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The Effect of CTL Models Assisted by Virtual Lab to Higher Order Thinking Skills (HOTS) and Student Learning Motivation

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Abstract: Implementation of The CTL Model Assisted by Virtual Lab to HOTS and Student Learning Motivation. This study aims to: 1) determine the effect of the implementation of CTL assisted by virtual lab on HOTS and student learning motivation; and 2) determine the correlation between learning motivation and HOTS of students using CTL assisted by virtual lab. Samples were taken by purposive sampling as many as 2 classes, namely experimental and control classes. Data analysis used right-side t-test and correlation test. This type of research is a quasi experiment with a quantitative approach. The instruments used were test instruments with cognitive level C4-C6 and non-test is student learning motivation questionnaire. The results: 1) the implementation of CTL assisted by a virtual lab has an effect on HOTS, namely $t_{count}>t_{table}$ (6.50>1.66827); 2) the implementation of CTL assisted by the virtual lab has an effect on student learning motivation, namely $t_{count}>t_{table}$ (5.00>1.66827) which shows Ho is rejected and Ha is accepted; 3) student learning motivation is correlated with HOTS using virtual lab-assisted CTL with $r_{count}>r_{table}$ (0.45>0.339).

Keywords: CTL, Virtual Lab, Higher Order Thinking Skills, Learning Motivation, acid-base

Abstrak:Penerapan Model CTL Berbantuan Virtual Lab Terhadap Kemampuan Berpikir Tingkat Tinggi dan Motivasi Belajar Siswa. *Penelitian ini bertujuan untuk : 1) mengetahui pengaruh penerapan CTL berbantuan virtual lab terhadap HOTS dan motivasi belajar siswa; dan 2) mengetahui korelasi antara motivasi belajar dengan HOTS menggunakan CTL berbantuan virtual lab. Sampel diambil secara purposive sampling sebanyak 2 kelas, yaitu kelas eksperimen dan kelas kontrol. Analisis data menggunakan uji-t pihak kanan dan uji korelasi. Jenis penelitian adalah quasi eksperimen dengan pendekatan kuantitatif. Instrumen yang digunakan adalah instrumen tes dengan tingkat kognitif C4-C6 dan non-tes berupa angket motivasi belajar siswa. Hasil penelitian: 1) implementasi CTL berbantuan virtual lab berpengaruh terhadap HOTS yaitu diperoleh $t_{hitung}>t_{tabel}$ (6,50>1,66827); 2) implementasi CTL berbantuan virtual lab berpengaruh terhadap motivasi belajar siswa yaitu diperoleh $t_{hitung}>t_{tabel}$ (5,00>1,66827) yang menunjukkan Ho ditolak dan Ha diterima; 3) motivasi belajar siswa berkorelasi dengan HOTS menggunakan CTL berbantuan virtual lab dengan $r_{hitung}>r_{tabel}$ (0,45>0,339).*

Kata kunci: *CTL, virtual lab, Kemampuan Berpikir Tingkat Tinggi, Motivasi,, asam basa.*

▪ INTRODUCTION

The advancement of science and technology is one of the variables that can have an impact on practically every aspect of human life. Technological Pedagogical Content Knowledge (TPACK) is one sort of new knowledge that instructors must understand in order to effectively incorporate technology into learning. TPACK is knowledge about using appropriate pedagogic technology to teach content (Rahmadi, 2019).

Chemistry learning is one of the learning that is classified as complex because chemistry cannot only be understood through theory, but needs to be studied through three aspects, namely macroscopic, microscopic, and symbolic. Chemical concepts are abstract in nature, there are many formulas and calculations, so that learning chemistry is difficult for students to understand which has an impact on student achievement (Kartini, 2019).

According to an interview with one of the chemistry teachers of MAN 2 Model Medan, the students of MAN 2 Model Medan have difficulty in understanding the concept. The percentage of students who completed the acid and base material was only about 33.3%. The low percentage of students who reach the minimum completeness criteria shows that student learning outcomes are still low due to students' logical and rational thinking skills are still not optimal so they need to be improved. This can be seen during the learning process, teachers usually only give questions with cognitive levels C1-C3 only. The lack of availability of questions that practice students' higher order thinking skills is what causes students' higher order thinking skills to remain low. Higher order thinking skills are a way of thinking that is no longer just verbal recall, but also interpreting the nature of what is within. The interpretation of meaning requires an integrative way of thinking through analysis, synthesis, combination, and reasoning to generate creative and productive ideas (Purnomo, 2019). The indicators of higher order thinking skills according to Prasetyani *et al.* (2016) are analyzing, evaluating and creating.

