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# The Influence of The STEM Learning Model on Improving Students' Scientific Literacy and Numeracy Skills on Reaction Rate Material

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## Abstract

*This study was conducted to determine whether the STEM learning model has a significant effect on students' scientific literacy and numeracy skills at the rate of material speed. The target population was grade XI students of SMA Negeri 3 Medan (consisting of 9 classes), and two classes were selected as samples through purposive sampling techniques. The type of research used was quasi-experimental (pseudo-research), with a Control Group Pretest-Posttest Design. The data collection instrument was a multiple-choice test (20 questions) designed to measure scientific literacy and numeracy, and has been tested for validity and reliability. Data analysis employed a one-tailed t-test (right-tailed) with a significance level of 0.05. The results of the statistical analysis showed that the t-count value (7.367) was greater than the t-table value (1.688), leading to the rejection of the null hypothesis ($H_0$) and the acceptance of the alternative hypothesis ($H_a$). In conclusion, the STEM learning model has a significant impact on enhancing students' scientific literacy and numeracy skills in the context of reaction rates.*

**Keywords:** Numerasi, reaction rate, science literacy, STEM model

## Introduction

Learning is a two-way interaction between teacher and student, in which various components play a role (Sugiharti & Anugrah, 2023). Learning is often an integral component of education, which has great significance in human life. Upbringing forms individuals not only intellectually competent but also with good character and skills relevant to the needs of the times.

Education in Indonesia is currently in the 21st century, an era marked by advances in science and technology. Education aims to develop students' skills to face the changing times (Zulanwari et al., 2023). Furthermore, in the 21st century, more than just competence in reading and writing, disciples were expected to master various other abilities. However, there are six basic literacies that students need to master: science literacy and numeracy (Sustina, 2023).

Understanding and applying scientific concepts in everyday life is the essence of scientific literacy. Mastery of this literacy is an important aspect, especially for students, as it plays a role in increasing their understanding of the environment and the ability to solve problems rationally, particularly in life phenomena (Nurfadillah et al., 2023). Numeracy refers to the ability to solve problems involving symbols, as well as mathematical applications relevant to life situations (Nurhayati et al., 2022). Referring to the two definitions, scientific literacy and numeracy are essential aspects of learning because both have a strong relationship with everyday life through problem-solving skills.

Problems related to the level of science literacy and numeracy in Indonesia are still a concern. Data from the 2022 PISA assessment illustrate this situation, where, although Indonesia has improved its ranking, students' science literacy and numeracy ability scores still show a gap compared to the average of other PISA participating countries, as officially released on December 5, 2023. As a result, Indonesia is ranked 68th (OECD, 2023). The low level of science literacy and numeracy is also supported by interviews conducted with chemistry teachers at SMA 3 Medan, which revealed that students have difficulty solving problems related to natural phenomena in the surrounding environment, completing calculation problems, and struggle to understand science material involving data, graphs, and experiments.

Implementing less innovative and teacher-centered learning models is one factor contributing to low scientific literacy and student numeracy among low-ability students (Aristawati, 2022). This is supported by Sugiharti & Zen (2020), who emphasized the importance of learning models as an effective means of conveying knowledge and improving student learning success in teaching and

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learning activities. This is supported by interviews conducted with chemistry teachers, who still primarily use lecture, discussion, and assignment methods when implementing learning. Teacher dominance in learning models can render students passive and less facilitated in developing scientific literacy, including the application of everyday scientific concepts and numeracy skills in calculation problems (Hijjayati et al., 2022).

The science material, including reaction rates, is highly relevant to chemistry learning. Reaction rates have numerous applications in various aspects of life. The reaction rate also involves mathematical calculations (Sakti et al., 2020). Reaction rate is a chemistry lesson material that is often considered difficult by students because it requires two key skills: conceptual understanding and calculation (Yerimadesi & Afendi, 2024). The average daily test score of 70 obtained by class XI MIPA 1 students of SMA Negeri 3 Medan in the 2023/2024 academic year for the Reaction Rate material is an indication of their less-than-optimal understanding of the material.

