



Development of Ethnoscience-Based Critical Thinking Instrument in Physics Learning

Ilwandri^{1*}, Festiyed², Tomi Apra Santosa³

^{1,3} Civil Engineering Lecturer, Adikarya Technical Academy

² Postgraduate Lecturer, FMIPA, Padang State University

^{1,3} Doctor of Science Education, FMIPA, Padang State University

* Corresponding Author. E-mail: ilwandriunp@gmail.com

Receive: 10/01/2023

Accepted: 10/02/2023

Published: 01/03/2023

Abstrak

Penelitian ini bertujuan untuk menghasilkan instrumen Project Based Learning terintegrasi etnosains yang valid dan reliabel pada materi Hukum Newton. Jenis penelitian ini adalah penelitian pengembangan dengan model 4D. Sampel penelitian berasal dari 2 orang dosen pendidikan fisika dan guru fisika SMA Negeri 4 Kerinci. Teknik pengumpulan data berasal dari observasi, wawancara dan angket validasi. Instrumen dalam penelitian ini adalah lembar validasi dengan menggunakan skala likers. Analisis data yang digunakan adalah teknik analisis kualitatif dan kuantitatif dengan bantuan aplikasi SPSS versi 21. Hasil penelitian menunjukkan nilai rata-rata validasi instrumen etnosains sebesar 0,710 dengan kriteria sangat valid dan nilai reliabilitas sebesar 0,845 dengan kriteria tinggi. Temuan ini menjelaskan bahwa instrumen etnosains yang diintegrasikan dengan pembelajaran berbasis proyek sangat layak untuk dikembangkan dalam pembelajaran fisika materi Hukum Newton.

Kata Kunci: Instrumen, Berpikir Kritis, Etnosains, Pembelajaran Sains, Fisika

Development of Ethnoscience-Based Critical Thinking Instrument in Physics Learning

Abstract

This study aims to find out to produce a valid and reliable Project Based Learning integrated ethnoscience instrument in Newton's Law material. This type of research is a development research with 4D model. The research sample came from 2 physics education lecturers and physics teachers of SMA Negeri 4 Kerinci. Data collection techniques come from observation, interviews and validation questionnaires. The instrument in this study was a validation sheet using a likers scale. Data analysis is qualitative and quantitative analysis techniques with the help of the SPSS version 21 application. The results show the average validation value of ethnoscience instruments of 0.710 with very valid criteria and a reliability value of 0.845 high criteria. This finding explains that the ethnoscience instrument integrated with project-based learning is very feasible to be developed in learning physics material on Newton's Law.

Keywords: Instrument, Critical Thinking, Ethnoscience, Science Learning, Physics

Introduction

Critical thinking is an ability that students must have in facing the 21st century (Untari et al., 2020; Suharyat et al., 2022; Suryono et al., 2023). Critical thinking is necessary for students to solve a problem (Kurniahtunnisa et al., 2016; Ludwig & Charbel, 2023; Shaw et al., 2019; Rahman et al., 2023). Ariani (2020) Critical thinking skills help students be more creative and active in learning. In addition, critical thinking encourages students to think at a higher level in the learning process (Farisi et al., 2017; Amin et al., 2020; Yustiana et al., 2022; Cahyono et al., 2021; Suharyat et al., 2022; Elfira & Santosa, 2023). Students who have critical thinking skills find it easier to understand the subject matter (Prihono et al., 2020; Ichsan et al., 2023)

Students' science critical thinking skills in Indonesia are still low (Hidayati et al., 2022; Rahmatia & Fitria, 2021; Oktarina et al., 2021; Sofianora et al., 2023). This can be seen from the 2018 PISA Research which shows the critical thinking skills of Indonesian students in the field of science obtained a score of 396 ranked 72 out of 78 members (Zulkifli et al., 2022; Rahman et al., 2023; Karim et al., 2023; Nurtamam et al., 2023). In teaching and learning activities teachers still use conventional methods (Ejin, 2017), so that students are less active in learning. Kono & Mamu (2016) stated that teachers who use consensual learning models have not been able to improve students' critical thinking skills. In addition, teachers have not been able to direct students to work on questions that lead students to think critically. So, there is a need for instruments that can encourage students to think critically in physics learning.

