

BAB V

KESIMPULAN DAN SARAN

A. Kesimpulan

Berdasarkan hasil penelitian dan pembahasan telah diuraikan pada bab sebelumnya, maka dapat disimpulkan beberapa hal sebagai berikut:

1. Proses pengembangan *e-modul* fisika menggunakan model POE pada materi pencemaran lingkungan untuk meningkatkan kemampuan *Science and Engineering Practices* (SEPs) murid SMA/MA dilaksanakan melalui tiga tahapan model Plomp, yaitu *Preliminary Research* (analisis kebutuhan dan studi literatur), *Development of Prototype Phase* (perancangan prototipe menggunakan aplikasi *Canva*, evaluasi formatif, dan revisi oleh validator), serta *Assessment Phase* (uji praktikalitas dan uji efektivitas). *E-modul* yang dihasilkan disusun secara sistematis dan mengintegrasikan tahapan POE dengan indikator SEPs pada setiap kegiatan pembelajaran.
2. Kualitas *e-modul* fisika menggunakan model POE pada materi pencemaran lingkungan telah memenuhi kriteria valid, praktis, dan efektif. *E-modul* dinyatakan sangat valid dengan rata-rata 87,48% (materi 85%, bahasa 96%, konstruksi 81,43%), serta sangat praktis dengan rata-rata 90,89% (pendidik 95%, murid 86,78%). Dari sisi efektivitas, hasil paired sample t-test menunjukkan signifikansi 0,000 ($p < 0,05$) dengan selisih rata-rata 36,79 poin antara *pretest* dan *posttest*, didukung nilai N-Gain rata-rata 0,7148 (71,40%) berkategori tinggi. Seluruh indikator SEPs berada pada kategori sangat efektif (rentang 81%–94%), dengan capaian

tertinggi pada indikator *Asking Questions and Defining Problems* (94%) dan capaian terendah pada indikator *Using Mathematics and Computational Thinking* serta *Engaging in Argument from Evidence* (masing-masing 81%).

B. Saran

Berdasarkan kesimpulan di atas, penulis mengusulkan beberapa saran yang diinginkan dapat memberikan kontribusi bagi pengembangan ilmu pengetahuan dan praktik pembelajaran fisika, sebagai berikut:

1. Bagi Pendidik

E-modul menggunakan POE ini dapat diadopsi sebagai alternatif bahan ajar fisika pada materi pencemaran lingkungan. Pendidik disarankan tidak hanya menjadikannya sebagai sumber belajar mandiri, tetapi juga memanfaatkannya untuk memfasilitasi diskusi kelas dan presentasi hasil kerja murid.

2. Bagi Murid

Murid disarankan memanfaatkan *e*-modul secara aktif dan reflektif sebagai sumber belajar mandiri yang dapat diakses kapan saja dan di mana saja, dengan mengikuti setiap tahapan POE memprediksi, mengamati, hingga menjelaskan fenomena agar keterampilan SEPs dapat berkembang secara optimal.

3. Bagi Peneliti Selanjutnya

Penelitian ini masih terbatas pada desain tanpa kelompok kontrol dan subjek satu kelas, sehingga penelitian selanjutnya disarankan memakai desain eksperimen dengan kelompok kontrol (*pretest-posttest control group design*) untuk memperkuat validitas temuan. Pengembangan e-modul menggunakan POE juga dapat diperluas ke materi fisika lain dengan sampel yang lebih besar dan beragam, serta mempertimbangkan variabel lain seperti gaya belajar atau kemandirian belajar murid.