Understanding reaction rates highlights the need for innovative learning models to enhance students' scientific literacy and numeracy, particularly in the context of reaction rates. Students can integrate conceptual understanding with numerical analysis skills. For example, textually understanding the factors that influence reaction rates (scientific literacy) and then analyzing experimental data to determine reaction orders and rate constants (numeracy). One of the learning models that can be used is STEM. As shown by Sugiharti et al. (2025), the Problem-Based Learning model is an alternative learning model that can also enhance scientific literacy, in addition to the STEM model. STEM is an integrated learning framework that provides a forum for developing student investigation activities, communication skills, critical thinking, and building students' understanding of phenomena in everyday situations (Starzinski, 2017). The STEM model encompasses academic understanding and involves science and mathematics processes and concepts that prepare students to address rapidly developing global challenges (Irmawati et al., 2021).

The implementation of STEM learning has been proven effective in improving students' scientific literacy and numeracy. This learning supports students to solve real problems by connecting them to scientific concepts and calculations (Amahoroe et al., 2020). Research by Astuti et al. (2023) demonstrates that STEM learning can enhance students' scientific literacy to a high level. Amarlita (2023) also stated that the application of STEM learning in the reaction rate material in class XI, as taught by MA Matlaul Anwar, has proven effective, with 25% of students achieving an outstanding category. Research by Diana & Saputri (2021) shows that STEM can improve students' numeracy skills. Additionally, according to Yusuf et al. (2022), STEM learning can motivate children to learn mathematics and enhance their numeracy skills.

Starting from the identification of the problems that have been described, this study aims to test "The Effect of the STEM (Science, Technology, Engineering, and Mathematics) Learning Model on Improving Students' Science Literacy and Numeracy Skills on Reaction Rate Material".

## Methods

This study used a Quasi-Experimental design with a two-group pretest-posttest Control model. The implementation took place at SMA Negeri 3 Medan, with the research subjects is experimental class (XI 1-1) where there are 16 men and 20 women and a control class (XI 1-3), each consisting of 36 students, where there are nine men and 26 women Details of this research design can be seen in Table 1.

**Tabel 1.** Two group pretest-posttest research design

| Group | Pretest | Treat | Posttest |
|---|---|---|---|
| **Experimental** | $O_1$ | $X_1$ | $O_2$ |
| **Control** | $O_1$ | $X_2$ | $O_2$ |

(Sugiyono, 2021)

Description:

$O_1$ : Before being treated, the experimental and control classes underwent an initial ability test (Pre-test).

$O_2$ : Final ability test (posttest) in the experimental class and control class after being given treatment

$X_1$ : Treatment using the STEM model on the reaction rate material

$X_2$ : Treatment using conventional learning on the reaction rate material.

To collect data, a 20-question multiple-choice science and numeracy literacy test was used, which met the criteria of validity, difficulty level, discriminatory power, and reliability. Data analysis was conducted using a one-tailed t-test (right-tailed) at a significance level of 0.05. Prior to this, data normality was assessed using the chi-square test, and homogeneity of variance was evaluated using the F-test, both with a significance level of 0.05.

## Results and Discussion

**Table 2** presents data on students' scientific literacy and numeracy abilities, obtained from both the control class and the experimental class, including pretest and posttest data.

**Table 2.** Data on students' scientific literacy and numeracy abilities

| Kelas | Pre-Test | Posttest |
|---|---|---|
| **Experimental** | 32.08 | 83.19 |
| **Control** | 31.66 | 71.80 |

The data in the table above shows the average value of students' abilities before and after taking the test. The experimental class exceeds the average value in the control class.

For hypothesis testing, a series of analysis requirement tests, including normality and homogeneity tests, were first conducted at a significance level of 0.05. The results of the normality test for students' scientific literacy and numeracy abilities are presented in **Table 3**.

**Table 3.** Normality test of students' science literacy and numeracy ability data

| Class | $X^2_{hit}$ | $X^2_{tabel}$ | α | Description |
|---|---|---|---|---|
| **Experimental** | 3.75 | 11.07 | 0.05 | Normal |
| **Control** | 4.91 | 11.07 | 0.05 | Normal |

Interpretation of the data in Table 3 shows that the significance value of the normality test for both classes is greater than $X^2_{hit} < X^2_{tabel}$, This means that the distribution of data on students' scientific literacy and numeracy skills, both taught with the STEM and conventional models, is normal. Information on the results of the homogeneity test of students' scientific literacy and numeracy skills can be found in **Table 4**.

**Table 4.** The homogeneity test of students' scientific literacy and numeracy abilities

| Class | $F_{hit}$ | $F_{tabel}$ | Description |
|---|---|---|---|
| **Experimental** | 1.39 | 1.74 | Homogeneous |
| **Control** | | | |

The interpretation of the data in Table 4 shows that $Fhit < F$table, indicating that the data on students' science literacy and numeracy abilities using the STEM model and the conventional model are homogeneous.

