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Analysis of Student Learning Motivation Using Virtual Chemistry Laboratory on the Material of Colligative Properties of Solutions Based on Gender Differences

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ABSTRACT. Based on the differences in learning patterns of male and female students, teachers must pay attention to learning patterns and media to increase student learning motivation. The purpose of this study was to analyze the overall learning motivation of students and see the differences in learning motivation of male and female students in learning chemistry using Virtual Chemistry Laboratory. This research was conducted in the 2022/2023 academic year at SMA Negeri 1 Pekaitan. The method used in this research is descriptive quantitative where the research design uses a one group pretest posttest design and the subjects in this study were selected based on probability sampling method. The instruments used in this study were pretest-posttest questionnaires, observation sheets and interviews to strengthen the data obtained. The results of the analysis of student learning motivation as a whole show a significance value (2-tailed) of 0.000 <0.05 so that it shows a positive relationship between the use of virtual laboratories and student learning motivation. The results of this study are expected to help teachers to increase student learning motivation using Virtual Chemistry Laboratory accompanied by direct practicum of the theory taught. Keywords: Learning Motivation, Virtual Chemistry Laboratory, Gender, Colligative Properties of Solutions
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INTRODUCTION

Learning motivation is a strong driving force for students as a driving force to carry out the learning process, ensure the continuity of the learning process, and create learning directions to achieve learning goals (Yanti et al., 2024). Learning motivation in the educational process is one of the most important factors for students as a driver of increasing their desire to learn in achieving learning goals. Students with high learning motivation will get higher achievement, while vice versa for students with low learning motivation will get low achievement. (Yogi Fernando et al., 2024)

One of the media that can be used in chemistry learning is a virtual chemistry laboratory (Ikhsan & Afdal, 2016). Virtual laboratory can be defined as software that has interactivity to simulate certain clinical practices by replicating conventional laboratories (Wibawanto, 2020). because chemistry learning often requires experimental methods so that students can observe the teaching material provided. Although virtual chemistry laboratories cannot replace real chemistry laboratories one hundred percent, using this media will greatly assist the chemistry learning process, especially in generating student learning motivation. (Ikhsan & Afdal, 2016). Virtual chemistry laboratory is a system that can be used to support practicum systems that run conventionally (Darojat, 2022).

In addition to the use of virtual chemistry laboratory media, the role of gender is also thought to influence learning motivation (Amin, 2018). Gender is a trait inherent in men and women that is shaped by socio-cultural factors of society, so that several assumptions are born about the social and cultural roles of men and women (Sirait et al., 2024). Different genders also give rise to different brain characters. The different brain structures of men and women produce different ways and styles of learning. Male students find it easier to learn something in a way that emphasizes hand-on activities such as practicum, assembling tools and so on that have minimal communication (verbal and non-verbal), while female students prefer learning activities using

methods and learning styles related to communication such as speaking, writing, discussion and presentation (Amin, 2018).

This study was conducted in two variables, namely the dependent variable which examines student learning motivation and the independent variable, namely virtual laboratory media (virtual chemistry laboratory) on the material of colligative properties of solutions. Colligative properties of solutions are properties of solutions that depend on the number of particles of solute in the solution, but do not depend on the type of solvent (Rusdiani et al., 2019).

Based on the description above, the purpose of the study was to determine the level of motivation and differences in learning motivation of male students and female students in chemistry learning using virtual laboratory media.

METHOD

This study uses a quantitative descriptive method with the research design used is One Group Pretest-Postest in which there is one group given treatment. Quantitative descriptive research is research that systematically and accurately describes a symptom, fact, or event (Azizi & Rachmadi, 2020). This research was conducted precisely at SMAN 1 Pekaitan Rokan Hilir Regency. The population and sample in this study were XII MIPA class students of State Senior High School 1 Pekaitan, totaling 33 students. The sample for this study was determined using probability sampling technique. The probability sampling method is a method that provides equal opportunities for all members of the population (Septiani et al., 2020).

To obtain specific data, researchers used the following data collection techniques:

1. Observation

Observation is a form of data collection used to identify and directly observe the situation in the field so that researchers can explain the problem under study. The purpose of using an observation sheet is to collect information or data and measure the factors observed (Kurniawati, 2020).