The difficulties experienced by students in learning acid-base materials may also be caused by a lack of student motivation in participating in learning. Salta & Koulougliotis (2012) stated that low student motivation in chemistry is caused by the application of teacher learning that is less interesting and less involving the role of students. The lesson process is only teacher-centered so that students are only fixated on what the teacher gives them which causes students to tend to be passive in the learning. Teachers as facilitators are required to be able to modify or even apply new methods that students prefer and increase their activity (Rustiningsih, 2021). Teachers need to choose the right learning model to facilitate the process of forming knowledge in students, but teachers must also pay attention to whether the learning model used is effective and efficient. The CTL model is one of models that teachers can employ to help students learn chemistry (Riyadi *et al*., 2015). The CTL model is a learning idea that connects learning materials to real-world circumstances for students and helps them to find connections between their knowledge and its application in their daily life (Ansori *et al*., 2020). Utaminingsing & Shufa (2019) argued that the Contextual learning model is an effort to manage learning so that students can get meaningful learning where the subject matter studied is related to the environment. Giving students contextual challenges might help them strengthen their thinking skills. Contextual problems can familiarize students with thinking to be able to solve these problems.

Students are not only directed to solve problems that only apply a certain formula, but can apply it to solve problems in everyday life so that students know the benefits of learning chemistry at school. Thus, the implementation of the CTL models can improve learning motivation and students' higher order thinking skills will also develop because through this learning students are invited to think in obtaining concepts. Many previous studies have stated that the CTL model can increase student motivation and learning achievement.

Yulianti (2021) suggests that implementation CTL models can increase in the learning motivation of X3 class students of SMK-SMTI Padang in the Chemical Industrial Process (PIK) subject. This is evidenced by the increase in student motivation from good with a value of 3.61 to good with a value of 3.82. Learning outcomes also showed an increase from the class average of 82.95 in the first cycle to 83.93 in the second cycle. Likewise, the final grade point average increased from 84.39 in the first cycle to 85.24 in the second cycle. Furthermore, Firdausy *et al*. (2020) found that the average learning outcomes of experimental class students (64,93) who used the CTL model were greater than the average learning outcomes of control class (48,89) who used conventional models.

In supporting the application of the CTL models, it can be combined with learning media. Virtual laboratory is one type of learning media that can be employed in the learning. Virtual laboratories can improve critical thinking skills in scientific research, increase student motivation in learning chemistry, making students active and independent in the learning process, improve science process skills, and improve students' scientific attitudes (Lestari *et al*., 2023). olabs is a virtual laboratory that can be used in chemistry instructional medium for acid-base materials. Olabs App is an interactive multimedia-based application that contains all laboratory tools and materials made by software to make it easier for users to feel as if they are doing practicum activities in an actual laboratory (Rihi et al., 2022). According to Rahmi (2022), the virtual laboratory with the TPS learning model was able to significantly improve student learning outcomes, with 66.67% of students experiencing an increase in medium learning outcomes and 33.33% experiencing an increase in high learning outcomes. According to Purnamasari & Lutfi (2021) research, the score of student learning outcomes on acid-base material has increased and is classified as effective, with an average percentage of N-Gain value of 80%. N-Gain value of 80% on average. Furthermore, he declared to have accomplished learning as measured by classical completeness.

Based on the description above, the writer wants to do research with the title "The Effect of CTL Models with Virtual Lab to Higher Order Thinking Skills and Student Learning Motivation".

▪ METHOD

The design used in this research was Posttest Only Control Group Design consisting of experimental and control class. Purposive sampling technique was used in this study, namely XI IPA 2 as an experiment class using CTL model assisted by virtual lab and XI IPA 1 as a control class using conventional learning. Purposive sampling technique was used due to the similarity of the teachers who teach and the abilities of the two classes.

