abstract: The purpose of this study is to discuss the testing using the Mann-Whitney method and the Wilcoxon signaled level for learning perfect cube and cube root. This research is a quantitative study, while the method used is experimental. The quantitative approach used includes the Mann-Whitney test and Wilcoxon's signed rank test. The conclusions of this study are that: 1) for the Mann-Whitney test on the pretest value of the control group and the experimental group it is concluded that before the treatment of two groups, namely control and experiment, had the same ability in mastering the material to the third power and the cube root; 2) For the Mann-Whitney test on the post-test scores of the control group and the experimental group, it is concluded that after the treatment of two groups, namely the control and the experimental group, they have different abilities in mastery of the material in the third power and the cube root; whereas 3) for the Wilcoxon-signed level test on the pretest and posttest scores of the experimental group, it was concluded that there was a difference between the conditions before and after being given treatments on the mastery of the material to the third power and the perfect cube root.

Keyword: kcube root perfect, cube, Mann-Whitney test, Wilcoxon-signed level test

INTRODUCTION

Learning is a process of developing the potential of students by empowering all the potential they have, so that students are able to increase their competence which appears in the skills to think logically, critically and creatively (Sukarti, 2019, p. 9). By learning mathematics students will learn to reason critically, creatively, and actively. This field of mathematics study is necessary for calculation and thinking in solving various problems (Zulkarnain, 2020, p. 2).

Given that the results of learning mathematics currently do not meet expectations, it is necessary to have continuous efforts in terms of improving learning. Thus, the role of teachers in providing meaningful learning experiences is indispensable. How a teacher finds the best way to convey teaching materials, so that students can understand and remember it longer (Hikmah, 2016: 81). Interaction or reciprocal relationship between teachers and students is the main way for the continuity of the learning process (Arpandisyah, 2017, p. 116).

Algebra is the most basic subject that must be mastered by students in mathematics lessons. Algebra has been known for centuries. One of the materials related to algebra is the cube root. The cube root is the opposite of the cube. One way to solve the cube root problem is to find the same three numbers to be multiplied or better known by trial and error (Wulandari, 2019, p. 13).

The author focuses on learning mathematics with the cube root material. The cube root material is important for students to master. Through learning activities students are

expected to be able to express their ideas in the form of a presentation of information based on facts from an event or incident experienced or seen in everyday life. Thus, learning activities will train students to think about how to compose the facts they know into a form of answer in the form of prime numbers (Bakar, 2013, p. 6).

Determining the square root of an integer (perfect square) of more than 100 and the square root of an integer (cubic) of more than 1,000 is still a problem for seventh grade students of junior high school. This is due to the lack of source books and handbooks for students in schools that discuss practical and easy ways to determine square roots and cube roots of integers. Students who are good at mastery of the multiplication concept rely more on trial and error, so it takes quite a long time. Whereas for students who have not mastered the multiplication concept well, they become passive (Hariyadi, 2012, p. 31).

A cubic number is a number obtained from the result of triple multiplication (three equal numbers, multiplied), expressed in mathematical terms by a power of three (n^3). cube in mathematics (arithmetic and algebra) is the result of multiplying a number n twice in a row by itself, or it is said to experience the power of three times: $n^3 = n \times n \times n$. While operation Calculate the Square Root, the formula $\sqrt[3]{a} = d$, d is called the cubic root number (Subai'ah, 2014, p. 62).

Calculating the cube and drawing the cube root is still needed by students to solve problems in everyday life. For example, how to determine the length of the ribs or volume of a cuboid shape (dice, bathtub, box, etc.). The withdrawal of the cube root is the opposite operation of the cube (Pujiati & Dharmawati, 2010, p. 40). According to Jerry Bobrow (2008, p. 34), the cube root of a number, you have to find a number which, if multiplied by the number itself three times, gives the original number.

Of the many questions, there is usually a cube root problem. If you understand how to quickly solve the cube root can be done in just seconds. So that the remaining time you have in it is used to work on other problems. But if students do not understand the technique of counting quickly, then students will find it difficult and waste time on the exam. Not only during exams, during daily learning there are still many students who find it difficult to do math problems (Rahayu, 2016, pp. 18-19). To repeat the training that has been given, because by repeating the training techniques that have been carried out will make the participants not forget to do how to calculate fast, precise, easy and fun cube root (Purba & Zetli, 2020, p. 30).

This study aims to provide a description of the mathematical learning of the cube material using the Pascal triangle and the quick solution of the perfect cube root and then testing it using the Mann-Whitney test and the Wilcoxon level.