2. Questionnaire

In this study, researchers have four alternative answers on a Likert scale, namely: strongly agree (SS), agree (S), disagree (TS), strongly disagree (STS), with the highest score of 4 for positive statements and the lowest 1 for negative statements, and the score details are as follows

Table: Likert Scale Score

Answer	positive	Negative
strongly agree	4	1
strongly agree	3	2
disagree	2	3
strongly disagree	1	4

3. Interview

Interview is a form of non-test type evaluation tool that is carried out through conversation and question and answer, either directly or indirectly with students (Phafiandita et al., 2022).

Data analysis is a way of processing research results and drawing conclusions. (Hajar et al., 2021). The data analysis techniques used are instrument analysis, research data analysis, n-gain test, significance test (sign-test). The validity test in this study includes content and empirical validity. Content validity was carried out through discussions with experts to ensure the instrument was in accordance with the research objectives. Empirical validity was tested using

product moment correlation at a significance level of $\alpha = 0.05$ to see the validity based on the data collected.

Meanwhile, reliability is used to measure the consistency of the instrument. An instrument is said to be good if it is reliable, consistent, or stable and productive.

Table: Test Reliability Coefficient Interpretation Classification

No	Range	Range
1.	$R_{11} \leq 0, 20$	very low
2.	$0,20 < R_{11} \leq 0,40$	low
3.	$0,40 < R_{11} \leq 0,60$	Simply
4.	$0,60 < R_{11} \leq 0,80$	high
5.	$0,80 < R_{11} \leq 1,00$	very high

Data analysis was carried out descriptively to determine student learning motivation. For each aspect evaluated in the data collection from the questionnaire is expressed by the following formula

$$P = \frac{The\ sum\ of\ the\ respondent's\ answer\ scores}{Ideal\ score\ answer} \text{ x } 100\ \%$$

Furthermore, the results of the descriptive analysis determine whether students are highly motivated to learn, high, medium, low, or very low. The findings are then categorized using the percentage scale criteria.

Table: Respondent answer criteria

No	Criteria	Category
1.	$25 \leq X \prec 0, 20$	very low
2.	$40 \leq X \prec 55$	low
3.	$55 \leq X \prec 70$	Simply
4.	$70 \prec X \prec 85$	high
5.	$85 \leq X \prec 100$	very high

Calculation of the N-Gain test obtained from the pretest and posttest results of the experimental class. used to measure the increase in learning outcomes between pretest and posttest, using the formula. (Wahab et al., 2021)

$$N - Gain = \frac{Shoes\ posttest\ -\ Shoes\ pretest}{Maximum\ score\ -\ Pretest\ score}$$

Hake's interpretation of N- Gain is as follows:

Table: N-Gain Interpretation Classification

N-Gain Value	Category
$G > 0,7$	High
$0,3 < g < 0,7$	Medium
$g < 0,3$	Low

The significance test is used to determine whether there is an increase in student learning motivation using virtual laboratory media. The hypothesis was tested with comparing tcount and

ttable, where if $t_{count} > t_{table}$, the alternative hypothesis (Ha) is accepted, indicating an increase in motivation.

RESULT AND DISCUSSION

Result

1. Instrument Test Analysis Results

The questionnaire content validity test was conducted to see whether the questionnaire items reflected the overall material studied. The content validity test of the questionnaire was carried out by Mrs. Sri Suparmi, S.Pd., a chemistry teacher at SMA Negeri 1 Pekaitan, with the direction of the supervisor. After content validation, empirical validity test was conducted using Microsoft Excel on 40 questionnaire items tested on 35 respondents. As a result, 15 items were declared invalid because r count < r table at 5% significance, so only 25 items were used for research. The reliability test using SPSS 20.0 shows a Cronbach Alpha value of 0.871, indicating that the 25 questionnaire items are reliable and ready to be used for data measurement.

2. Data Analysis Results

a. Results of Student Learning Motivation Data

Data on students' initial motivation before being given treatment in the form of learning using a virtual chemistry laboratory was obtained from a student learning motivation questionnaire with 35 students as respondents. The following is a list of data distribution tables of students' initial learning motivation.

