



Analysis of Food Vlog Media Integrated Ethnoscience Usage on Students' Critical Thinking Skill

**Indah Beti Lestari, Deni Darmawan, Laksmi Dewi, Yulia Rahmawati*

**Curriculum Development Department, Universitas Pendidikan Indonesia, Bandung, Indonesia*

*Correspondence: E-mail: indah8371@upi.edu

ABSTRACT

This study investigates the effect of implementing Food Vlog media in ethnoscience-integrated science instruction on students' critical thinking skills. The research employed a quantitative approach using a reasoned multiple-choice test to assess students' critical thinking. The participants were middle school students (SMP and MTs) engaged in science learning activities designed with ethnoscience content and supported by Food Vlog-based media. Data were collected through pre-tests and post-tests, and analyzed using parametric statistical methods. A paired sample t-test was conducted using SPSS (Statistical Package for the Social Sciences) to determine the statistical significance of the differences in students' scores before and after the intervention. The results indicated a significance value of 0.000, which is below the threshold of 0.005, confirming a statistically significant improvement. The N-Gain test further demonstrated that the improvement in students' critical thinking skills falls within the medium category for both SMP and MTs groups. These findings suggest that the use of Food Vlog media in ethnoscience-integrated science learning contributes positively to the development of critical thinking skills. The study highlights the pedagogical potential of combining digital media and cultural content to foster meaningful cognitive engagement in science education.

ARTICLE INFO

Article History:

Submitted/Received 12 Aug 2024
First Revised 01 Oct 2024
Accepted 23 Nov 2024
First Available Online 28 Nov 2024
Publication Date 01 Dec 2024

Keyword:

Analysis, Critical Thinking, Ethnoscience, Food Vlog, Skills.

1. INTRODUCTION

Learning media is a teaching tool that allows teachers to give learning materials while enhancing student creativity and interest in learning (Susilana et al., 2024; Tafonao, 2018). Learning media makes students' attention more focused and critical in education. One of the media that can steal students' attention is Vlog media. A vlog or Video Blog is a blog in the form of videos. In general, the most significant element of a Vlog is that a person creates their own experience and broadcasts it as a video on various platforms such as YouTube, Vimeo, Dailymotion, and Facebook, and the individuals who produce the video are referred to as "Vloggers" (Fidan & Debbag, 2018). A Vlog is a video feature that gives online announcements that allow anybody to produce and contribute content, the film collection is a documentary audio-visual lifestyle and communication vehicle (Kumar & Singh, 2024; Maulidah, 2018). Vlogs can be developed as single photo recordings or by combining several images/photos. With available software, it is possible to edit the film and integrate it with the audio or integrate more than one recording into one embodiment to become a coherent Vlog recording (Snelson, 2015). The process of creating a vlog typically involves several stages, including selecting a topic, choosing a suitable web-host platform, developing a compelling title, organizing the content, uploading the video, sharing it on relevant platforms, and periodically updating the vlog to maintain engagement (Izzah & Hadi, 2018).

Prior studies have demonstrated that vlog media has considerable potential to enhance the learning experience across various disciplines. Its effectiveness as an instructional tool has been affirmed in studies exploring its application in classroom contexts (Al Hibra et al., 2019; Wang, 2017). The integration of vlog-based learning has been shown to improve student motivation and confidence, particularly in language instruction environments (Sari, 2018; Toha et al., 2020). In vocational education, vlog media has contributed to the development of students' English language proficiency, offering engaging and contextually relevant learning experiences (Arumsari et al., 2019; Debbag & Fidan, 2022). In the field of science education, STEM-oriented vlog content has proven suitable for supporting online learning and facilitating conceptual understanding (Huang et al., 2022; Karatay et al., 2024).

Despite its promise, the use of vlog media in science education, particularly when integrated with local cultural contexts, remains underexplored. Ethnoscience, which incorporates indigenous knowledge and local wisdom into scientific concepts, offers a culturally relevant framework for learning. Integrating vlog media with ethnoscience-based content provides a rich context for meaningful learning, bridging everyday experiences with academic knowledge. The inclusion of students' cultural backgrounds in science education has been shown to enhance engagement and conceptual understanding (Decristan et al., 2015; Rahmawati et al., 2023).

This integration aligns with constructivist theories, notably Piaget's emphasis on learning through experience and Ausubel's theory of meaningful learning, which underscores the connection between new information and existing cognitive structures (Agra et al., 2019). Ethnoscience-based vlog media engage students in inquiry-driven tasks, such as investigating the roles of food additives and responding to peer interactions on online platforms. These experiences promote critical reflection and personal meaning-making.