The instruments used are multiple choice test instruments with C4-C6 cognitive levels and non-test instruments is student learning motivation questionnaires. Before

the test instrument was used, an instrument test was first conducted to determine the validity,difficulty level,test distinguishing power, and reliability. The research data were statically analyzed using the right-side t-test and correlation test. Before hypothesis testing, normality and homogeneity were first tested as t-test prerequisites.

a. Normality test

The data normality test is intended to determine whether the data to be processed has a normal distribution or not. To test the normality of the data in this study, Chi Square Test was used. The steps taken are as follows:

1) set the number of interval classes that have been determined in the chi-squared test, namely 6. This corresponds to the 6 fields in the Normal Standard Curve, namely: 2,34%; 13,53%; 34,13%; 34.13%; 13,53%; 2,34%.
2) Determine the length of the class interval (PK) with the formula:
   $PK = \frac{data\ terbesar - data\ terkecil}{6}$
3) Arranging data into a helper table to determine the Chi Square price with the formula:
   $x^2 = \sum \frac{(fo - fh)^2}{fh}$
   Description:
   fo = frequency of observed data
   fh = expected data frequency (percentage area of each field multiplied by the amount of data)
4) Comparing the calculated Chi-Square price (x^2) with the Chi-Square table price at α=0.05 with db = 5. If the calculated $X^2_{count} < X^2_{table}$ then the data is normally distributed (Silitonga, 2014).

b. Homogeneity Test

The purpose of this homogeneity test is to assess whether or not the data has a homogeneous variance. The formula used is:

$$F_{count} = \frac{varians\ terbesar}{varians\ terkecil}$$

If $F_{count} < F_{table}$ (α) ((db = (n-1)(n-2)) then the data is homogeneous (Silitonga, 2014).

c. Hypothesis Testing

After analyzing the data for normality and homogeneity, if the data is found to be regularly distributed and homogenous, the hypothesis test can employ parametric statistical analysis. The research hypothesis was tested using a one-sided t-test (right side), formula:

$$t_{count} = \frac{(X_1 - X_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

where :
t_{count} = calculation t price
X_1 = average of experiment class
X_2 = average of the control class
n_1 = number of experiment samples
n_2 = number of control samples

S_1^2 = variance in the experiment class
S_2^2= variance in the control class

How to test with the criteria to reject Ho if $t_{count} > t_{table}$, Ha is accepted. Testing is carried out at a significance level of 5% and dk = n1 + n2 - 2 (Silitonga, 2014).

d. Correlation Test

To determine the relationship between student motivation and students' higher order thinking skills, a correlation test analysis was used. The product Moment formula can be used to calculate the correlation coefficient between variables X and Y:

$$r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{\{N \sum X^2 - (\sum X)^2\}\{N \sum Y^2 - (\sum Y)^2}}$$

Description:
r_{xy} = correlation coefficient
X = learning motivation score
Y = value of learning outcomes

For the significance of a simple correlation, it is done by comparing the r value obtained with the r table at a certain level of significance, with the criteria: if r-hit ≥ r-table then Ho is rejected, Ha is accepted, which means: There is a significant positive/negative correlation between variable X and variable Y (Silitonga, 2014).

▪ RESULT AND DISCUSSION

RESULT

1. Students Higher Order Thinking Skills

Table 1. and Figure 1. shows the average of higher-order thinking skills of students in the experiment and control class after the learning process is completed.

Table 1. Mean, Standard Deviation, and Variance of Students' Higher-Order Thinking Skills

Class	Mean	Standard Deviation	Variance
Experiment	78,97	9,830	96,64
Control	64,41	8,596	73,89

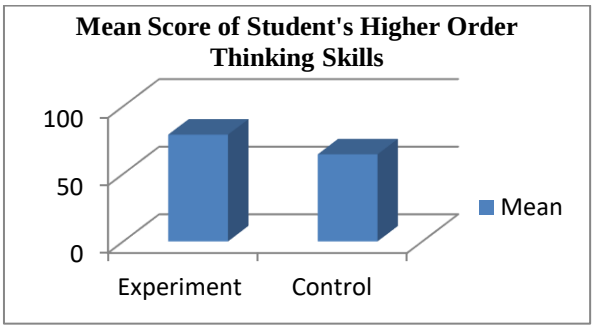

Figure 1. Diagram of the Mean Higher-Order Thinking Skills of Experiment and Control Class Students

Based on the table 1. and figure 1. above the average value of students' higher order thinking skills and standard deviation for the experimental class (72,68 ± 6,22) and for the control class (64,12 ± 7,79) were obtained. This means that the average value in the experiment class taught with the CTL model assisted by virtual lab is higher than the control class taught with conventional learning models.