DAFTAR PUSTAKA

- Agustiani, S., & Jailani, J. (2023). Pengaruh Pendekatan Contextual Teaching And Learning Terhadap Hasil Belajar, Kemampuan Komunikasi Dan Berpikir Kritis Siswa. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, 12(2), 2253. <https://doi.org/10.24127/ajpm.v12i2.6118>
- Annisa Achsanti, Y., Dina Prasetyowati, & Fenny Roshayanti. (2023). Penerapan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Hasil Belajar Kognitif Matematika Kelas V Sekolah Dasar. *Didaktik: Jurnal Ilmiah PGSD STKIP Subang*, 9(3), 1237–1249. <https://doi.org/10.36989/didaktik.v9i3.1585>
- Aswirna, P. (n.d.). *Pengembangan E-Modul Fisika Berbasis Model Trait Treatment Interaction Terhadap Keterampilan Berpikir Kritis*.
- Aswirna, P., & Harahap, K. (2020). The Android-Based Learning Media Using The Trait Treatment Interaction Model as Implementation of Industrial Era 4.0. *Journal of Physics: Conference Series*, 1594(1), 012024. <https://doi.org/10.1088/1742-6596/1594/1/012024>
- Aswirna, P., Kiswanda, V., Nurhasnah, N., & Fahmi, R. (2022). Implementation of STEM E-Module with SDGs Principle to Improve Science Literacy and Environment-friendly Attitudes in Terms of Gender. *JTK (Jurnal Tadris Kimiya)*, 7(1), 64–77. <https://doi.org/10.15575/jtk.v7i1.16599>
- Barth-Cohen, L. A., Braden, S. K., Young, T. G., & Gailey, S. (2021). Reasoning with evidence while modeling: Successes at the middle school level. *Physical Review Physics Education Research*, 17(2), 020106. <https://doi.org/10.1103/PhysRevPhysEducRes.17.020106>
- Berlian, A. R., Disha, L. P. I., Herman, N. B., Sabila, S. R., Amalia Putri, Y. D., Sudarti, S., & Subiki, S. (2024). The Relationship between Interest and Learning Motivation with Physics Learning Outcomes on the Concept of Newton's Laws. *Konstan - Jurnal Fisika Dan Pendidikan Fisika*, 9(01), 90–95. <https://doi.org/10.20414/konstan.v9i01.308>
- Brand, B. R. (2020). Integrating science and engineering practices: Outcomes from a collaborative professional development. *International Journal of STEM Education*, 7(1), 13. <https://doi.org/10.1186/s40594-020-00210-x>
- Budiarti, W. N., & Riwanto, M. A. (2021). Pengembangan Modul Elektronik (E Modul) Keterampilan Berbahasa Dan Sastra Indonesia Sd Untuk Meningkatkan Keterampilan Menyimak Mahasiswa Pgsd. *Elementary School: Jurnal Pendidikan dan Pembelajaran ke-SD-an*, 8(1). <https://doi.org/10.31316/esjurnal.v8i1.996>
- Bybee, R. W. (2013). *Translating the NGSS for classroom instruction*. Nsta Press, National Science Teachers Association.
- C. Cruz, L. I., & C. Rivera, K. (2022). Development And Validation Of Project-Based Module For Selected Topics In Biology. *International Journal of Educational Research & Social Sciences*, 3(3), 1124–1137. <https://doi.org/10.51601/ijersc.v3i3.374>
- Calabrese, J. E., Songer, N. B., Cordner, H., & Kalani Aina, D. (2023). How do we design curricula to foster innovation, motivation and interest in STEM

