



Exploration of Teachers' Creative Thinking Ability Profile in Implementing Chemistry Learning in Senior High Schools

***Jesi J. Pongkendek & Diana Rochintaniawati**

Science Education Study Program/Faculty of Mathematics and Science Education – Universitas Pendidikan Indonesia, Bandung – Indonesia 40154

Received 23 June 2025, Revised 24 July 2025, Accepted 31 July 2025

doi: [10.22487/j.24775185.2025.v14.i3.pp157-162](https://doi.org/10.22487/j.24775185.2025.v14.i3.pp157-162)

Abstract

This study addresses the limited empirical evidence regarding chemistry teachers' creative thinking performance in Indonesia. To fill this gap, the present research aims to explore the creative thinking ability profile of senior high school chemistry teachers. This quantitative descriptive study employed an exploratory design and included 21 chemistry teachers from various provinces in Indonesia. Data were collected using a validated creative thinking questionnaire consisting of four indicators: fluency, flexibility, originality, and elaboration. The results indicated that 66.67% of teachers were in the "Very Good" category, 28.57% in the "Good" category, and only 4.76% in the "Fair" category. Among the indicators, fluency showed the highest average score (91.23%), followed by elaboration (86.67%), flexibility (84.95%), and originality (80.38%). These findings indicate that chemistry teachers demonstrate strong abilities in generating and elaborating ideas. At the same time, originality remains comparatively lower due to systemic constraints such as inflexible education policies and limited pedagogical autonomy. The study also highlights the importance of institutional support, training programs, and collaborative learning environments that promote pedagogical creativity among teachers. Enhancing originality, in particular, requires schools to provide more autonomy and flexibility in instructional planning. Ultimately, the results of this study can serve as a reference for educational policymakers and curriculum developers in designing teacher development programs that not only improve content delivery but also cultivate innovative teaching mindsets, essential for meeting the demands of 21st-century learning.

Keywords: Chemistry teacher; classroom innovation; creative thinking; science education

Introduction

Chemistry is widely perceived as a challenging subject, which affects students' motivation to learn (Lin & Wu, 2021; Pongkendek et al., 2021). Therefore, teachers must design instructional strategies that help students relate chemistry to real-life contexts (Ramadhan & Ijrana, 2023; Nurmilawati et al., 2021).

Creativity is recognised as a core 21st-century teaching competency, especially in science learning, where students are expected to experiment, explore, and communicate ideas in innovative ways (Runco, 2023; Syafitri et al., 2022). Creative teaching also encourages divergent thinking, multiple solution pathways, and meaningful engagement with scientific phenomena (Fakhriyah et al., 2022; Pongkendek et al., 2019).

Teachers with strong creative thinking ability are more adaptive, reflective, and responsive to classroom dynamics (Sternberg, 2021; Amelia, 2023; Fitriyani et al., 2021). However, previous research shows that teachers face challenges such as

inflexible education policies, administrative workload, and limited autonomy, which hinder the application of creative practices (Anderson et al., 2022; Nugraha et al., 2023; Tanjua et al., 2024).

Chemistry is an abstract and representational subject, requiring teachers to creatively transform macroscopic, submicroscopic, and symbolic representations into learning experiences that students can understand (Kapici, 2023; Santos & Arroio, 2016). This implies that creative thinking for chemistry teachers is not only related to producing attractive teaching media but also includes the ability to design analogies, models, demonstrations, inquiry tasks, and meaningful explanations that help students make sense of complex chemical concepts (Craft, 2010; Rahmawati et al., 2019; Veerasinghan et al., 2021).

Creative thinking in teaching chemistry involves teachers' ability to generate diverse instructional ideas (fluency), modify strategies based on student needs (flexibility), create unique or unconventional learning activities (originality), and elaborate these ideas into structured learning

*Correspondence:

Jesi J. Pongkendek

e-mail: jejepongkendek@upi.edu

© 2025 the Author(s) retain the copyright of this article. This article is published under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

sequences (elaboration) (Runco & Acar, 2012; Jamal et al., 2020; Guilford, 2017). These abilities are essential because learning chemistry requires students to engage in experimentation, scientific reasoning, and innovative problem-solving when dealing with abstract phenomena (Raman et al., 2024; Yao, 2023; Rahmah & Widjajanti, 2025).

