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The Influence Of Google Sites Based Computational Chemistry Media Using A Problem Based Learning

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***Abstract**:* *The purpose of this study was to determine how students' learning outcomes and motivation regarding reaction rates are affected by the use of Google Sites, a computational chemistry-based learning tool. Taman Siswa High School, Medan Area District, Medan City and the Computational Chemistry Lab of the Chemistry Department, Faculty of Mathematics and Natural Sciences (FMIPA) were the locations of this study. The population consisted of 11th grade students, namely 8 classes at Taman Siswa High School, Medan. The sample consisted of 11th grade MIPA-1 students as the experimental class and 11th grade MIPA-2 students as the control class. The results of the posttest hypothesis test using the t-test indicate this, with $T_{test} > T_{table} = 4.71 > 1.671$. The t-test for student learning motivation revealed that $T_{test} > T_{table} = 2.26 > 1.671$. A very strong relationship of 0.917 was found between student learning outcomes and motivation.*

***Keywords**:* *google sites media; computational chemistry; problem based learning; reaction rate.*

INTRODUCTION

Education is an essential part of life. It encompasses all the knowledge we gain throughout our lives, which helps us grow as individuals. Education occurs throughout our lives. The curriculum is a plan created by the government for the education system. The curriculum helps us learn how to learn to achieve specific goals. Whether we study alone or in a group, learning often occurs in everyday activities. Many of the things we do every day are actually ways of learning (Afrianis & Ningsih, 2022).

One school implementing the "Independent Curriculum" is Taman Siswa Senior High School in Medan. Observations and interviews at the high school in Medan revealed that the content is still conceptual, and learning methods are still based on textbooks. Blackboards and textbooks are the primary tools. Although numerous learning resources are available, their use is not always effective. This leads to students losing interest and failing to understand the lessons. Students still struggle to understand the changes in reactants or products over time, resulting in low learning outcomes regarding reaction rates. Lack of student motivation and low learning outcomes in chemistry, particularly regarding reaction rates, may be the cause.

Chemistry has evolved quite rapidly along with scientific advances. Computational chemistry is a new field of chemistry that has developed quite rapidly. In computational chemistry, large chemical structures (macromolecules like proteins or multimolecular systems like gases, liquids, solids, and liquid crystals) are simulated using computer programs that translate chemical theory. These programs are then applied to real-world chemistry (Noufal, 2025). Chemdraw, Avogadro, and Jmol Marvil's sketches can all be used in computational chemistry animation and visualization tools (Harahap et al., 2022).

Along with the rapid advancement of technology, teaching in schools has also changed significantly, triggering a number of reform initiatives in the field of education. Curriculum, methodology, equipment, and assessment have all evolved significantly in school education. The management, structure, staffing, and supervision of education itself have also changed. The use of teaching aids, educational tools, audio, visual, and audiovisual materials, and other school equipment must adapt to these advancements due to the increasing prominence of technology. These advancements align with curriculum requirements, resources, techniques, and student abilities to achieve learning objectives (Moto, 2019).

Because it can be viewed anytime and from anywhere, Google Sites is a useful learning tool (Rosiyana, 2021). Google offers a free web hosting service called Google Sites. You can create web pages using Google Sites for various online purposes. Among the many advantages offered by Google Sites are sophisticated designs and themes. You can easily and conveniently add analytics, webmaster tools, and of course, AdSense to Google Sites. Because these services are hosted on the Google.com domain, search engines will have an easier time indexing your published web pages (Setiawan, 2023).

Teachers are crucial to the learning process and key to success. They are responsible for designing, implementing, and evaluating learning outcomes. Consequently, various learning models are used in the teaching and learning process, facilitating student understanding of the content. The use of learning models that enhance student learning activities is crucial for inspiring students to learn (Meilasari et al., 2020).

This educational approach focuses on students. Problem-based learning engages students in solving real-world problems. It's a learning method that encourages students to think from multiple perspectives and work collaboratively. There are six characteristics of problem-based learning. First, students are the center of learning. Second, students learn in groups with teacher guidance. Third, teachers act as mentors. Fourth, real-world problems are essential for learning. Fifth, these challenges help students improve their knowledge and problem-solving skills. Sixth, the knowledge gained helps students understand the problems around them and find solutions.