1.1 Results of Data Analysis of Higher Order Thinking Skills

Normality Test

Table 2. shows the results of the normality test of higher order thinking skill data as a t-test requirement.

Table 2. Normality Test Results of Students Higher Order Thinking Skills

Class	X^2_{count}	X^2_{table}	α
Experiment	9,12	11,07	0,05
Control	7,18	11,07	0,05

Based on Table 2. the normality test results obtained $X^2_{count} < X^2_{table}$ which shows that the data on the higher-order thinking skills in the experiment and control classes are normally distributed.

Homogeneity Test

Table 3. shows the results of the homogeneity test of higher-order thinking skills data as a t-test requirement.

Table 3. Homogeneity Test Results of Students' Higher Order Thinking Skills

Class	S^2	F_{count}	F_{table}
Experiment	96,64	1,31	1,79
Control	73,89		

Based on table 5, the price of $F_{count} < F_{table}$ which shows the data on students' higher order thinking skills in the both classes are **homogeneous.**

Hypothesis Test

The right-side t-test was used for hypothesis testing because it is a one-side statistical test. The null hypothesis is rejected and the alternative hypothesis is accepted, if $t_{count} > t_{table}$. Table 4. shows the results of the hypothesis test.

Table 4. Data on Students' Higher Order Thinking Skills Hypothesis Testing Results

Class	Mean	t_{count}	t_{table}	Description
Experiment	78,97	6,50	1,66	Ho was rejected and
Control	64,41			Ha was accepted

According to the results of hypothesis testing in table 4.7. obtained $t_{count} > t_{table}$ namely 6.50 > 1.66827, then Ho is rejected, Ha is accepted, namely the implementation of the CTL models with virtual lab effect on students' higher order thinking skills in acid-base material.

2. Student Learning Motivation

Table 1. and Figure 1. shows the average of learning motivation in the experiment and control class after the learning process is completed.

Table 5. Mean, Standard Deviation, and Variance of Learning Motivation

Class	Mean	Standard Deviation	Variance
Experiment	72,68	6,217	38,65
Control	64,12	7,788	60,65

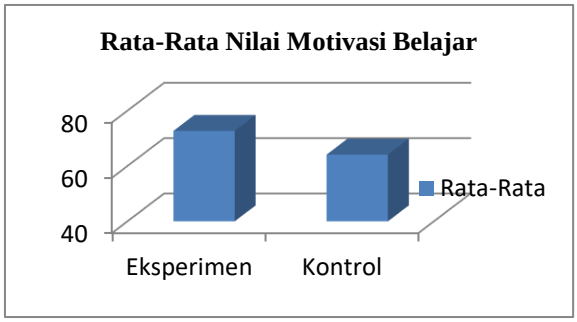

Figure 2. Diagram of the Mean Student Learning Motivation of Experiment and Control Class

2.1 Results of Data Analysis of Student Learning Motivation

Normality Test

Table 6. shows the results of the normality test of learning motivation data as a prerequisite for the t-test.

Table 6. Data Normality Test Results of Learning Motivation

Class	X^2_{count}	X^2_{table}	A
Experiment	4,62	11,07	0,05
Control	9,15	11,07	0,05

Based on Table 6. the normality test results obtained $X^2_{count} < X^2_{table}$, indicating that the data on student learning motivation in the experiment and control class are normally distributed.

Homogeneity Test

The results of homogeneity test for higher order thinking skills as a prerequisite for the t-test are showed in Table 7.

Table 7. Homogeneity Test Results of Student Learning Motivation Data

Class	S^2	F_{count}	F_{table}
Experiment	38,65	1,57	1,79
Control	60,65		

Based on table 7. obtained the price of $F_{count} < F_{table}$ which shows the data on student learning motivation in the both classes are **homogeneous.**

Hypothesis test

The right-side t-test was used for hypothesis testing because it is a one-side statistical test. Ho is rejected and Ha is accepted, if $t_{count} > t_{table}$. Table 8. shows the results of the hypothesis test.