Physics is a compulsory subject for high school students that must be completed with grades in accordance with

the Teaching Completeness Criteria. Physics learning leads students to be able to think critically in order to provide solutions to problems (Rahman & Ristiana, 2020). Research results by Rofiah et al., (2013) stated that the development of physics instruments helps teachers to improve higher order thinking skills. In addition, the instrument can help teachers in evaluating student learning outcomes (Sari et al., 2018). Research results Sulistiyono *et al.*, (2019) stated that the development of instruments in physics learning evaluates students' attitudes and responsibilities. The development of ethnosain-based critical thinking instruments helps students introduce their local wisdom (Fitria & Widi, 2015; Subali, 2020; Hallatu & Palittin, 2021; (uhaimi et al., 2022).

Previous research by Amarila *et al.*, (2014) stated that the development of a valid critical thinking instrument will shape the quality of students' thinking in learning physics. Penelitian oleh Putri et al., 2016) explains the development of instruments related to proper physics learning will be able to measure students' critical thinking skills. However, the reality is that teachers have not been able to make the right instruments that direct students to think critically. Desiriah & Setyarsih (2021) The development of valid and reliable instruments is able to measure students' high-level thinking skills. Based on the above problems, this research aims to produce valid and reliable ethnoscience-based critical thinking instruments in physics learning.

Methods

This research is a type of Research & Development research using the 4D model. This research was conducted at SMA Negeri 4 Kerinci. The research sample

came from 2 physics education lecturers and 1 physics teacher of SMA Negeri 4 Kerinci. Data collection techniques in this study were observation, interview and questionnaire. Instruments in the form of tests and validation sheets. The test consists of 10 multiple choice questions related to critical thinking in learning physics material Newton's law, while the validation sheet is used to measure the feasibility of questions in learning physics material newton's law. Criteria for validation and reliability of questions can be seen (Tables 1 and 2). The data analysis technique is quantitative analysis with the help of the SPSS version 16 application with the criteria for critical thinking skills can be seen in Table 1.

Table 1. Criteria for Question Validity

Angka	Criteria
0.80 – 1.00	Very High
0.60 – 0.80	High
0.40 – 0.60	Simply
0.20 – 0.40	Low
0.00 – 0.20	Very Low

Source: (Hamidah & Wulandari, 2021)

Table 2. Reliability criteria

Angka	Kriteria
0.80 – 1.00	Very High
0.60 – 0.79	High
0.40 – 0.59	Simply
0.20 – 0.39	Low
0.00 – 0.19	Very Low

Source: (Hamidah & Wulandari, 2021)

Table 3. Critical Thinking Ability Interpretation Criteria

Angka	Criteria
81- 100	Very Good
61 – 80	Good
41 – 60	Simply
21– 40	Less
< 20	Very Less

Source: Purnigrum dalam Hamidah & Wulandari (2021)

Result

The results of the development of ethnoscience-based critical thinking instruments in learning physics newton's law material. The first stage of needs analysis, curriculum analysis and analysis of student evaluation questions in ecology and environmental materials. The second stage makes the design of critical thinking instruments in accordance with the Basic Competencies and Core Competencies of newton's law material. Furthermore, the third stage is Develop. At this stage, the instrument was validated by content validation, language validation and material validation by physics education lecturers and physics teachers. The results of the validation of critical thinking instruments in learning newton's law material can be seen in Table 3.

Table. 3 HOTS Instrument Validation Results

No	Validation	Skor	Peresentase (%)	Criteria
1	Content	49	86 %	Very Valid
2	Languange	41	80 %	Valid
3	Material	45	88 %	Very Valid
Average				Valid

Based on Table. 3 explains that the content validation value obtained a score of 49 with very valid criteria valid, language validation score 451, material validation score 47 and the average value of the validity test obtained a score of 45 with very valid criteria valid. This shows that ethnosain-based critical thinking instruments are suitable for use in learning biology class X SMA Negeri 4 Kerinci newton's law material. The next stage is implementation. At this stage the instrument that has been validated by experts and revised is then carried out a limited trial on students by giving Higher Order Thinking Skills (HOTS) questions. The

Resul and Discussion

results of the limited trial validation can be seen in Table 4.

