JPPIPA 12(2) (2026)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Utilization of Social Media (Instagram, Youtube, Tiktok) to Improve Students' Creativity and Learning Outcomes in Learning Acid-Base Theory in High School

Riga Oktry Silpa[1], Rahadian Zainul[1*], Umar Kalmar Nizar[1], Desy Kurniawati[1]

[1] Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Negeri Padang, Padang, Indonesia.

Received: December 20, 2025
Revised: January 11, 2026
Accepted: February 25, 2026
Published: February 28, 2026

Corresponding Author:
Rahadian Zainul
rahadianzmsiphd@fmipa.unp.ac.id

DOI: 10.29303/jppipa.v12i2.14016

Abstract: Acid-base material in high school chemistry learning is often considered difficult because of its abstract nature, causing misconceptions and mere memorization in grade XI students. Social media (Instagram, YouTube, TikTok) with 139 million YouTube users and 127 million TikTok users in Indonesia has the potential as an interactive media, but has not been explored multi-platform inquiry-based. This study aims to develop an acid-base e-Module based on an integrated social media inquiry model to improve student creativity and learning outcomes. The quasi-experimental method with a Non-Equivalent Control Group Design was applied to two grade XI classes of MAN 6 Pasaman Barat. The experimental class used an e-Module with a social media link, while the conventional control. Data obtained from the validity and practicality test were analyzed using Aiken's V formula and practicality percentages. The validity test result showed a V value of 0.90, indicating a valid category. The analysis of the teacher practicality questionnaire showed an 86% score categorized as very practical, while the student practicality questionnaire showed an 84% score categorized as practical). The t-test yielded a sig (2-tailed) value of 0.02. Based on these results, it can be concluded that the developed e-module is valid, practical, and effective to improve students' creativity and learning outcomes.

Keywords: Acid-base theory; E-module; Inquiry model; Nonequivalent control group; Quasi experimental; Social medias

Introduction

The development of digital technology has made social media an integral part of people's lives, especially the younger generation and high school students. Platforms like YouTube, TikTok, and Instagram serve not only as entertainment and communication tools but also hold significant potential as interactive learning media. Data reportal (2024) in Widaningsih et al. (2023) data shows high social media user penetration in Indonesia: YouTube with 139 million users, TikTok 127 million, Facebook 118 million, and Instagram 101 million. These figures illustrate the significant opportunity to utilize social media as an effective learning tool for the digital generation. In the educational context, one of the main challenges is how to leverage social media to increase student engagement and understanding in subjects considered difficult, such as chemistry. Chemistry is known to be a highly challenging subject due to its abstract nature and the need for in-depth conceptual (Defista & Aznam, 2024). The topic of acids and bases is often considered complex because it involves complex concepts, various scientific theories, and mathematical calculations (Ardianti et al., 2021; Hamerská et al., 2024). This leads to many students experiencing misconceptions and difficulty understanding the relationships between concepts. Based on a study by Sudirman et al. (2025), most eleventh-grade students face significant difficulties in understanding acid-base concepts, particularly in pH

How to Cite:
Silpa, R. O., Zainul, R., Nizar, U. K., & Kurniawati, D. Utilization of Social Media (Instagram, Youtube, Tiktok) to Improve Students' Creativity and Learning Outcomes in Learning Acid-Base Theory in High School. *Jurnal Penelitian Pendidikan IPA*, *12*(2), 66-73. https://doi.org/10.29303/jppipa.v12i2.14016

calculations, acid-base strength, and titration. This phenomenon demonstrates the need for innovative and contextual learning approaches so that students can learn in a more engaging, creative, and digitally relevant way. Conventional learning approaches, still dominant in schools, such as lectures and question-and-answer methods, are considered ineffective in addressing these challenges (DeCoito & Estaiteyeh, 2022; Newton et al., 2020). Teachers tend not to optimally integrate digital media, resulting in less active student engagement (Ramadhana & Muchlis, 2022). Therefore, technology-based learning innovations are needed that can encourage more active student participation and hone their creativity and conceptual understanding. One relevant model for this context is the guided inquiry learning model (Hisyam & Handayani, 2024; Pedaste et al., 2015). This model focuses on student activeness in discovering and investigating concepts through experiments or scientific phenomena (Wu et al., 2023).

