

DAFTAR PUSTAKA

- Arikunto, S. (2019). *Prosedur : Suatu Pendekatan Praktik*. Rineka Cipta.
- Adila, A. S. D., Sutopo, S., & Wartono, W. (2017). Deskripsi Kesulitan Mahasiswa pada Materi Termodinamika. In *Seminar Nasional Pendidikan IPA 2017* (Vol. 2).
- Alfahinsa, M. Z. M., & Fauziah, A. N. M. (2025). Analisis respons siswa terhadap media simulasi pada materi suhu dan kalor. *PENSA: E-Jurnal Pendidikan Sains*, 13(3), 85–92.
- Amelia, C., Efendi, R., & Sari, I. M. (2025). The effect of multi-representation-based physics learning on students' representation translation ability in linear motion topics. *Jurnal Pendidikan MIPA*, 26(1), 643–656.
- Aqra, R., Al-Rjoub, A., & Al-Hmoud, N. (2022). Thermoelectric effects and applications: An advanced physics laboratory experiment. *European Journal of Physics*, 43(5), 055101. <https://doi.org/10.1088/1361-6404/ac72d3>
- Arsyad, A. (2014). *Media pembelajaran* (Edisi revisi). Rajawali Pers.
- Astra, I. M., Budi, E., & Evita, C. (2020). The effects of active learning model guided note taking on student's critical thinking ability in high school. *Journal of Physics: Conference Series*, 1521(2), 022006. <https://doi.org/10.1088/1742-6596/1521/2/022006>
- Ataide, V. N., Mendes, L. F., Gama, L. I. L. M., & Richter, E. M. (2021). Enhanced performance of pencil-drawn paper-based electrochemical devices by laser treatment. *RSC Advances*, 11, 3636–3645.
- Bilhaque, R. V., Syaripudin, T., & Giwangsa, S. F. (2022). Pengembangan LKPD berbasis model Problem Based Learning untuk meningkatkan hasil belajar siswa pada materi hak dan kewajiban. *Jurnal Pendidikan Guru Sekolah Dasar (JPGSD)*, 7(3), 71–79. <https://doi.org/10.17509/jpgsd.v7i3.5714>
- Bond, M. (2020). Facilitating student engagement through educational technology. *Educational Technology Research and Development*, 68(5), 1–25.
- Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and educational technology. *Educational Technology Research and Development*, 68, 3221–3250. <https://doi.org/10.1007/s11423-020-09821-5>
- Branch, R. M. (2009). *Instructional Design: The ADDIE approach*. Springer.
- Brown, B., & Singh, C. (2021). Student Understanding of the First Law and Second Law of Thermodynamics.

- Creswell, J. W., & Creswell, J. D. (2023). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (6th ed.). SAGE Publications.
- Castañeda, J., Torres, J., & Martínez, D. (2022). Thermodynamics education and energy transformation understanding in higher education. *Education Sciences*, 12(4), 245. <https://doi.org/10.3390/educsci12040245>
- Çengel, Y. A., & Boles, M. A. (2019). *Thermodynamics: An engineering approach* (9th ed.). McGraw-Hill Education.
- Callister, W. D., & Rethwisch, D. G. (2020). *Materials Science and Engineering: An Introduction* (10th ed.). Wiley.
- Daruka, A. (2024). How Does The Concentration Of Graphite In A Mixture Of Clay Affect The Electrical Resistance. *IOSR Journal of Applied Physics*, 16(1), 9–13.
- DiSessa, A. A. (2018). A friendly introduction to “knowledge in pieces”: Modeling types of knowledge and their roles in learning. In *Invited lectures from the 13th international congress on mathematical education* (pp. 65–84). Springer.
- Faizin, A., Susantini, E., & Raharjo, R. (2024). Application of a guided inquiry learning model to improve students' scientific literacy skills. *IJORER: International Journal of Recent Educational Research*, 5(2), 490–503.
- Fajarianingtyas, D. A., & Hidayat, J. N. (2022). Pengembangan lembar kerja mahasiswa PBL berorientasi kemampuan pemecahan masalah perkuliahan biologi dasar. *Bioeduca*, 4(2), 43–50. <https://doi.org/10.21580/bioeduca.v4i2.11670>
- Floyd, T. L. (2018). *Electronic Devices* (10th ed.). Pearson.
- Foroushani, S. (2019). Misconceptions in Engineering Thermodynamics: A Review.
- Goldsmid, H. J. (2016). *Introduction to thermoelectricity* (2nd ed.). Springer. <https://doi.org/10.1007/978-3-662-49256-7>
- Gupta, R. (2022). *Physics for Paramedical and Allied Health Science Courses*. CBS Publishers & Distributors Pvt. Ltd.
- Handayani, A. I. S., Indriyani, A. R., Rosida, A. S. G., Astutik, S., & Meilina, I. L. (2025). Analisis Kesulitan Mahasiswa Program Studi Pendidikan Fisika Universitas Jember dalam Memahami Konsep Termodinamika. *U-Teach: Journal Education of Young Physics Teacher*, 6(1), 73–85.