Critical thinking is a fundamental cognitive ability, especially within the demands of the Fourth Industrial Revolution, as it empowers learners to interpret information critically, recognize underlying patterns, formulate logical conclusions, and address complex challenges. This skill set is further elaborated in a critical thinking framework that includes components such as explanation, inference, and strategic problem-solving, which are

essential for engaging with modern scientific problems (Dwyer et al., 2014). Other scholars also emphasize critical thinking as central to intelligent information processing, highlighting its significance in both academic contexts and real-life decision-making processes (Afwiyana, 2019; Butler et al., 2017; Zubaidah, 2018).

The topic of food additives provides an ideal context for applying critical thinking within science education. Students must evaluate the safety, purpose, and implications of various chemical substances used in food preservation and flavor enhancement. By situating these discussions within culturally relevant vlog media, educators can cultivate scientific literacy and civic responsibility. Students become more aware of food safety and the environmental and health implications of food consumption practices (Görür Topalcengiz, 2021)

Existing studies have yet to examine the combined use of ethnoscience and vlog media in developing students' critical thinking skills. Most prior work has examined these elements independently, leaving a gap in understanding their synergistic potential. This study addresses that gap by investigating the effect of ethnoscience-integrated vlog media on students' critical thinking in science classrooms. Therefore, the purpose of this study is to analyze the impact of Food Vlog media, integrated with ethnoscience content, on enhancing students' critical thinking skills in middle school science education. The findings are expected to contribute to the development of culturally responsive pedagogy and innovative science instruction that aligns with 21st-century competencies.

2. METHODOLOGY

2.1 Research Design

This study employed a quantitative research design to examine the impact of Food Vlog media integrated with ethnoscience on students' critical thinking skills in science education. The design involved a pre-test and post-test approach to assess students' performance before and after the implementation of the intervention. The assessment was conducted using a reasoned multiple-choice test developed to measure critical thinking specifically within the topic of food and drink additives.

2.2 Data Collection

Students' critical thinking skills were evaluated using a reasoned multiple-choice instrument. The test was aligned with the minimum completeness criteria (KKM) for the topic, which was set at 73. Classical learning completeness was defined as being achieved if at least 75% of students scored at or above the KKM. The test was administered before and after the implementation of the Food Vlog media to capture changes in critical thinking abilities. Pre-test and post-test data were collected from the same group of students to ensure consistency.

2.3 Data Analysis

Quantitative data from the pre-test and post-test were analyzed using SPSS (Statistical Package for the Social Sciences). The analysis began with a normality test to determine whether the data were normally distributed. If the assumption of normality was met, the paired sample t-test was employed to examine whether the differences in students' critical thinking scores before and after the intervention were statistically significant. The hypotheses for this study were as follows:

- H0: There is no statistically significant difference in critical thinking skills between pre-test and post-test scores, indicating that Food Vlog media in ethnosience-integrated science instruction does not affect critical thinking.
- Ha: There is a statistically significant difference in critical thinking skills between pre-test and post-test scores, suggesting that Food Vlog media in ethnosience-integrated science instruction has an effect on critical thinking.

Decision-making was based on the significance value obtained from SPSS output. If the p-value was less than 0.05, the null hypothesis (H0) was rejected, and the alternative hypothesis (Ha) was accepted. To determine the magnitude of the improvement in critical thinking skills, normalized gain (N-Gain) scores were calculated using the formula proposed by Meltzer (2002). The N-Gain index measures the effectiveness of the intervention in terms of relative improvement from pre-test to post-test. The classification for interpreting N-Gain scores followed the criteria outlined by Hake (1999), as shown in Table 1.

Table 1. Interpretation Classification $\langle g \rangle$

$\langle g \rangle$	Interpretation
$\langle g \rangle \geq 0.7$	High
$0.3 \leq \langle g \rangle \leq 0.7$	Currently
$\langle g \rangle < 0.3$	Low

3. RESULT AND DISCUSSION

3.1 Result

The results of the pre-test and post-test provided empirical evidence of students' critical thinking performance. The pre-test served to establish baseline data regarding students' initial cognitive abilities in analyzing chemical substances found in food and beverages. Following the integration of Food Vlog media within the ethnosience-based science learning framework, a post-test was administered to assess the progression of students' critical thinking skills. The pre-test findings indicated that only a small proportion of students demonstrated mastery of the content, with the average score falling below the established competency threshold. In contrast, the post-test results showed a complete improvement in student performance, with all participants achieving scores above the minimum mastery criteria and a substantial increase in average achievement levels. To determine the statistical significance of this improvement, a paired sample t-test was conducted. Prior to the test, data normality was verified using the Shapiro-Wilk test in SPSS (Statistical Package for the Social Sciences), which confirmed the suitability of parametric analysis. The statistical outcomes underscore the effectiveness of Food Vlog media in enhancing students' critical thinking skills in the context of culturally integrated science instruction.