- learning? *Journal of Research in Innovative Teaching & Learning*.
<https://doi.org/10.1108/JRIT-06-2023-0064>
- Campbell, T., & Lee, O. (2021). Instructional Materials Designed for A Framework for K-12 Science Education and the Next Generation Science Standards: An Introduction to the Special Issue. *Journal of Science Teacher Education*, 32(7), 727–734.
<https://doi.org/10.1080/1046560X.2021.1975359>
- Christian, K. B., Kelly, A. M., & Bugallo, M. F. (2021). NGSS-based teacher professional development to implement engineering practices in STEM instruction. *International Journal of STEM Education*, 8(1), 21.
<https://doi.org/10.1186/s40594-021-00284-1>
- Drits-Esser, D., Hardcastle, J., Bass, K. M., Homburger, S., Malone, M., Pompei, K., DeBoer, G. E., & Stark, L. A. (2021). Randomized Controlled Trial of a Cohesive Eight-Week Evolution Unit That Incorporates Molecular Genetics and Principles of the Next Generation Science Standards. *CBE—Life Sciences Education*, 20(3), ar50. <https://doi.org/10.1187/cbe.20-01-0008>
- Fakhrurrazi, F., Sajidan, S., & Karyanto, P. (2019). Keefektifan Penggunaan Modul Sistem Gerak pada Manusia Berbasis Inkuiri Interactive Demonstration untuk Memberdayakan Keterampilan Berpikir Analitis Siswa. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 4(4), 478–483. <https://doi.org/10.17977/jptpp.v4i4.12265>
- Fatimah, F. N. U., Siswanto, J., Nuroso, H., & Hayat, M. S. (2023). Implementation of the education for sustainable development (ESD) based predict, observe, and explain (POE) learning module to improve critical thinking skills. *Practice of The Science of Teaching Journal: Jurnal Praktisi Pendidikan*, 2(2), 52–63. <https://doi.org/10.58362/hafecspost.v2i2.32>
- Ferlianti, S., Efendi, R., & Feranie, S. (2023). Development Trend Physics Mobile Learning In 21St Century: A Systematic Literature Review. *Jurnal Penelitian Pendidikan IPA*, 9(6), 162–167.
<https://doi.org/10.29303/jppipa.v9i6.3580>
- Ghita, D., Ahmad, M., Liantanty, F., & Ahmar, H. (2021). Effect of e-module stage iv childbirth care with blended learning model on skills improvement of midwifery students. *International Journal of Health & Medical Sciences*, 4(1), 110–116. <https://doi.org/10.31295/ijhms.v4n1.1527>
- Grapin, S. E., Haas, A., Llosa, L., Wendel, D., Pierson, A., & Lee, O. (2023). Multilingual learners' epistemologies in practice in the context of computational modeling in an elementary science classroom. *Journal of Research in Science Teaching*, 60(9), 1998–2041.
<https://doi.org/10.1002/tea.21850>
- Gray, K. E., Wittmann, M. C., Vokos, S., & Scherr, R. E. (2019). Drawings of energy: Evidence of the Next Generation Science Standards model of energy in diagrams. *Physical Review Physics Education Research*, 15(1), 010129. <https://doi.org/10.1103/PhysRevPhysEducRes.15.010129>
- Habibah, R., & Fauzi, A. (2023). Preliminary Study: Analysis of the Need for Physics E-Modules as Guided Inquiry-Based Teaching Materials at MAN 1 Mandailing Natal. *Jurnal Penelitian Pendidikan IPA*, 9(12), 10886–10891.

- <https://doi.org/10.29303/jppipa.v9i12.5912>
- Hai, Md. A., & Geraets, J. A. (2023). An Assessment of Students' Enthusiasm for Pre-Class Preparation. *Open Journal of Social Sciences*, 11(08), 112–134. <https://doi.org/10.4236/jss.2023.118008>
- Haryadi, R., & Fauziah, A. (2024). Development Of Physics Comic Learning Media Contextual Model With Poe Method On The Subject Of Effort And Energy On Interest In Learning Physics. *Journal of Learning and Technology in Physics*, 3(2), 35. <https://doi.org/10.24114/jltp.v3i2.57053>
- Hastini, L. Y., Fahmi, R., & Lukito, H. (2020). Apakah Pembelajaran Menggunakan Teknologi dapat Meningkatkan Literasi Manusia pada Generasi Z di Indonesia? *Jurnal Manajemen Informatika (Jamika)*, 10(1), 12–28. <https://doi.org/10.34010/jamika.v10i1.2678>
- Hu, P., Gao, C., Gao, R., Chen, J., & Huang, S. (2024). *Large Language Models are Limited in Out-of-Context Knowledge Reasoning* (arXiv:2406.07393). arXiv. <https://doi.org/10.48550/arXiv.2406.07393>
- Irawati, A. E., & Setyadi, D. (2021). Pengembangan E-Modul Matematika pada Materi Perbandingan Berbasis Android. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(3), 3148–3159. <https://doi.org/10.31004/cendekia.v5i3.467>
- Islamiati, E. F., Subagia, I. W., & Suma, K. (2024). Development of Teaching Modules in the Implementation of the Independent Curriculum to Improve the Quality of the Learning Process and Student Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 10(11), 9097–9105. <https://doi.org/10.29303/jppipa.v10i11.7521>
- Juita, D., Gita, M., & Yusmaridi, M. (2020). Penggunaan model pembelajaran predict-observe-explain-write (poew) disertai peta konsep dalam meningkatkan hasil belajar biologi. *Indonesian Journal of Education and Learning*, 4(1), 408.
- Kaldaras, L., Akaeze, H., & Krajcik, J. (2021). Developing and validating Next Generation Science Standards -ALIGNED learning progression to track THREE-DIMENSIONAL learning of electrical interactions in high school physical science. *Journal of Research in Science Teaching*, 58(4), 589–618. <https://doi.org/10.1002/tea.21672>
- Kaldaras, L., Yoshida, N. R., & Haudek, K. C. (2022). Rubric development for AI-enabled scoring of three-dimensional constructed-response assessment aligned to NGSS learning progression. *Frontiers in Education*, 7, 983055. <https://doi.org/10.3389/educ.2022.983055>
- Khotimah, N., Rusyati, L., Sriwulan, W., & Hakim, M. I. (2023). Upaya Peningkatan Kemampuan Mengamati, Menerapkan Konsep, Dan Meyimpulkan Peserta Didik Menggunakan Pembelajaran Berbasis Praktikum. *Prima Magistra: Jurnal Ilmiah Kependidikan*, 4(3), 373–380. <https://doi.org/10.37478/jpm.v4i3.2813>
- Kiswanda, V., & Aswirna, P. (2022). *Pengembangan E-Modul Fisika Berbasis Stem Dengan Prinsip Pembangunan Berkelanjutan Terhadap Literasi Sains Siswa Kelas XI*.
- Kristiyanto, W. H. (2022). Teaching Physics in Scientific Information Disclosure