- Haryadi, R., Pujiastuti, H., & Utomo, D. W. (2026). Interactive visualization of thermodynamic concepts through augmented reality to improve critical thinking. *Computers & Education: X Reality*, 8, 100137. <https://doi.org/10.1016/j.cexr.2026.100137>
- Hew, K. F., Jia, C., Gonda, D. E., & Bai, S. (2020). Transitioning to the “new normal” of learning in unpredictable times: Pedagogical practices and learning performance in fully online flipped classrooms. *International Journal of Educational Technology in Higher Education*, 17(1), 1–22. <https://doi.org/10.1186/s41239-020-00234-x>
- Horowitz, P., & Hill, W. (2015). *The Art of Electronics* (3rd ed.). Cambridge University Press.
- Incropera, F. P., DeWitt, D. P., Bergman, T. L., & Lavine, A. S. (2017). *Fundamentals of Heat and Mass Transfer* (8th ed.). John Wiley & Sons.
- Kilde Löfgren, S., Weidow, J., & Enger, J. (2023). Rolling balls or trapping ions? How students relate models to real-world phenomena in the physics laboratory. *Science Education*, 107(5), 1215–1237. <https://doi.org/10.1002/sce.21802>
- Kolb, D. A. (2015). *Experiential learning: Experience as the Source of Learning and Development* (2nd ed.). Pearson.
- Kustandi, C., & Darmawan, D. (2020). Pengembangan media pembelajaran: Konsep dan aplikasi. Kencana.
- Latip, A., & Permanasari, A. (2021). Pengembangan alat peraga fisika berbasis *Research and Development* untuk meningkatkan pemahaman konsep peserta didik. *Jurnal Pendidikan Fisika*.
- Lee, J. H. S., & Ramamurthi, K. (2022). *Fundamentals of thermodynamics*. CRC Press. <https://doi.org/10.1201/9781003224044>
- Long, C., & Sayma, N. (2009). *Heat transfer*. Ventus Publishing ApS.
- Maulida, F., Alatas, F., & Solehat, D. (2024). Studi Literatur Miskonsepsi Pembelajaran Hukum I Termodinamika: Identifikasi dan Solusi. Prosiding Seminar Nasional Fakultas Ilmu Tarbiyah dan Keguruan UIN Syarif Hidayatullah Jakarta.
- Mayer, R. E. (2021). *Multimedia learning* (3rd ed.). Cambridge University Press. <https://doi.org/10.1017/9781316941350>
- McKenney, S., & Reeves, T. C. (2018). *Conducting educational Design research* (2nd ed.). Routledge. <https://doi.org/10.4324/9781315105647>

- Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. B. (2020). *Fundamentals of engineering thermodynamics* (9th ed.). Wiley.
- Mulla, R., & Dunnill, C. W. (2021). *Single material thermocouples* from graphite traces: Fabricating extremely simple and low-cost thermal sensors. *Carbon Trends*, 3, 100077. <https://doi.org/10.1016/j.cartre.2021.100077>
- Munfaridah, N., Avraamidou, L., & Goedhart, M. (2021). The use of multiple representations in undergraduate physics education. *Eurasia Journal of Mathematics, Science and Technology Education*, 17(1), em1934. <https://doi.org/10.29333/ejmste/9577>
- Mursali, S., & Safnowandi. (2016). Pengembangan LKM biologi dasar berorientasi pembelajaran inkuiri untuk meningkatkan keterampilan proses sains mahasiswa. *Bioscientist: Jurnal Ilmiah Biologi*, 4(2), 56–62. <https://doi.org/10.33394/bioscientist.v4i2.218>
- Nielsen, W., Turney, A., Georgiou, H., & Jones, P. (2022). Meaning making with multiple representations: A case study of a preservice teacher creating a digital explanation. *Research in Science Education*, 52(3), 871–890. <https://doi.org/10.1007/s11165-021-10038-2>
- Nurmi, N., Yunita, A., Yusri, R., & Delyana, H. (2020). Efektivitas penggunaan lembar kerja mahasiswa berbasis Project Based Learning (PjBL) terintegrasi ICT. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, 9(4), 1018–1025. <https://doi.org/10.24127/ajpm.v9i4.3190>
- Panuluh, A. H. (2022). Improving the science process skills of physics education students by using guided inquiry practicum. *arXiv*. <https://arxiv.org/abs/2211.04006>
- Parinduri, S. H., & Parinduri, H. (2024). Analisis Kemampuan Matematika Dalam Pemecahan Masalah Termodinamika. *Jurnal Inovasi Pendidikan Sains dan Terapan*, 3(1), 44–49.
- Piernas-Muñoz, M. J., & Zarrabeitia, M. (2025). Revisiting intercalation anode materials for potassium-ion batteries. *Materials*, 18(1), 190. <https://doi.org/10.3390/ma18010190>
- Plomp, T., & Nieveen, N. (2013). *Educational Design research*. Netherlands Institute for Curriculum Development (SLO).
- Purwaningsih, S., & Pujaningsih, F. B. (2023). Validitas lembar kerja mahasiswa berbasis proyek materi observabel dan operator pada mata kuliah fisika kuantum. *Physics and Science Education Journal (PSEJ)*, 3(3), 169–177. <https://doi.org/10.30631/psej.v3i3.2187>
- Puspitarini, I. D., & Ajidewantara, B. (2021). Pengembangan lembar kerja mahasiswa berbasis PjBL materi kinematika di masa pembelajaran daring. *Seminar Nasional Teknologi Pendidikan*.

