PROFIL ASESMEN EPISTEMIK SAINS UNTUK KOMPETENSI MENJELASKAN FENOMENA SECARA ILMIAH PADA PEMBELAJARAN BIOLOGI

SKRIPSI

Diajukan untuk memenuhi syarat memperoleh gelar Sarjana Pendidikan Program Studi Pendiidkan Biologi

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ABSTRAK

PROFIL ASESMEN EPISTEMIK UNTUK KOMPETENSI MENJELASKAN FENOMENA SECARA ILMIAH PADA PEMBELAJARAN BIOLOGI

Rendahnya literasi sains siswa, khususnya dalam kompetensi menjelaskan fenomena secara ilmiah, menunjukkan perlunya asesmen yang tidak hanya menekankan pada penguasaan konsep, tetapi juga pada keterampilan epistemik. Kompetensi menjelaskan fenomena ilmiah penting untuk melatih siswa berpikir kritis, logis, serta mampu menghubungkan konsep sains dengan fenomena nyata. Kompetensi ini merujuk pada indikator dalam PISA 2025 Science Framework. Desain penelitian menggunakan metode deskriptif kuantitatif dengan sample purposive sampling sebanyak 225 siswa kelas X-XI di lima SMA berakreditasi A,B, dan C. instrumen utama terdiri dari kuesioner skala likert (1-4) yang telah diuji validitas dan reabilitasnya Penelitian ini membandingkan pengalman belajar, pengalaman asesmen, kesesuaian antara keduanya, serta kendala dan harapan siswa disekolah dengan akreditasi A,B, dan C. metode deskriptif kuantitatif digunakan dengan melibatkan 225 siswa kelas X dan XI dari lima sekolah di Bandung dan Cimahi. Hasil menunjukkan bahwa pengalaman belajar sering, namun lemah dalam merevisi hipotesis dan menggunakan representasi visual. Asesmen sering menggunakan bentuk representasi berupa presentasi. Kesesuaian antara pengalaman belajar dan asesmen umumnya sering sesuai. Kendala utama siswa adalah kurangnya pemahaman konsep dan kesulitan menyampaikan penjelasan terstruktur. Harapan siswa meliputi pembelajaran interaktif, bimbingan jelas, dan kesempatan revisi. Perbandingan antara akreditasi menunjukkan sekolah dengan akreditasi A lebih banyak dan konsisten melakukan pembelajaran asesmen epistemik sains. Akreditasi sekolah B menunjukkan hasil yang hampir sama, namun masih memerlukan dukungan dalam pengelolaan waktu. Sementara akreditasi sekolah C belum sepenuhnya konsisten menerapkan pembelajaran dan asesmen yang lebih baik.

Kata kunci: asesmen epistemik, menjelaskan fenomena ilmiah, kompetensi sains, pembelajaran biologi, PISA 2025.

ABSTRACT

EPISTEMIC ASSESSMENT PROFILE FOR THE COMPETENCE OF EXPLAINING PHENOMENA SCIENTIFICALLY IN BIOLOGY LEARNING

The low level of students' scientific literacy, particularly in the competence of explaining phenomena scientifically, indicates the need for assessments that emphasize not only conceptual mastery but also epistemic skills. The competence of explaining scientific phenomena is important to train students to think critically, logically, and be able to connect scientific concepts with real phenomena. This competence refers to the indicators in the PISA 2025 Science Framework. The research design used a quantitative descriptive method with a purposive sampling sample of 225 students in grades X-XI in five high schools accredited A, B, and C. The main instrument consisted of a Likert scale questionnaire (1-4) that had been tested for validity and reliability. This study compared learning experiences, assessment experiences, the suitability between the two, as well as obstacles and expectations of students in schools with A, B, and C accreditation. The quantitative descriptive method was used involving 225 students in grades X and XI from five schools in Bandung and Cimahi. The results showed that learning experiences were frequent, but weak in revising hypotheses and using visual representations. Assessments often used presentations as a form of representation. The suitability between learning experiences and assessments was generally often appropriate. The main obstacles students face are a lack of conceptual understanding and difficulty delivering structured explanations. Student expectations include interactive learning, clear guidance, and opportunities for revision. A comparison of accreditation levels shows that schools with A accreditation consistently implement epistemic science assessments more frequently and consistently. Schools with B accreditation show similar results, but still require support in time management. Meanwhile, schools with C accreditation have not yet consistently implemented better learning and assessments.