In the context of acids and bases, the guided inquiry model has been shown to improve students' conceptual understanding and critical thinking skills (Kriswantoro et al., 2025). This model positions students as knowledge discoverers, while the teacher acts as a facilitator guiding the investigation process. Furthermore, various previous studies have shown that the use of social media can strengthen learning effectiveness due to its visual, interactive, and fun nature. Research by Ross et al. (2025), Tamaño (2025) showed that the integration of social media such as Instagram and TikTok in chemistry learning positively impacted learning outcomes. The experimental class that used social media experienced a higher average post-test score than the control class. Visual content such as infographics and short videos can help visualize complex chemical concepts (Zhang & Jenkinson, 2024; Monib et al., 2025). In addition to improving learning outcomes, the use of social media can also foster student creativity. By creating content such as experimental videos, illustrations, or infographics, students can connect scientific concepts with real-world practice while simultaneously practicing critical thinking and digital communication skills (Dias-Oliveira et al., 2024; Thornhill-Miller et al., 2023).

The integration of various platforms such as YouTube (video tutorials), Instagram (infographics and quizzes), and TikTok (creative videos) allows students to learn in a style that suits their individual preferences. On the other hand, technological innovation in education is also evident in the development of digital and inquiry-based e-modules. E-modules can facilitate independent learning and enrich understanding of abstract concepts through interactive visualization (Sikumbang et al., 2025). Research by Dewita et al. (2023) showed that guided inquiry-based e-modules featuring acid-base experiment videos significantly improved learning outcomes, with an N-Gain value of 0.71 (high category). This means that digital-based learning has proven effective in reinforcing chemistry concepts even without physical laboratory facilities. Although there is a lot of research on the use of social media and e-modules in education, most previous studies have focused on a single platform and have not combined multiple social media simultaneously. This is where the research gap lies. Not many studies have explored the integration of multiple platforms (Instagram, YouTube, TikTok) in inquiry-based chemistry learning, and empirically analyzed its effects on student creativity and learning outcomes.

This study aims to fill this gap by comprehensively examining the impact of the combination of three platforms on students' cognitive and affective achievement, analyze the effect of social media use such as Instagram, YouTube, and TikTok on improving student creativity in learning about acids and base. In addition, this study also aims to measure the effectiveness of the integration of these three platforms in improving high school students' learning outcomes on acid- base concepts, which are often consider abstract and difficult to understand.

Method

This study used a quasi-experimental method with the aim of measuring the impact of social media use such as Instagram, YouTube, and TikTok on student creativity and learning outcomes in chemistry learning about acids and bases. According to Goldfarb et al. (2022), a quasi-experiment is a research approach that can produce causal inferences even without full randomization, while still controllings external variables that might influence the research results. The research design used was a Non-Equivalent Control Group Design, a research design involving two groups without randomization: one experimental group and one control group. The subjects of this study were eleventh-grade high school students in phase F who were studying the theory of Acids and Bases, two chemistry teachers from senior high schools and three chemistry lectures from the Faculty of Mathematics and Natural Sciences, Padang State University. The sample consisted of two classes from the same school with comparable academic abilities.

The data collection instruments used in this study are validation questionnaires and practicality questionnaires, and pretest and posttest questions for critical thinking ability. The validation questionnaires were analyzed using Aiken's V formula, which is as follows:

$$V = V = \frac{\sum s}{n\,(c-1)} \quad (1)$$
$$S = r - l_0$$

Explanation:
r: the value given by the validator
c: highest validity score (in this case = 5)
l0: lowest validity score (in this case = 1)
n: number of expert validators

Table 1. Criteria for Validation Questionnaire

Mean score	Criteria
V > 0.80	Valid
0.40 < V ≤ 0.80	Moderate
V ≤ 0.40	Poor

The practicality questionnaire is analyzed using the percentage of practicality with Formula 2.