- Era Through Daily Physics Learning. *Journal of Physics: Conference Series*, 2392(1), 012028. <https://doi.org/10.1088/1742-6596/2392/1/012028>
- Kusumaningtyas, R., Sholehah, I. M., & Kholifah, N. (2020). Peningkatan Kualitas Pembelajaran Guru Melalui Model dan Media Pembelajaran bagi Generasi Z. *Warta LPM*, 23(1), 54–62. <https://doi.org/10.23917/warta.v23i1.9106>
- Kwak, S. G., & Park, S.-H. (2019). Normality Test in Clinical Research. *Journal of Rheumatic Diseases*, 26(1), 5. <https://doi.org/10.4078/jrd.2019.26.1.5>
- Latifah, N., Ashari, & Kurniawan, E. S. (2020). Pengembangan e-Modul Fisika Untuk Meningkatkan Kemampuan Berpikir Kritis Peserta Didik. *JIPS: Jurnal Inovasi Pendidikan Sains*, 01. <http://jurnal.umpwr.ac.id/index.php/jips>
- Lilly, S., McAlister, A. M., Fick, S. J., Chiu, J. L., & McElhaney, K. W. (2022). Elementary teachers' verbal supports of science and engineering practices in an NGSS-ALIGNED science, engineering, and computational thinking unit. *Journal of Research in Science Teaching*, 59(6), 1035–1064. <https://doi.org/10.1002/tea.21751>
- Linda, Harma. 2019. *Pengembangan Modul Fisika Materi Suhu, Kalor dan Teori Kinetik Gas dengan Model POE (Predict-Observe-Explain) dalam Meningkatkan Motivasi Belajar Peserta Didik Kelas XI SMA/MA*. Skripsi. Padang: Universitas Islam Negeri Imam Bonjol Padang.
- Mahardika, S. P., Hidayati, S. N., & Aulia, E. V. (2024). Efektivitas Discovery Learning Berorientasi Video Microlearning dalam Meningkatkan Keterampilan Berpikir Kritis Siswa. *Nusantara: Jurnal Pendidikan Indonesia*, 4(4), 909–918. <https://doi.org/10.14421/njpi.2024.v4i4-1>
- Manggala, M. A., Nyanasuryanadi, P., & Suherman, H. (2024). Inovatif Pembelajaran Menggunakan E-Modul. *JETISH: Journal of Education Technology Information Social Sciences and Health*, 3(1).
- Mayanti, A., Poluakan, C., & Tumimomor, F. R. (2022). Pengaruh Model Problem Based Learning (PBL) Menggunakan Metode Demonstrasi dan Eksperimen pada Pembelajaran Fisika tentang Hukum Newton. *Charm Sains: Jurnal Pendidikan Fisika*, 3(1), 9–14. <https://doi.org/10.53682/charmsains.v3i1.144>
- Mitasari, D., Adha, I., & Fitriyana, N. (2020). Efektivitas Model Pembelajaran Predict, Observe, Explain (Poe) Pada Pembelajaran Matematika Siswa Kelas Vii Smp Negeri Selangit. *Journal of Mathematics Science and Education*, 2(2), 60–67. <https://doi.org/10.31540/jmse.v2i2.528>
- Nanda, G. F., & Suari, M. (2024). Penerapan E-Modul Berbasis Discovery Learning Berbantuan Phet Simulation Terhadap Kemampuan Berpikir Kritis Peserta Didik Fisika Kelas X Sma Kartika 1-5 Padang. *Journal Cerdas Mahasiswa*, 6(2), 206-216.
- Ningsih, E. P. (2024). Implementasi Teknologi Digital dalam Pendidikan: Manfaat dan Hambatan. *EduTech Journal*, 1(1), 1–8. <https://doi.org/10.62872/qbp1fg61>
- Nordine, J. C., & Lee, O. (2023). On the Nature and Utility of Crosscutting Concepts. *Education Sciences*, 13(7), 640.