METHOD

The method as a work tool emphasizes the workings of the mind in order to understand the object of research. In this study, the method used was experimental. While the approach in this study used is quantitative. The quantitative approach used includes the Mann-Whitney test and Wilcoxon's signed rank test.

Hypothesis testing through the Mann-Whitney method is applied because hypothesis testing through the distribution of the t value (t test) in parametric statistics cannot be done (Lukiastuti & Hamdani, 2012, p. 158). In principle, hypothesis testing through this distribution is applied to ensure the same or different values of the two sample groups (which are assumed to represent two populations) and the two groups of variables that are determined independently. Since testing this hypothesis involves a value marked with the letter U to formulate the testing criteria and final conclusions, it is also known as the U test (U test). The U value of the control group (U1) and the experimental group (U2) is known by applying the formula:

$$U_1 = (n_1 \; x \; n_2) + \frac{n_1 \; x \; (n_1 + 1)}{2} - R_1$$

$$U_2 = (n_1 \; x \; n_2) + \frac{n_2 \; x \; (n_2 + 1)}{2} - R_2$$

Where U^1 is the U value calculated in the first sample group and U^2 is the U value calculated in the second sample group, R^1 is the total number of levels in the first sample group, R^2 is the overall number of levels in the second sample group, n^1 is the number of samples in the first group, n^2 is the number of samples in the second group, and 1 and 2 are constants. Of the two calculated U values, the smaller value is chosen. As for the value of U, the result of the bigger calculation is denoted as U'. The U value 'is used to double-check whether the U value of the calculation results is correct. Re-checking the U value of the calculation results is carried out through a formula.

$$U = (n_1 \; x \; n_2) - U'$$

Meanwhile, hypothesis testing through the Wilcoxon level is carried out to ensure whether or not there is a difference in conditions after a certain treatment is given. This test is applied to ensure that a treatment or stimulus is deemed capable of producing better results (Lukiastuti & Hamdani, 2012, p. 86). In this hypothesis testing method, assumptions about the nature and form of data distribution and population parameters do not have to be fulfilled first. This happens because this method is a form of non-parametric statistical method. In this test the sum of all these levels is compared. The smaller number of overall levels is used as the T value of the calculation result. The T value resulting from this calculation can be derived from the number of positive or negative levels.

Research design is the whole of planning to answer research questions and anticipating some of the difficulties that may arise during the research process. This is important because the research design is a strategy to obtain the data needed for hypothesis testing or to answer research questions, and as a tool to control influential variables in research (Sugiyono, 2010). The following is the research design used in this study.
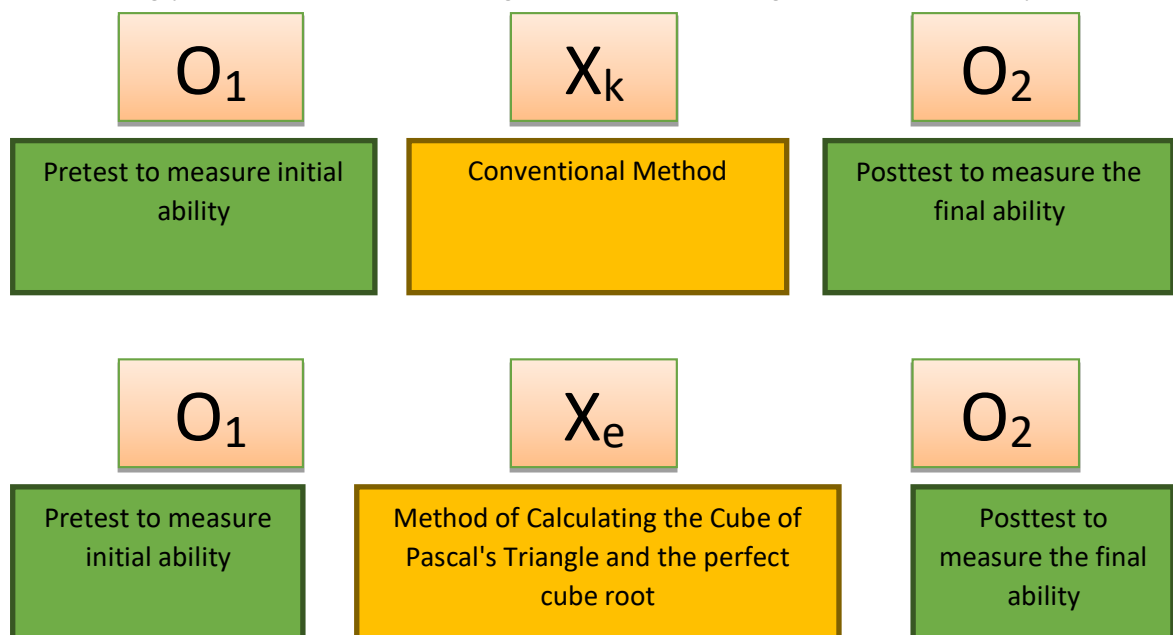