Table 4. Student Critical Thinking Interpretation Results

Index	Criteria	Limited Product Trial	
		Frequency	Total
0.81 - 1.00	Very High	4	40
0.61 - 0.80	High	4	40
0.41 - 0.60	Simply	1	10
0.21 - 0.40	Low	1	10
0.00 - 0.20	Very Low	0	0
Total		10	100

Based on Table 4. Shows the results of limited instrument trials of critical thinking in physics learning there are 4 (40%) questions that have very high validation, 8 (40%) questions have high validity, 4 (40%) questions have sufficient validity and 1 (10%) has low validity. From the results of the limited trial, the Higher Order Thinking Skills (HOTS) instrument in physics learning is very feasible to be used in learning newton's law material. Furthermore, from the limited test results of the HOTS instrument, the lowest rcount was 0.220 with low criteria while the highest rcount was 0.820 with very high validity. With an average score of 0.710 with valid criteria. Furthermore, the results of the HOTS instrument reliability test in learning newton's physics can be seen in Table 5.

Table 5. Reliability Test Results

Product Trial	α	Criteria
Uji Coba Produk Terbatas	0.845	High

Based on Table 5. Explaining the results of the HOTS instrument reliability test in the limited product trial obtained $\alpha = 0.972$ with very high criteria. This shows that this ethnossian-based critical thinking instrument is very valid and reliable to be developed in learning newton's law physics.

Discussion

The development of ethnosience-based critical thinking instruments in learning physics newton's law material is very feasible to develop. Ethnocentric-based critical thinking instruments are very important for teachers in developing students' critical thinking skills in learning (Fitriani, 2020; Rahman et al., 2023). The development of valid and reliable ethnosience-based critical thinking instruments will encourage students' critical and creative thinking skills in learning. (Agustin et al., 2018; Novitra et al., 2021).

In developing ethnosian-based critical thinking instruments for physics learning, questions must refer to critical thinking indicators so that students can think critically. Fradila et al., (2021) stated that ethnosain-based critical thinking instruments that have good validity, reliability and difficulty index values will result in appropriate use to measure students' critical thinking skills. From the validity test results obtained an average score of 0.710 and reliability of 0.845 with very high criteria. The use of appropriate critical thinking instruments in biology learning will be able to be used in evaluating the quality of student learning (Shaw et al., 2019). (Al-fikry & Syukri, 2018) stated that the development of ethbosience-based critical thinking instruments can encourage students to more easily solve a problem related to physics learning questions.

Conclusion

Based on this research, it can be concluded that ethnosience-based critical thinking has a validation value of 0.710 with decent criteria, reliability of 0.845 high criteria. These findings explain that the critical thinking instrument is very valid and reliable to use in newton's law material. So, the ethnosience-based

critical thinking instrument is very feasible to be developed in physics learning at school.