$$NP = \frac{R}{SM} \times 100\% \quad (2)$$

Explanation:
NP: final score
R: obtained score
SM: maximum score

Table 2. Criteria for Practicality Questionnaire

Mean Score (%)	Criteria
86 – 100	Very Practical
76 – 85	Practical
60 – 75	Moderately Practical
55 – 59	Less Practical
≤ 54	Not Practical

The improvement in students' critical thinking skills is measured by calculating the N-Gain value from the pretest and posttest scores obtained using Formula 3.

$$N - Gain = \frac{Posttest\ score - Pretest\ score}{Maximum\ score - Pretest\ score} \quad (3)$$

Next, the average N-Gain value of the students is calculated using Formula 4.

$$Average\ N - Gain = \frac{\sum N - Gain\ for\ students}{Number\ of\ students} \quad (4)$$

Table 3. Classification of N-Gain

N-Gain score <g>	Classification
<g> ≥ 0.70	High
0.70 > <g> ≥ 0.30	Medium
0.30 > <g>	Low

The N-Gain value will be statistically tested to determine its significant improvement using SPSS software.

Result and Discussion

Research result

Based on the objectives and procedures of the research that has been implemented, a chemistry learning e-module on the topic of Acids and Bases was developed that utilizes social media (Instagram, YouTube, and TikTok) using the inquiry learning model. This e-module is designed to improve student creativity and learning outcomes. The research process involved several stages, namely preparation, validation, interviews, and practicality testing by teachers and students. The validity test was carried out by three lecturers and two chemistry teachers, while the practicality test was carried out by two chemistry teachers and students of class XI F.1 MAN 6 Pasaman Barat. During the preparation stage, interviews were conducted with chemistry teachers and questionnaires were distributed to students of class XI F MAN 6 Pasaman Barat. The interview results showed that most students considered chemistry a difficult subject because it is abstract and complex. The most dominant difficulty was found in the material on acids and bases, where students tended to only memorize without understanding the concepts in depth, so they easily forgot the material.

Teachers stated the need for teaching materials that could link chemical concepts to real phenomena so that students could more easily understand the concepts of acids and bases. The questionnaire given to students also showed that most of them preferred teaching materials with an attractive appearance, colorful, illustrated, and accompanied by many contextual examples. In addition, almost all students have smartphones that are often used to search for learning materials on the internet, so the use of social media as a learning medium is considered very relevant. Based on these results, the e-Module was designed following the components developed by the Ministry of Education and Culture (2017) in Kartikasari et al. (2023) and Purwanti et al. (2023) with several modifications. The main components include a cover with an attractive and contextual visual design, user instructions for teachers and students, learning outcomes and objectives, activity sheets based on inquiry syntax (problem orientation, problem identification, hypothesis formulation, data analysis, and drawing conclusions), formative-summative exercises and tests, and answer keys as a form of feedback. After the design was completed, an assessment was conducted by experts or validators consisting of three chemistry lecturers and two chemistry teachers to validate the content and construct of the e-Module. The results of the analysis using the Aiken's V formula.

Table 4. Validation Results of the E-Module

Components	V score	Category
Content	0.89	Valid
Language	0.88	Valid
Presentation	0.89	Valid
Graphic	0.93	Valid
Average	0.90	Valid

Based on Table 4, the components of validity of the acid-base e-module have an average V value of 0,89, categorized as valid. This indicates that the developed e-module is valid in terms of content suitability, confirming that it adheres to the principles of knowledge and is based on the curriculum or developed from appropriate materials and theories. According to Li et al. (2024) and O'Neill et al. (2023) content validity signifies that the instructional material is aligned with a strong theoretical rationale or curriculum. The average V value for the language component of the developed e-module is 0,88, categorized as valid. This implies that the language used in the developed e-module conforms to the rules of proper Indonesian language, is communicative, and easily understandable. Depdiknas (2008) in Stelea et al. (2025) states that good e-modules use simple sentences to ensure clear communication and user friendly information presentation. Communicative and simple language enhances understanding of concepts and increases students' learning interest (Fan, 2022; Aswad et al., 2024).