Table: Frequency Distribution of Student Learning Motivation Pre-test Data

No	Interval Class	Frequency	
		Absolute	Absolute %
1.	25 < X ≤ 40	-	-
2.	40 < X ≤ 55	-	-
3.	55 < X ≤ 70	14	40 %
4.	70 < X ≤ 85	21	60 %
5.	85 < X ≤ 100	-	-

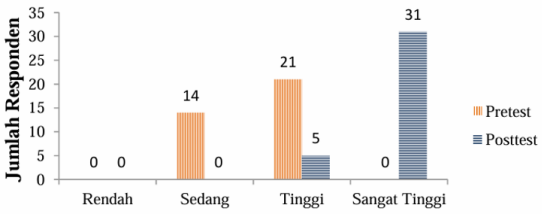
Data on student learning motivation after being given treatment in the form of learning using virtual chemistry laboratory was obtained from a questionnaire given to 35 respondents. The following is a list of data distribution tables of students' final learning motivation.

Table: Frequency Distribution of Post-test Data on Student Learning Motivation

No	Interval Class	Frequency	
		Absolute	Absolute %
1.	25 < X ≤ 40	-	-

2.	40 < X ≤ 55	-	-
3.	55 < X ≤ 70	-	-
4.	70 < X ≤ 85	5	14,28 %
5.	85 < X ≤ 100	30	85,71%
Jumlah		35	100%

Based on the frequency distribution table above, it can be illustrated with the following graph:

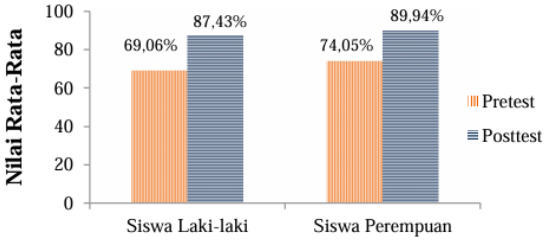


Category Interval

Figure 1: Frequency Distribution of Pretest and Posttest of Student Learning Motivation

Based on the figure above, it can be seen that the results of descriptive analysis of student learning motivation in the moderate category before being given treatment were 40% of students and after being given treatment there were no students who had learning motivation Furthermore, in the high category before being given treatment as many as 60% of students and after being given treatment in this category decreased, namely only 15% of students. In the very high category before being given treatment there were no students who reached this category and after being given treatment there were 85% of students who had achieved learning motivation in the very high category.

Changes in Student Motivation after Treatment at SMAN 1 Pekaitan



Gender

Figure 2: Changes in Learning Motivation of Male Students and Female Students after Treatment

Based on the figure above, it shows that before being given treatment, the male student group has an average motivation of 69.06%%, which is in the medium category, and the female student group has an average motivation of 74.05%, which is in the high category. After being given the treatment, the motivation of the male student group increased to 87.43%, which is in the very high category. And in the female student group, the average learning motivation of the female student group has increased to 89.94%, which is also in the very high category.

Average of Pretest Posttest Score per indicator at SMAN 1 Pekaitan

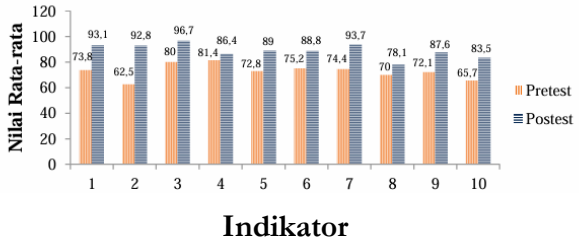


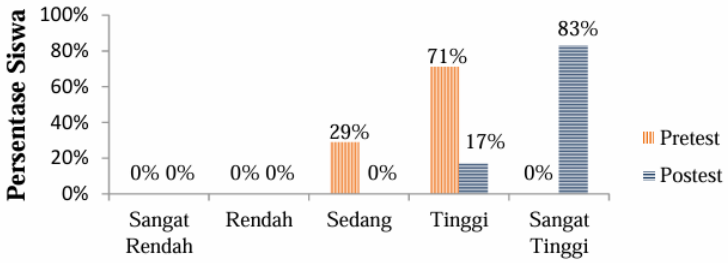
Figure 3: Average Pretest Posttest Score Per Indicator of Student Learning Motivation

The average pretest and posttest scores per indicator in the figure show that each indicator has increased. The lowest average pretest score on the second indicator, namely interesting learning activities, while the highest average pretest on the fourth indicator, namely the existence of punishment. The lowest average posttest score on the eighth indicator, namely study habits, while the highest average posttest score on the third indicator, namely the existence of awards. The difference in the average pretest and posttest scores is highest in the third indicator of learning motivation, namely the existence of rewards, while the difference in the average pretest and posttest scores of student learning motivation is lowest in the indicator of interesting learning activities.

