Jurnal Zarah
Vol. 14 No.1 (April 2026)
Halaman 1–11
p-ISSN: 2354-7162 | e-ISSN: 2549-2217
Available online at https://ojs.umrah.ac.id/index.php/zarah/index
DOI: 10.31629/zarah.v14i1.7821

THE EFFECTIVENESS OF A LOCAL WISDOM BASED E-MODULE ON CHEMICAL KINETICS TOWARD STUDENTS' CONCEPTUAL UNDERSTANDING AND COLLABORATION SKILLS

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Abstract

This study aimed to develop and evaluate a local wisdom-based e-module on chemical kinetics integrating the Malay cultural context of Kepurun from Daik Lingga. The research employed a pre-experimental design, specifically the one-group pretest-posttest design, to examine the effect of e-module on students learning outcomes. The e-module was created using the Canva platform and tested through a One-Group Pretest–Posttest design involving 26 eleventh-grade students at SMA Negeri 1 Lingga. Data were collected using a conceptual understanding test and a collaborative skills observation sheet, then analyzed using the normality test, paired sample t-test, effect size Cohen's d and N-Gain score. The results showed that the data were normally distributed ($p > 0.05$) and there was a significant difference between pretest and posttest scores ($p < 0.05$). The N-Gain scores for conceptual understanding (0.72) were categorized as high and moderate, respectively. The observation was conducted by a teacher to determine the level of students' collaboration skills. These findings indicate that the developed e-module is valid, practical, and effective in enhancing students' conceptual understanding and collaborative skills through interactive and culturally relevant digital learning.

Keywords: e-Module, Conceptual Understanding, Collaboration Skills, Chemical Kinetics, Local Wisdom

INTRODUCTION

The demands of 21st-century education require students to develop higher-order cognitive skills, particularly conceptual understanding, along with collaborative abilities that form a fundamental aspect of essential soft skills. This educational paradigm shift underscores the importance of designing innovative learning materials such as electronic modules (e-modules) that incorporate elements of local wisdom to promote relevant and meaningful learning experiences (Rukmana et al., 2024). The integration of online-based media has also proven to be highly advantageous in supporting the effectiveness of distance learning (Kurmalasari, 2022). In the context of chemistry education, particularly in the study of reaction kinetics, the use of e-modules is anticipated to overcome challenges associated with students' difficulties in understanding abstract and complex scientific concepts. Moreover, such digital learning resources are expected to foster the development of 21st-century competencies, including creativity, collaboration, critical thinking, and communication skills (Yupeni et al., 2025).

Recent educational assessments at SMA Negeri 1 Lingga revealed that students' average achievement in the topic of Chemical Kinetics remains considerably low, with a mean score of only 45 well below the established Minimum Mastery Criterion (KKM). This condition highlights the urgent need for innovation in instructional strategies to strengthen students' conceptual understanding while simultaneously nurturing collaboration skills as part of essential 21st-century competencies (Siregar et al., 2022). Based on the aforementioned gap between the required 21st-century competencies and the current low student achievements at SMA Negeri 1 Lingga, it is concluded that a more contextual and interactive approach is necessary.

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Therefore, the present study aims to design and evaluate a local wisdom-based e-module on chemical kinetics as a solution to enhance students' conceptual understanding and collaborative competence.

The persistent low achievement levels are mainly associated with the continued use of traditional teaching methods and the lack of interactive, contextual learning materials. Moreover, the limited incorporation of local cultural values into chemistry instruction has further reduced students' engagement and contextual relevance in learning activities (Puspita & Azizah, 2024). The unavailability of electronic modules that meaningfully integrate local wisdom into chemistry learning has become a critical barrier to the creation of deep, reflective, and meaningful learning experiences (Septiandari, D., & Kartikasari, R. D., 2025). To bridge this gap, the current research develops a local wisdom-based e-module rooted in the Malay Daik Lingga tradition known as "Kepurun," utilizing the Canva platform as its primary medium. This e-module is expected to enhance students' conceptual mastery and collaboration skills through contextually relevant and interactive digital learning experiences (Zulfadli et al., 2023).