The average V value for the presentation component of the developed e-module is 0.89, categorized as valid. This value indicates that the e-module has been presented systematically and in accordance with the components of e-Module learning. Furthermore, the e-Module has been able to direct students to carry out activities that align with the syntax of the inquiry learning model. One of the principles of e-module development is that it is packaged for use in the learning process (Marlena et al., 2022; Marsila et al., 2025). The average V value for the graphic design component of the developed e-module is 0.93, categorized as valid. This score indicates that the e-Module has a clear, organized, and attractive layout, illustrations, images, display design, and font size. The presence of images in the e-Module can attract students' interest in learning because it prevents them from getting bored with just reading the text (Dwivedi et al., 2022). The results of the validation by material experts have a total percentage of 0.90 so that the e-module is declared valid for use in terms of material.

Practicality Test

The practicality test of the e-module was conducted by giving a practicality test questionnaire to two chemistry teachers and 16 class XI F.1 students at MAN 6 Pasaman Barat. Data processing from the results of practical tests from teachers and students can be seen in table 5.

Table 5. Results of Practicality Testing

Aspect	Average NP score (100%)	
	Teachers	Students
Ease of use	83	86
Time Efficiency	85	81
Utility	90	85
Average	86	84
Category	Very practical	Practical

Based on Table 5, it can be seen that the average practicality test results for the ease of use of the e-module obtained from teacher and student questionnaires were 83 and 86, respectively, with both categories being practical and very practical. These categories indicate that the e-module is easy to use in learning. The use of e-modules in learning makes students more interested in understanding the material provided. Students can access the learning materials in the e-module whenever they want via their mobile phones (Palumpun et al., 2022). The average result of the practicality test on the assessment of the time efficiency of using e-modules in learning obtained from teacher and student response questionnaires were 85 and 81, respectively, with both categories being practical. This indicates that the e-module is efficient in terms of time for use in learning. E-modules are teaching materials that contain learning objectives or competencies in each learning activity, materials, summaries, and systematic evaluations. E-modules can facilitate students to learn independently, in groups, or conventionally. E-modules are presented with self-study instructions so that students can learn at their own pace (Apriyani et al., 2025; Widya et al., 2023).

The average practicality test result for the benefits of using e-Modules in learning, obtained from the teacher response questionnaire, was 90, categorized as very practical. Meanwhile, the average practicality test result from the student response questionnaire was 85, categorized as practical. The practicality test results from both the teacher and student questionnaires indicate that the e-Modules created can assist teachers in delivering learning materials and can help students understand the learning materials and motivate them. Hairani et al. (2023), Stecuła et al. (2022), Rahmayani et al. (2024) explains that e-Modules are teaching materials presented electronically to support active learning. E-Modules will make it easier for teachers to deliver material to students and make learning more engaging because they are in line with current technological developments. Based on Table 5, it can be concluded that the developed acid-base e-module has a practicality

category with an average practicality level of the teachers and student response questionnaires of 86% (Very Practical) and 84% (Practical) respectively. It can be concluded that this inquiry-based e-module can be used in chemistry learning and has a positive impact on improving student learning outcomes.

Creativity Test

This creativity test aims to determine the differences in student creativity levels between the experimental class, which used social media to present assignments, and the control class, which completed assignments conventionally without utilizing social media. The results of the creativity test analysis obtained by students in the control and experimental classes can be seen in Table 6.

Table 6. Results of Student Creativity Test Analysis

Class	Creativity score	Category
Experiment	85.60	very creative
Control	62.50	quite creative

Based on the creativity test scores in Table 6, it shows that the average score of the experimental class, namely 85.60, is higher than the score of the control class, namely 62.60. These data indicate that the level of creativity of students in the experimental class is higher than the level of creativity of students in the control class.

N-Gain Test

Gain scores are obtained from the relationship between pretest and posttest scores on the improvement of students' learning outcomes before and after using the acid-base e-Module material with the use of social media. The results of the analysis of pretest and posttest scores obtained by students in the control and experimental classes can be seen in Table 7.