Figure 1. **Research Design**

Information:

X^k = treatment / treatment given to the control group

X^e = treatment / treatment given to the experimental group

O^1 = pretest

O^2 = posttest

The sampling technique used for this design was purposive sampling. Purposive sampling is a sampling technique with certain considerations. The consideration in taking sampling is that research is specifically intended to examine elementary school students in grade 6 (six) in Pemalang Regency.

RESULT AND DISCUSSION

Following are the treatments in this experimental research, the treatment is in the form of learning mathematics using the method of calculating the cube by utilizing Pascal's triangle and calculating the perfect three square root using the Yin Yang method.

Calculate the Power of Three

The power of three and even to any number consisting of two numbers can be calculated more easily by using Pascal's triangle (Arryawan, 2011, p. 161).
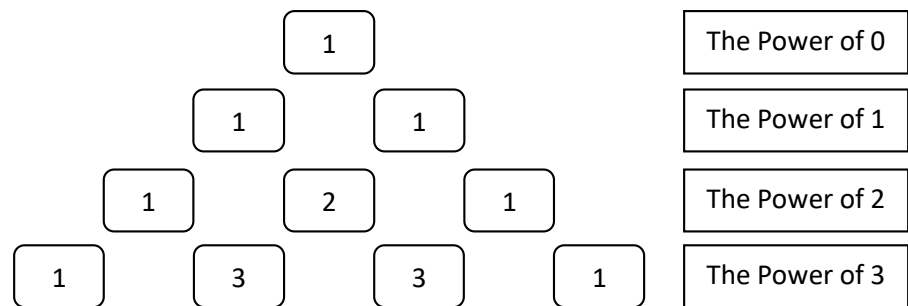
Figure 2. Pascal's Triangle

$(a + b)^2$ $=$ $a^2 + 2ab + b^2$

$(a + b)^3$ $=$ $a^3 + 3a^2b + 3ab^2 + b^3$

In this study, the rank discussed is limited to only the power of three. For powers of four, five and so on, the method is similar, just enter the formula derived from Pascal's triangle.
Example: what is 24^3 (twenty-four to the power of three)?

$$
\begin{array}{lllllll}
 & 2^3 & = & 0 & 8 & & \\
3. & 2^2 & 4 & = & 4 & 8 & \\
3. & 2 & 4^2 & = & 9 & 6 & \\
 & 4^3 & = & & 6 & 4 & \\
\hline
 & & & 1 \quad 3 \quad 8 \quad 2 \quad 4 & & & +
\end{array}
$$

Calculate the Perfect Cube Root

Calculating the perfect cube root is easier than calculating the perfect square root, because the cube root has definite units so we don't have to choose. Look at the following table:

Table 1. **Characteristics of a Perfect Cube Root**

The Power of 3	Unit	Explanation
$1^3 = 1$	1	Same
$2^3 = 8$	8	Complement of 10
$3^3 = 27$	7	Complement of 10
$4^3 = 64$	4	Same
$5^3 = 125$	5	Same
$6^3 = 216$	6	Same
$7^3 = 343$	3	Complement of 10
$8^3 = 512$	2	Complement of 10
$9^3 = 729$	9	Same

We can see that the unit value of the root is the same as the root number except for the unit numbers 2 (two), 3 (three), 7 (seven), 8 (eight). The unit values of the square root of 3 for 2, 3, 7, 8 are also easy to remember because they are the complement of ten. If the unit of number is 8 (eight), then the result of the square root is united by 2 (two), and vice versa. This also applies to pairs 3 (three) and 7 (seven). As for other numbers, the unit of the cube root is the same as the unit of the number itself. If we memorize the cube from `1 to 9, we can find the perfect cube root to the five digit number.

The steps for calculating the perfect cube root are as follows: (Arryawan, 2011, p. 164)

1. First: make a limit as far as 3 (three) digits measured from the right.

2. Second: find the cube of the number that is closer to the front number.

3. Third: find the unit of the cube root by looking at the unit of the number rooted.

Example: what is the cube root of 658503?

$$\sqrt[3]{658503} = ?$$

The first step

658	503

Second step

A power of three that's close to 658?