Keywords: *epistemic assessment, explaining scientific phenomena, science competencies, biology learning, PISA 2025.*

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DAFTAR PUSTAKA

A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. (2012). In *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. National Academies Press. https://doi.org/10.17226/13165

Ainsworth, S. (2006). DeFT: A conceptual framework for considering learning with multiple representations. *Learning and Instruction*, *16*(3), 183–198. https://doi.org/10.1016/j.learninstruc.2006.03.001

Arnold, J. C., Boone, W. J., Kremer, K., & Mayer, J. (2018). Assessment of competencies in scientific inquiry through the application of rasch measurement techniques. *Education Sciences*, *8*(4). https://doi.org/10.3390/educsci8040184

Azizah, N. N., & Hidayat, R. (2024). Pengembangan Asesmen Digital Berbasis Game Edukatif Quizizz pada Mata Pelajaran Marketing. *Journal of Innovation and Teacher Professionalism*, *2*(2), 195–209. https://doi.org/10.17977/um084v2i22024p195-209

Bartholomew, H., Osborne, J., & Ratcliffe, M. (2004). Teaching students "ideas-about-science": Five dimensions of effective practice. In *Science Education* (Vol. 88, Issue 5, pp. 655–682). https://doi.org/10.1002/sce.10136

Barzilai, S., & Zohar, A. (2012). Epistemic Thinking in Action: Evaluating and Integrating Online Sources. *Cognition and Instruction*, *30*(1), 39–85. https://doi.org/10.1080/07370008.2011.636495

Baume, D., Yorke, M., & Coffey, M. (2004). What is happening when we assess, and how can we use our understanding of this to improve assessment? *Assessment and Evaluation in Higher Education*, *29*(4), 451–477. https://doi.org/10.1080/02602930310001689037

Bengio, Y., Goodfellow, I., & Courville, A. (2015). *Deep Learning*.

Berland, L. K., & Reiser, B. J. (2009). Making sense of argumentation and explanation. *Science Education*, *93*(1), 26–55. https://doi.org/10.1002/sce.20286

Bienkowski, M., Feng, M., & Means, B. (2012). *Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics: An Issue Brief Center for Technology in Learning SRI International*. http://www.ed.gov/technology.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *International Journal of Phytoremediation*, *21*(1), 7–74. https://doi.org/10.1080/0969595980050102

Bloemendaal, N., De Moel, H., Martinez, A. B., Muis, S., Haigh, I. D., Van Der Wiel, K., Haarsma, R. J., Ward, P. J., Roberts, M. J., Dullaart, J. C. M., & Aerts, J. C. J. H. (2022). A globally consistent local-scale assessment of future tropical cyclone risk. In *Sci. Adv* (Vol. 8). https://www.science.org

Bransford, John. (2006). *How people learn : brain, mind, experience, and school*. Recording for the Blind & Dyslexic.

Brusilovsky, P. (2007a). LNCS 4321 - User Models for Adaptive Hypermedia and Adaptive Educational Systems. In *LNCS* (Vol. 4321).

Bybee, R. W. (2010). What is STEM education? In *Science* (Vol. 329, Issue 5995, p. 996). https://doi.org/10.1126/science.1194998

bybee2010. (n.d.).

Chinn, C. A., Golan Duncan, R., & Av-Shalom, N. Y. (2021). Applying the Grasp-of-Evidence Framework to Design and Evaluate Epistemically Complex Learning Environments. *Information and Technology in Education and Learning*, *1*(1), Inv-p004-Inv-p004. https://doi.org/10.12937/itel.1.1.inv.p004

Chinn, C. A., & Malhotra, B. A. (2002a). Epistemologically Authentic Inquiry in Schools: A Theoretical Framework for Evaluating Inquiry Tasks. *Science Education*, *86*(2), 175–218. https://doi.org/10.1002/sce.10001