After the data is typically distributed and homogeneous, a hypothesis test is conducted using the t-test (right side) with a significance level of $\alpha = 0.05$, as shown in **Table 5**.

**Table 5.** Hypothesis test of students' science literacy and numeracy abilities

| Class | $t_{hit}$ | $t_{tabel}$ | Description |
|---|---|---|---|
| **Experimental** | 7.367 | 1.688 | Ho is rejected, and Ha is accepted. |
| **Control** | | | |

The study's results showed a significant influence of the STEM model on students' scientific literacy and numeracy skills. This was proven based on the results of the hypothesis test analysis, which yielded a t-count of 7.367 and a t-table value of 1.688. Because t-count ≥ t-table according to the Ho rejection area, Ha was accepted. It can be concluded that the STEM model has a significant influence on students' scientific literacy and numeracy skills, as the average value of scientific literacy and numeracy skills taught through the STEM learning model is higher than those taught through the conventional learning model.

Permanasari (2024) stated that STEM has a positive influence on students' scientific literacy. STEM helps students understand the concept of science and its connection to everyday life, which is a key aspect of scientific literacy (Yuliardi & Dahlan, 2022). Furthermore, Dasgupta et al. (2019) argue that STEM equips students with scientific literacy skills, which are reflected in their ability to read, write, observe, and carry out scientific practices. These skills are important capital for them to interact in society and solve everyday problems.

The study by Yatin et al. (2023) also showed that the average value of numeracy skills for students taught using the STEM learning model was higher than that for students taught using the conventional learning model. In STEM learning, students not only learn numbers and formulas abstractly, but they also see how mathematics is used as a tool to understand and solve problems in everyday life (Li et al., 2020). STEM often involves the use of various measuring instruments, data analysis software, and other technologies. Practical experience with these tools enhances students' understanding of measurement, data representation, and the interpretation of numerical results, which are key aspects of numeracy skills (Herman et al., 2024).

## Conclusions

Based on the t-test analysis, the calculated t-value is 7.367, which is greater than the t-table value of 1.688. Therefore, Ha is accepted and Ho is rejected. This study concludes that the STEM model has a significant influence on students' scientific literacy and numeracy abilities regarding the reaction rate material.

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## References

Amahoroe, R. A., Arifin, M., & Solihin, H. (2020). Penerapan desain praktikum berbasis STEM pada pembuatan tempe dari fermentasi biji nangka (*artocarpus heterophyllus*) untuk meningkatkan literasi sains siswa SMK. *Molluca Journal of Chemistry Education (MJoCE)*, *10*(2), 89-100.

Amarlita, D. M. (2023). Penerapan pendekatan STEM pada materi laju reaksi siswa kelas XI. *Journal on Education*, *5*(2), 4349–4353.

Astuti, W., Sulastri, S., Syukri, M., & Halim, A. (2023). Implementasi pendekatan science, technology, engineering, and mathematics untuk meningkatkan kemampuan literasi sains dan kreativitas siswa. *Jurnal Pendidikan Sains Indonesia*, *11*(1), 25–39.

Aristawati, I. V. A. (2022). Model project based learning sebagai upaya peningkatan konsentrasi, kemampuan literasi numerasi dan literasi sains siswa SMK. *Jurnal Thalaba Pendidikan Indonesia*, *5*(2), 80-91.

Dasgupta, C., Magana, A. J., & Vieira, C. (2019). Investigating the affordances of a CAD-

enabled learning environment for promoting integrated STEM learning. *Computers & Education*, *129*(February), 122- 142.

Diana, H. A., & Saputri, S. (2021). model project based learning terintegrasi steam terhadap kecerdasan emosional dan kemampuan berpikir kritis siswa berbasis soal numerasi. *Numeracy, 8*(2), 113-127.

Herman, T., Akbar, A., Farokhah, L., Febriandi, R., Zahrah, R. F., Febriani, W. D., & Abidin, Z. (2024). *Kecakapan abad 21: Literasi matematis, berpikir matematis, dan berpikir komputasi*. Bandung: Indonesia Emas Group.

Hijjayati, Z., Makki, M., & Oktaviyanti, I. (2022). Analisis faktor penyebab rendahnya kemampuan literasi baca-tulis siswa kelas 3 di SDN Sapit. *Jurnal Ilmiah Profesi Pendidikan*, *7*(3b), 1435-1443.