Table 2. Critical Thinking Pre-Posttest Normality Test Results

Test	Sig. Shapiro-Wilk	Information
Pretest	0,168	Normally distributed
Post-test	0,079	Normally distributed

After the data has been declared normal, the t-test using a paired sample t-test to determine the average difference between critical thinking skills from the pretest and post-test results can be performed to assess the influence of using Food Vlog media in the context of Ethnosains integrated science learning critical thinking skills or not can be performed.

Table 3. Test Results of the Influence of Media on Critical Thinking

	N	Correlation	T	Sig.
Pretest & Posttest	48	0,094	13,100	0,000

The relevance of the SPSS output is considered as the basis for decision-making. If the significance value is less than 0.05, H_0 is rejected, and H_a is accepted; if the significance value is more significant than 0.05, H_0 is accepted, and H_a is rejected. The paired sample t-test findings on the SPSS output reveal that the significance value achieved is $0.000 < 0.005$, indicating that H_0 is rejected and H_a is accepted. The paired sample t-test results show an average difference between critical thinking skills from the pretest and post-test results, implying that the use of Food Vlog media in the context of Ethnoscience integrated science learning impacts critical thinking skills.

We continued to conduct the N-Gain test after discovering an effect between Food Vlog media in the setting of Ethnoscience integrated science learning and critical thinking abilities. The N-Gain exam also determined how much students' critical thinking abilities increased after being treated with Food Vlog media in the context of Ethnoscience integrated science instruction. The following N-Gain test results are shown in Table 4.

Table 4. Critical Thinking N-Gain Test Results

Education units	N-Gain	Criteria
MTs Al Uswah Bergas	0,43	Currently
SMP 1 Bergas	0,55	Currently

The N-Gain test results show that the scores for SMP and MTs are both in the medium category. However, the SMP score is still superior, namely 0.55, while the MTs score shows an increase of 0.43.

3.2 Discussion

Food Vlog media in the framework of ethnoscience-integrated science instruction is also designed to foster students' critical thinking abilities. Prior studies have shown that the use of interactive media in learning can significantly support this objective, particularly when the media is contextually relevant to the subject matter (Johan et al., 2022; Zulhelmi et al., 2017). Interactive multimedia has also been proven to enhance students' critical thinking capabilities, as demonstrated by differences in essay performance and observational data between control and experimental groups (Sa'adah et al., 2020; Yakob et al., 2020). As a form of interactive learning media, ethnoscience-integrated Food Vlog serves as a suitable pedagogical tool in this regard.

Critical thinking is broadly defined as a problem-solving competency that involves engaging with multiple objects and abstract concepts (Sholihah & Lastariwati, 2020; Sidiq et al., 2021).

It includes the capacity to formulate problems, compare facts, and evaluate arguments based on logic and relevance to arrive at well-supported conclusions (Ahmad, 2021). In this study, students' critical thinking skills were measured using reasoned multiple-choice items aligned with key cognitive indicators. The paired sample t-test revealed a positive impact of Food Vlog media on students' scientific learning outcomes and critical thinking development.

This finding is consistent with prior research emphasizing the importance of media-content alignment in fostering higher-order thinking (Zhu et al., 2021; Zulhelmi et al., 2017). As an audio-visual tool, vlog media presents information through text, graphics, and sound, which can significantly increase student motivation and attention in the learning process (Dewi & Rimpiati, 2016; Xie et al., 2021). Furthermore, incorporating local cultural knowledge through ethnoscience integration has been shown to enhance both cognitive engagement and attitudes toward local wisdom (Johan et al., 2020; Rahmawati et al., 2020; Wibowo & Ariyatun, 2020).