Chinn, C. A., & Malhotra, B. A. (2002b). Epistemologically Authentic Inquiry in Schools: A Theoretical Framework for Evaluating Inquiry Tasks. *Science Education*, *86*(2), 175–218. https://doi.org/10.1002/sce.10001

Davenport, C., & Pagnini, F. (2016). Mindful learning: A case study of langerian mindfulness in schools. *Frontiers in Psychology*, *7*(SEP). https://doi.org/10.3389/fpsyg.2016.01372

Dede, C. (2009). Immersive interfaces for engagement and learning. In *Science* (Vol. 323, Issue 5910, pp. 66–69). https://doi.org/10.1126/science.1167311

Dewey, J. (n.d.). *EXPERIENCE & EDUCATION*.

Dewi, A. C. (n.d.). *STRATEGI PEMBELAJARAN BAHASA INDONESIA BERBASIS AI DALAM MENINGKATKAN LITERASI DIGITAL SISWA* (Vol. 5).

Driver, R., & Osborne, J. (2000). Establishing the Norms of Scientific Argumentation in Classrooms. In *Sci Ed* (Vol. 84).

Duschl, R. (2008). Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of Research in Education*, *32*, 268–291. https://doi.org/10.3102/0091732X07309371

Duschl, R. A. (2020). Practical reasoning and decision making in science: Struggles for truth. *Educational Psychologist*, *55*(3), 187–192. https://doi.org/10.1080/00461520.2020.1784735

Duschl, R. A., & Grandy, R. (2013a). Two Views About Explicitly Teaching Nature of Science. *Science and Education*, *22*(9), 2109–2139. https://doi.org/10.1007/s11191-012-9539-4

Educator, A., & Spring, |. (2012). *Principles of Instruction Research-Based Strategies That All Teachers Should Know*. www.ibe.unesco.org/fileadmin/user_upload/

Erduran, Sibel., & Aleixandre, Marilar. (2007). *Argumentation in science education : perspectives from classroom-based research*. Springer.

Feriyanto, F., & Anjariyah, D. (2024). Deep Learning Approach Through Meaningful, Mindful, and Joyful Learning: A Library Research. *Electronic Journal of Education, Social Economics and Technology*, *5*(2), 208–212. https://doi.org/10.33122/ejeset.v5i2.321

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and

mathematics. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Ginanjar, W. S., Utari, S., & Muslim, Dr. (2015). PENERAPAN MODEL ARGUMENT-DRIVEN INQUIRY DALAM PEMBELAJARAN IPA UNTUK MENINGKATKAN KEMAMPUAN ARGUMENTASI ILMIAH SISWA SMP. *Jurnal Pengajaran Matematika Dan Ilmu Pengetahuan Alam*, *20*(1), 32. https://doi.org/10.18269/jpmipa.v20i1.559

Goh, D. (2016). Expanded Understandings of the Connective Approach in Helping Students Construct Scientific Explanations. *SAGE Open*, *6*(3). https://doi.org/10.1177/2158244016663608

Graham, S., & Perin, D. (2007). A Meta-Analysis of Writing Instruction for Adolescent Students. *Journal of Educational Psychology*, *99*(3), 445–476. https://doi.org/10.1037/0022-0663.99.3.445

Griffin, P., McGaw, B., & Care, E. (2012). Assessment and teaching of 21st century skills. In *Assessment and teaching of 21st century skills* (Vol. 9789400723245). Springer Netherlands. https://doi.org/10.1007/978-94-007-2324-5

Hattie, J., & Timperley, H. (2007). The power of feedback. In *Review of Educational Research* (Vol. 77, Issue 1, pp. 81–112). SAGE Publications Inc. https://doi.org/10.3102/003465430298487

He, P., Chen, I. C., Touitou, I., Bartz, K., Schneider, B., & Krajcik, J. (2023). Predicting student science achievement using post-unit assessment performances in a coherent high school chemistry project-based learning system. *Journal of Research in Science Teaching*, *60*(4), 724–760. https://doi.org/10.1002/tea.21815

Hofer, B. K. (2001). Personal Epistemology Research: Implications for Learning and Teaching. In *Journal of Educational Psychology Review* (Vol. 13, Issue 4).