- <https://doi.org/10.3390/educsci13070640>
- Nurhasnah, N., Kasmita, W., Aswirna, P., & Abshary, F. I. (2020). Developing Physics E-Module Using “Construct 2” to Support Students’ Independent Learning Skills. *Thabiea : Journal Of Natural Science Teaching*, 3(2), 79. <https://doi.org/10.21043/thabiea.v3i2.8048>
- Nurhayati, S. H., Siahaan, S. M., & Syuhendri. (2024). Need Analysis of E-module Based on the Theory of Conceptual Change in Earth and Space Material for Class X of Vocational School in the Sumatra. *Jurnal Penelitian Pendidikan IPA*, 10(8), 6198–6205. <https://doi.org/10.29303/jppipa.v10i8.7637>
- Okpatrioka Okpatrioka. (2023). Research And Development (R&D) Penelitian Yang Inovatif Dalam Pendidikan. *Dharma Acariya Nusantara: Jurnal Pendidikan, Bahasa dan Budaya*, 1(1), 86–100. <https://doi.org/10.47861/jdan.v1i1.154>
- Oksa, S., & Soenarto, S. (2020). Pengembangan E-Modul Berbasis Proyek Untuk Memotivasi Belajar Siswa Sekolah Kejuruan. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, 4(1), 99–111. <https://doi.org/10.21831/jk.v4i1.27280>
- Oliver, S. (2020). *Physics without Physis: On Form and Teleology in Modern Science* (Vol. 46). Project MUSE. <https://muse.jhu.edu/article/933565>
- Padwa, T. R., & Erdi, P. N. (2021). Penggunaan E-Modul Dengan Sistem Project Based Learning. *JAVIT : Jurnal Vokasi Informatika*, 21–25. <https://doi.org/10.24036/javit.v1i1.13>
- Pang, X., Hong, R., Zhou, Z., Lv, F., Yang, X., Liang, Z., Han, B., & Zhang, C. (2024). *Physics Reasoner: Knowledge-Augmented Reasoning for Solving Physics Problems with Large Language Models* (arXiv:2412.13791). arXiv. <https://doi.org/10.48550/arXiv.2412.13791>
- Paoliana, N., Taufik, M., & Rokhmat, J. (2020). *Pengaruh Model Pembelajaran POE (Predict-Observ- Explain) terhadap Hasil Belajar dan Kreativitas Fisika Peserta Didik*.
- Permatasari, H. H. N., Suharno, & Suryana, R. (2023). The Effectiveness of the Predict-Observe-Explain (POE) Model in The Physics Electronic Modules to Improve Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, 9(12), 10679–10688. <https://doi.org/10.29303/jppipa.v9i12.4681>
- Plomp, T., & Nieveen, N. M. (2010). *An introduction to educational design research: Proceedings of the seminar conducted at the East China Normal University, Shanghai (PR China), November 23-26, 2007* (3rd print). SLO.
- Puji Purdhiyah, Wulandari, S., Wulandari, M., & Annovasho, J. (2022). Studi Literatur: Penerapan Model Pembelajaran Prediction, Observation, and Explanation (POE) pada Pembelajaran Fisika. *Charm Sains: Jurnal Pendidikan Fisika*, 3(2), 87–95. <https://doi.org/10.53682/charmsains.v3i2.190>
- Putri, L. D. F., Ahmadi, B. Z. R., & Aulia’, K. K. (2025). Membaca Krisis Lingkungan Melalui Lensa Tafsir Ekologi: Analisis QS. al-Rūm [30]: 41. *Canon Religia*, 3(1), 35–48. <https://doi.org/10.30762/cr.v3i1.3143>
- Putri, N., Junaidi, E., Hakim, A., & Anwar, Y. A. S. (2022). Pengembangan