Consequently, evaluations need to be based on real-world scenarios involving students. One of the many characteristics of learning using the Problem-Based Learning paradigm is that students become accustomed to solving problems and feel challenged to do so, both in the classroom and in real-world situations. As they become accustomed to communicating with group members and then with peers, it fosters social cohesion. Because students may need to use experiments to solve a problem, it also strengthens the bond between professor and student. Furthermore, it introduces students to the use of experimental techniques. The purpose of this study was to determine how student learning outcomes and motivation regarding reaction rates were influenced by the use of Google Sites, a computational chemistry-based learning tool (Hakim et al., 2023).

LITERATURE REVIEW

In modern society, where digital transformation impacts people's lives, education is a significant catalyst for change. Chemistry education is highly important in national development and supports a country's movement into the efficiency-driven development phase. Chemistry includes many abstract concepts, so for many students, the learning process is complicated and requires attention. Recent research in this area shows that both teachers and researchers agree that technology provides an opportunity to solve this task of making chemistry learning more attractive. The importance of the digital environment for the education system (teaching and assessment-ment) leads to the need for quality standards. The digital setting enables individual discussion of the content, provides personal feedback to learners, and consists of motivational elements. The system involves five steps: analysis, design, development, quality assurance and evaluation, and implementation (Ika, 2026).

Intrinsic Motivation is Because everyone has a desire to do something, intrinsic motivation comes from within and is not influenced by external factors. Intrinsically motivated people will not be satisfied until their efforts produce the desired results. For example, someone who enjoys reading will seek out books to read on their own without any encouragement. Without waiting for guidance, responsible and hardworking individuals will learn to the fullest. Extrinsic Motivation: Students are motivated to learn by external factors, such as invitations, orders, or coercion from others. For example, when students complete their homework, they simply follow the teacher's directions; otherwise, the teacher will reprimand them (Prasetya, 2022).

One learning media used during this pandemic is website media with Google Sites. Learning media based on Google Sites can support online learning because of its flexible nature to be accessed on various devices such as smartphones, laptops, and tablets. This makes it easier for students to access without taking up storage space on the devices they are using, and there is no need to install applications. Media websites based on Google Sitescan also improve student learning outcomes. Website-based learning that contains audio and visuals can increase students' interest in learning in class. Added that Google Sites are the easiest and most straightforward way to build web-based learning media for teachers. The teacher only uses drag and click to set up access control and requires no programming knowledge. In addition, Google-based websites are free of charge or free and easy to access. It is hoped that learning media based on Google Site chemical bonding material can make it easier for teachers to explain multilevel chemical representations and make it easier for students to understand the learning materials provided by the teacher (Veni, 2023).

The Problem Based Learning model can also help students overcome specific problems they face such as lack of domain-specific knowledge, problem-solving skills, self-direction, and collaborative skills (Kim et al., 2018). In addition to implementing the Problem Based Learning model, researchers also connect these variables with multimedia assistance to improve students' motivation and critical thinking skills. This is because the learning media and learning models used by teachers do not pay attention to submicroscopic representations and do not link lessons to the environment, so teachers need to develop Interactive Chemistry Multimedia, assisted by PBL (Problem Based Learning) to improve students Generic Science Skills (Erika, 2023).

Computational chemistry methods can represent almost any chemical entity, from simple to highly complex, making them inherently versatile (Alifani et al., 2022). NWChem software is a tool for creating computational chemistry media. NWChem software is used to optimize molecules into realistic shapes. Currently, Jmol is a computer program used to model three-dimensional chemical structures. Jmol offers three-dimensional depictions of molecules that can be used for study or as a teaching tool. Avogadro is a program that can be used to view the three-dimensional structure of a molecule. Avogadro is software built on Mac OS, Linux, and Windows operating systems. (Warda, 2023). Google Sites is a program that can store and present various types of data in one location, including text, photos, videos, and other materials. Google Sites has many benefits, such as being free and easy to use, accessible from anywhere and at any time, having an attractive appearance, and being able to connect various types of information through links, including text, videos, photos, audio, presentations, and other materials (Napitu et al., 2023).