- Rahmawati, D., Bakri, F., & Budi, E. (2023, November). Desain aktivitas Laboratorium Pada Materi Hubungan Medan Listrik dan Medan Magnet dengan Set Praktikum Thomson. In *PROSIDING SEMINAR PENELITIAN DAN PENGABDIAN KEPADA MASYARAKAT* (Vol. 1, No. 1, pp. 1-8).
- Rahmawati, D., & Setyarsih, W. (2021). Kajian literatur pembelajaran multirepresentasi pada materi fisika tingkat SMA. *IPF: Inovasi Pendidikan Fisika*, 10(2), 1–10. <https://doi.org/10.26740/ipf.v10n2.p1-10>
- Rayanto, Y. H., & Rusmawan, A. (2020). Penelitian pengembangan model ADDIE dan R2D2. Lembaga Academic & Research Institute.
- Reif, F. (2008). *Applying cognitive science to education*. MIT Press.
- Rianti, R., Gunawan, G., Vewawati, N. N. S. P., & Taufik, M. (2024). The effect of problem-based learning model assisted by PhET simulation on understanding physics concepts. *Lensa: Jurnal Kependidikan Fisika*, 12(1). <https://doi.org/10.33394/j-lkf.v12i1.8783>
- Riduwan. (2015). *Skala Pengukuran Variabel-Variabel Penelitian*. Alfabeta.
- Rohima, N. (2023). Penggunaan media pembelajaran untuk meningkatkan keterampilan belajar pada siswa. *Publikasi Pembelajaran*, 1(1), 1–12.
- Rowe, D. M. (2018). *Thermoelectrics handbook: Macro to nano*. CRC Press.
- Rustandi, A., & Rismayanti, R. (2021). Penerapan model ADDIE dalam pengembangan media pembelajaran di SMPN 22 Kota Samarinda. *Jurnal Fasilkom*, 11(2), 57–60. <https://doi.org/10.37859/jf.v11i2.2546>
- Sadiman, A. S. (2006). *Media pendidikan: Pengertian, pengembangan, dan pemanfaatannya*.
- Santhalia, P. W., & Yuliati, L. (2021). An Exploration of Scientific Literacy on Physics Subjects within Phenomenon-based *Experiential learning*. *Jurnal Penelitian Fisika dan Aplikasinya (JPFA)*, 11(1), 72–82. <https://doi.org/10.26740/jpfa.v11n1.p72-82>
- Scott, E. E., Wenderoth, M. P., & Doherty, J. H. (2020). *Design-based research: A methodology to extend and enrich biology education research*. *CBE—Life Sciences Education*, 19(2), es11. <https://doi.org/10.1187/cbe.19-11-0245>
- Setiani, D., Setiahawati, S., & Khasanah, W. N. (2024). Enhancing physics conceptual understanding through discussion method and virtual laboratory media. *Indonesian Science Education Journal*, 5(2). <https://doi.org/10.62159/isej.v5i2.1760>