Hsieh, Y. H., & Tsai, C. C. (2014). Students' Scientific Epistemic Beliefs, Online Evaluative Standards, and Online Searching Strategies for Science Information: The Moderating Role of Cognitive Load Experience. *Journal of Science Education and Technology*, *23*(3), 299–308. https://doi.org/10.1007/s10956-013-9464-6

Immordino-Yang, M. H., & Damasio, A. (2007). We Feel, Therefore We Learn: The Relevance of Affective and Social Neuroscience to Education. *Mind, Brain, and Education*, *1*(1), 3–10. https://doi.org/10.1111/j.1751-228x.2007.00004.x

Juhji, J., & Mansur, M. (2020). PENGARUH LITERASI SAINS DAN KETERAMPILAN BERPIKIR KRITIS TERHADAP PENGUASAAN KONSEP DASAR BIOLOGI. *EDUSAINS*, *12*(1), 113–122. https://doi.org/10.15408/es.v12i1.13048

Kebutuhan, A., Ajar, B., Studi, :, Mata, K., Asesmen, K., Biologi, P., Fitri, T., 1∗, W., & Antika, R. N. (2024). Edukatif: Jurnal Ilmu Pendidikan. *Jurnal Ilmu Pendidikan*, *6*(2). https://doi.org/10.31004/edukatif.v6i2.6543

Khery, Y., Sarjan, M., Ahzan, S., & Efendi, I. (2022). Konseptualisasi Literasi Sains Mengacu pada Kerangka Sains Pisa Sejak Tahun 2000. *Educatoria : Jurnal Ilmiah Ilmu Pendidikan*, *2*(4), 200–231. https://doi.org/10.36312/ejiip.v2i4.117

Kim, K. G. (2016). Book Review: Deep Learning. *Healthcare Informatics Research*, *22*(4), 351. https://doi.org/10.4258/hir.2016.22.4.351

Klassen, A. C., Creswell, J., Plano Clark, V. L., Smith, K. C., & Meissner, H. I. (2012). Best practices in mixed methods for quality of life research. In *Quality of Life Research* (Vol. 21, Issue 3, pp. 377–380). https://doi.org/10.1007/s11136-012-0122-x

Kuhn, D. (1999). A Developmental Model of Critical Thinking. In *Source: Educational Researcher* (Vol. 28, Issue 2).

Kusuma Putri, R., Pendidikan, Y., & Medan, S. A. (2020). PENGEMBANGAN INSTRUMEN TES LITERASI SAINS SISWA PADA TOPIK KEANEKARAGAMAN MAKHLUK HIDUP. *Jurnal Pendidikan Dan Pembelajaran Biologi*, *4*(1), 71–78.

Lederman, N. G., Lederman, J. S., & Antink, A. (2013). Nature of Science and Scientific Inquiry as Contexts for the Learning of Science and Achievement of Scientific Literacy. In *International Journal of Education in Mathematics* (Vol. 1, Issue 3). www.ijemst.com

Lee, S. W. Y., Luan, H., Lee, M. H., Chang, H. Y., Liang, J. C., Lee, Y. H., Lin, T. J., Wu, A. H., Chiu, Y. J., & Tsai, C. C. (2021). Measuring epistemologies in science learning and teaching: A systematic review of the literature. *Science Education*, *105*(5), 880–907. https://doi.org/10.1002/sce.21663

Lin, T. J., Deng, F., Chai, C. S., & Tsai, C. C. (2013). High school students' scientific epistemological beliefs, motivation in learning science, and their relationships: A comparative study within the Chinese culture. *International Journal of Educational Development*, *33*(1), 37–47. https://doi.org/10.1016/j.ijedudev.2012.01.007

Lipnevich, A. A., & Panadero, E. (2021). A Review of Feedback Models and Theories: Descriptions, Definitions, and Conclusions. In *Frontiers in Education* (Vol. 6). Frontiers Media S.A. https://doi.org/10.3389/feduc.2021.720195

Masayu Andayanie, L., Syahriandi Adhantoro, M., Purnomo, E., & Tribuana Kurniaji, G. (2025). *Implementation of Deep Learning in Education: Towards Mindful, Meaningful, and Joyful Learning Experiences Journal of Deep Learning Implementation of Deep Learning in Education: Towards Mindful, Meaningful, and Joyful Learning Experiences* (Vol. 1, Issue 1). https://journals2.ums.ac.id/index.php/jdl

