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REINVENTING PROFESSIONAL DEVELOPMENT PROGRAM TO EQUIP TEACHERS WITH CULTURALLY-ROOTED TEACHING MATERIAL DEVELOPMENT SKILLS

Mohamad Arif Rahmansyah[1]*, Yus Alvar Saabighoot[2]
[1]Teacher Professional Education Program, Universitas Terbuka, Tangerang Selatan, Indonesia
[2]Department of Early Childhood Teacher Education, Universitas Terbuka, Tangerang Selatan, Indonesia
email: mohamad.arif@ecampus.ut.ac.id

Abstract: The integration of ethnoscience into teaching materials is increasingly important in creating contextual and meaningful learning- however, many teachers still lack the competence to develop such materials. This study aims to develop a professional development program to enhance teachers^ skills in analyzing and integrating ethnoscience into instructional materials. The study employed the ADDIE model limited to the analysis, design, and development stages, focusing on prototype development and validation, with implementation and evaluation reported separately. The resulting program consists of two main components: core training (5M Training) and accompanying training (PERMAC). The developed program was evaluated through expert validation and a limited-scale trial involving six teachers from a junior high school in West Java, Indonesia. The expert validation results indicate that the program is valid and appropriate in terms of content, design, and implementation aspects. The limited trial shows a very high level of participant satisfaction, reaching 98.43% (very satisfactory category). In addition, participants^ competence demonstrated significant improvement, with an average N-gain score of 0.99 (high category). In conclusion, the developed program is considered valid and feasible to support teachers in developing ethnoscience-integrated teaching materials, although further studies are needed to examine its effectiveness in broader implementation.

Keywords: ethnoscience; teacher development; teaching materials; ADDIE; professional training.

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INTRODUCTION

Education in the 21st century demands learning experiences that are academically rigorous, contextually meaningful, and culturally situated. Among the pedagogical frameworks responding to this demand, ethnoscience — the systematic study of how cultural groups classify and interpret natural phenomena — has attracted substantial scholarly attention as a

mechanism for bridging indigenous knowledge systems with formal science education. A comprehensive meta-analysis by Festiyed et al. (2025) found that ethnoscience-based culturally responsive science education produced a statistically significant positive effect on junior high school students' learning outcomes (Cohen's $d = 0.65$, $p < 0.01$), alongside improvements in scientific literacy, student interest, and attitudes toward science. Rasmawan et al. (2025), through a systematic review of 43 peer-reviewed studies indexed in Scopus and ERIC, confirmed that indigenous knowledge integration consistently produces positive impacts across conceptual mastery, higher-order thinking skills, motivation, and student engagement.

In Indonesia, ethnoscience integration is strongly anchored in national curriculum policy. The Merdeka Curriculum (Kurikulum Merdeka) explicitly mandates contextual, student-centered learning rooted in local wisdom and cultural identity. Sihombing et al. (2025), in a systematic review of ethnoscience research in Indonesia (2020–2025), documented growing evidence supporting the integration of indigenous cultural practices — including traditional agriculture, artisanal crafts, and medicinal plant use — into science curricula. Their review confirmed that ethnoscience-based instructional materials are widely implemented and effective in facilitating conceptual understanding while nurturing cultural appreciation. Comparative studies demonstrate that students using ethnoscience materials achieve better outcomes in learning results, scientific literacy, character development, problem-solving, and motivation compared to those using conventional materials (Damayanti et al., 2021; Zidny et al., 2020; Putri et al., 2022).

Despite this policy and research landscape, a persistent implementation gap remains. Many teachers lack the competence, tools, and frameworks necessary to systematically identify local cultural practices and translate them into structured instructional materials. Widiyawati et al. (2023), in a phenomenological study, found that junior high school science teachers recognized ethnoscience's importance within the Merdeka Curriculum but lacked systematic pedagogical methods. Budiarti et al. (2022) found that five of eight elementary school teachers had no specific understanding of ethnoscience-based learning. Oktaviani et al. (2024) demonstrated that 100% of teachers surveyed expressed the need for ethnoscience-based materials, underscoring a universal competence gap. Andayani et al. (2021) similarly identified significant deficits in teacher knowledge of ethnoscience and its classroom application.

Teacher professional development programs represent the primary institutional mechanism for addressing such gaps. However, Revina et al. (2023) identified four critical weaknesses consistently found across Indonesian teacher professional development (TPD) reforms: lack of consideration for teachers' actual skills and backgrounds, insufficient relevance of training content, absence of quality feedback, and no workshop follow-up support. Tupamahu et al. (2025) further confirmed that scheduling constraints, cognitive overload, and lack of sustained institutional support remain key barriers to PD effectiveness. This study was designed to address these challenges by developing a structured professional development

program specifically tailored to equip junior high school science teachers with the competencies required to analyze and integrate ethnoscience into instructional materials, using the Analysis, Design, and Development stages of the ADDIE instructional design model, with Implementation and Evaluation planned as subsequent research phases.

METHOD

Research Design

This study employed a Research and Development (R&D) approach guided by the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), which has been validated as an effective framework for systematic program development (Adeoye & Jimoh, 2024; Spatioti et al., 2022). In this study, the three stages of Analysis, Design, and Development were fully executed, while Implementation and Evaluation are planned for future research phases. A limited trial was conducted during the Development stage to assess program feasibility and initial effectiveness. Purposive sampling was used to select six science teachers from a junior high school in West Java, selected for their demonstrated proficiency in instructional material development. The study addressed three research questions: (1) What design of a professional development program is appropriate for enhancing teachers' ethnoscience integration competence? (2) What factors influence teachers' ability to integrate ethnoscience into instructional materials? and (3) How feasible and effective is the developed program at the limited trial stage?