Several studies show that chemistry teachers still face difficulties in applying originality and flexibility due to rigid curriculum structures, limited pedagogical autonomy, and time constraints, which often lead to procedural and teacher-centred instruction (Munawwarah & Cahyani, 2025; Anderson et al., 2022; Nugraha et al., 2023; Tanjua et al., 2024). These challenges indicate that chemistry teachers' creative practices have not fully aligned with the expectations of modern science education, which demands innovative, inquiry-oriented, and authentic learning experiences (Morris, 2025; Jegstad, 2024).

Furthermore, previous studies have not provided a comprehensive mapping of chemistry teachers' creative thinking abilities across regions in Indonesia, particularly when analysed using established dimensions such as fluency, flexibility, originality, and elaboration. Most research tends to focus on student creativity or media innovation rather than investigating teachers' creative capacity in real classroom practice (Fakhriyah et al., 2022; Pongkendek et al., 2019).

Therefore, this study aims to explore the creative thinking ability profile of chemistry teachers in implementing chemistry instruction, using four indicators identified by Guilford (2017): fluency, flexibility, originality, and elaboration.

Methods

Research Design and Approach

This research uses a quantitative, descriptive, exploratory design. The purpose of this approach is to systematically describe the profile of teachers' creative thinking skills in implementing chemistry learning at the Senior High School (SMA) level, based on questionnaire data analysed quantitatively (Sugiyanto et al., 2018; Pongkendek et al., 2022).

According to Creswell & Creswell (2017), a quantitative descriptive approach is suitable for describing population characteristics or social phenomena based on numerical data. In the context of this study, data were obtained through a closed questionnaire developed from Guilford's (2017) theoretical framework of creative thinking ability and processed quantitatively to yield general and detailed descriptions.

Subjects and Research Location

The subjects of this study were 21 high school chemistry teachers from 21 schools across various provinces in Indonesia. This number is considered adequate for exploratory studies using questionnaire instruments, as it emphasises depth of profile rather than generalisation (Pugu et al., 2024;

Iskandar et al., 2023). The selection of subjects was carried out using purposive sampling, with the criteria that teachers who actively teach chemistry in high school and are willing to serve as respondents in the preliminary test of this study.

Research Instrument

The instrument used in this study is a questionnaire on teachers' creative thinking ability in implementing chemistry instruction, developed based on Guilford's theoretical framework. This questionnaire is arranged in the form of a 5-point Likert scale and includes four indicators of creative thinking ability, namely:

- 1) Fluency
- 2) Flexibility
- 3) Originality
- 4) Elaboration

The questionnaire underwent expert validation by three chemistry education specialists, who evaluated item clarity, relevance, and representativeness. The Item-level Content Validity Index (I-CVI) ranged from 0.80 to 1.00, meeting the minimum criterion of a valid instrument (Kipli & Khairani, 2020; Aksah et al., 2021; Zahra & Subekti, 2025). Cronbach's Alpha reliability coefficient was 0.87, indicating high internal consistency (Ekolu & Quainoo, 2019; Forester et al., 2024).

The teacher's creative thinking ability questionnaire lattice for implementing chemistry learning is shown in **Table 1**.

Table 1. Student creative thinking skills questionnaire grids

Indicator	Description	Question
Fluency	generate many ideas or solutions to a problem or task	1, 2, 3, 4,
	provide many ways or suggestions for doing things	5
Flexibility	thinks of more than one answer	6, 7, 8, 9,
	generate different or diverse ideas for a problem or task	
	Look at a problem from different points of view	
	Look for many alternatives or different directions	
Originality	able to change approach or way of thinking	10
	able to present original ideas that have not been presented before	
	think of an unusual way to make unusual combinations of parts	
	able to enrich and develop an idea or product	
Elaboration	able to add or elaborate on details of an object, an idea	16, 17,
		18, 19,
		20

Data Collection Technique

Data collection was conducted online by distributing digital questionnaires via Google Forms to teachers. Teachers were asked to answer all statements based on their actual classroom practice in teaching chemistry.