Integrating cultural contexts within digital learning materials can serve as a pedagogical bridge between abstract scientific concepts and students' everyday realities. Such contextualization has the potential to significantly improve both conceptual comprehension and collaborative learning capacities. Previous empirical studies have confirmed that e-modules are valid and effective learning tools that not only improve motivation and overcome learning challenges but are also adaptable for diverse learners, including those with special educational needs (Sanjoyo et al., 2023). Furthermore, digital e-modules have been shown to strengthen computational thinking skills (Haryanti et al., 2023) and foster student-centered learning environments that shift instructional focus from teachers to learners (Rukmana et al., 2024).

The development of e-modules has become increasingly crucial in providing innovative learning materials that align with current digital technological advancements, enabling greater flexibility and accessibility for students in the learning process (Prinesia Togatorop et al., 2025). These digital learning resources are not limited to digitized print materials but also encompass audiovisual content and integrated technologies that comprehensively support teaching and learning activities (Rukmana et al., 2024). The utilization of digital media platforms, such as Canva, in developing science learning materials, including e-modules, has been proven effective in enhancing students' conceptual understanding (Purnomo et al., 2025).

Moreover, e-modules function as alternative learning media that complement instructional activities, particularly in integrating local wisdom to promote cultural literacy and students' critical thinking skills (Wahyudi et al., 2025). Interactive e-modules allow the incorporation of graphics, animations, music, or videos, making them more appealing to learners who are familiar with technology (Rukmana et al., 2024). A learning module is defined as a self-contained, complete, and systematically structured learning material whether in print or digital form designed to facilitate independent learning (Najuah et al., 2020).

The evolution of learning modules into electronic modules (e-modules) has transformed them into more interactive, adaptive, and easily accessible media through digital devices such as smartphones, in accordance with the demands of 21st-century learning. The e-module developed in this study utilizes the Canva platform as its main tool. The use of this platform enables the integration of various multimedia elements that support interactive and visually engaging learning (Samad et al., 2023). The growing awareness among teachers regarding the importance of technology-based learning media has led to a decreased reliance on conventional instructional materials (Nevrita et al., 2020). The integration of local wisdom elements, such as folklore and traditional stories, can also enrich e-modules, making them more relevant and attractive to students (Septiandari, D., & Kartikasari, R. D., 2025).

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Interactive learning through e-modules has also been proven effective in increasing students' learning interest and enjoyment, while simultaneously fostering the development of student-centered learning systems (Rukmana et al., 2024). E-modules, or electronic modules, serve as digital learning tools that incorporate textual, visual, animated, procedural, assessment, graphical, and video-based content. These materials can be accessed and studied anytime and anywhere through electronic devices, thereby supporting flexible, independent, and engaging learning experiences.

Conceptual understanding forms the foundation of cognitive competence, encompassing more than the simple recall of facts or information. It refers to the learner's ability to construct meaning, explain relationships among ideas, and apply knowledge flexibly in a variety of contexts (Yunuka, 2016). Students who demonstrate conceptual understanding are able to connect prior knowledge with new information, interpret abstract principles, and utilize these connections to solve novel and unfamiliar problems.

Bloom's taxonomy identifies three key dimensions of conceptual understanding: translation, interpretation, and extrapolation (Simorangkir & Sinaga, 2022). *Translation* involves transforming abstract ideas into tangible or real-world examples and expressing concepts through alternative representations such as definitions, illustrations, or restatements. *Interpretation* emphasizes the comprehension of key ideas presented in various forms of communication such as graphs, tables, diagrams, or visual data and the ability to convey their meaning accurately. Meanwhile, *extrapolation* refers to the capacity to infer or predict outcomes based on existing information, encompassing skills such as estimation, reasoning, differentiation, and synthesis.

In the context of chemical kinetics, conceptual understanding requires students to grasp fundamental principles such as factors affecting reaction rates, reaction order, and activation energy. Learners who have attained conceptual understanding can define and reinterpret key concepts, articulate interrelationships among variables, and synthesize their understanding into coherent explanations. This depth of comprehension enables students to not only recall scientific facts but also to apply their conceptual frameworks in analyzing and solving real-world chemical problems.