Table 7. The Result of the N-Gain Analysis of Students' Pretest and Posttest Scores

Class	Average N-gain	Category
Experiment	0.56	Moderate
Control	0.49	Moderate

Based on the N-Gain value in Table 7, it shows that the average N-Gain of the experimental class, which is 0.56, is higher than the N-Gain of the control class, which is 0.49. These data indicate that the learning outcomes of students in the experimental class are higher than the learning outcomes of students in the control class.

Normality Test

Normality testing aims to determine whether the data is normally distributed. The normality test data is obtained using the Shapiro-Wilk test. The decision criteria are based on the significance value (sig): if sig > 0.05, the data is normally distributed, and if sig ≤ 0.05, the data is not normally distributed. The results of the normality test analysis can be seen in Table 8.

Table 8. Result of the Normality Test

Class	α	Significance (Sig)	Decision
Experiment	0.05	0.06	Normally
Control		0.10	distributed

Based on Table 8, the significance (sig) of the control and experimental classes is greater than α. The data shows that the pretest and posttest scores of the control and experimental classes are normally distributed.

Homogeneity Test

Homogeneity testing aims to determine whether the data has homogeneous variances. The decision criteria are based on the significance value (sig): if sig > 0.05, the data has homogeneous variances. The data for the homogeneity test is obtained through the homogeneity of variance test. The results of the homogeneity test analysis can be seen in Table 9.

Table 9. Result of the Homogeneity Test

Class	α	Significance (Sig)	Decision
Experiment	0.05	0.82	Homogeny
Control			

Based on Table 9, the significance (sig) of the control and experimental classes is greater than α. These data indicate that the pretest and posttest scores of the control and experimental classes have homogeneous variance data.

Hypothesis Test

Hypothesis test data is obtained through an independent sample t-test. The results of the hypothesis test analysis can be seen in Table 10.

Table 10. Result of the Hypothesis Test

Class	Significance (Sig)	Decision
Experiment	0.02	H0 rejected
Control		H1 accepted

Based on Table 10, the significance (sig) of the control and experimental classes is less than 0.05. The data indicates that H0 is rejected and H1 is accepted, where the learning outcomes of the experimental class are higher than the learning outcomes of the control class. Social media-based e-modules can help students discuss and ask questions flexibly, thereby strengthening conceptual understanding (Ayani et al., 2025; Tong et al., 2022; Alshammary & Alhalafawy,

2023). All analysis results support that e-modules integrated with social media are effective for use in acid-base learning, both in improving learning outcomes and student creativity and motivation. Based on this, it can be concluded that the increase in learning outcomes of the class that uses the acid-base e-module created (experimental class) is greater than the increase in learning outcomes of the class that does not use the acid-base e-module (control class).

Conclusion

Based on the research results and discussion, it can be concluded that the acid-base e-module using social media (Instagram, YouTube, and TikTok) to improve students' creativity and learning outcomes has a validity level with a valid category and practicality with a very practical category. The average scores obtained for the content validity test, construct validity, practicality by teachers, and practicality by students are 0.90, 0.85, 86, and 84, respectively. Furthermore, the use of the e-module is also effective in improving students' learning outcomes. This is evidenced by the N-Gain value obtained by the experimental class (0.56) which is higher than the N-Gain of the control class (0.49).

Acknowledgments
Thank you to the thesis advisor for guiding the research and writing of this article to completion. Thank you to MAN 6 Pasaman Barat for the assistance and permission during the research process. Thank you to the editors who reviewed and studied this article. Thank you to my parents for their moral and material support. And thanks to all those who have helped and cannot be mentioned one by one.