Irmawati, I., Syahmani, S., & Yulinda, R. (2021). Pengembangan modul IPA pada materi sistem organ dan organisme berbasis STEM-inkuiri untuk meningkatkan literasi sains. *Journal of Mathematics Science and Computer Education, 1*(2), 64-73.

Li, Y., Wang, K., Xiao, Y., & Froyd, J. E. (2020). Research and trends in STEM education: A systematic review of journal publications. *International Journal of STEM Education*, *7*(March), 1–16.

Nurfadillah, T., Elvia, R., & Elvinawati. (2023). Pengembangan instrumen tes kimia berbasis literasi sains untuk mengukur literasi siswa. *ALOTROP Jurnal Pendidikan dan Ilmu Kimia, 7*(1), 44-56.

Nurhayati, N., Asrin, A., & Dewi, N. K. (2022). Analisis kemampuan numerasi siswa kelas tinggi dalam penyelesaian soal pada materi geometri di SDN 1 Teniga. *Jurnal Ilmiah Profesi Pendidikan*, *7*(2b), 723-731.

OECD. (2023). PISA 2018 Assessment and Analytical Framework. In OECD, PISA *2018 Science Framework* (pp. 97–117). Paris: OECD Publishing.

Permanasari, A. (2024). STEM education: Inovasi dalam pembelajaran sains. *Prosiding Seminar Nasional Pendidikan Sains (SNPS) 2016* (pp 23-34). Surakarta: Universitas Sebelas Maret.

Sakti, S., Fatah, A. H., & Anggraeni, M. E. (2020). Analisis materi ajar konsep laju reaksi pada buku teks kimia SMA/MA. *Jurnal Ilmiah Kanderang Tingang*, *11*(1), 78-91.

Starzinski, A. (2017). *Foundational elements of a STEAM learning model for Elementary School.* Unpublished master's thesis. Minnesota: Hamline University.

Sugiharti, G., & Anugrah, A. N. (2023). The influence of problem-based-learning models and macromedia flash to increase chemistry learning activities and results. *European Chemical Bulletin*, *12*(6), 146-158.

Sugiharti, G., Dalimunthe, M., & Anugrah, A. N. (2025). Effectiveness of implementing problem-based learning modules to improve students' science literacy and higher-order thinking. *Journal of Posthumanism*, *5*(3), 899-905.

Sugiharti, G., & Zen, Y. (2020). Perbedaan hasil belajar siswa dengan model pembelajaran *problem based learning* (PBL) dan inkuiri terbimbing menggunakan media courselab pada materi struktur atom. *Jurnal Penelitian Bidang Pendidikan*, *26*(1), 1-8.

Sugiyono. (2021). *Metode penelitian kuantitatif, kualitatif dan R&D*. Bandung: Alfabeta.

Sustina, Y. (2023). Pengembangan profesi pendidik di era society 5.0, dinas keperpustakaan dan kearsipan provinsi Banten. *Retrieved January 3, 2025, from Web site: https://dpk.bantenprov.go.id/Layanan/topic/516,24/02/2023.*

Yatin, Y., Abidin, Z., & Arip, A. G. (2023). Pengembangan e-modul berbasis STEM dengan media canva untuk meningkatkan literasi sains dan numerasi siswa SMP. *Jurnal Ilmiah Wahana Pendidikan*, *9*(22), 888-903.

Yerimadesi, Y., & Afendi, S. (2024). Pengembangan modul laju reaksi berbasis *problem based learning* terintegrasi TPACK untuk fase F. *Jurnal Ilmiah Profesi Pendidikan, 9*(1), 426-432.

Yuliardi, R., & Dahlan, J. A. (2022). STEM highlights: Principles, frameworks, and implementation strategies in improving scientific literacy. *International Journal on Emerging Mathematics Education (IJEME)*, *6*(2), 119–130.

Yusuf, I., Ma'rufi, & Nurdin. (2022). Pendekatan STEM untuk meningkatkan kemampuan berpikir kritis dan motivasi belajar siswa pada pembelajaran matematika. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika, 2*(1), 26 – 40.

Zulanwari, Z. A. Z., Ramdani, A., & Bahri, S. (2023). Analisis kemampuan literasi sains siswa SMA terhadap soal–soal PISA pada materi virus dan bakteri. *Journal of Classroom Action Research, 5*(May), 210–216.