Table 8. Data on Student Learning Motivation Hypothesis Test Results

Class	Mean	T_{count}	t_{table}	Description
Experiment	72,68	5,00	1,66	Ho was rejected and Ha was accepted
Control	64,12			

Table 8 shows the outcomes of hypothesis testing. The fact that $t_{count} > t_{table}$, i.e. 5.00 > 1.66827, indicates that Ho is rejected and Ha is accepted, indicating that the implementation of CTL models with virtual lab media has an effect on students' learning motivation on acid-base material.

3. Correlation Test of Learning Motivation with Students' Higher Order Thinking Skills

Correlation analysis is used to measure how close the relationship is between learning motivation and students' higher-order thinking skills using a simple correlation test (r_{xy}) using the formula product moment.

Table 9. Correlation Test between Learning Motivation and Students' Higher Order Thinking Skills

Class	r_{count}	r_{table}	Description
Experiment	0,45	0,339	Ho was rejected and Ha was accepted

Because $r_{count} > r_{table}$ is 0.45> 0.339, Ho is rejected and Ha is accepted meaning that there is a correlation between student learning motivation and students' higher order thinking skills taught with the CTL model assisted by Virtual Lab.

DISCUSSION

The first hypothesis is about students' higher order thinking skills. After a one-side statistical test (right-side) with a significance level of 0.05, obtained $t_{count} > t_{table}$ namely 6.50 > 1.66827. This suggests that Ho is rejected and Ha is accepted, implying that the use of CTL models with virtual lab media has an effect on students' higher order thinking skills in acid-base. The findings of this study correspond with those of Calista *et al*. (2022) who found that using the CTL model can increase students' higher-order thinking skills. The results show that t_{count} 3,43>t_{table} 1,67, indicating that the application of the CTL model has an effect on students' higher order thinking skills.

The second hypothesis is about student learning motivation. After the one-side statistical test (right-side) was carried out with a significance level, it was obtained $t_{count} > t_{table}$ namely 5.00 > 1.66827. This means that Ho is rejected and Ha is accepted, so it can be said that the implementation of CTL models with virtual lab media effect on students' learning motivation. This is consistent with the findings of Sari *et al*. (2020), who found changes in the learning motivation of students who were given the CTL model with those who used conventional learning models. Research by Malinda *et al*.

(2016) shows that there is an influence on class motivation using virtual lab media than class learning using the experimental method, namely 0.702 > 0.510.

The advantage of the CTL model is that students will be able to master abstract concepts through concrete learning experiences. Contextual learning involves students to play an active role in relating academic lessons to real life contexts. By using the CTL models, it can create a more interesting atmosphere in the teaching and learning process so that it is hoped that student interest will be better and learning achievement will increase (Purnamasari *et al*., 2017). Research conducted by Adawiyah *et al*. (2021) stated that theoretically media *virtual lab* is an efficient tool to help understand topics developed in classrooms and labs. Students also become more active in the learning process. Classes that use virtual laboratories are more effective than classes that do not use dynamic visualization elements.

The third hypothesis concerns the correlation test between students' learning motivation with students' higher order thinking skills. This hypothesis test is calculated by the correlation formula and obtained $r_{count} > r_{table}$ namely 0.45 > 0.339, which means there is a correlation between motivation with students' high-order thinking skills with CTL models with virtual lab media. The correlation coefficient r = 0.45 includes the correlation with the sufficient category. The contribution of students' motivation to students' higher order thinking skills using determination (CD) is 20.25% while 79.75% is caused by other factors. Based on the research, it is possible to conclude that there is a significant influence between learning motivation with students' higher-order thinking skills who are taught using CTL models with virtual lab media on acid-base materials.

▪ CONCLUSION

Based on the findings of the research, it is possible to conclude that the effect of CTL models with the assistance of virtual lab media has an effect on students' higher order thinking skills (t_{count} 6,50 > t_{table} 1,66827) and student learning motivation (t_{count} 5,00 > t_{table} 1,66827) in acid base material. Correlation test obtained $r_{count} > r_{table}$ (0.45>0.339) which means that student learning motivation is positively and significantly correlated with students' higher order thinking skills using the CTL model assisted by virtual lab media.

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