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The Effectiveness of Using Chemistry Literacy-Based Learning Videos on the Problem-Solving Ability of Grade X Students at SMA Negeri 16 Batam

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Abstract: Low understanding of subject matter, particularly in chemistry—especially in aspects of chemical literacy such as conceptual knowledge, contextual understanding, and higher-order thinking skills (HOTS)—combined with students' limited problem-solving skills, has resulted in poor learning outcomes at SMA Negeri 16 Batam. Another contributing factor is the limited use of instructional media that supports real-life skill development. This study aimed to determine the effectiveness of chemistry literacy-based learning videos in improving the problem-solving abilities of Grade X students. The research employed a quasi-experimental method with a nonequivalent control group design. The sample consisted of two purposively selected classes: an experimental group taught using chemistry literacy-based videos and a control group using PowerPoint media. Research instruments included a chemical literacy test and a problem-solving skills test. Data were analyzed using an independent t-test to compare group results and an N-Gain test to evaluate treatment effectiveness. Findings revealed that the use of chemistry literacy-based videos significantly enhanced students' chemical literacy, problem-solving skills, and overall learning outcomes compared to the control group. The N-Gain value of 73% categorized the intervention as moderately effective. Thus, chemistry literacy-based videos are effective instructional media for improving the quality of chemistry learning at the senior high school level.

Keywords: Chemistry literacy; Effectiveness learning videos; Grade X students; SMA Negeri 16 Batam; Problem-solving ability

Introduction

Education in the 21st century is no longer limited to the transfer of knowledge but is directed toward the development of competencies that prepare students to face global challenges. One of the essential competencies emphasized in science education is scientific literacy, which covers not only the understanding of theoretical concepts but also the ability to apply them in real-world contexts. For chemistry learning, this literacy is translated into chemical literacy, which is a combination of conceptual knowledge, contextual application, and problem-solving ability that allows students to make informed decisions in their everyday lives (Mashami et al., 2025).

According to Millenia et al. (2022), science literacy is an approach that goes beyond memorization of theories. It promotes deeper understanding, critical thinking, and the ability to apply principles in varied situations. The demand for scientific literacy is

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increasingly urgent in the era of rapid technological change, where students are expected to become not only consumers of information but also active problem solvers and contributors to society. Without this competence, students risk being left behind in a world dominated by innovation and global competition.

Indonesia's performance in the Program for International Student Assessment (PISA) illustrates the severity of this challenge. PISA, organized by the OECD, measures the literacy levels of 15-year-old students worldwide, focusing on reading, mathematics, and science. In the 2022 PISA results, Indonesia ranked 69th out of 80 countries, with a science literacy score of 383—lower than the previous cycle in 2018 (Hanifah et al., 2024). This decline signals a systemic problem in how science, particularly chemistry, is taught and learned in schools.

The low score reflects that most Indonesian students are unable to achieve the minimum competency level required to apply science in real-life contexts. This gap suggests that teaching has largely remained theoretical and exam-oriented, with limited emphasis on practical skills, contextual understanding, and higher-order thinking. In fact, Shaw et al. (2021) emphasize that mentoring and effective teaching strategies are crucial in building science literacy, a perspective also supported by Shaleha et al. (2022).

Chemistry literacy, as part of science literacy, becomes even more significant because chemistry is often perceived as one of the most difficult subjects in high school. Students struggle with its abstract concepts, complex symbols, and sequentially structured knowledge. Shwartz et al., as cited in Imaduddin et al. (2019), classify chemical literacy into four aspects: content knowledge, context application, higher-level cognitive skills, and affective aspects. Mastery of these four components is essential to prepare students for advanced study and real-world application.

Despite the emphasis on literacy, many students in Indonesia still find chemistry difficult to grasp. Research by Norjana et al. (2016) showed that students' understanding of the Basic Laws of Chemistry is relatively low, with average scores of only 48.15. Laliyo et al. (2020) further highlight that the abstract nature of this material often prevents students from connecting chemical principles with real-life phenomena, thereby limiting both conceptual mastery and motivation.

The challenges are compounded by students' declining interest in chemistry as a subject. Accraf et al. (2019) found that many students approach chemistry passively, relying heavily on rote memorization and failing to engage with its practical applications. This lack of engagement not only reduces comprehension but also prevents the development of crucial 21st-century skills such as problem-solving and critical thinking.

At the same time, teaching practices remain dominated by conventional methods, such as lectures and the use of static media like textbooks or PowerPoint slides. These methods are insufficient to address the abstractness of chemical concepts or to encourage active student participation. When learning is limited to verbal explanations, students often perceive the subject as monotonous and detached from their daily lives, further reinforcing negative attitudes toward chemistry.