Discussion

The high percentage of categories can be seen from the indicators used by researchers to measure student learning motivation. Some indicators of learning motivation include:

1. conducive learning environment

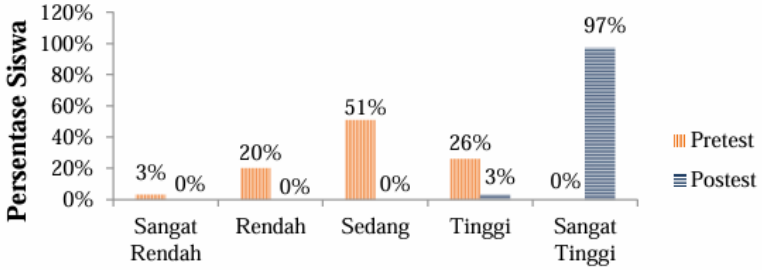


Learning motivation category interval

Figure 4: Percentage of learning motivation category indicators conducive learning environmen

In the first indicator, namely a conducive learning environment consisting of three statement items. in the pretest students have learning motivation in the medium and high categories. In the moderate category as many as 29% and in the high category as many as 71%. Whereas in the posttest it was seen that there were no students who had learning motivation in the moderate category. In the high category, it has also been seen to decrease by 17% from the pretest. Then in the posttest there were students who had learning motivation in the very high category, namely 83%. In this study, it can be said that the use of virtual laboratories can increase student learning motivation in the conducive learning environment indicator. When the pretest students still have learning motivation in the medium and high categories. However, after the posttest, namely after the use of virtual laboratories, it has increased to the high and very high categories. It can be said that a conducive learning environment and a comfortable learning environment allows a student to learn well. The classroom is a structured environment that runs based on time, rules with certain patterns, and delivers teaching mostly using verbal instructions (Suryani et al., 2022).

2. Indicators of interesting learning activities

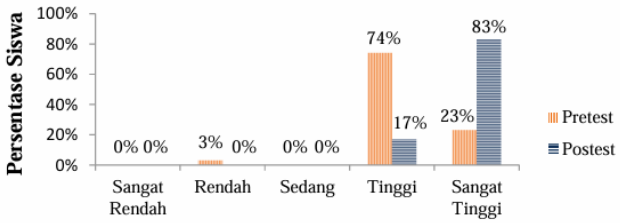


Interval of learning motivation category

Figure 5: Percentage category of learning motivation indikator interesting learning activities

The second indicator, namely interesting learning activities, consists of two statement items. It can be seen that the pretest results still have students who have learning motivation in the very low, low, medium high, and very high categories. In the very low category, namely 3%, the low category is 20%, the medium category is 51% and in the high category is 26%. Whereas in the posttest it was seen that there were no students who had learning motivation in the very low, low and medium categories. The high category has also been seen to decrease by 3% from the pretest. Then in the posttest there were students who had learning motivation in the very high category, namely 97%. So this research can be said that the use of virtual laboratory media can increase student learning motivation in the indicator of interesting learning activities. When pretest students still have learning motivation in the very low, low, medium and high categories. However, after the posttest, namely after the use of virtual laboratory media, it has increased in the high and very high categories. So it can be said that the existence of interesting learning activities can increase student learning motivation. Interesting learning activities carried out by teachers can be in the form of applying learning models and using learning media.

3. Indicator Rewards

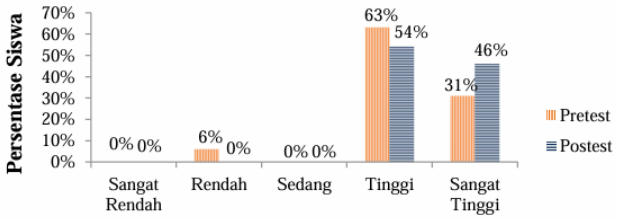


learning motivation category interval

Figure 6: Percentage of Learning Motivation Category Indicator ofinnter Appreciation

The third indicator, namely the existence of awards, consists of one statement item. It can be seen that the pretest results of students who have learning motivation in the low category and are also in the high and very high categories. In the low category, there were 3%, 74% in the high category and 23% in the very high category. Whereas in the posttest it was seen that there were no students who had learning motivation in the low category. In the high category there was also a decrease of 17% from the pretest. Then in the posttest students who had learning motivation in the high category increased by 83%. So this study can be said that the use of virtual laboratory media can increase student learning motivation in the indicator of appreciation. awards can be given by teachers to students in the form of praise which will make students become more enthusiastic about learning because students feel valued (Rosyid & Wahyuni, 2021).