- Setiyaningsih, A., Yuwono, M. R., & Wijayanti, S. (2022). Analisis kelengkapan LKPD sebagai media pembelajaran matematika peserta didik. *Jurnal Ilmiah Kependidikan (JWD)*, 1(2), 42–47.
- Sharma, A., et al. (2025). Flexible thermoelectric generator based on graphite composites. *Ceramics International*.
<https://doi.org/10.1016/j.ceramint.2025.02.412>
- Silvianti, S., & Guspatni. (2022). Praktikalitas media pembelajaran PowerPoint-iSpring pada materi kimia. *Jurnal Pendidikan Kimia Universitas Riau*, 7(2), 88–95.
- Sinensis, A. R., Firman, H., Hamidah, I., & Muslim. (2018). Pengembangan Lembar Kerja Mahasiswa Berbasis Pemecahan Masalah Kolaboratif Berbantuan Simulasi Interaktif pada Materi Termodinamika. *Prosiding SNFA*.
- Snyder, G. J., & Toberer, E. S. (2008). Complex thermoelectric materials. *Nature Materials*, 7(2), 105–114. <https://doi.org/10.1038/nmat2090>
- Söderström, E. (2022). Challenges and strategies in physics laboratory work.
- Spector, J. M., Merrill, M. D., Elen, J., & Bishop, M. J. (Eds.). (2020). *Handbook of research on educational communications and technology* (5th ed.). Springer. <https://doi.org/10.1007/978-3-030-36119-8>
- Sugiyono. (2019). *Metode penelitian dan pengembangan (R&D)*. Alfabeta.
- Sutarja, M. C., & Wulandari, A. Y. R. (2021). Identifying students' difficulty in the basic of thermodynamics. *Journal of Physics: Conference Series*, 2126(1), 012010. <https://doi.org/10.1088/1742-6596/2126/1/012010>
- Sutrio, Harjono, A., & Sahidu, H. (2021). Pengembangan Bahan Ajar Fisika Eksperimen Berbasis Proyek untuk Meningkatkan Penguasaan Scientific Method Calon Guru. *Jurnal Ilmiah Profesi Pendidikan*, 6(1), 126–134.
- Tam, W. C., et al. (2011). The Effect of High Thermal Conductivity Porous Media on Enhancing Heat Transfer in Pool and Flow Boiling. Tersedia melalui ResearchGate.
- Tang, K. S., Delgado, C., & Moje, E. B. (2021). An integrative framework for the *Analysis* of multiple representations in science education. *Science Education*, 105(4), 1–27. <https://doi.org/10.1002/sce.21624>
- Thakur, A. S., Dubey, S., Thakur, A. S., & Vaish, R. (2025). DIY of pencil drawn Seebeck effect. *Physics Education*, 60(6), 065011. <https://doi.org/10.1088/1361-6552/adfff2>

- Umardiyah, F., & Nabila, A. I. (2022). Pengembangan media pembelajaran flash card untuk meningkatkan kemampuan berpikir kritis siswa SMA pada materi dimensi tiga. *Jurnal Pendidikan Matematika Universitas Lampung*, 10(4).
- Utami, S. D., & Dewi, I. N. (2020). Pengembangan lembar kerja mahasiswa berbasis pemberdayaan berpikir melalui pertanyaan pada mata kuliah pengetahuan lingkungan. *Bioscientist: Jurnal Ilmiah Biologi*, 8(2), 327–...
- Walsh, C., Lewandowski, H. J., & Holmes, N. G. (2022). Skills-focused lab instruction improves critical thinking skills and experimentation views for all students. *Physical Review Physics Education Research*, 18(1), 010128. <https://doi.org/10.1103/PhysRevPhysEducRes.18.010128>
- Widoyoko, E. P. (2012). Teknik penyusunan instrumen penelitian. Pustaka Pelajar.
- Worku, D. T., Ejigu, M. A., Gebremeskal, T. G., & Kassa Gogie, T. (2025). Assessing the impact of multiple representations based instruction integrated with formative assessment practice on students' problem-solving performance. *Research in Science & Technological Education*. <https://doi.org/10.1080/02635143.2025.2469062>
- Wörner, S., Kuhn, J., & Scheiter, K. (2022). The best of two worlds: Combining real and virtual experiments. *Review of Educational Research*, 92(6), 911–952. <https://doi.org/10.3102/00346543221079417>
- Xie, S., Ni, K., & Zhu, Y. (2026). Electronic properties of carbon-based superatomic structures. *Advanced Functional Materials*, 36(2), 2508106. <https://doi.org/10.1002/adfm.202508106>
- Yazawa, K., Bahk, J. H., & Shakouri, A. (2021). Thermoelectric energy conversion devices and systems. World Scientific.
- Yolanda, N. S. (2022). Praktikalitas media pembelajaran matematika menggunakan aplikasi Powtoon. *Jurnal Kepemimpinan dan Kepengurusan Sekolah*, 7(4).
- Yuliana, I., Widiarini, P., & Sudiatmika, A. A. I. A. R. (2026). Identifikasi Miskonsepsi Mahasiswa Calon Guru Fisika pada Materi Termodinamika melalui Tes Diagnostik Four Tier Berbasis Web. *NUSRA: Jurnal Penelitian dan Ilmu Pendidikan*, 7(2), 211–225.
- Yuniati, M., & Nashikhah, M. (2023). Lembar kerja mahasiswa berbasis Project Based Learning pada mata kuliah busana anak. *Jurnal Ilmiah Pendidikan dan Pembelajaran*, 7(3), 510–517. <https://doi.org/10.23887/jipp.v7i3.57996>