METHODS

This research was conducted in two locations: Taman Siswa High School, Jalan Singosari No. 11, Sei Rengas Permata, Medan Area District, Medan City, North Sumatra Province, and the Chemistry Computation Laboratory, Faculty of Mathematics and Natural Sciences, Medan State University, on eleventh-grade students in the even semester of the 2025/2026 academic year. This research will be conducted from November to January 2026.

The population used in this study is all eleventh-grade science students at Taman Siswa High School in the 2025/2026 academic year, consisting of eight science classes. Sampling in this study using random sampling technique, This random sampling technique helps reduce the risk of errors that may occur in the study, this is because members of the population have the same opportunity to be selected thus minimizing errors in sample selection. The method of taking random sampling is the Lottery Technique Method by giving numbers to all members of the population, then taking numbers randomly like a lottery. Random number table using a random number table available in statistics books to select samples. Computer random number generator using features such as random in Microsoft Excel to select 33 samples randomly. Of the 8 classes of XI in SMA Taman Siswa, researchers have selected two classes, namely class XI - 1 with a total of 33 students as the experimental class and class XI - 2 with a total of 36 students as the control class.

This research is experimental in nature. The research sample was divided into two groups: Group 1, the experimental group, received instruction using a problem-based learning model through Google Sites-based learning materials, while Group 2, the control group, received instruction using a constructivist learning method.

Conducting a pretest in the class to measure initial abilities before administering the treatment. The experimental class was taught using Google Sites learning media based on computational chemistry calculations using the Problem-Based Learning (PBL) model. Distributing questionnaires to students in the experimental class. After the classroom learning process was completed, a posttest was administered to the experimental class. Final Stage is Processing data obtained from the pretest, posttest, and student learning motivation. Analyzing the data obtained from the research and drawing conclusions from the research conducted. Drawing conclusions.

RESULT AND DISCUSSION

Computational Research Results. To analyze the reaction mechanism and rate of the chemical reaction CH_3COOCH_3 + H_2O based on its characteristics, this study employed computational chemistry techniques utilizing the Restricted Hartree–Fock (RHF) method and the 3-21G basis set. Molecular structure optimization, calculation of the total energy of reactants and products, and identification of activation energies were among the calculations performed in this study. NWChem software version 6.6 was used to perform the computational geometry optimization calculations. The Restricted Hartree–Fock (RHF) approach was applied in this study using the 3-21G basis set. Acetic acid, bromomethane, hydrogen bromide, ethyl bromide, and ethene were among the compounds calculated.

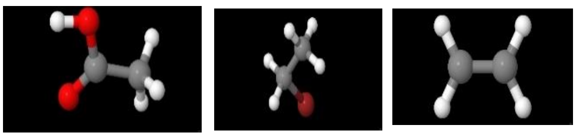
Tabel 1.1 *Energi Specification Compounds*

No	Compound Name	Energi
1	Asam Asetat	-226.53423733
2	Bromo Metana	-2638.27182918
3	Etena	-278.39348047

4	Etil Bromida	-2638.27182908
5	Metanol	-114.39801847
6	Klorin	-108.86800503
7	Ester	-265.33047105
8	Hidrogen Bromida	-256.06206468
9	Metanol	-496.39417755
10	Oksigen	-149.20412837
11	Bromo Etana	-1310.72019532
12	Metil Asetat	-2997.47091441
13	Etanol	-1740.00158226

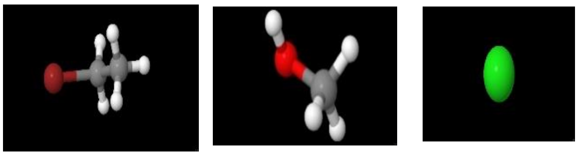
During my research, I used several software applications, including Avogadro, NWChem, and Jmol, based on the results of computational chemistry simulations. Initially, Avogadro was used to draw the molecular structures of several compounds, including acetic acid, bromomethane, ethene, ethyl bromide, methanol, chlorine, esters, hydrogen bromide, methanol, and oxygen. The drawn structures were then exported in Z-matrix format and used as input data for further computations. The Hartree-Fock (HF) technique and the 3-21G basis set were used to optimize the geometry and determine the total energy of each chemical compound during the computational calculations using NWChem version 6.6. The overall energy value of the optimized structure is the main result of these calculations. The Jmol software was then used to visualize the three-dimensional molecular structures using the calculated data. The graph below shows the structure of each compound after the calculations.