4. Indicator of punishment



learning motivation category interval

Figure 7: Percentage Category of Learning Motivation Indicator of Punishment

The fourth indicator, namely the existence of punishment, consists of one statement item. It can be seen that the pretest results still have students who have learning motivation in the low category and are in the high and very high categories. In the low category, as many as 6%, 63% in the high category and 31% in the very high category. Whereas in the posttest it was seen that there were no students who had learning motivation in the low category. In the high category, there was also a decrease of 54% from the pretest. Then in the posttest students who had learning motivation in the very high category increased by 46%. So in this research it can be said that the use of virtual laboratories can increase student learning motivation in the indicator of punishment. This means that by imposing rewards or punishments as the end of learning triggers students to continue to be enthusiastic about learning. Because every student must have known and believed that when doing good things, they will get good results too, and vice versa (Arta Jaya, 2022).

5. Indicators of enjoyment in learning

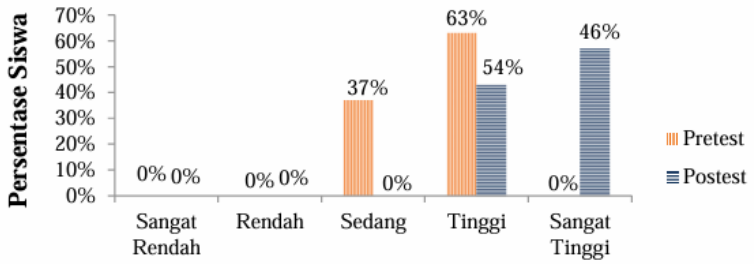


Figure 8: Percentage of Learning Motivation Categories of Pleasure in Learning Indicators

The fifth indicator, namely pleasure in learning, consists of three statement items. It can be seen that the pretest results of students who have learning motivation in the medium and high categories. In the moderate category, 37% and in the high category, 63%. While in the posttest, it can be seen that there are no students who have learning motivation in the moderate category. In the high category, it has also been seen to decrease, namely 54% from the pretest. Then in the posttest there were students who had learning motivation in the very high category, namely 46%. So in this study it can be said that the use of virtual laboratory media can increase student learning motivation in the indicator of pleasure in learning. It can be said that the pleasure in learning indicator has a positive effect on student learning motivation. The pleasure in learning that students have is due to the desire of students to learn by themselves. interest is a tendency of a person to want to do something and can be seen from a person's behaviour such as a sense of pleasure, interest and a desire to participate in learning. (Alfazani & Khoirunisa A, 2021)

6. Indicators of need in learning

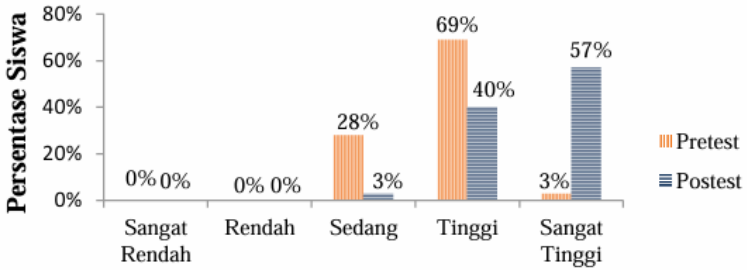


Figure 9: Percentage of Learning Motivation Categories of Needs Indicators in Learning

The sixth indicator, namely the need to learn, consists of three statement items. It can be seen that the pretest results of students who have learning motivation in the moderate category, and are in the high and very high categories. In the moderate category, 28%, in the

high category, 69% and in the very high category, 3%. Whereas in the posttest it was seen that students who had learning motivation in the moderate category decreased by 3% from the pretest. In the high category, there was also a decrease of 40% from the pretest. Then in the very high category, it increased by 57% from the pretest. So in this study it can be said that the use of virtual laboratories can increase student learning motivation in the indicator of learning needs. High student motivation to learn due to internal encouragement or student interest in learning. (Yogi Fernando et al., 2024).