The answer is 8

Because 8 to the power of 3 is 512

9 to the power of 3 is greater than 658

Third step

503 is 3, so the root unit must be 7

So the result is 87

The following shows the data regarding the pretest and posttest scores of the two groups, namely control and experiment:

Table 2. **Values of pretest and posttest control and experiment groups**

CONTROL GROUPS		EXPERIMENT GROUPS	
PRETEST	POSTTEST	PRETEST	POSTTEST
30	80	70	90
35	55	50	85
80	75	80	100
50	70	65	70
30	50	50	70
60	90	80	100
30	50	55	50
40	60	70	80
60	80	40	60
50	70	60	100

The following shows the results of the Man Whitney test for the pretest and posttest scores for the control group and the experimental group:
With regard to this research, in essence, the hypothesis is nil and the alternative hypothesis formulated states that:

1. For the Mann-Whitney test pretest control group and experimental group

H_0 : There is no difference in the pretest scores of the control group and the experimental group

H_1 : There are differences in the pretest scores of the control group and the experimental group

2. For the Mann-Whitney posttest test, the control group and the experimental group

H_0 : There is no difference in the post-test scores of the control group and the experimental group

H_1 : There is a difference in the post-test scores of the control group and the experimental group

In this study, the hypothesis testing carried out was one-sided testing, namely the right side. For one-sided testing, the applied significance level is 2.50%. If we look in the table, the U value for the number of samples from the control group (n1) is 10 and the sample for the experimental group (n2) is 10 and the significance level is 2.50% is 23. The U value is the basis for the formulation of the test criteria and the final conclusion.

So that the test criteria applied to this case illustration is that the null hypothesis can be accepted if

$$U \leq 23$$

Meanwhile, the null hypothesis is rejected if

$$U > 23$$

At this stage, the number of levels must be calculated first so that the U value can be found. The calculation for the number of levels is shown in the following table.

Table 3. Pretest Mann Whitney Test of the Control Group and the Experiment Group

CONTROL GROUP PRETEST			EXPERIMENT GROUP PRETEST	
VALUE	RANK		VALUE	RANK
30	2		70	16.5
35	4		50	8.5
80	19		80	19
50	8.5		65	15
30	2		50	8.5
60	13		80	19
30	2		55	11
40	5.5		70	16.5
60	13		40	5.5
50	8.5		60	13
R1	77.5		R2	132.5

From the calculations made with the help of the table above, the total level of the control group (R1) was 77.5 and the experimental group (R2) was 132.5. These two values are used as the basis for calculating the U value. The U value of the control sample group is equal to

$$U_1 = (n_1 \ x \ n_2) + \frac{n_1 \ x \ (n_1 + 1)}{2} - R_1$$

$$U_1 = (10 \ x \ 10) + \frac{10 \ x \ (10 + 1)}{2} - 77,5 = (100 + 55) - 77,5 = 77,5$$

While the U value of the experimental sample group was equal to

$$U_2 = (n_1 \ x \ n_2) + \frac{n_2 \ x \ (n_2 + 1)}{2} - R_2$$

$$U_2 = (10 \ x \ 10) + \frac{10 \ x \ (10 + 1)}{2} - 132,5 = (100 + 55) - 132,5 = 22,5$$

From the two calculated U values, we determine the smaller value. Hence, the U value chosen was 22.5. While the value of U is greater, namely 77.5 is chosen as U'. In order to make the calculation of the U value more convincing, we need to apply the calculation in another way to determine the amount

$$U = (n_1 \ x \ n_2) - U'$$

$$U = (10 \ x \ 10) - 22,5 = 77,5$$

Apparently, the value is also the same as the value obtained by the first method. So that the U value calculated is 22.5.

From the results of calculations carried out in the previous stage, the U value is 22.5. This value is clearly smaller than the U value in the table of 23. In accordance with the applicable test criteria, the null hypothesis which states that there is no difference in the pretest value of the control group and the experimental group is accepted. While the alternative hypothesis which states that there are differences in the pretest scores of the control group and the experimental group is rejected.