The 3D structures of acetic acid, bromomethane, and ethane compounds resulting from geometry optimization are visualized using Jmol software, as shown below.



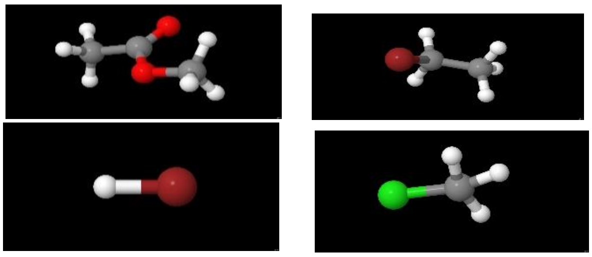
Picture 1.1 *Acetic Acid, Bromometahe, and Ethane*

The 3D structures of ethyl bromide, methanol, and chlorine compounds resulting from geometry optimization using Jmol software are determined as follows.



Picture 1.2 *Ethyl bromide, methanol, and chlorine.*

The 3D structures of ester compounds, hydrogen bromide, methanol, and oxygen, resulting from geometry optimization using Jmol software, are as follows.



Picture 1.3 *Ester, Hydrogen Bromide, Methanol and Oxgen.*

The 3D structure of the transition compound resulting from the optimization of the divicular geometry using Jmol software was determined as follows.

Picture 1.4 *Transition Compound*

The following item analysis results were calculated after a pilot test of the test used as a research instrument, specifically its validity, reliability, difficulty level, and discriminatory power:

The validity test was conducted on upper grades, specifically grade XII, after all 40 questions given to expert lecturers were declared valid. Twenty valid questions, numbered 1, 2, 3, 5, 6, 7, 11, 12, 14, 15, 16, 20, 21, 23, 25, 28, 34, 35, 37, and 39, were used in this study. These questions were selected to reflect each indicator of success.

Of the forty questions given to students, a medium difficulty level met the requirements. However, to achieve high-quality questions, the difficulty level must be balanced, meaning there are easy, medium, and difficult questions in proportion.

Table 1.2 *Level of Difficulty of Questions*

Level of difficulty	No Question	Amount
Easy	11,15,18,22,24,31,32, 35	8
Medium	1,2,3,5,6,7,9,12,14,16, 20,21,27,28,29,34,39	17
Hard	4,8,10,13,17,19,23,25, 26,30,33,36,37,38,40	15

A total of 14 questions were classified as poor, 11 as adequate, 5 as good, 1 as very good, and 9 as poor or questions that should be removed based on the results of the discrimination test given to students.

Table 1.3 *Difference Power Test*

Question Category	No. Question	Amount
Bad	4,8,13,18,20,25,26,27 ,29,30,33,34,36,38	8
Fair	2,6,7,11,12,16,21,23 35,37,39	11
Good	1,3,5,14,28	5
Very Good	15	1
Not Good	9,10,17,19,22,24,31 32,40	9

The reliability test of the K-R 20 instrument using Excel yielded an r value of 0.83, which is classified as very high reliability according to standard interpretation. This indicates that the test instrument items have strong internal consistency and are suitable for use as a reliable measurement tool when collecting research data. Therefore, this research tool is considered reliable.

Dik :

K = 20

V_1 = 16,996

Σpq = 3,666

Dit : R11 ......??

Answer :

$$R_{11} = \frac{(K)}{(K-1)} \; \frac{(Vt - \Sigma pq)}{Vt}$$

$$R_{11} = \frac{20}{(20-1)} \; \frac{(16{,}996-3{,}666)}{16{,}996}$$

$$R_{11} = \frac{20}{19} \; \frac{13{,}3\ 3}{16{,}996}$$

$$R_{11} = 1{,}052 \times 0{,}784$$

$$R_{11} = 0{,}83$$

The chi-square test was used to test for data normality. Posttest results for both sample groups showed normal data (counts < table) at a significance level of 0.05 for both the experimental and control classes. Based on this calculation, it can be concluded that the data are normally distributed.