Collaboration skills are essential competencies in the 21st century (Trilling & Fadel, 2009), encompassing the ability to interact, share ideas, take responsibility, and work together in groups to achieve common goals. These skills are often assessed using observation rubrics while students are engaged in project-based tasks. In the context of chemistry learning, collaboration allows students to discuss, express arguments, and solve complex problems together, thereby deepening their understanding of chemical concepts (Sugiarni et al., 2024).

The assessment of collaboration includes indicators such as communication, social interdependence, cooperation and task distribution, resource sharing, conflict resolution, and problem-solving. The objectives of collaborative learning include defining team roles, providing mutual support, showing respect, developing empathy, accepting group member differences, listening attentively, maintaining effective communication, building friendships, and being able to provide explanations (Child & Shaw, 2018).

Griffin (2017) categorizes three dimensions of collaboration in problem solving: participation, perspective taking, and social regulation. Participation involves action, interaction, and task completion, while perspective taking encompasses adaptive responses and awareness in listening. Social regulation includes negotiation, self-evaluation, transactive memory, and efforts to maintain responsibility. The key aspects in assessing students' collaborative skills are communication ability, cooperation ability, commitment, and task completion skills.

Etymologically, *local wisdom* consists of two words: *wisdom* and *local*. Local wisdom can also be referred to as *local knowledge*, *local policy*, or *local genius*. According to Njatrijani

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(2018), local wisdom refers to a way of life, a body of knowledge, and a set of life strategies used by local communities to solve problems and meet their daily needs.

The one example of local wisdom is traditional Malay cuisine from the Riau Islands, namely *Kepurun* (Suhadi, 2021). *Kepurun* is a traditional sago porridge typical of the Malay community in Lingga, known not only as a daily dish but also as an inherited cultural expression of local wisdom. In their book *Warisan Budaya Tak Benda Tradisi dan Budaya Melayu Lingga Bunda Tanah Melayu Tahun 2019*, (Swastiwi, 2019) state that *Kepurun* is one of the traditional foods of Lingga Regency, made from sago and served with seasoned broth.

According to Andi et al. (2023), truths that have become traditions and have been continuously practiced in a particular region while carrying significant values for life, are referred to as local wisdom. Integrating local wisdom into learning is essential, as it fosters an appreciation and love for the surrounding environment (Shufa, 2018). When incorporated into the learning process, local wisdom can cultivate students' affection for their region and enable them to apply school knowledge to real-life contexts.

METHODS

The research employed a pre-experimental design, specifically the one-group pretest-posttest design. This approach was used to examine the effect of the e-module on students' learning outcomes.

Table 1. Research Design of the One Group Pretest–Posttest Design

Group	Pretest	Treatment	Posttest
Experimental	Q_1	X	Q_2

Description:
Q_1 : Initial test (*pretest*) conducted before treatment
X : Treatment using the *local wisdom-based e-module*
Q_2 : Final test (*posttest*) conducted after treatment

This study utilized test instruments and observation sheets. The test consisted of 20 multiple-choice questions that had been validated for both the pretest and posttest. The test was designed to measure students' conceptual understanding. Observation sheets were used by a teacher to assess students' collaboration skills before and during the implementation of the *e-module* in the learning process.

The multiple-choice questions were used to evaluate students' conceptual understanding of the *chemical kinetics* topic. The development of these questions followed a specification grid (blueprint) presented in the subsequent Table 2.

Table 2. Blueprint of Pretest and Posttest Questions

No	Aspect Assessed	Indicator	Number of items	Cognitive Level
1	Conceptual Understanding	Identifying effective collisions	2	C2 C3
		Explaining the relationship between reaction rate and collision theory	4	C2 C4 C5
		Explaining the relationship between surface area and collisions affecting the reaction rate	5	C2 C3 C4 C5
		Predicting the rate of two reactions with different temperatures	4	C2 C3 C4 C5
		Explaining the reason	5	C4 C5

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No	Aspect Assessed	Indicator	Number of items	Cognitive Level
		why the reaction rate increases when the temperature is raised		

Source: Adapted and modified from Kemdikbudristek (2022) and Haris (2023)
Remarks : C2 (Understanding), C3 (Applying) C4 (Analyzing), C5 (Evaluating).