7. Indicator of parental encouragement

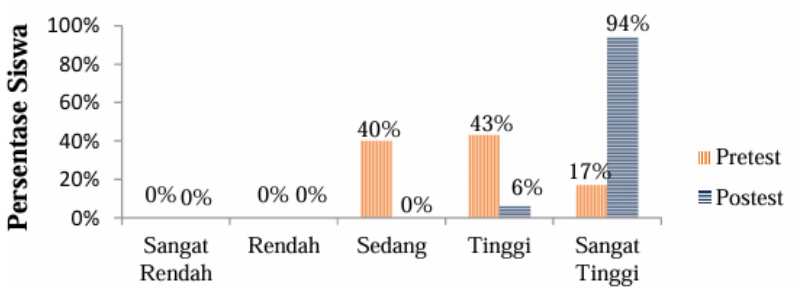


Figure 10: Percentage of Learning Motivation Indicator Categories Parental Encouragement

The seventh indicator, namely parental encouragement, consists of four statement items. It can be seen that the pretest results of students who have learning motivation in the moderate category, and are in the high and very high categories. In the moderate category, 40%, in the high category, 43% and in the very high category, 17%. Whereas in the posttest it was seen that there were no students who had learning motivation in the moderate category. In the high category there was also a decrease of 6% from the pretest. Then in the very high category increased by 94%. So in this study it can be said that the use of virtual laboratory media can increase student learning motivation in the indicator of parental encouragement. the role of parents has a positive effect on student learning motivation. (Kusumaningrini & Sudibjo, 2021).

8. Indicators of study habits

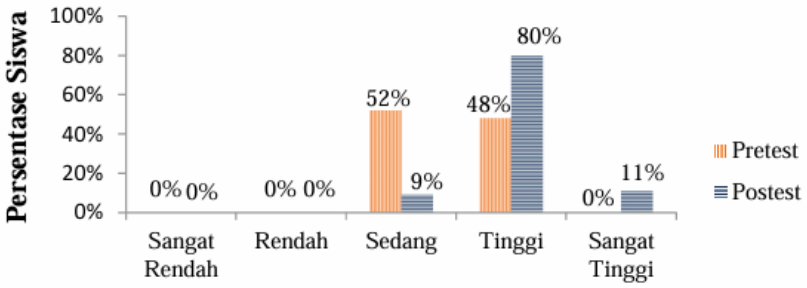
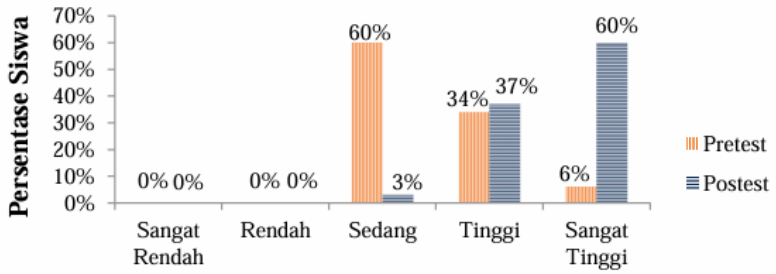


Figure 11: Percentage of Learning Motivation Categories of Learning Habits Indicators

The eighth indicator, namely study habits, consists of three statement items. It can be seen that the pretest results of students who have learning motivation in the medium and high categories. In the moderate category, 52% and in the high category, 48%. Whereas in the posttest it can be seen that there are no students who have learning motivation in the moderate category. In the high category, it increased by 80% from the pretest. Then in the posttest students who had learning motivation in the very high category were 11%. So in this study it can be said that the use of virtual laboratory media can increase student learning motivation in the learning habits indicator. Good study habits are characterised by making a study schedule

and implementing it, diligently reading textbooks and making notes, repeating lessons regularly, and doing assignments (Siti Zailiah, 2023).

9. Indicator of desire or will to succeed

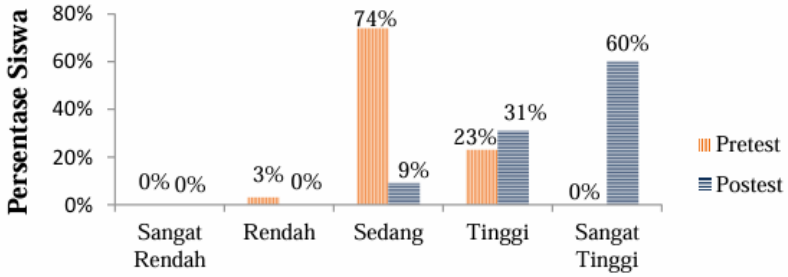


learning motivation category interval

Figure 12: Percentage Category of Learning Motivation Indicator Desire or Desire to Succeed