Reference

- Agustin, N., Susilogati, S., & Addiani, K. (2018). desain instrumen tes bermuatan etnosains untuk mengukur kemampuan berpikir kritis siswa sma. *Jurnal Inovasi Pendidikan Kimia*, 12(2), 2159 – 2169.
- Al-fikry, I., & Syukri, M. (2018). Pengaruh Model Problem Based Learning Terhadap Kemampuan Berpikir Kritis Peserta Didik Pada Materi Kalor. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 06(01), 17–23. <https://doi.org/10.24815/jpsi.v6i1.10776>
- Amin, S., Utaya, S., Bachri, S., & Susilo, S. (2020). Effect of problem-based learning on critical thinking skills and environmental attitude. *Journal for the Education of Gifted Young Scientists*, 8(2), 743–755.
- Ariani, R. F. (2020). PENGARUH MODEL PEMBELAJARAN PROBLEM BASED LEARNING TERHADAP KEMAMPUAN BERPIKIR KRITIS SISWA SD. *Jurnal Imiah Pendidikan Dan Pembelajaran*, 4(3), 422–432.
- Cahyono, B., Semarang, U. N., & Education, F. (2021). Problem-based learning supported by arguments scaffolding that affect critical thinking teacher candidates. *Cypriot Journal of Educational Sciences*, 16(6), 2956–2969.
- Dian Ratih Utama Sari, Sri Wahyuni, R. W. B. (20181). PENGEMBANGAN INSTRUMEN TES MULTIPLE CHOICE HIGH ORDER THINKING PADAPEMBELAJARAN FISIKA BERBASIS. *Jurnal Pembelajaran Fisika*, 7(1), 100–107.
- Ejin, S. (2017). Pengaruh Model Problem Based Learning (PBL Terhadap Pemahaman Konsep dan Keterampilan Berpikir Kritis Siswa Kelas IV SDN Jambu Hilir Baluti 2 Pada Mata Pelajaran Ilmu Pengetahuan Alam. *Jurnal Pendidikan (Teori Dan Praktik)*, 1(1), 66. <https://doi.org/10.26740/jp.v1n1.p66-72>
- Eka Desiriah1), W. S. (2021). TINJAUAN LITERATUR PENGEMBANGAN INSTRUMEN PENILAIAN KEMAMPUAN BERPIKIR TINGKAT TINGGI (HOTS) FISIKA DI SMA. *ORBITA. Jurnal Hasil Kajian, Inovasi, Dan Aplikasi Pendidikan Fisika*, 7(1), 79–89.
- Elfira, I., & Santosa, T. A. (2023). Literature Study : Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, 9(1), 133–143. <https://doi.org/10.29303/jppipa.v9i1.2555>
- Emi Rofiah, Nonoh Siti Aminah, E. Y. E. (2013). PENYUSUNAN INSTRUMEN TES KEMAMPUAN BERPIKIR TINGKAT TINGGI FISIKA PADA SISWA SMP Oleh: Emi Rofiah, Nonoh Siti Aminah, Elvin Yusliana Ekawati Program Studi Pendidikan Fisika Fakultas Keguruan dan Ilmu Pendidikan Universitas Sebelas Maret. *Jurnal Pendidikan Fisika*, 1(2), 17–22.
- F.S. Putri? , E. Istiyono, E. N. (2016). PENGEMBANGAN INSTRUMEN TES KETERAMPILAN BERPIKIR KRITIS DALAM BENTUK PILIHAN GANDA BERALASAN (POLITOMUS) DI DIY. *Unnes Physics Education Journal*, 5(2), 76–84.
- Farisi, A., Hamid, A., & Fisika, P. (2017). |

- 283 pengaruh model pembelajaran problem based learning terhadap kemampuan berpikir kritis dalam meningkatkan hasil belajar siswa pada konsep suhu dan kalor. *Jurnal Ilmiah Mahasiswa (JIM) Pendidikan Fisika*, 2(3), 283–287.
- Fitria, M., & Widi, A. (2015). The Development of Ethnoscience-Based Chemical Enrichment Book as a Science Literacy Source of Students. *International Journal of Chemistry Education Research*, 2(1), 50–57.
- Fitriani, A. (2020). PBLPOE : A Learning Model to Enhance Students ' Critical Thinking Skills and Scientific Attitudes. *International Journal of Instruction*, 13(2), 89–106.
- Fradila, E., Razak, A., Santosa, T. A., Arsih, F., & Chatri, M. (2021). Development Of E-Module-Based Problem Based Learning (PBL) Applications Using Sigil The Course Ecology And Environmental Education Students Master Of Biology. *International Journal of Progressive Sciences and Technologies (IJPSAT)*, 27(2), 673–682.
- Hallatu, T. G. R., & Palittin, I. D. (2021). Ethnoscience-based science learning in elementary schools Ethnoscience-based science learning in elementary schools. *Journal of Physics: Conference Series*, 1987, 1–8. <https://doi.org/10.1088/1742-6596/1987/1/012055>
- Hidayati et al. (2022). The PBL vs . Digital Mind Maps Integrated PBL : Choosing Between the two with a view to Enhance Learners ' Critical Thinking Nurkhairo Hidayati Sri Amnah. *Participatory Educational Research (PER)*, 9(3), 330–343.
- Ichsan, Yayat Suharyat, Tomi Apra Santosa, E. (2023). The Effectiveness of STEM-Based Learning in Teaching 21 st Century Skills in Generation Z Student in Science Learning : A. *Jurnal Penelitian Pendidikan IPA*, 9(1), 150–166. <https://doi.org/10.29303/jppipa.v9i1.2517>
- Kono, R., & Mamu, H. D. (2016). PENGARUH MODEL PROBLEM BASED LEARNING (PBL) TERHADAP PEMAHAMAN KONSEP BIOLOGI DAN KETERAMPILAN BERPIKIR KRITIS SISWA TENTANG EKOSISTEM DAN LINGKUNGAN DI KELAS X SMA NEGERI 1 SIGI. *Jurnal Sains Dan Teknologi*, 5(1), 28–38.
- Kurniahtunnisa et al. (2016). PENGARUH MODEL PROBLEM BASED LEARNING TERHADAP. *Journal of Biology Education*, 5(3), 310–318.
- Ludwig, A., & Charbel, N. (2023). Philosophy of Ethnobiology : Understanding Knowledge Integration and Its Limitations Philosophy of Ethnobiology : Understanding Knowledge Integration. *Journal of Ethnobiology*, 40(1), 3–20.
- M. Hisyam Baidlowi1*, Sunarmi1, S. (2019). PENGEMBANGAN INSTRUMEN SOAL ESSAY TIPE HIGHER ORDER THINKING SKILLS (HOTS) MATERI STRUKTUR JARINGAN DAN FUNGSI ORGAN PADA TUMBUHAN KELAS XI SMAN 1 TUMPANG. *Jurnal Pendidikan Biologi*, 10(2013), 57–65.
- M. Karim , Syafrul Antoni2, Karlini Oktarina3, T. A. S. (2023). The Effect of Teacher Professionalism in Islamic Religious Education in the Era of Society 5.0 in Indonesia: A Meta-Analysis. *Jurnal Pendidikan Dan Konseling*, 5(2), 1349–1358.
- Miske H. Hamidah1*, S. S. W. (2021). ENGEMBANGAN INSTRUMEN PENILAIAN BERBASIS HOTS MENGGUNAKAN APLIKASI “QUIZZZ.