Table 1.4 *Pretest – Posttest Normality Test*

No.	Data	Count	Table	Conclusion
1	Posttest Experi Ment Class	3,84	7,815	Normal
2	Posttest Control Class	4,63	7,815	Normal

Based on the table above, it can be concluded that:

1. Using the actual significance level of α = 0.05 and a dk of 5 is 7.815. From the data shown in the table, the normality test for the experimental class student learning outcomes yielded a posttest count of 3.84. It can be concluded that the chemistry learning outcomes data are normally distributed.

2. Using the actual significance level of α = 0.05 and a dk of 5 is 7.815. From the data shown in the table, the normality test for the control class student learning outcomes

yielded a posttest count of 4.63. It can be concluded that the chemistry learning outcomes data are normally distributed.

The purpose of this study was to compare the pretest and posttest results of students in the experimental and control groups to conduct an n-gain analysis to measure student performance progress in learning. Learning outcomes improved by 0.51% (51%) in the experimental group. Student achievement improved by 0.41% (41%) in the control group. This section provides further details on the N-Gain test results on learning outcomes in the experimental group.

Table 1.5 *N - Gain Calculation of Experimental Class*

Pretest	Posttest	N	Gain	Interpretensi
37,33	70,33	30	0,51	Medium

Table 1.6 *Calculation of N - Gain of Control class*

Pretest	Posttest	N	Gain	Interpretensi
39,33	64,33	30	0,41	Medium

Homogeneity Test The table below shows the homogeneity test findings for post-test data from the experimental and control classes, comparing the F-test < F-table at a significance threshold of α = 0.05.

Table 1.7 *Pretest – Posttest Homogenity Test*

Data Source	Class	S2	Fcount	Ftable	C
Posttest	Experimental	60	1,77	1,87	h
	Control	108			h

S2 = Sample Variance; Ftable = db (n1 – 1), (n2 – 1) (α = 0.05)

The table values for the F distribution with a significance threshold of α = 0.05 and a numerator and denominator of 29 were used to calculate the posttest scores for the experimental and control groups. This yielded an Ftable of F0.05 (29.29) = 1.87. The posttest results for both classes were homogeneous because the calculated F value was smaller than the Ftable.

To determine whether there is a relationship between student motivation to learn chemistry and Google Sites materials based on computational chemistry within the Problem-Based Learning paradigm on the topic of reaction rates, a hypothesis test was conducted. A correlation test was used to evaluate the hypothesis, and the results showed that rxy = 0.917 and rtable = 0.361. Since rxy > rtable (0.917 > 0.361), Ho is rejected and Ha is accepted. Therefore, it can be concluded that there is a correlation (0.917, a very high correlation category) between student motivation to learn chemistry and their learning outcomes. According to Rahman et al. (2021), there is a very strong correlation (0.616) between learning motivation and learning outcomes, and learning motivation plays a crucial role in improving student learning outcomes in every learning activity. Student achievement is determined by motivation. Therefore, students will achieve better learning outcomes if they are more motivated to learn.

The average learning motivation of students in each class (experimental class and control class) can be used to determine the calculation results directly.

Table 1,8 *Motivation Questionnaire Data*

Realm	Class	Average
Motivation	Experiment	75,80
	Control	64,30

Another study using computational chemistry-based media but with different materials corroborated this finding. According to Nilmaritro et al. (2023), students' learning motivation increased by 85.64% when they learned about molecular structure through computational chemistry-based media. Mulatsih (2019) emphasized that the direction and objectives of learning are strongly influenced by learning motivation. Because highly motivated students learn significantly more, motivation is a component that can improve the quality of learning. Furthermore, engaging media can increase students' enthusiasm for learning, according to research by Jannah et al. (2020).

CONCLUSION

After conclusions the research, the following conclusions were reached:

1. There is a significant influence of the use of Google Sites media based on computational chemistry in the Problem-Based Learning model on student learning outcomes on the topic of reaction rates in grade XI students of SMA Taman Siswa Medan.

2. There is a significant influence of the use of Google Sites media based on computational chemistry in the Problem-Based Learning model on student learning motivation on the topic of reaction rates in grade XI students of SMA Taman Siswa Medan.

3. The use of Google Sites media based on computational chemistry in the Problem-Based Learning model has a positive correlation between learning motivation and learning outcomes, namely 0.917 (high correlation).

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