Author Contributions
R. O. S contributed to conducting research, developing the product, analyzing data, and writing the article. R. Z., served as the advisor in the research and writing activities. U. K. N and D. K served as product validators.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

References

Alshammary, F. M., & Alhalafawy, W. S. (2023). Digital Platforms and the Improvement of Learning Outcomes: Evidence Extracted from Meta-Analysis. *Sustainability*, *15*(2), 1305. https://doi.org/10.3390/su15021305

Apriyani, K., Ernalida, E., & Suhendi, D. (2025). The Effectiveness of Writing Short Story Texts Using E-Modules Based on Electronic Publication for Senior High School. *AL-ISHLAH: Jurnal Pendidikan*, *17*(3). https://doi.org/10.35445/alishlah.v17i3.4437

Ardianti, S., Wiji, W., & Widhiyanti, T. (2021). Conceptions and troublesome knowledge on acid-base using the two-tier multiple-choice diagnostic test. *Journal of Physics: Conference Series*, *2098*(1), 012032. https://doi.org/10.1088/1742-6596/2098/1/012032

Aswad, M., Putri, A. M. J., & Sudewi, P. W. (2024). Enhancing Student Learning Outcomes through the Communicative Language Teaching Approach. *AL-ISHLAH: Jurnal Pendidikan*, *16*(4). https://doi.org/10.35445/alishlah.v16i4.5204

Ayani, N. I., Ratnawulan, R., Fauzi, A., Emiliannur, E., & Yulia, D. (2025). Learners' Needs for E-Modules in Dynamic Fluid Learning Integrated with 21st Century Skills. *Jurnal Penelitian Pendidikan IPA*, *11*(2), 1053–1062. https://doi.org/10.29303/jppipa.v11i2.4383

DeCoito, I., & Estaiteyeh, M. (2022). Online teaching during the COVID-19 pandemic: Exploring science/STEM teachers' curriculum and assessment practices in Canada. *Disciplinary and Interdisciplinary Science Education Research*, *4*(1), 8. https://doi.org/10.1186/s43031-022-00048-z

Defista, C., & Aznam, N. (2024). Chemistry-Focused Conceptual Understanding Research Trends: A Systematic Review. *Jurnal Penelitian Pendidikan IPA*, *10*(4), 180–187. https://doi.org/10.29303/jppipa.v10i4.6534

Dewita, R., & Andromeda, A. (2023). Efektivitas Penggunaan E-Modul Titrasi Asam Basa Berbasis Inkuiri Terbimbing Terintegrasi Video Percobaan Terhadap Hasil Belajar Peserta Didik. *Jurnal Pendidikan MIPA*, *13*(1), 211–217. https://doi.org/10.37630/jpm.v13i1.861

Dias-Oliveira, E., Pasion, R., Vieira Da Cunha, R., & Lima Coelho, S. (2024). The development of critical thinking, team working, and communication skills in a business school–A project-based learning approach. *Thinking Skills and Creativity*, *54*, 101680. https://doi.org/10.1016/j.tsc.2024.101680

Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., Dennehy, D., Metri, B., Buhalis, D., Cheung, C. M. K., Conboy, K., Doyle, R., Dubey, R., Dutot, V., Felix, R., Goyal, D. P., Gustafsson, A., Hinsch, C., Jebabli, I., & Wamba, S. F. (2022). Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, *66*, 102542. https://doi.org/10.1016/j.ijinfomgt.2022.102542

Fan, X. (2022). The development of EFL Learners' willingness to communicate and self-efficacy: The role of flipped learning approach with the use of social media. *Frontiers in Psychology*, *13*, 1001283. https://doi.org/10.3389/fpsyg.2022.1001283

Goldfarb, A., Tucker, C., & Wang, Y. (2022). Conducting Research in Marketing with Quasi-Experiments. *Journal of Marketing*, *86*(3), 1–20. https://doi.org/10.1177/00222429221082977

Hairani, S., & Amini, R. (2023). Development of Integrated Thematic Teaching Materials Based on Creative Problem Solving Assisted by Kvisoft Flipbook Maker Pro in the Third Grade of Elementary School. *AL-ISHLAH: Jurnal Pendidikan*, *15*(2), 2156–2165. https://doi.org/10.35445/alishlah.v15i2.2864

Hamerská, L., Matěcha, T., Tóthová, M., & Rusek, M. (2024). Between Symbols and Particles: Investigating the Complexity of Learning Chemical Equations. *Education Sciences*, *14*(6), 570. https://doi.org/10.3390/educsci14060570