To identify students' collaboration skills based on each developed indicator, the researcher designed an instrument on collaboration skills consisting of seven statement indicators with four response criteria at Table 3.

Table 3. Blueprint of the Collaboration Skills Instrument

No	Aspect Assessed	Indicator
1	Cooperation	Reminding peers when they have not completed their tasks
2	Effective Communication	Completing and attending group assignments (active participation in discussions)
3	Commitment and Responsibility	Expressing opinions Completing tasks on time
4	Collaborative Problem Solving	Working together to solve problems encountered during learning activities
5	Working Productively	Actively participating in group presentations Searching for relevant information sources

Source: Adapted and modified from (Coufal, K. L., & Woods, 2018) and (Griffin, 2017).

Table 4. Likert Scale Criteria for Observing Students' Collaboration Skills

No	Assessment Criteria	Score
1	Strongly Agree	4
2	Agree	3
3	Disagree	2
4	Strongly Disagree	1

Source : Sugiyono (2015)

The level of students' conceptual mastery was determined by analyzing their posttest and pretest outcomes, with the scores calculated based on the following formula:

$$Score = \frac{Knowledge\ Score}{Maximum\ Score} \times 100$$

The types of data used in this development research consist of quantitative and qualitative data. Quantitative data were obtained from the effectiveness tests of students' conceptual understanding and collaborative skills. Meanwhile, qualitative data were collected in the form of descriptions, suggestions, and feedback derived from observer observations. The data analysis technique employed was descriptive analysis to describe the mean scores.

Effectiveness Testing Procedure

The results of the pretest and posttest, as well as observation scores before and during the use of the e-module in the effectiveness test, were analyzed using normality tests, paired sample *t*-tests, and N-gain analysis with the aid of SPSS Statistics 25.0 for Windows.

The normality test was conducted on the pre-test and post-test data using the SPSS Statistics 25.0 for Windows program. Based on the data analysis, if the significance value is below 0.05, it indicates that the tested data have a significant difference from the standard normal data, meaning that the data are not normally distributed. Conversely, if the significance value is above 0.05, it means that there is no significant difference between the tested data and the standard normal data, indicating that the data are normally distributed.

For the standard normal:

$$Cohen's\ d = \sqrt{\frac{SD_1^2 + SD_2^2}{2}}$$

SD1 = Standard deviation of the pretest class group
SD 2 = Standard deviation of the posttest class group

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For the not normally distributed:

$$r = \frac{Z}{\sqrt{N}}$$

Notes:
Z = *Wilcoxon test*
N = totally data
$\sqrt{N}$ = the square root of totally subject research.

If the data in this study are normally distributed, the analysis continues with a paired sample *t*-test. However, if the data are not normally distributed, the analysis proceeds using the Wilcoxon signed-rank test as a non-parametric alternative (Spring, 2025). A significance value (2-tailed) of less than 0.05 indicates a significant difference between the initial and final variables. This finding demonstrates a meaningful effect of the use of the e-module in chemistry kinetics learning. Next test will be the effect size Cohens'd for normally distributed and not normally distributed will be taken by Rank-Biserial.

The e-module is considered effective in improving students' conceptual understanding and collaborative skills if the results of the paired sample *t*-test show a significance value (α) < 0.05 and the N-gain score exceeds 0.03.

$$N - Gain = \frac{S_{Post} - S_{Pre}}{S_{maks} - S_{pre}}$$

Interpretation of the N-Gain value calcualtion is as follows:

Table 5. N-Gain Value Categories

Score N-Gain	Category
N-gain > 0.7	High
0.3 < N-gain > 0.7	Medium
N-gain < 0.3	Low

Source: (Hake, 1998)

The interpretation criteria for N-Gain are High (>0.7), Medium (0.3–0.7), and Low (<0.3). These standards guarantee clarity and reproducibility of the analysis, which corresponds with the evaluative stage of the pre-experimental study to determine the e-module's effectiveness in improving student learning outcomes.