Assessment of critical thinking in this study was based on five key indicators: elementary clarification, essential support, inference, advanced clarification, and strategic thinking. The N-Gain analysis showed an improvement in students' performance across these indicators, with gains linked to specific improvements in each critical thinking component. The first indicator, elementary clarification, involved students' ability to analyze questions, recognize key arguments, and provide direct responses to scenario-based prompts. The second indicator, essential support, tested students' capacity to evaluate the credibility of questions and interpret textual information using higher-order thinking, particularly within the cognitive domain C5.

Inference, the third indicator, focused on students' ability to synthesize information and draw logical conclusions. Students initially struggled with this, but showed marked improvement after engaging with vlog-based content. The fourth indicator, advanced clarification, required students to interpret abstract assumptions and provide deeper analytical explanations, assessed through a range of cognitive levels from C3 to C5. Finally, strategic thinking evaluated students' problem-solving approaches, where they identified challenges, formulated solutions, and justified their reasoning. This aspect was also supported by questions aligned to cognitive levels C3 through C5. Although students' pretest scores indicated low initial proficiency in critical thinking, substantial improvement was observed following the intervention with Food Vlog media, as supported by the N-Gain outcomes.

This research holds important implications for both pedagogy and technology integration. The use of Food Vlog media not only enhances the engagement of science learning by providing visually and aurally appealing content, but also encourages deeper cognitive processing as students analyze information and present arguments effectively. The reflective nature of this learning model promotes the development of critical thinking, while also advancing digital literacy and communication competencies. If implemented successfully, this approach has the potential to transform students' attitudes toward science, fostering greater enthusiasm and confidence in engaging with complex scientific concepts. Nonetheless, its effectiveness may vary depending on instructional design and technological infrastructure available within the learning environment.

4. CONCLUSION

The study concludes that the integration of Food Vlog media within ethnoscience-based science instruction effectively fosters the development of students' critical thinking skills. The implementation of this media resulted in a meaningful improvement in students' ability to

analyze, evaluate, and reflect on scientific concepts grounded in real-life cultural contexts. The consistent difference in learning outcomes before and after the intervention demonstrates the media's capacity to enhance cognitive engagement in science learning. Further analysis revealed that the learning gains varied between educational institutions, with students in certain school contexts showing greater improvements. This suggests that institutional environment and readiness may play a role in optimizing the benefits of ethnoscience-integrated media.

The significance of this research lies in its contribution to innovative, culturally relevant pedagogy that aligns with contemporary educational reforms. By embedding local knowledge within digital learning environments, Food Vlog media supports meaningful learning experiences and strengthens students' connection to scientific content. This approach not only enriches science education but also supports the broader goals of character development and cultural preservation. Future research is encouraged to explore the adaptability of this media model across different learning domains and age groups. Investigating its long-term impact on skills such as self-regulated learning, collaboration, and scientific literacy could further establish its role as a transformative tool in education.

REFERENCES

- Afwiyana, N. D., & Amrozi, Y. (2019). Langkah cerdas bermedia sosial di kalangan santri milenial. *SAINTEKBU*, 11(2), 39-44. <https://doi.org/10.32764/saintekbu.v11i2.361>
- Agra, G., Formiga, N. S., Oliveira, P. S. D., Costa, M. M. L., Fernandes, M. D. G. M., & Nóbrega, M. M. L. D. (2019). Analysis of the concept of Meaningful Learning in light of the Ausubel's Theory. *Revista brasileira de enfermagem*, 72, 248-255. <https://doi.org/10.1590/0034-7167-2017-0691>
- Ahmad, D. N. (2021). Analysis of SAVI learning model with the task of observation of video on science learning in producing analytical thinking and critical thinking abilities. *Jurnal Penelitian Pendidikan IPA*, 7(1), 121-128. <https://doi.org/10.29303/jppipa.v7i1.543>
- Al Hibra, B., Hakim, L., & Sudarwanto, T. (2019). Development of vlog learning media (video tutorial) on student materials. Tax at SMK PGRI 1 Jombang. *International Journal of Educational Research Review*, 4(3), 435-438. <https://doi.org/10.24331/ijere.573945>
- Arumsari, A., Octaviani, S. K., & Pravitasari, S. G. (2019). The Implementation of Video Blogging to Improve English Speaking Skill and English Learning Motivation of Eleventh Grade Students. *International Journal of English Linguistics, Literature, and Education (IJELLE)*, 1(2), 60-65. <https://doi.org/10.32585/ijelle.v1i2.537>
- Butler, H. A., Pentoney, C., & Bong, M. P. (2017). Predicting real-world outcomes: Critical thinking ability is a better predictor of life decisions than intelligence. *Thinking Skills and Creativity*, 25, 38-46. <https://doi.org/10.1016/j.tsc.2017.06.005>
- Debbag, M., & Fidan, M. (2022). Vlogs for enhancing trainee teachers' motivational beliefs about school experience and teaching practice: They are on the factory floor for professional development. *Journal of Research on Technology in Education*, 54(5), 719-735. <https://doi.org/10.1080/15391523.2021.1911721>
- Decristan, J., Hondrich, A. L., Büttner, G., Hertel, S., Klieme, E., Kunter, M., ... & Hardy, I. (2015). Impact of additional guidance in science education on primary students'