- Efisiensi: Kajian Ilmu Administrasi*, 18(1), 105–124.
- Novitra, F., Festiyed, Yohandri, & Asrizal. (2021). Development of Online-based Inquiry Learning Model to Improve 21st-Century Skills of Physics Students in Senior High School. *Eurasia Journal of Mathematics, Science and Technology Education*, 17(9), 1–20. <https://doi.org/10.29333/ejmste/11152>
- Nurtamam, M. E., Santosa, T. A., Aprilisia, S., Rahman, A., & Suharyat, Y. (2023). Meta-analysis: The Effectiveness of lot-Based Flipped Learning to Improve Students ' Problem Solving Abilities. *Edumaspul :Jurnal Pendidikan*, 7(1), 1491–1501.
- Oktarina, K., Suhaimi, S., Santosa, T. A., & ... (2021). Meta-Analysis: The Effectiveness of Using Blended Learning on Multiple Intelligences and Student Character Education During the Covid-19 Period. ... *Journal of Education ...*, 4(3), 184–192. <http://journal.ummat.ac.id/index.php/IJECA/article/view/5505><https://journal.ummat.ac.id/index.php/IJECA/article/download/5505/pdf>
- Prihono, E. W., Khasanah, F., Konvensional, P., Berpikir, K., & Matematis, K. (2020). PENGARUH MODEL PROBLEM BASED LEARNING TERHADAP. *EDUMAT: Jurnal Pendidikan Matematika*, 8(1), 74–87. <https://doi.org/10.20527/edumat.v8i1.7078>
- Rahman, A., Islam, P. A., Bekasi, U. I., Ipa, P., Padang, U. N., Jambi, U., Pendidikan, M., Islam, A., Uin, F., & Bonjol, I. (2023). *Meta-Analysis: Pengaruh Pendekatan STEM berbasis Etnosains Terhadap Kemampuan Pemecahan Masalah dan Berpikir Kreatif Siswa*. 3, 2111–2125.
- Rahman, A., & Ristiana, E. (2020). Pengaruh Model PBL Terhadap Kemampuan Berpikir Kritis dan Pemahaman Konsep IPA Siswa Kelas V SDN 30 Sumpangbita. *Edumaspul: Jurnal Pendidikan*, 4(1), 29–41.
- Rahman, A., Santosa, T. A., Suharyat, Y., & Aprilisia, S. (2023). The Effectiveness of AI Based Blended Learning on Student Scientific Literacy : *LITERACY : International Scientific Journals Of Social, Education and Humaniora*, 2(1), 141–150.
- Rahmatia, F., & Fitria, Y. (2021). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis di Sekolah Dasar. *Jurnal Pendidikan Tambusa*, 4(3), 2685–2692.
- Raula Samsul Amarila? , Noor Aini Habibah, A. W. (2014). PENGEMBANGAN ALAT EVALUASI KEMAMPUAN BERPIKIR KRITIS SISWA PADA PEMBELAJARAN IPA TERPADU MODEL WEBBED TEMA LINGKUNGAN. *Unnes Science Education Journal*, 3(2), 563–569.
- Shaw, A., Liu, O. L., Gu, L., Kardonova, E., Chirikov, I., Li, G., Hu, S., Yu, N., Ma, L., Guo, F., Su, Q., Shi, J., Loyalka, P., Shaw, A., Liu, O. L., Gu, L., Kardonova, E., & Chirikov, I. (2019). Studies in Higher Education Thinking critically about critical thinking : validating the Russian HEIghten ® critical thinking assessment Thinking critically about critical thinking : validating the Russian. *Studies in Higher Education*, 50(9), 1–17. <https://doi.org/10.1080/03075079.2019.1672640>
- Sofianora, A., Suharyat, Y., & Santosa, T. A. (2023). *PENGARUH PROFESIONALITAS GURU MATEMATIKA DALAM MENINGKATKAN KOMPETENSI SISWA ERA REVOLUSI INDUSTRI 5 . 0 DI*