The following shows the results of the Mann Whitney test for the post-test scores of the control group and the experimental group:

Table 4. Mann Whitney Posttest Test for Control and Experimental Groups

CONTROL GROUP		EXPERIMENT GROUP	
POSTEST VALUE	RANK	POSTEST VALUE	RANK
80	13	90	16.5
55	4	85	15
75	11	100	19
70	8.5	70	8.5
50	2	70	8.5
90	16.5	100	19
50	2	50	2
60	5.5	80	13
80	13	60	5.5
70	8.5	100	19
R1	84	R2	126

From the calculations made with the help of the table above, the total level of the control group (R1) is 84 and the experimental group (R2) is 126. These two values are used as the basis for calculating the U value. The U value of the control sample group is equal to

$$U_1 = (n_1 \ x \ n_2) + \frac{n_1 \ x \ (n_1 + 1)}{2} - R_1$$

$$U_1 = (10 \ x \ 10) + \frac{10 \ x \ (10 + 1)}{2} - 84 = (100 + 55) - 84 = 71$$

While the U value of the experimental sample group was equal to

$$U_2 = (n_1 \ x \ n_2) + \frac{n_2 \ x \ (n_2 + 1)}{2} - R_2$$

$$U_2 = (10 \ x \ 10) + \frac{10 \ x \ (10 + 1)}{2} - 126 = (100 + 55) - 126 = 29$$

From the two calculated U values, we determine the smaller value. Therefore, the value of U chosen is 29. Meanwhile, the value of U which is greater, namely 71 is chosen as U'. In order to make the calculation of the U value more convincing, we need to apply the calculation in another way to determine the amount

$$U = (n_1 \; x \; n_2) - U'$$

$$U = (10 \; x \; 10) - 29 = 71$$

Apparently, the value is also the same as the value obtained by the first method. So that the U value of the calculation results is indeed 29.

From the results of calculations carried out in the previous stage, the U value is 29. This value is clearly greater than the U value in the table of 23. In accordance with the applicable test criteria, the null hypothesis which states that there is no difference in the posttest scores of the control group and the experimental group is stated. rejected. While the alternative hypothesis which states that there are differences in the post-test scores of the control group and the experimental group is accepted.

The following shows the test results through the Wilcoxon marked level for the pretest and posttest scores of the experimental group:

With regard to this research, in essence, the hypothesis is nil and the alternative hypothesis formulated states that:

H_0:   There is no difference in the pretest and posttest scores of the experimental group

H_1:   There are differences in the pretest and posttest scores of the experimental group

In this study, the enforced significance level was 2.50%. In the table, the T value for the number of pairs of observations is 10 and the significance level of 2.50% is 8. The T value in the distribution table is 8. Therefore, the testing criteria applied in this study is that the null hypothesis is accepted if

$$T > 8$$

Meanwhile, the null hypothesis is rejected if

$$T < 8$$

At this stage, the marked level must be calculated in advance through a predetermined procedure. The calculation for the number of levels marked is shown in the following table:

Table 5. The Wilcoxon Signed Level Test for the Pretest - Posttest Value of the Experimental Group

| | VALUES | DIFFERENCE | | THE SUM OF SIGNED'S RANK (T) | |
| | POSTTEST | | | | |
PRETEST (N1)	(N2)	(N2 – N1)	RANK/LEVEL	+	-
70	90	20	6	6	
50	85	35	9	9	
80	100	20	6	6	
65	70	5	1.5	1.5	
50	70	20	6	6	
80	100	20	6	6	
55	50	-5	1.5		1.5
70	80	10	3	3	

40	60	20	6	6	
60	100	40	10	10	
				+ T = 53.5	-T = 1.5

From the calculation steps that have been done in the table, the number of levels obtained is 53.5 (for a positive level) and 1.5 (for a negative level). As has been determined, the T value chosen from the calculation is a smaller value because of that, the T value selected in this study is 1.5.

The conclusion is formulated after we compare the T value in the table with the calculated t value, then aligned with the applied test criteria. Based on the calculation results, the T value is 1.5. This value is smaller than the T value in the table of 8. Thus, the null hypothesis which states that there is no difference in the pretest and posttest scores of the experimental group is rejected. While the alternative hypothesis which states that there are differences in the pretest and posttest scores of the experimental group is accepted.

CONCLUSION

Based on the above test, it was concluded: 1) for the Mann-Whitney test on the pretest value of the control group and the experimental group it was concluded that there was no difference between the two groups, in the sense that before the treatment or treatment of the two groups, namely control and experiment, had the same ability in mastery of the material. cube and cube root; 2) For the Mann-Whitney test on the post-test scores of the control group and the experimental group, it is concluded that there is a difference between the two groups, in the sense that after the treatment or treatment of the two groups, namely the control and experiment have different abilities in mastering the material to the third rank and the cube root; whereas 3) for the Wilcoxon-signed tier test on the pretest and posttest scores of the experimental group, it was concluded that there was a difference between the conditions before and after being given treatment or treatments on the mastery of the material to the third rank and the perfect cube root.

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