- conceptual understanding. *The Journal of Educational Research*, 108(5), 358-370. <https://doi.org/10.1080/00220671.2014.899957>
- Dewi, L. M. I., & Rimpiati, N. L. (2016). Efektivitas penggunaan media pembelajaran video interaktif dengan seting diskusi kelompok kecil untuk meningkatkan keterampilan berpikir kritis pada anak usia dini. *Jurnal Pendidikan Universitas Dhyana Pura*, 1(1), 31-46.
- Dwyer, C. P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Thinking skills and Creativity*, 12, 43-52. <https://doi.org/10.1016/j.tsc.2013.12.004>
- Fidan, M., & Debbag, M. (2018). The usage of video blog (Vlog) in the "School Experience" Course: The opinions of the pre-service teachers. *Journal of Education and Future*, 13, 161-177.
- Görür, N., & Topalcengiz, Z. (2021). Food safety knowledge, hygiene practices, and eating attitudes of academics and university students during the coronavirus (COVID-19) pandemic in Turkey. *Journal of Food Safety*, 41(5), e12926. <https://doi.org/10.1111/jfs.12926>
- Hake, R. R. (1999). *Analizing change/gain scores*. Dept of Physics Indiana University.
- Huang, X., Erduran, S., Zhang, P., Luo, K., & Li, C. (2022). Enhancing teachers' STEM understanding through observation, discussion and reflection. *Journal of Education for Teaching*, 48(5), 576-591. <https://doi.org/10.1080/02607476.2021.2006571>
- Izzah, L., & Hadi, M. S. (2018). Pembelajaran introduction to linguistics melalui vlog. *Seminar Nasional Pendidikan Era Revolusi "Membangun Sinergitas Dalam Penguatan Pendidikan Karakter Pada Era IR 4.0,"* 191-198.
- Johan, R. C., Rullyana, G., & Ardiansah, A. (2022). Hyper content e-module in information behavior course with the assistant of screencast. *Journal of Education and Learning (EduLearn)*, 16(2), 210-218. <https://doi.org/10.11591/edulearn.v16i2.20339>
- Johan, R. C., Sutisna, M. R., Rullyana, G., & Ardiansah, A. (2020). Developing online learning communities. In *Borderless Education as a Challenge in the 5.0 Society* (pp. 145-153). Routledge.
- Juwantara, R. A. (2019). Analisis teori perkembangan kognitif piaget pada tahap anak usia operasional konkret 7-12 tahun dalam pembelajaran Matematika. *Jurnal Ilmiah Pendidikan Guru Madrasah Ibtidaiyah*, 9(1), 27-34.
- Karatay, S. K., Bakirci, H., & Bülbül, S. (2024). Mobile learning supported science teaching application: Electric charges and electric energy. *Education and Information Technologies*, 29(15), 19783-19811. <https://doi.org/10.1007/s10639-024-12631-0>
- Kumar, L., & Singh, D. K. (2024). A novel aspect of automatic vlog content creation using generative modeling approaches. *Digital Signal Processing*, 104462. <https://doi.org/10.1016/j.dsp.2024.104462>
- Maulidah, I. (2017, August). Vlog: The mean to improve students' speaking ability. In *International Conference on English Language Teaching (ICONELT 2017)* (pp. 12-15).