McNeill, K. L., & Krajcik, J. (2008). Scientific explanations: Characterizing and evaluating the effects of teachers' instructional practices on student learning. *Journal of Research in Science Teaching*, *45*(1), 53–78. https://doi.org/10.1002/tea.20201

Momsen, J., Speth, E. B., Wyse, S., & Long, T. (2022). Using Systems and Systems Thinking to Unify Biology Education. *CBE Life Sciences Education*, *21*(2). https://doi.org/10.1187/cbe.21-05-0118

Niate, M., Djulia, E., Studi, P., Biologi, P., & Biologi, J. (2022). Profil Kemampuan Literasi Sains Siswa Kelas X pada Aspek Kompetensi Materi Vertebrata Profile of Students Scientific Literacy Skills in Grade X on The Competency Aspect of Vertebrate Topic. In *Jurnal Biologi Edukasi Edisi* (Vol. 29).

Nicol, D., & MacFarlane-Dick, D. (2006a). Formative assessment and selfregulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education*, *31*(2), 199–218. https://doi.org/10.1080/03075070600572090

Nicol, D., & MacFarlane-Dick, D. (2006b). Formative assessment and selfregulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education*, *31*(2), 199–218. https://doi.org/10.1080/03075070600572090

Nieminen, J. H., & Lahdenperä, J. (2024). Assessment and epistemic (in)justice: how assessment produces knowledge and knowers. *Teaching in Higher Education*, *29*(1), 300–317. https://doi.org/10.1080/13562517.2021.1973413

OECD Economic Outlook, Volume 2024 Issue 2 (Vol. 2024). (2024). OECD Publishing. https://doi.org/10.1787/d8814e8b-en

Osborne, J. (2010). Arguing to learn in science: The role of collaborative, critical discourse. In *Science* (Vol. 328, Issue 5977, pp. 463–466). https://doi.org/10.1126/science.1183944

Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research in Science Teaching*, *41*(10), 994–1020. https://doi.org/10.1002/tea.20035

Penelitian Pendidikan, J., Butir Soal IPA Pokok Bahasan Biologi di SMP Tentang Keterampilan Menjelaskan Fenomena Secara Ilmiah, S., Ilannur, A., Ratna Wulan, A., & Diana, S. (2020). *The Study of Instrument Assessment in Biology Subjects about Explaining Phenomena Scientifically Skills in Junior High School*. *20*(2), 163–173.

Peters-Burton, E. E., Parrish, J. C., & Mulvey, B. K. (2019). Extending the Utility of the Views of Nature of Science Assessment through Epistemic Network Analysis. *Science and Education*, *28*(9–10), 1027–1053. https://doi.org/10.1007/s11191-019-00081-x

pew_research_center_-_income-based_digital_divides_tech_adoption. (n.d.).

PISA 2015 Assessment and Analytical Framework. (2017). OECD. https://doi.org/10.1787/9789264281820-en

PISA 2018 Results (Volume I). (2019). OECD. https://doi.org/10.1787/5f07c754-en

PISA 2025 SCIENCE FRAMEWORK (DRAFT). (2023a).

PISA 2025 SCIENCE FRAMEWORK (DRAFT). (2023b).

Price, M., Carroll, J., O'Donovan, B., & Rust, C. (2011). If I was going there I wouldn't start from here: A critical commentary on current assessment practice. *Assessment and Evaluation in Higher Education*, *36*(4), 479–492. https://doi.org/10.1080/02602930903512883

Rini, C. P., Dwi Hartantri, S., & Amaliyah, A. (2021). Analisis Kemampuan Literasi Sains Pada Aspek Kompetensi Mahasiswa PGSD FKIP Universitas Muhammadiyah Tangerang. *JURNAL PENDIDIKAN DASAR NUSANTARA*, *6*(2), 166–179. https://doi.org/10.29407/jpdn.v6i2.15320

Rizki, A., & Santoso, T. (2019). . (n.d.).