Learning media play a vital role in bridging the gap between abstract concepts and students' everyday experiences. Well-designed media can make invisible processes more tangible, increase student engagement, and support different learning styles. For chemistry, audiovisual media such as videos are particularly powerful because they combine visual and auditory elements to present concepts systematically and dynamically (Asnur et al., 2025).

Videos allow educators to illustrate processes such as chemical reactions, which cannot always be directly observed in a school laboratory due to limitations of time, equipment, or safety. Moreover, videos can be replayed, paused, and reviewed, offering flexibility for students to learn at their own pace. This interactive feature makes them superior to static media and highly aligned with the principle of self-directed learning promoted by the Merdeka Curriculum.

Research supports the effectiveness of video-based learning. Abidah (2024) note that videos improve efficiency in material delivery, particularly for subjects requiring both conceptual and procedural understanding. The integration of sound and visuals helps students retain information better, focus longer, and develop a stronger connection between theoretical knowledge and practical application.

In chemistry, video-based media can also enhance students' problem-solving abilities. Problem-solving in this context refers to the process of identifying a problem, analyzing variables, and applying appropriate strategies to reach a solution. According to Sidiq et al (2022), effective problem solving requires systematic description, planning, execution, and evaluation of solutions. Videos can support this process by presenting problems in contextualized scenarios that mirror real-life situations.

Tanjung (2018) identifies four indicators of problem-solving skills: understanding the problem, planning a solution, executing the plan, and applying relevant concepts. Learning videos provide a platform for students to observe these steps in action and to practice them independently. By allowing repetition and control over pace, videos give learners more opportunities to refine their skills and internalize strategies.

The uniqueness of this research lies in combining chemical literacy and problem-solving as dual outcomes of a single intervention: chemistry literacy-based learning videos. While previous studies often focused on either improving content understanding or enhancing problem-solving skills separately, this research explicitly integrates both dimensions. The study positions video media not just as a supplementary tool but as a central medium to transform how chemistry is learned (Taali et al., 2024).

Verbal knowledge Government Regulation (2010) the importance of this research also stems from alignment with the Merdeka Curriculum, which emphasizes independent, contextual, and skill-oriented learning. Sherly et al. (2021) argue that students and teachers need greater autonomy to innovate, explore, and learn creatively. By using chemistry literacy-based videos, educators can foster an environment where students actively construct knowledge, rather than passively receive it.

This innovation also addresses a broader national concern: the mismatch between school graduates' skills and labor market demands. As Yaumi et al. (2018) highlights, many graduates are unable to compete in the job market due to insufficient preparation in critical, creative, and problem-solving competencies. Chemistry literacy-based videos contribute to closing this gap by nurturing transferable skills that are valuable beyond the classroom.

The rapid advancement of digital technology provides further rationale for adopting video-based media in schools. Students today are digital natives, accustomed to accessing information through multimedia platforms. Ignoring this reality risks creating a disconnect between how students learn outside school and how they are taught inside school. Integrating videos into chemistry instruction capitalizes on students' familiarity with digital tools, making learning more relevant and engaging.

Another reason this research is crucial is that it responds to the diversity of learning styles among students. As Chania et al. (2017) note, some students are visual learners, while others are auditory. Videos cater to both groups simultaneously, ensuring inclusivity and enhancing the potential for meaningful learning outcomes. This is especially relevant in classrooms where students' backgrounds, abilities, and preferences are highly heterogeneous.

Field interviews at SMA Negeri 16 Batam further confirm the urgency of this intervention. Students reported difficulties in understanding chemistry due to limited instructional time, conventional teaching methods, and lack of resources such as textbooks. These constraints highlight the need for more efficient and accessible learning media that can supplement classroom teaching and support independent learning.

The incorporation of Quantum Learning principles into video-based instruction adds another layer of uniqueness to this study. Quantum Learning emphasizes freedom, enjoyment, and engagement in the learning process (Oktoviana et al., 2017). By embedding these principles into e-modules or videos, educators can transform students' perceptions of chemistry from a difficult subject into an enjoyable and rewarding experience, ultimately enhancing motivation and retention.

In conclusion, this research is important because it directly addresses multiple pressing issues: Indonesia's low performance in science literacy, the inherent difficulty of chemistry as a subject, students' weak problem-solving skills, and the limited use of innovative learning media. By integrating chemical literacy with problem-solving through video-based instruction, this study offers a unique and timely contribution to educational practice. It not only supports the goals of the Merdeka Curriculum but also equips students with the competencies they need to thrive in a globalized, technology-driven world.