Hisyam, M., & Handayani, S. (2024). The Influence of Guided Inquiry Learning in the Context of Socio-Scientific Issues (SSI) on Students' Chemistry Literacy and Environmental Awareness on Reaction Rate Material. *Jurnal Penelitian Pendidikan IPA*, *10*(8), 5877–5884. https://doi.org/10.29303/jppipa.v10i8.7369

Kartikasari, M., Ismet, I., & Sriyanti, I. (2023). Development of an E-Module Based on the 5E Learning Cycle to Improve the Creative Thinking Abilities of Junior High School Students. *Jurnal Penelitian Pendidikan IPA*, *9*(SpecialIssue), 121–129. https://doi.org/10.29303/jppipa.v9iSpecialIssue.6528

Kriswantoro, Melfiza, Haryanto, & Hasibuan, M. H. E. (2025). The Effectiveness of Structured and Guided Inquiry Learning Models in Enhancing Students' Science Process Skills on Acid-Base Topics in Senior High School. *Jurnal Penelitian Pendidikan IPA*, *11*(5), 329–340. https://doi.org/10.29303/jppipa.v11i5.11193

Li, F., & Wang, L. (2024). A study on textbook use and its effects on students' academic performance. *Disciplinary and Interdisciplinary Science Education Research*, *6*(1), 4. https://doi.org/10.1186/s43031-023-00094-1

Marlena, N., Patrikha, F. D., & Dwijayanti, R. (2022). Electronic Modules in an Indonesian Higher Education: Conceptualisation, Development and Application. *AL-ISHLAH: Jurnal Pendidikan*, *14*(3), 3943–3954. https://doi.org/10.35445/alishlah.v14i3.1473

Marsila, N., Yerimadesi, Alizar, & Andromeda. (2025). Development of an Acid-Base E-Module Based on Guided Discovery Learning with Ethnoscience Content to Improve Literacy and Numeracy. *Jurnal Penelitian Pendidikan IPA*, *11*(8), 1125–1135. https://doi.org/10.29303/jppipa.v11i8.12439

Monib, W. K., Qazi, A., & Apong, R. A. (2025). Microlearning beyond boundaries: A systematic review and a novel framework for improving learning outcomes. *Heliyon*, *11*(2), e41413. https://doi.org/10.1016/j.heliyon.2024.e41413

Newton, P. M., Da Silva, A., & Berry, S. (2020). The Case for Pragmatic Evidence-Based Higher Education: A Useful Way Forward? *Frontiers in Education*, *5*, 583157. https://doi.org/10.3389/feduc.2020.583157

O'Neill, L., Lauridsen, H. H., Østengaard, L., & Qvortrup, A. (2023). Validity evidence for the Experiences of Teaching and Learning Questionnaire (ETLQ) in evaluations of quality learning: A systematic critical literature review. *Studies in Educational Evaluation*, *78*, 101283. https://doi.org/10.1016/j.stueduc.2023.101283

Palumpun, N. S., Wilujeng, I., Suryadarma, I. G. P., Suyanta, S., & Syaukani, M. H. (2022). Identifikasi Kemandirian Belajar Peserta Didik Menggunakan E-Modul Berbantuan Liveworksheet Terintegrasi Potensi Lokal Toraja. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 558–565. https://doi.org/10.29303/jppipa.v8i2.1245

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A. N., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*, 47–61. https://doi.org/10.1016/j.edurev.2015.02.003

Purwanti, I. T., Eliwarti, E., & Jismulatif, J. (2023). E-Module of Meaning in Interpersonal Context in Online Learning: Implementation and Students' Feedback. *AL-ISHLAH: Jurnal Pendidikan*, *15*(1), 271–286. https://doi.org/10.35445/alishlah.v15i1.2566

Rahmayani, M. & Asrizal. (2024). Integrated Renewable Energy E-Module PBL Model with Smartphone to Improve Students' Creative Thinking and Communication Skills. *JPI (Jurnal Pendidikan Indonesia)*, *13*(1), 93–104. https://doi.org/10.23887/jpiundiksha.v13i1.65177