RESULTS AND DISCUSSION

The research and development outcomes produced by the researcher consist of a local wisdom-based e-module for teaching kinetic material in Grade XI. The researcher implemented a pre-experimental design to examine the students' response to the e-module featuring local wisdom. Bahauddin (2019) notes that this design provides a planned and comprehensive framework to assess whether an educational product is valid and useful for the target audience.

The pre-experimental design follows a systematic procedure involving pre-testing, treatment, and post-testing. These steps are structured to objectively measure changes in student performance and ensure the reliability of the research data. Each stage in the pre-experimental design emphasizes controlled observation and data-driven analysis to ensure that the e-module effectively improves learning outcomes and meets high-quality standards (Siregar et al., 2022).

The effectiveness test of the chemistry kinetics e-module was carried out by assessing two key aspects: students' conceptual understanding and collaboration skills in Grade XI. Conceptual understanding was measured based on the results of a pretest, administered before the use of the e-module, and a posttest, conducted after its application during the chemistry learning process on the topic of chemical kinetics. The effectiveness results in terms of students' conceptual understanding are presented in the following Table 6.

Table 6. Average Prestest and Posttest Scores sf Students

Test Type	Average Score
Pretest	47.69
Posttest	86.73

Source: SPSS *Statistic 25.0 for Windows*

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The table indicates an average rise of 39.04 points following the use of the created learning media e-module.

Table 7. Tests of Normality

Variable	Kolmogorov-Smirnov Statistic			Shapiro-Wilk Statistic		
	Statistic	Df	Sig.	Statistic	df	Sig.
Pretest of Learning Outcomes of E-Module	0.166	26	0.062	0.936	26	0.109
Posttest of Learning Outcomes of E-Module	0.175	26	0.040	0.929	26	0.073

Source: SPSS *Statistic 25.0 for Windows*

Table 7 presents the results of the normality test using the Shapiro–Wilk method, which obtained significance values of 0.109 for the pretest and 0.073 for the posttest. Since both significance values are greater than 0.05, it indicates that there is no significant difference between the observed data and the standard normal distribution. Therefore, the data are considered to be normally distributed.

Table 8 displays the results of the paired sample t-test, which showed a significance value less than 0.05. The next tes, we continue by effect size Cohen's d. Effezt size from conseptual understanding is 2.78. This finding indicates a significant difference between the initial and final variables (pretest and posttest scores). Consequently, it can be concluded that the use of the chemistry kinetics e-module had a meaningful and positive effect on students' learning outcomes, particularly in enhancing their conceptual understanding during the learning process of chemical kinetics (Reksamunandar, 2020).

Table 8. Paired Sample Test

Paired Differences	95% Confidence Interval of Difference	Pair 1 Pretest Hasil Belajar E-Modul-Posttest Hasil Belajar E-Modul	
		Mean	-39.038
		Std Deviation	18.277
		Std Error Mean	3,584
		Lower	-46.421
		Upper	-31.656
		T	-10.891
		Df	25
		Sig (2-talled)	0.000

Source: SPSS *Statistic 25.0 for Windows*

Additionally, to assess the impact of learning, an evaluation of learning outcomes was performed using the Normalized Gain (N-Gain) equation:

$$\boldsymbol{N - Gain = \frac{86.73 - 47.69}{100 - 47.69} = 0.72}$$

According to classification, Value of N-gain Conseptual Understanding 0.72 falls into high category.

Table 9. Distribution of Students N-Gain Categories

Category N-gain	Value Interval	Total of Students	Percentage
High	N-gain ≥ 0.7	14	53.85%
Medium	0.3 < N-gain > 0.7	11	42.31%
Low	N-gain < 0.3	1	3.84%
Total		26	

Source: Excel Programme

The table above shows that the majority of students (53.85%) experienced improvement within the *high* category, while 42.31% demonstrated *moderate* improvement, and only 3.84% were classified in the *low* category. The

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obtained N-Gain score of 0.72, which falls into the *high* category, indicates that the local wisdom–based e-module was substantially effective in improving students' conceptual understanding, supported by several contributing factors(Setiawan et al., 2024).