The ninth indicator, namely the desire or desire to succeed, consists of three statement items. It can be seen that the pretest results of students who have learning motivation in the moderate category, some are in the high and very high categories. In the moderate category, 60%, in the high category, 34% and in the very high category, 6%. In the posttest, students who had learning motivation in the moderate category decreased by 3% from the pretest. While in the high category it was seen to increase by 37% from the pretest and in the very high category it increased by 60% from the pretest. So in this study it can be said that the use of virtual laboratory media can increase student learning motivation in the indicator of desire or desire to succeed. During the teaching and learning process, students listened and recorded the material explained. In addition, there are also some students who actively ask the teacher about material that is not understood (Ayumi & Ferianto, 2023).

10. Indicators of future hopes or aspirations



learning motivation category interval

Figure 13: Percentage of Learning Motivation Category Indicators of Future Expectations or Ideals

The last indicator, namely the existence of future hopes or ideals, consists of two statement items. It can be seen that the pretest results of students who have learning motivation in the low, medium and some are in the high category. In the low category, namely 3%, the medium category is 74%, and the high category is 23%. While in the posttest there were no students who had learning motivation in the low category. In the medium category, it seems that it has decreased by 9% from the pretest. Then in the posttest students have learning motivation in the high category increased by 31% from the pretest, and there are students who have learning motivation in the very high category, namely as many as 60%. So that in this study it can be said that the use of virtual laboratory media can increase student learning motivation in the indicator of future hopes or ideals. Students whose learning motivation is high cannot be separated from their future goals or goals. This can be seen

when the researcher enters the classroom, there are several students who tell about their goals. There are students who aspire to be midwives, doctors, teachers and others. Basically, students already have goals that they want to achieve, so that it encourages students to learn.

The N-gain test was conducted to obtain the results of the learning effectiveness category using virtual chemistry laboratory on student learning motivation on the material of colligative properties of solutions. N-gain calculations are obtained from the results of student pretests and posttests. Based on the results of the study, there were 3 students whose average score was included in the high category because the results of the students' questionnaire answers had almost reached the highest score in each indicator. As for the medium category, there are 32 students. The overall pretest average score was 72.3 while the overall average score was 88.8. The difference between the pretest and posttest scores of student learning motivation is 16.5.

The significance test (sign test) aims to determine the significance of the effect of using virtual laboratories on student learning motivation. This analysis uses SPSS version 2.0, which is based on the significance value. Based on the overall student learning motivation, the significance value (sign-test) is 0.000. Because the value of sig. (2-tiled) = 0.000 <0.05, Ha is accepted and it can be concluded that there is a positive and significant relationship between the use of virtual laboratories and student learning motivation. Based on gender differences in learning motivation of male students and female students, the significance value (sign-test) is 0.092. Because the value of sig. (2-tiled) = 0.092 > 0.05 then H0 is accepted, based on per indicator obtained significance value (sign test) is 0.070. Because the sig value. (2-tileod) = 0.070 > 0.05 then H0 is accepted.

This study shows that student learning motivation increases significantly when using virtual laboratory media. So it can be said that the implementation of learning activities using virtual laboratory media can increase student learning motivation. The highest indicator of motivation is interesting learning activities, where 97% of 35 students have very high learning motivation. This emphasises the importance of creating interesting and interactive learning to increase students' enthusiasm for learning. In contrast, the learning habit indicator showed the lowest result, with only 11% of students having very high motivation, indicating that this aspect still needs more attention in the learning process.

In addition, the study also found that there was no significant difference in learning motivation based on gender, both for male and female students. This is because both male and female students simultaneously experienced an increase in their learning motivation after being given learning using virtual laboratory media. Both experienced an increase in motivation after using the virtual laboratory. Some indicators such as pleasant learning environment, rewards, and future goals showed significant differences, while indicators such as punishment, pleasure in learning, and parental encouragement did not show significant differences. Overall, the use of virtual labs proved to be an effective medium in increasing students' learning motivation.

CONCLUSION

Based on the research results, it can be concluded that:

1. Students' learning motivation towards learning using virtual laboratories as a whole has increased significantly. This is evidenced by the sig value. (2-tiled) of 0.000 <0.05, so there is a positive relationship between the use of laboratory media and learning motivation.

2. There is no significant difference between male students and female students in increasing their learning motivation because the test results show a sig value. (2-tiled) of 0.092 > 0.05.

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