Data Analysis Techniques

The data obtained were analysed quantitatively using percentages to determine the

distribution of respondents into five categories of creative thinking ability, namely:

Table 2. Categorisation of creative thinking skills from questionnaire results

Percentage (%)	Category of Creative Thinking Skills
84-100	Very Good
68-83	Good
52-67	Fair
36-51	Poor
20-35	Very Poor

(Modification of Nuraini & Hidayah, 2022).

Furthermore, the profile of teachers' creative thinking skills was analysed based on the overall results and each indicator to provide a comprehensive and specific picture.

Research Ethics

This study was conducted in accordance with the principles of research ethics. All participants were informed of the study's purpose and assured of the confidentiality of their personal data. Participation was voluntary and without coercion.

Results and Discussion

Overview of Teachers' Creative Thinking Ability

Table 3. Results of the teacher's creative thinking ability questionnaire

Creative thinking category	Number of Teachers	Percentage (%)
Very Good	14	66,67
Good	6	28,57
Fair	1	4,76
Poor	0	0
Very Poor	0	0
Total	21	100

Based on Table 3 above, the respondents, who were chemistry teachers, generally have good pedagogical awareness and capacity to support creativity-based learning. Teachers with substantial professional experience and exposure to Higher Order Thinking Skills (HOTS) training tend to adopt teaching practices that facilitate creative thinking (Gradini et al., 2025; Cojorn, 2024; Puspitasari, 2025). Teachers' ability to create a learning environment that provides space for exploration, open reasoning, and expression of ideas is an important indicator of the successful integration of creativity in chemistry learning.

Analysis of Each Indicator of Creative Thinking Ability

To identify the most dominant dimensions and those that still need strengthening, the four indicators of creative thinking based on Guilford's theory (Guilford, 2017) were analysed. The results are as follows:

Table 4. Profile of creative thinking ability indicators based on questionnaires

Indicator	Percentage (%)	Category
<i>Fluency</i>	91,23	Very Good
<i>Flexibility</i>	84,95	Very Good
<i>Originality</i>	80,38	Good
<i>Elaboration</i>	86,67	Very Good
Total	85,81	Very Good

Fluency

This indicator obtained the highest score (91.23%) and was classified as very good. This shows that teachers can create ample space for students to convey many ideas and solutions during chemistry instruction. This is reflected in the teachers' practice of giving sufficient time, encouraging the exploration of ideas, and avoiding judgment of students' answers.

Success in this dimension indicates that teachers already understand the importance of providing students with space for divergent thinking (Veerasingham et al., 2021; Nemetallah & Darwesh, 2024; Ratno et al., 2024). Learning that is not overly focused on a single answer allows students to explore chemical concepts through a variety of creative approaches.

Flexibility

The flexibility score is also high (84.95%) and classified as excellent. Teachers tend to accept various problem-solving approaches, provide space for diverse points of view, and adapt learning strategies to the specific context of each student.

This dimension is important because teachers' cognitive flexibility can open opportunities for students to think across concepts and form meaningful connections between chemistry concepts (Honra & Monterola, 2024; Elsaidawy, 2024). A flexible teacher not only changes methods but also understands students' varied thought processes.

Origination

The originality indicator has the lowest score (80.38%), although it is still in the good category. This finding shows that teachers are relatively less than optimal at stimulating or accommodating students' unique and unconventional ideas. This may be influenced by standardised curricula that prioritise procedural answers, administrative workload that limits time for creativity, and limited autonomy in lesson design (Nugraha et al., 2023; Tanjua et al., 2024). This trend is consistent with Anderson et al. (2022), who found that systemic constraints reduce teachers' opportunities to express original ideas.