These findings are consistent with previous studies demonstrating that the use of constructivism-based learning materials, such as e-modules, significantly contributes to the improvement of students' learning outcomes (Rukmana et al., 2024). Similarly, the average N-Gain index of 0.53, categorized as *moderate*, also supports the effectiveness of using e-modules in science learning integrated with mind mapping and cultural context, which has been shown to meaningfully enhance students' learning achievement (Dwipayana et al., 2024).

Collaboration skills were obtained through classroom observations conducted both before and during the implementation of the e-module in the chemistry learning process on the topic of chemical kinetics. Observation was conducted to determine the level of students' collaboration skills while using the e-module. This observation was assisted by a teacher and carried out over four meetings.

Result of observation collaboration skills show in Table 10.

Tabel 10. Results of Students' Collaboration Skills Observation

Aspect	Meeting			
	I	II	III	IV
Cooperation	Fair	Good	Very Good	Very Good
Effective communication	Fair	Good	Good	Very Good
Commitment and responsibility	Poor	Good	Very Good	Very Good
Effective communication (problem solving)	Fair	Good	Good	Very Good
Group process	Fair	Good	Very Good	Very Good

Source: Processed research data (2025)

The data in the table above indicate that the use of the e-module from the first meeting to the fourth meeting showed significant improvement and positive development. Group work was carried out effectively, in which each individual was able to demonstrate responsibility and communicate well within collaborative group activities.

This finding is consistent with previous studies highlighting the potential of e-modules to facilitate collaborative learning (Chidayati et al., 2021). It is also supported by other research indicating that the use of interactive multimedia in learning can enhance students' 21st-century skills, including collaboration (Mufit et al., 2023).

This improvement was driven by the instructional structure of the e-module, which required students to analyze and solve contextual problems (the "Kepurun" phenomenon) collaboratively in groups. The structured learning design within the e-module encouraged active interaction and idea sharing among students, thereby stimulating the development of their teamwork and communication skills (Rukmana et al., 2024).

Qualitatively, the components of effective communication and teamwork showed the most notable increases. Students who were initially passive (scores of 1–2) became more active in contributing ideas and reminding their peers during group tasks, reflecting a positive behavioral shift toward more collaborative learning engagement.

The significant improvement within the moderate category also indicates that the developed e-module has successfully fostered collaboration skills, which represent one of the essential 21st-century competencies(Trilling & Fadel, 2009). enhancement of collaboration skills indicate that the local wisdom–based Chemical Kinetics e-module is effective for use

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in the context of developing interactive learning media.

CONCLUSION

This study successfully developed and evaluated a local wisdom-based e-module on chemical kinetics that integrates the Malay cultural context of *Kepurun* from Daik Lingga. Based on the validation and field-testing results, the e-module is proven to be a valid, practical, and effective learning resource. Statistical analysis confirms a significant improvement in students' outcomes, with an High N-Gain score for conceptual understanding (high category). It can be concluded that the integration of local wisdom into digital learning media effectively enhances students' engagement and achievement by bridging scientific concepts with their cultural reality at SMA Negeri 1 Lingga.

RECOMMENDATIONS

Based on the findings of this study, several strategic recommendations are proposed. Chemistry teachers are strongly encouraged to adopt and adapt this local wisdom-based e-module to enhance students' engagement and conceptual understanding through contextual digital learning. Educational institutions should support such innovations by providing adequate digital facilities and training for teachers to develop interactive materials rooted in regional culture. Furthermore, curriculum developers are advised to systematically integrate local wisdom into science curricula to promote learning that is aligned with the *Merdeka Belajar* principles. Finally, future researchers should expand the scope of this study by applying the e-module to different chemistry topics or educational levels and employing more rigorous experimental designs, such as using control groups, to further validate its broader effectiveness.

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