Quantum Learning, according to DePorter et al. (2015), is a learning model that has the ability to improve students' understanding, enhance their ability to remember, and give them an understanding that learning is a fun and rewarding process. According to the statement Huda et al. (2013), Quantum Learning is also a learning model that combines various positive effects and interactions with the learning environment, which impacts the learning process and students' motivation. If lessons are delivered in an enjoyable manner and in a supportive environment, students will find it easier to absorb the material. Quantum Learning is a learning model that adapts every plan, method, and learning activity to the students' learning environment. This can motivate and improve students' performance.

Method

This study adopts a quantitative approach with an experimental method based on positivism philosophy. This approach is applied to analyze a predetermined population or sample through a prepared research instrument. The collected data is then analyzed using statistical techniques to test the established hypothesis. This study uses a quasi-experimental design with a nonequivalent control group design, in which the selection of the experimental and control groups is not done randomly. Quasi-experimental design was chosen because it is not possible to randomize participants into experimental and control groups since the classes have already been formed naturally, so the researchers used the existing classes as the treatment and control groups. The researcher can still test the effect of a treatment without having to change the existing structure or system. All participants can still benefit, while the impact is still being evaluated.

The purpose of this study was to assess the impact of using literacy-based chemistry learning videos on the problem-solving abilities of tenth-grade students at SMA Negeri 16 Batam. This study involved two sample groups, namely the experimental group and the control group. The experimental group was given treatment in the form of the use of video learning media that focused on the subject of Basic Chemistry Laws, while the control group followed the learning process using student textbooks and PowerPoint presentations that discussed the same subject, namely Basic Chemistry Laws. The design of this research can be described as follows:

Table 1. Normality Test of Pre-test and Post-test Data of Experimental and Control Classes

Group	Pretest	Perlakuan	Posttest
Experimental	O1	X1	O2
Control	O3	X2	O4

Description: O_1 = Pretest for the experimental and control groups; O_2 = Final test (posttest) for the experimental and control groups; X_1 = Treatment using chemistry literacy-based video media for the experimental group; X_2 = Treatment using PPT for the control group.

Data collection methods are procedures used to obtain relevant information in research. In this research and development study, data was collected through a test approach. Tests as a data collection method are evaluation techniques involving a series of questions designed to measure various aspects, such as skills, knowledge, intelligence, abilities, or talents of individuals. The data collection method in this study was conducted by administering tests to students, including chemistry literacy tests and problem-solving ability tests. Data was collected through the administration of pre-tests and post-tests to two research groups, namely the experimental group and the control group. The instruments used in this process consisted of essay-type and multiple-choice questions, designed to assess students' understanding and skills comprehensively in various aspects relevant to the research focus.

Result and Discussion

Result

The instruments used in this study underwent a series of testing procedures to ensure their quality and consistency. The tests carried out were validity tests by experts. Further details regarding the instruments used in this study are presented as follows.

Table 2. Results of Problem Solving Instrument Reliability Testing Reliability Statistics

Cronbach's Alpha	N of Items
.753	3
.774	3

Based on the table above, Cronbach's Alpha value is 0.774, which is > 0.70, so the instrument is considered reliable with high criteria.

This study will analyze data related to chemical literacy skills, problem-solving skills, and learning outcomes by utilizing data obtained through pretest and posttest completion related to chemical literacy, problem-solving skills, and student learning outcomes. The collected data will be analyzed to evaluate the level of improvement in students' ability to solve mathematical problems through the use of instructional videos. The analysis process will include statistical tests such as normality tests, homogeneity tests, N-Gain tests, and t-tests:

Table 3. N-Gain Effectiveness Interpretation Categories

n-Gain (g)	Interpretation
$g > 0.7$	Height
$0.3 < g \leq 0.7$	Currently
$g \leq 0.3$	Low

Table 4. Normality test of Experimental Class and Control Class Pre-test and Post-test

Independent Samples normality		
Class	Kolmogorov-Smirnov	Shapiro-Wilk
	Sig.	Sig.
Pretest Experimental	0.200	0.200
Pretest Control	0.085	0.269
Pretest Experimental	0.001	0.916
etest Control	0.003	0.025

Based on the results of the above test, it is known that the significance value of the pre-test problem solving in the experimental class is 0.200, which means $> \alpha = 0.05$, and likewise for the control class, which is 0.085, which means $> \alpha = 0.05$, so the data is declared to be normally distributed. Then, the posttest results from the experimental class have a significance value of <.001 and the posttest results from the control class are also 0.003. These significance values are $< \alpha = 0.05$, so the posttest data from the experimental class is declared to be not normally distributed. Therefore, it can be concluded that the problem-solving data from the experimental class and the control class are not normally distributed.