In fact, originality is the core of creativity. According to Purwanto et al. (2024), learning that is too locked into procedural structures will inhibit the emergence of innovative original ideas. Therefore, training and open learning models, such as problem-

based or inquiry-based learning, that provide a safe space for thinking outside the box are needed (Cahyani et al., 2022).

Elaboration

Elaboration is also high (86.67%), indicating that the teacher has encouraged students to elaborate on and develop the ideas they expressed. This is shown by writing scientific reasoning, explaining problem-solving steps, and giving feedback on students' ideas.

The elaboration dimension is closely related to scientific communication skills. Teachers who provide elaborative space tend to help students engage in metacognitive reflection and significantly improve science literacy (Tang, 2020; Maharani et al., 2024). It also strengthens students' arguments by helping them convey ideas logically and systematically.

Reflections and Implications of Research Results

The results of this study provide an important reflection: chemistry teachers in Indonesia already have a solid capacity for creative thinking, particularly in providing an exploratory space (fluency), flexible thinking, and idea development (elaboration). However, challenges regarding originality still arise, often not naturally emerging in learning due to time constraints, standardised curricula, or a normative teacher mindset.

The results align with previous studies indicating that Indonesian teachers generally excel in fluency, flexibility, and elaboration while struggling with originality due to structural limitations (Nugraha et al., 2023; Ratno et al., 2024; Tanjua et al., 2024). This suggests a national pattern that requires targeted professional development focused on innovative instructional design.

Therefore, it is necessary to strengthen teachers' pedagogical competence in designing learning experiences that challenge students' originality, for example, through creative problem-solving, STEM-based inquiry, or context-based issue-based projects.

In addition, these results can serve as a basis for self-evaluation by teachers and education stakeholders (schools, education offices, universities) to develop professional training programs grounded in creativity, not only in content knowledge but also in innovative strategies to foster creative students.

Conclusions

This study concludes that chemistry teachers in senior high schools demonstrate strong creative thinking abilities, particularly in fluency, flexibility, and elaboration. Originality, however, remains the weakest dimension, underscoring the need for greater pedagogical autonomy and targeted professional development programs that help teachers design unique, innovative instructional

strategies. Strengthening originality is essential to preparing students to become creative and critical thinkers, consistent with the goals of modern science education.

Conflict of Interest

The authors declare no conflict of interest in the conduct and reporting of this research.

Acknowledgment

The authors would like to thank all chemistry teachers who have participated in this study.

References

- Aksah, H., Johar, S., Usman, I. M., & Che-Ani, A. I. (2021). Design and implementation of content validity: instrument development for evaluating functional building performance. *WSEAS Trans on Environment and Development*, 17(9), 973–982.
<https://doi.org/10.37394/232015.2021.17.90>
- Amelia, U. (2023). Tantangan pembelajaran era society 5.0 dalam perspektif manajemen pendidikan. *Al-Marsus: Jurnal Manajemen Pendidikan Islam*, 1(1), 68–82.
<https://doi.org/10.30983/al-marsus.v1i1.6415>
- Anderson, R. C., Katz-Buonincontro, J., Bousset, T., Mattson, D., Beard, N., Land, J., & Livie, M. (2022). How am I a creative teacher? beliefs, values, and affect for integrating creativity in the classroom. *Teaching and Teacher Education*, 110, 1–13.
<https://doi.org/10.1016/j.tate.2021.103583>
- Cahyani, C. D., Suyitno, A., & Pujiastuti, E. (2022). Studi literatur: model pembelajaran blended learning dalam meningkatkan kemampuan berpikir kreatif dan rasa ingin tahu siswa dalam pembelajaran matematika. *Prisma, Prosiding Seminar Nasional Matematika* (pp. 272–281). Semarang: Universitas Negeri Semarang.
- Craft, A. (2010). *Creativity and education futures: Learning in a digital age*. Amerika Serikat: ERIC.
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: qualitative, quantitative, and mixed methods approaches*. London: Sage Publications.
- Ekolu, S. O., & Quainoo, H. (2019). Reliability of assessments in engineering education using cronbach's alpha, KR and split-half methods. *Global Journal of Engineering Education*, 21(1), 24–29.
<https://www.wiete.com.au/journals/GJEE/Publish/vol21no1/03-Ekolu-S.pdf>
- Elsaidawy, R. A. (2024). Proposed enrichment activities based on cognitive flexibility theory (CFT) to treat difficulties in learning chemistry in english and develop motivation among students of official language secondary schools. *Journal of Scientific Research in Education*, 25(3), 311–402.
<https://doi.org/10.21608/jsre.2024.266195.1654>