- Modul Pembelajaran Kimia Berbasis POE (Predict, Observe, Explain) pada Materi Sifat Koligatif Larutan di Masa Pandemi Covid-19. *Chemistry Education Practice*, 5(1), 45–51. <https://doi.org/10.29303/cep.v5i1.2729>
- Putri, Yoza Yulia. 2024. *Pengembangan E-Modul Fisika Model Project Based Learning untuk Meningkatkan Kemampuan Peserta Didik dalam Science and Engineering Practices*. Skripsi. Padang: Universitas Islam Negeri Imam Bonjol Padang.
- Rahman Hakim, Z., & Sugiyono, S. (2024). Analisa Sentimen Terhadap Kereta Cepat Jakarta – Bandung Menggunakan Algoritma Naïve Bayes Dan K-Nearest Neighbor. *Jurnal Sains dan Teknologi*, 5(3), 939–945. <https://doi.org/10.55338/saintek.v5i3.1423>
- Rahmi, E., Ibrahim, N., & Kusumawardani, D. (2021). Pengembangan Modul Online Sistem Belajar Terbuka Dan Jarak Jauh Untuk Meningkatkan Kualitas Pembelajaran Pada Program Studi Teknologi Pendidikan. *Visipena*, 12(1), 44–66. <https://doi.org/10.46244/visipena.v12i1.1476>
- Riska, F. M., Fitriana, S., Hardianti, T., Rizaldi, R., Syahwin, S., & Mardiana, N. (2023). Pengaruh Bahan Ajar Berbasis Inkuiri Terbimbing Berbantuan V-Lab (Virtual Laboratory) Pada Materi Momentum Dan Impuls Untuk Meningkatkan Literasi Sains Siswa. *Silampari Jurnal Pendidikan Ilmu Fisika*, 5(2), 200–213. <https://doi.org/10.31540/sjpif.v5i2.2352>
- Rizki, P. A., Rahmadinanti, M. O., Istifadah, H., Rokhma, R. Y., Kaneishia, S., Sudarti, S., & Subiki, S. (2023). Pengaruh Minat Belajar Terhadap Kemampuan Praktikum Fisika Materi Hukum Newton Pada Mahasiswa Pendidikan Fisika. *Jurnal Sains Riset*, 13(2), 369–378. <https://doi.org/10.47647/jsr.v13i2.1528>
- Rosenberg, J. M., Borchers, C., Dyer, E. B., Anderson, D., & Fischer, C. (2021). *Understanding Public Sentiment About Educational Reforms: The Next Generation Science Standards on Twitter*. 7. <https://doi.org/10.1177/233285842111024261>
- Saberi, M. (2023). *Promoting Understanding of Three Dimensions of Science Learning Plus Nature of Science Using Phenomenon-Based Learning*.
- Salmia, S., Sudarmin,. (2023). Development Of Quality Instruments And Data Collection Techniques. *Jurnal Pendidikan Dan Pengajaran Guru Sekolah Dasar (JPPGuseda)*, 6(1), 119–124. <https://doi.org/10.55215/jppguseda.v6i1.7527>
- Samya, C. E. P., Muhibbuddin, M., & Ilyas, S. (2021). The Effectiveness of Predict Observe Explain Learning Model to Students' Critical Thinking Skills. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, 6(3), 228. <https://doi.org/10.26737/jipf.v6i3.2213>
- Sandoval, W., Kovach, J., Perez, L., Kim-John, L., & Kawasaki, J. (2023). Using Argument to Reason About Science Practice. *Science and Children*, 60(7), 54–57. <https://doi.org/10.1080/00368148.2023.12315939>
- Sari, M., & Asmendri, A. (2020). Penelitian Kepustakaan (Library Research) dalam Penelitian Pendidikan IPA. *Natural Science*, 6(1), 41–53. <https://doi.org/10.15548/nsc.v6i1.1555>
- Schaben, C., Andersson, J., & Cutucache, C. (2022a). A multiple case study to