Atlantis Press. <https://doi.org/10.2991/iconelt-17.2018.3>

- Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible “hidden variable” in diagnostic pretest scores. *American journal of physics*, 70(12), 1259-1268. <https://doi.org/10.1119/1.1514215>
- Oktariani, O., Febliza, A., & Fauziah, N. (2020). Keterampilan berpikir kritis calon guru kimia sebagai kesiapan menghadapi revolusi industri 4.0. *Journal of Natural Science and Integration*, 3(2), 114-127. <http://dx.doi.org/10.24014/jnsi.v3i2.8791>
- Rahmawati, Y., Ridwan, A., Cahyana, U., & Wuryaningsih, T. (2020). The integration of ethnopedagogy in science learning to improve student engagement and cultural awareness. *Universal Journal of Educational Research*, 8(2), 662-671. <http://dx.doi.org/10.13189/ujer.2020.080239>
- Rifa'i, A., & Anni, C. T. (2011). *Psikologi Pendidikan*. Universitas Negeri Semarang Press.
- Sa'adah, M., Suryaningsih, S., & Muslim, B. (2020). Pemanfaatan multimedia interaktif pada materi hidrokarbon untuk menumbuhkan keterampilan berpikir kritis siswa. *Jurnal Inovasi Pendidikan IPA*, 6(2), 184-194. <https://doi.org/10.21831/jipi.v6i2.29680>
- Sari, P. (2017). Using vlog in the youtube channel as a means to improve students' motivation and confidence to speak english in intermediate 1 level of LB-LIA Jambi. *International Journal of Language Teaching and Education*, 1(1), 38-44. <https://doi.org/10.22437/ijolte.v1i1.459>
- Sholihah, T. M., & Lastariwati, B. (2020). Problem based learning to increase competence of critical thinking and problem solving. *Journal of Education and Learning (EduLearn)*, 14(1), 148-154. <https://doi.org/10.11591/edulearn.v14i1.13772>
- Sidiq, Y., Ishartono, N., Desstya, A., Prayitno, H. J., Anif, S., & Hidayat, M. L. (2021). Improving elementary school students' critical thinking skill in science through hots-based science questions: A quasi-experimental study. *Jurnal Pendidikan IPA Indonesia*, 10(3), 378-386. <https://doi.org/10.15294/jpii.v10i3.30891>
- Snelson, C. (2015). Vlogging about school on YouTube: An exploratory study. *New Media & Society*, 17(3), 321-339. <https://doi.org/10.1177/1461444813504271>
- Susilana, R., Johan, R. C., & Rullyana, G. (2024). Pengembangan modul digital pembelajaran daring. UPI Press.
- Tafonao, T. (2018). Peranan media pembelajaran dalam meningkatkan minat belajar mahasiswa. *Jurnal komunikasi pendidikan*, 2(2), 103-114. <https://doi.org/10.32585/jkp.v2i2.113>
- Toha, M., Fikri, D., & Yusroh, M. (2023). Exploring students' perceptions toward vlogging as a tool for enhancing English vocabulary acquisition. *Abjadia: International Journal of Education*, 8(2), 168-179. <https://doi.org/10.18860/abj.v8i2.22867>
- Wang, Y. H. (2017). Exploring the effectiveness of integrating augmented reality-based materials to support writing activities. *Computers & Education*, 113, 162-176. <https://doi.org/10.1016/j.compedu.2017.04.013>

- Wibowo, T., & Ariyatun, A. (2020). Kemampuan literasi sains pada siswa sma menggunakan pembelajaran kimia berbasis etnosains. *Edusains*, 12(2), 214-222. <https://doi.org/10.15408/es.v12i2.16382>
- Xie, Q., Liu, X., Zhang, N., Zhang, Q., Jiang, X., & Wen, L. (2021). Vlog-based multimodal composing: Enhancing EFL learners' writing performance. *Applied Sciences*, 11(20), 9655. <https://doi.org/10.3390/app11209655>
- Yakob, M., Sari, R. P., & El Islami, R. A. Z. (2020, June). The effectiveness of science experiment through multimedia teaching materials to improve students' critical thinking. In *Journal of Physics: Conference Series* (Vol. 1567, No. 4, p. 042018). IOP Publishing. <https://doi.org/10.1088/1742-6596/1567/4/042018>
- Zhu, S., Yang, H. H., Wu, D., & Chen, F. (2021). Investigating the relationship between information literacy and social media competence among university students. *Journal of educational computing research*, 59(7), 1425-1449. <https://doi.org/10.1177/0735633121997360>
- Zubaidah, S. (2018, October). Mengenal 4C: Learning and innovation skills untuk menghadapi era revolusi industri 4.0. In *2nd Science Education National Conference* (Vol. 13, No. 2, pp. 1-18).
- Zulhelmi, Z., Adlim, A., & Mahidin, M. (2017). Pengaruh media pembelajaran interaktif terhadap peningkatan keterampilan berpikir kritis siswa. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 5(1), 72-80.