- Fakhriyah, F., Masfuah, S., & Hilyana, F. S. (2022). *TPACK dalam pembelajaran IPA*. Jawa Tengah: Penerbit NEM.
- Fitriyani, Y., Supriatna, N., & Sari, M. Z. (2021). Pengembangan kreativitas guru dalam pembelajaran kreatif pada mata pelajaran IPS di sekolah dasar. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, 7(1), 97–109. <https://doi.org/10.33394/jk.v7i1.3462>
- Forester, B. J., Khater, A. I. A., Afgani, M. W., & Isnaini, M. (2024). Penelitian kuantitatif: Uji reliabilitas. *EDU SOCIETY: Jurnal Pendidikan, Ilmu Sosial Dan Pengabdian Kepada Masyarakat*, 4(3), 1812–1820. <https://doi.org/10.56832/edu.v4i3.577>
- Guilford, J. P. (2017). Creativity: a quarter century of progress. In *Perspectives in creativity* (pp. 37–59). Ingggris: Routledge.
- Honra, J. R., & Monterola, S. L. C. (2024). Fostering cognitive flexibility of students through design thinking in biology education. *Cogent Education*, 11(1), 1–14. <https://doi.org/10.1080/2331186X.2024.2415301>
- Iskandar, A., Fitriani, R., Ida, N., & Sitompul, P. H. S. (2023). *Dasar metode penelitian*. Makassar: Cendekiawan Inovasi Digital Indonesia.
- Jamal, S. N., Ibrahim, N. H., Halim, N. D. A., & Surif, J. (2020). Validity and reliability of chemistry creativity test for Malaysian chemistry students. *PalArch's Journal of Archaeology of Egypt/Egyptology*, 17(7), 4379–4397. <https://archives.palarch.nl/index.php/jae/article/view/2438/2389>
- Jegstad, K. M. (2024). Inquiry-based chemistry education: a systematic review. *Studies in Science Education*, 60(2), 251–313. <https://doi.org/10.1080/03057267.2023.2248436>
- Kapici, H. Ö. (2023). From Symbolic Representation to Submicroscopic One: Preservice Science Teachers' Struggle with Chemical Representation Levels in Chemistry. *International Journal of Research in Education and Science*, 9(1), 134–147. <https://doi.org/10.46328/ijres.3122>
- Kipli, M., & Khairani, A. Z. (2020). Content validity index: an application of validating cipp instrument for programme evaluation. *Ioer International Multidisciplinary Research Journal*, 2(4), 31–40. <https://doi.org/10.54476/iimrj313>
- Lin, C. Y., & Wu, H. K. (2021). Effects of different ways of using visualizations on high school students' electrochemistry conceptual understanding and motivation towards chemistry learning. *Chemistry Education Research and Practice*, 22(3), 786–801. <https://doi.org/10.1039/D0RP00308E>