Rohmi, P. (2017). PENINGKATAN DOMAIN KOMPETENSI DAN PENGETAHUAN SISWA MELALUI PENERAPAN LEVELS OF INQUIRY DALAM PEMBELAJARAN IPA TERPADU. *EDUSAINS*, *9*(1). https://doi.org/10.15408/es.v9i1.1979

Ruiz-Primo, M. A., & Furtak, E. M. (2007). Exploring teachers' informal formative assessment practices and students' understanding in the context of scientific inquiry. *Journal of Research in Science Teaching*, *44*(1), 57–84. https://doi.org/10.1002/tea.20163

Sadler, T. D. (2004). Informal reasoning regarding socioscientific issues: A critical review of research. In *Journal of Research in Science Teaching* (Vol. 41, Issue 5, pp. 513–536). https://doi.org/10.1002/tea.20009

Sadler, T. D., & Zeidler, D. L. (2009). Scientific literacy, PISA, and socioscientific discourse: Assessment for progressive aims of science education. *Journal of Research in Science Teaching*, *46*(8), 909–921. https://doi.org/10.1002/tea.20327

Säljö, R. (n.d.). *Literacy, Digital Literacy and Epistemic Practices: The Co-Evolution of Hybrid Minds and External Memory Systems*. www.idunn.no.

Sandoval, W. (2014). Science Education's Need for a Theory of Epistemological Development. *Science Education*, *98*(3), 383–387. https://doi.org/10.1002/sce.21107

Sandoval, W. A. (2005). Understanding students' practical epistemologies and their influence on learning through inquiry. In *Science Education* (Vol. 89, Issue 4, pp. 634–656). https://doi.org/10.1002/sce.20065

Sandoval, W. A., & Millwood, K. A. (2005). *The Quality of Students' Use of Evidence in Written Scientific Explanations*.

Septiani, E., & Mellisa, M. (2024). Motivasi Belajar Peserta didik Di Masa Pascapandemi Covid-19 Dalam Pembelajaran Biologi Kelas XI IPA SMA Negeri 2 Pekanbaru. *BIODIK*, *10*(3), 400–415. https://doi.org/10.22437/biodik.v10i3.23523

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, *78*(1), 153–189. https://doi.org/10.3102/0034654307313795

Simonneaux, L. (2013). Troy D. Sadler (ed.): Socio-Scientific Issues in the Classroom: Teaching, Learning and Research. *Science & Education*, *22*(3), 723–728. https://doi.org/10.1007/s11191-012-9472-6

Thill, E. E., Poumarat, G., & Rigoulet, N. (1997). Task-involvement and ego-involvement goals during actual and imagined movements: Their effects on cognitions and vegetative responses. In *Behavioural Brain Research* (Vol. 82).

Thomas, J. W. (2000). *A REVIEW OF RESEARCH ON PROJECT-BASED LEARNING The Autodesk Foundation 111 McInnis Parkway San Rafael, California 94903 (415) 507-6336 Fax (415) 507-6339 http://www.autodesk.com/foundation*. http://www.autodesk.com/foundation

WHY IS A K-12 SCIENCE FRAMEWORK NEEDED? (n.d.). www.nationalacademies.org/bose

Yani Balaka, M., & Abyan, F. (2022). *METODOLOGI PENELITIAN KUANTITATIF*. www.penerbitwidina.com

Yilmaz-Tüzün, Ö., & Topcu, M. S. (2010). Investigating the relationships among elementary school students' epistemological beliefs, metacognition, and constructivist science learning environment. *Journal of Science Teacher Education*, *21*(2), 255–273. https://doi.org/10.1007/s10972-009-9163-6

Zakaria, M. R., & Rosdiana, L. (n.d.). *Profil Literasi Sains Peserta Didik Kelas VII pada Topik Pemanasan Global*.

Zheng, J., Lajoie, S., & Li, S. (2023). Emotions in self-regulated learning: A critical literature review and meta-analysis. In *Frontiers in Psychology* (Vol. 14). Frontiers Media S.A. https://doi.org/10.3389/fpsyg.2023.1137010

Zohar, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching*, *39*(1), 35–62. https://doi.org/10.1002/tea.10008