- INDONESIA : SEBUAH META-ANALISIS. 10(2).
- Subali, B. (2020). Implementation of Ethnoscience-based Guided Inquiry Learning on The Scientific Literacy and The Character of Elementary School Students. *Journal of Primary Education*, 9(52), 139–147.
- Suhaimi, Santosa, T. A., & Aprilisia, S. (2022). Analisis Pendekatan Saintifik Dalam Pembelajaran IPA Selama Pandemi Covid-19 di Sekolah Dasar. *Jurnal Didika: Wahana Ilmiah Pendidikan Dasar*, 8(1), 92–101.
- Suharyat, Y., Santosa, T. A., Aprilisia, S., & Yulianti, S. (2022). International Journal of Education and Literature (IJEL) Meta-Analysis Study : The Effectiveness of Problem Solving Learning in Science Learning in Indonesia. *International Journal of Education and Literature (IJEL) Amik Veteran Porwokerto*, 1(3), 6–13.
- Sulistiyono1 Mundilarto2, H. K. (2019). Pengembangan Instrumen Penilaian Kerja Laboratorium Fisika untuk Mengukur Sikap dan Tanggung Jawab Siswa. *Jurnal Materi Dan Pembelajaran Fisika (JMPPF)*, 9(1), 43–49.
- Suryono, W., Haryanto, B. B., Santosa, T. A., Suharyat, Y., & Sappaile, B. I. (2023). The Effect of The Blended Learning Model on Student Critical Thinking Skill : Meta-analysis. *Edumaspul - Jurnal Pendidikan*, 7(1), 1386–1397.
- Untari, R., Indrayani, L., & Triwiswara, M. (2020). Scientific reconstruction of indigenous knowledge of batik natural dyes using ethno-STEM approach Scientific reconstruction of indigenous knowledge of batik natural dyes using ethno-STEM approach. *Journal of Physics: Conference Series PAPER*, 0–6. <https://doi.org/10.1088/1742-6596/1567/4/042046>
- Yustiana el al. (2022). The Effect of E-Learning Based on the Problem-Based Learning Model on Students ' Creative Thinking Skills During the Covid-19 Pandemic. *International Journal of Instruction*, 15(2), 329–348.
- Zulkifli Zulkifli, Agus Supriyadi, Erwinsyah Satria, & Tomi Apra Santosa. (2022). Meta-analysis: The Effectiveness of the Integrated STEM Technology Pedagogical Content Knowledge Learning Model on the 21st Century Skills of High School Students in the Science Department. *Psychology, Evaluation, and Technology in Educational Research*, 1(2), 68–76. <https://doi.org/10.55606/ijel.v1i2.32>