- Maharani, R., Marsigit, M., Wijaya, A., & Muqoddaroh, F. (2024). Pengembangan video animasi melalui capcut berbasis model pembelajaran metakognisi kolaboratif pada konten fenomena pertumbuhan untuk meningkatkan literasi matematika. *Jurnal Tadris Matematika*, 7(2), 159–174. <http://dx.doi.org/10.21274/jtm.2024.7.2.159-174>
- Morris, D. L. (2025). Rethinking science education practices: Shifting from investigation-centric to comprehensive inquiry-based instruction. *Education Sciences*, 15(1), 1–18. <https://doi.org/10.3390/educsci15010073>
- Munawwarah, M., & Cahyani, V. P. (2025). Pedagogical content knowledge in chemistry education: its significance for pre-service chemistry teachers. *Journal of Tropical Chemistry Research and Education*, 7(1), 61–75. <https://doi.org/10.14421/jtcre.2025.71-06>
- Nemt-allah, M., & Darwesh, A. (2024). Fostering flexible minds: the effect of probing questions in enhancing divergent thinking in geography. *Journal of Palestine Ahliya University for Research and Studies*, 3(2), 45–57. <https://orcid.org/0009-0001-0908-4648>
- Nugraha, I. R. R., Supriadi, U., & Firmansyah, M. I. (2023). Efektivitas strategi pembelajaran project based learning dalam meningkatkan kreativitas siswa. *Jurnal Penelitian Dan Pendidikan IPS*, 17(1), 39–47. <https://doi.org/10.21067/jppi.v17i1.8608>
- Nuraini, S., & Hidayah, R. (2022). Profil keterampilan berpikir kreatif peserta didik dan media pembelajaran yang sesuai pada materi ikatan kimia di SMA. *Prosiding Seminar Nasional Kimia*, (pp. 85–93). Semarang: Universitas Negeri Semarang.
- Nurmilawati, S., Agung, S., & Murniati, D. (2021). Identifikasi pengetahuan dan kompetensi sains siswa berdasarkan socio-scientific issues (SSI) pada materi sistem koloid. *Jurnal Riset Pendidikan Kimia*, 11(1), 35–40. <https://doi.org/10.21009/JRPK.111.06>
- Pongkendek, J. J., Ahmar, D. S., Munandar, H., & Azzajjad, M. F. (2022). Student perceptions of online learning during the covid-19 pandemic. *EduLine: Journal of Education and Learning Innovation*, 2(1), 1–16. <https://doi.org/10.35877/454RI.eduline607>
- Pongkendek, J., Marpaung, D., & Parlindungan, J. (2021). The use of chemsketch to increase student learning outcomes and motivation in learning hydrocarbons. *Jurnal Pembelajaran Kimia*, 6(1), 9–18. <https://doi.org/10.17977/um026v6i12021p009>