- understand how students experience science and engineering practices. *Frontiers in Education*, 7, 960346. <https://doi.org/10.3389/feduc.2022.960346>
- Schaben, C., Andersson, J., & Cutucache, C. (2022b). *A multiple case study to understand how students experience science and engineering practices*. <https://doi.org/10.3389/feduc.2022.960346>
- Simbolon, D. E., Indrawati, S., & Ernalida, E. (2021). The Need Analysis of Student Worksheet for Writing Drama Script of Seventh Grade Student. *Jurnal Pendidikan Dan Pengajaran*, 54(1), 120. <https://doi.org/10.23887/jpp.v54i1.33230>
- Suyono, Nasrudin, H., & Yonata, B. (2020). Consistency and Relevance of Structured Lecture Materials in Physical Chemistry 3 Subjects. *Proceedings of the International Conference on Research and Academic Community Services (ICRACOS 2019)*. Proceedings of the International Conference on Research and Academic Community Services (ICRACOS 2019). <https://doi.org/10.2991/icracos-19.2020.40>
- Venida, A. C., & Sigua, E. M. (2020). Predict-Observe-Explain Strategy: Effects on Students' Achievement and Attitude towards Physics. *Jurnal Pendidikan MIPA*, 21(1), 78–94. <https://doi.org/10.23960/jpmipa/v21i1.pp78-94>
- Vermaas, P., & Stone, T. (2020). Normative Design for Society and Anticipatory Technology Development: A Double Challenge for Design Research. *Balancing Innovation and Operation*. Proceedings of NordDesign 2020. <https://doi.org/10.35199/NORDDESIGN2020.39>
- Waruwu, M. (2024). Metode Penelitian dan Pengembangan (R&D): Konsep, Jenis, Tahapan dan Kelebihan. *Jurnal Ilmiah Profesi Pendidikan*, 9(2), 1220–1230. <https://doi.org/10.29303/jipp.v9i2.2141>
- Wilujeng, I., & Putri, T. S. Y. (2020). Development of SETS E-Module Integrated with POE Model for Science Learning. *Journal of Educational Science and Technology (EST)*, 252–264. <https://doi.org/10.26858/est.v1i1.14735>
- Wysession, M. E. (2022). The Challenge of Getting Earth and Space Science Into U.S. High Schools. *Perspectives of Earth and Space Scientists*, 3(1), e2022CN000161. <https://doi.org/10.1029/2022CN000161>
- Xi, W., Ping, Y., Zhang, F., Ye, X., Fu, M., & Liu, Y. (2024). Interdisciplinary Teaching in the American Next Generation Science Standards: Research Findings and Implications for China. *International Journal of New Developments in Education*, 6(9). <https://doi.org/10.25236/IJNDE.2024.060902>
- Yulkifli, Y., Yohandri, Y., & Azis, H. (2022). Development of physics e-module based on integrated project-based learning model with Ethno-STEM approach on smartphones for senior high school students. *Momentum: Physics Education Journal*, 93–103. <https://doi.org/10.21067/mpej.v6i1.6316>
- Zakiah, I., Hendriana, H., & Hidayat, W. (2022). The Effect of Contextual Learning Trough Teaching Materials Application-Based on Problem Solving Ability. *Eduma : Mathematics Education Learning and Teaching*, 11(1), 20. <https://doi.org/10.24235/eduma.v11i1.9604>

Zinger, D., Haymore Sandholtz, J., & Ringstaff, C. (2020). Teaching Science in Rural Elementary Schools: Affordances and Constraints in the age of NGSS. *The Rural Educator*, 41(2), 14–30. <https://doi.org/10.35608/ruraled.v41i2.558>