Table 5. Homogeneity test of the Experimental Class and Control Class Pre-test and Post-test

Independent Samples Homogeneity		
Experimental Class and Control	Levene Statistic	Sig.
Based on Mean	1.341	0.251
Based on Mean	1.207	0.276
Based on Median and with adjusted df	1.207	0.276
Based on trimmed mean	1.327	0.253

Based on the test results above, the significance value of the learning outcomes of the experimental and control classes is 0.251. This value is greater than α > μ = 0.05, so it can be concluded that the learning outcome data obtained from the control and experimental classes are homogeneous. Next, a homogeneity test was conducted on the chemical literacy and problem-solving tests. The following are the results of the homogeneity test for the chemical literacy test.

From the results of the previous normality test, Table 4. shows that the significance value of the problem-solving data is <0.05, indicating that the data is not normally distributed. Therefore, the proposed hypothesis was tested using the Mann-Whitney Test (U-Test). This non-parametric statistical test is applied when the data does not meet parametric assumptions, such as normal distribution and homogeneity of variance. The Mann-Whitney test is used to determine whether there is a significant difference between two independent samples. It serves as an alternative to the parametric t-test, with the commonly used significance level (α) of 5% (0.05).

The following presents the results of the Mann-Whitney test, which was conducted to analyze problem-solving skills tests, which aimed to evaluate significant differences between the tested groups.

Table 6. Mann Whitney Problem Solving Test Results

Solution to problem		
Mann-Whitney U	306.500	0.251
Wilcoxon W	972.500	0.276
Z	-3.657	0.276
Asymp. Sig.	<,001	0.253

Based on the results of the Mann-Whitney test, a significance value of <0.001 was obtained. Because this significance value is less than <0.05, the null hypothesis α0 is rejected. Rejection of α0 means that the alternative hypothesis α2 is accepted. In other words, these results indicate a significant effect of the use of chemical literacy-based videos on students' problem-solving skills in the basic laws of chemistry topic in grade 10 of SMAN 16 Batam.

Table 7. Independent T-Test Results of Learning Outcomes

Independent Samples T-Test				
Experimental Class and Control		Sig.	t	Sig. (2tailed)
Learning outcomes	Equal variances assumed Equal variances not assumed	0.251	-2.408 -2.394	0.019 0.020

Based on the results of the t-test, a significance value of 0.019 was obtained. Because this significance value is less than <0.05, the null hypothesis α is rejected. Rejection of α indicates that the alternative hypothesis α is accepted. In other words, the results of this test indicate a significant effect of the use of chemical literacy-based videos on student learning outcomes in the basic laws of chemistry material in grade 10 of SMAN 16 Batam. This means that the use of chemical literacy-based videos effectively influences student learning outcomes in the context of learning the basic laws of chemistry material in that class.

Discussion

The findings of this study indicate that the use of chemistry literacy-based videossignificantly improves student learning outcomes.This improvement can be observed from the learning outcome test scores before and after thetreatment, where there is a statistically significant difference. Thisindicates that the use of video media integrated with elements ofchemistry literacy can support conceptual understanding and improvestudents' overall learning achievement. Based on the results of the t-testthat was conducted, a significance value of 0.019 was obtained. Because thissignificance value is less than < 0.05, the null hypothesis *H*0 is rejected.The rejection of H0 indicates that the alternative hypothesis H1 is accepted.In other words, the results of this test indicate that there is a significant effect of the use of chemistry literacy-based videos on student learning outcomesin basic chemistry material in class X at SMAN 16 Batam.

Conclusion

The results of the analysis show that the chemical literacy skills of 10th grade students at SMAN 16 Batam are significantly higher in classes that use chemistry literacy-based videos than in classes that use PowerPoint (PPT) media, based on the Independent t-test. In addition, students' problem-solving skills are also significantly higher in classes that use chemistry literacy-based videos, according to the results of the Mann-Whitney analysis. Similarly, the learning outcomes of tenth-grade students showed a significant improvement in classes that used chemistry literacy-based videos compared to classes that used PowerPoint (PPT), based on the Independent t-test analysis.

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Author Contributions

Conceptualization and methodology, H. L. B.; software, validation, formal analysis, and investigation, H. L. B. and A.; data curation, H. L. B. and A.; writing—original draft preparation, H. L. B., A. and R.; writing—review and editing, R.

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Conflicts of Interest

There is no conflict of interest.

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