- Pongkendek, J., Parlindungan, J., & Sumanik, N. (2019). The development of direct learning strategies in topic solubility and solubility product. *International Conference on Social Science 2019 (ICSS 2019)* (pp. 177–181). Belanda: Atlantis Press.
<https://doi.org/10.2991/icss-19.2019.211>
- Pugu, M. R., Riyanto, S., & Haryadi, R. N. (2024). *Metodologi Penelitian; Konsep, Strategi, dan Aplikasi*. Jambi: PT. Sonpedia Publishing Indonesia.
- Purwanto, A., Suryadi, S., Nursifah, N., & Istiqomah, I. (2024). Perilaku inovatif guru melalui kepemimpinan transformasional, knowledge sharing, dan kompetensi digital. *Indo-MathEdu Intellectuals Journal*, 5(6), 7752–7762.
<https://doi.org/10.54373/imeij.v5i6.2145>
- Rahmah, A., & Widjajanti, E. (2025). Experiential learning and its impact on chemistry education : a systematic review of research trends. *Jurnal Pendidikan Kimia Indonesia*, 9(1), 1–12.
<https://doi.org/10.23887/jpki.v9i1.100440>
- Rahmawati, Y., Ridwan, A., Hadinugrahaningsih, T., & Soeprijanto. (2019). Developing critical and creative thinking skills through STEAM integration in chemistry learning. *Journal of Physics: Conference Series*, (pp. 1-7). Inggris: IOP Publishing.
- Ramadhan, M. R., & Ijirana. (2023). Analysis of the critical thinking skills of students in senior high school in solving the reaction rate problem. *Jurnal Akademika Kimia*, 12(4), 216–220.
<https://doi.org/10.22487/j24775185.2023.v12.i4.pp216-220>
- Raman, Y., Surif, J., & Ibrahim, N. H. (2024). The effect of problem based learning approach in enhancing problem solving skills in chemistry education: a systematic review. *International Journal of Interactive Mobile Technologies*, 18(5), 91–111.
<https://doi.org/10.3991/ijim.v18i05.47929>
- Ratno, S., Rahmadani, S., Purba, E. J., Silalahi, R., Saragih, A. B., Prajaya, M. G., & Sinurat, S. F. (2024). Analisis pengaruh kreativitas guru terhadap pengembangan kreativitas siswa dan keterampilan belajar siswa kelas 6 di SDN 106163 Bandar Klippa. *Katalis Pendidikan: Jurnal Ilmu Pendidikan Dan Matematika*, 1(4), 211–220.
<https://doi.org/10.62383/katalis.v1i4.982>
- Runco, M. A. (2023). *Creativity: Research, development, and practice*. New York: Academic Press.
- Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creativity Research Journal*, 24(1), 66–75.
<https://doi.org/10.1080/10400419.2012.652929>
- Santos, V. C., & Arroio, A. (2016). The representational levels: influences and contributions to research in chemical education. *Journal of Turkish Science Education*, 13(1), 3–18. <https://doi.org/10.36681/>
- Sternberg, R. J. (2021). Adaptive intelligence: Its nature and implications for education. *Education Sciences*, 11(12), 1–12.
<https://doi.org/10.3390/educsci11120823>
- Sugiyanto, F. N., Masykuri, M., & Muzzazinah. (2018). Analysis of senior high school students' creative thinking skills profile in Klaten regency. *Journal of Physics: Conference Series*, (pp. 1-5). Inggris: IOP Publishing.
<https://doi.org/10.1088/17426596/1006/1/012038>
- Syafitri, I., Haryanto, H., Fuldijatman, F., Rusdi, M., Afrida, A., & Yusnidar, Y. (2022). Pengaruh model PBL berbasis etnosains terhadap kemampuan berpikir kreatif siswa pada materi hidrolisis garam. *Hydrogen: Jurnal Kependidikan Kimia*, 10(2), 224–235.
<https://doi.org/10.33394/hjkk.v10i2.5723>
- Tang, K. S. (2020). The use of epistemic tools to facilitate epistemic cognition & metacognition in developing scientific explanation. *Cognition and Instruction*, 38(4), 474–502.
<https://doi.org/10.1080/07370008.2020.1745803>
- Tanjua, A. L., Dewi, D. E. C., Puspasari, N., Nugraha, H., & Meylindo, D. (2024). Kinerja guru dan permasalahannya. *Sinar Dunia: Jurnal Riset Sosial Humaniora Dan Ilmu Pendidikan*, 3(4), 161–171.
<https://doi.org/10.58192/sidu.v3i4.2729>
- Veerasingham, K., Balakrishnan., Damanhuri, M. I. M., & Gengatharan, K. (2021). Design thinking for creative teaching of chemistry. *International Journal of Academic Research in Business and Social Sciences*, 11(3), 670–687.
<http://dx.doi.org/10.6007/IJARBS/v11-i3/8979>
- Yao, J. (2023). Exploring experiential learning: enhancing secondary school chemistry education through practical engagement and innovation. *Journal of Education, Humanities and Social Sciences*, 22(1), 475–484.
<https://doi.org/10.54097/ehss.v22i.12508>
- Zahra, D. Z. A., & Subekti, H. (2025). Validasi modul ajar berbasis keterampilan proses sains menggunakan content validity index (CVI). *BIOCHEPY: Journal of Science Education*, 5(1), 613–617.
<https://doi.org/10.52562/biochephy.v5i1.1602>