Ramadhana, R., & Muchlis, M. (2022). Penerapan Model Pembelajaran Inkuiri Terbimbing Untuk Meningkatkan Keterampilan Berpikir Kritis Pada Materi Asam Basa. *Chemistry Education Practice*, *5*(2), 133–141. https://doi.org/10.29303/cep.v5i2.3379

Ross, N., Sulliman, B., & Van Heerden, M. (2025). Leveraging TikTok to enhance understanding and

engagement in university chemistry students: A South African case study. *Cogent Education*, *12*(1), 2536539. https://doi.org/10.1080/2331186X.2025.2536539

Sikumbang, N., Jasrial, Ridwan, & Rayendra. (2025). Development of E-Modules Integrate with PBL (Problem Base Learning) in High School Physicts Subject Class XI. *Jurnal Penelitian Pendidikan IPA*, *11*(6), 423–434. https://doi.org/10.29303/jppipa.v11i6.11627

Stecuła, K., & Wolniak, R. (2022). Advantages and Disadvantages of E-Learning Innovations during COVID-19 Pandemic in Higher Education in Poland. *Journal of Open Innovation: Technology, Market, and Complexity*, *8*(3), 159. https://doi.org/10.3390/joitmc8030159

Stelea, G. A., Robu, D., & Sandu, F. (2025). AccessiLearnAI: An Accessibility-First, AI-Powered E-Learning Platform for Inclusive Education. *Education Sciences*, *15*(9), 1125. https://doi.org/10.3390/educsci15091125

Sudirman, R. J. & Yerimadesi. (2025). Development of Acid-Base E-Modules Based on Guided Discovery Learning Using React Native to Improve Problem Solving Skills of Phase F High School Students. *Jurnal Penelitian Pendidikan IPA*, *11*(7), 934–946. https://doi.org/10.29303/jppipa.v11i7.12212

Tamaño, L. D. (2025). Utilizing TikTok in Enhancing Language Abilities: A Literature Review. *Journal of Digital Learning And Distance Education*, *4*(5), 1682–1688. https://doi.org/10.56778/jdlde.v4i5.586

Thornhill-Miller, B., Camarda, A., Mercier, M., Burkhardt, J.-M., Morisseau, T., Bourgeois-Bougrine, S., Vinchon, F., El Hayek, S., Augereau-Landais, M., Mourey, F., Feybesse, C., Sundquist, D., & Lubart, T. (2023). Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education. *Journal of Intelligence*, *11*(3), 54. https://doi.org/10.3390/jintelligence11030054

Tong, D. H., Uyen, B. P., & Ngan, L. K. (2022). The effectiveness of blended learning on students' academic achievement, self-study skills and learning attitudes: A quasi-experiment study in teaching the conventions for coordinates in the plane. *Heliyon*, *8*(12), e12657. https://doi.org/10.1016/j.heliyon.2022.e12657

Widaningsih, T. T., Kusumaningrat, M. M. W., & Marta, R. F. (2023). The Influence of TikTok Content Creator on Consumptive Behavior of Teenagers in Online Shopping. *Jurnal Aspikom*, *8*(2). https://doi.org/10.24329/aspikom.v8i2.1206

Widya, Ginting, F. W., Iqbal, M., & Andriani, R. (2023). Validity of a Physics E-Module Based on Creative Problem Solving Model Integrated With Renewable Energy. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 11544–11550. https://doi.org/10.29303/jppipa.v9i12.5959

Wu, L., Liu, Y., How, M.-L., & He, S. (2023). Investigating Student-Generated Questioning in a Technology-Enabled Elementary Science Classroom: A Case Study. *Education Sciences*, *13*(2), 158. https://doi.org/10.3390/educsci13020158

Zhang, K. E., & Jenkinson, J. (2024). The Visual Science Communication Toolkit: Responding to the Need for Visual Science Communication Training in Undergraduate Life Sciences Education. *Education Sciences*, *14*(3), 296. https://doi.org/10.3390/educsci14030296