Analysis Stage

The analysis stage comprised three components: a literature review of ethnoscience education and teacher professional development; structured questionnaires administered to teachers covering curriculum analysis, diagnostic assessment, science content delivery, factors influencing content presentation, and classroom implementation abilities (five-point scale; scores converted to percentages using: Score = (Obtained score / Maximum score) x 100%, interpreted using Riduwan's (2012) criteria); and systematic analysis of the Merdeka Curriculum to identify required instructional material components.

Design Stage

Based on analysis findings, the program was structured as a two-component system. Training objectives focused on three success indicators: (1) analyzing strengths and weaknesses of existing material development strategies; (2) analyzing multidimensional factors influencing science content presentation; and (3) modifying material development strategies using new knowledge. The training strategy adopted a participant-centered approach using discovery learning. The evaluation design followed the Kirkpatrick model: Level 1 (30-item satisfaction questionnaire, scale 1-7) and Level 2 (pretest/posttest using five essay questions; document assessment of skills competency).

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Development Stage

All program materials were produced during this stage: facilitator's guide, participant workbook, ethnoscience analysis templates, instructional material development rubrics, and pre/post-assessment instruments. The 5R Training — Remind, Reflect, Record, Research, Redesign — was developed as the core training sequence. The PERMAC model — Perception, Empathy, Reflection, Mastery, Action, Community — was developed as accompanying training. Implementation planning established a two-meeting schedule. Instrument development produced all training worksheets including Reminder Sheets, Self-Assessment Sheets, Peer Assessment Sheets, Identification and Solution Sheets, Modification Sheets, Problem-Solving Sheets, and Post-Training Plan Sheets.

Limited Trial

As part of the Development stage, a limited trial was conducted with six science teachers at junior high school in West Java to assess the program's feasibility and initial effectiveness prior to full-scale implementation. The total training comprised approximately 11.5 hours of contact time. Full-scale Implementation (Stage 4) with a broader participant group is planned as a subsequent research phase.

Evaluation within this study was limited to the limited trial scope, following two Kirkpatrick levels. Level 1 assessed participant satisfaction via a 30-item questionnaire. Level 2 assessed knowledge competency through pretest and posttest (5 essay questions) using the normalized gain formula of Hake (1998): N-gain = (Spost - Spre) / (Smax - Spre), categorized as High ($g >= 0.70$), Medium ($0.30 <= g < 0.70$), or Low ($g < 0.30$). Skills competency was assessed through document analysis of all training worksheets and final modified instructional material products. Full-scale Implemetnation anda Evaluation are planned as part of future implementation phases.

RESULT AND DISCUSSION

1. Analysis

a. Analysis of Needs

The literature review established that teacher proficiencies in constructing ethnoscience-integrated instructional materials were insufficient across Indonesian educational contexts. Widiyawati et al. (2023) documented that teachers lacked systematic pedagogical methods despite recognizing ethnoscience's importance; Budiarti et al. (2022) found that most elementary teachers had no specific understanding of ethnoscience-based learning; Andayani et al. (2021) identified significant deficits in teacher ethnoscience knowledge. These findings established the rationale for a specialized, structured training program. The literature further confirmed that professional development programs represent the optimal mechanism for addressing these gaps (Revina et al., 2023; Rasmitadila et al., 2024).

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b. Analysis of Teachers

A structured questionnaire assessed teachers' competencies across five dimensions. The overall average score of 3.53 (70.6%) placed teachers in the 'High' category (Riduwan, 2012), indicating commendable foundational competency. However, the lowest-scoring dimensions — analyzing factors influencing science content presentation (3.29) and implementing instructional materials in classroom settings (3.15) — precisely identify the competencies most demanding for ethnoscience integration.

Table 1. Teacher Questionnaire Results on Instructional Material Development

Indicator	Score
Curriculum analysis ability	3.78
Diagnostic assessment proficiency	3.61
Science content delivery competence	3.81
Analyzing factors influencing content presentation	3.29
Implementing materials in classroom settings	3.15
Average Score	3.53 (70.6%)

A supplementary questionnaire revealed critical training gaps. Critically, 100% of teachers had never received professional development focused on ethnoscience in teaching materials. Only 50% had received any training on creating teaching materials. This aligns with Ningrat et al. (2024), who found 88.23% of science teacher candidates at UIN Mataram demonstrated ethnoscience knowledge in the 'Low' category, and with Oktaviani et al. (2024), who found universal teacher demand for ethnoscience materials.

Table 2. Teacher Professional Development Experience

Training Focus	Never	1-2 Times
Diagnostic Assessment	16.67%	83.33%
Creating Teaching Materials	50%	50%
Ethnoscience in Teaching Materials	100%	0%

c. Analysis of Demands

Curriculum analysis of the Curriculum identified essential components for instructional materials: learning outcomes (Capaian Pembelajaran), learning objectives (Tujuan Pembelajaran), provoking questions (Pertanyaan Pemantik), meaningful learning, and Pancasila learner profile integration. Peer assessment data gathered during the training confirmed systematic gaps: only 2 of 6 teachers' materials included well-defined learning

outcomes; none incorporated students' initial competencies; only one integrated the Pancasila learner profile; and none integrated ethnoscience content — establishing a clear need for a comprehensive training program.

2. Design

a. Design of Learning Objectives

Training objectives were formulated with three progressive success indicators: (1) demonstrating proficiency in analyzing strengths and weaknesses of existing instructional material strategies; (2) proficiently analyzing multidimensional factors influencing science content presentation; and (3) skillfully modifying material development strategies using newly acquired knowledge. This progressive sequencing reflects the constructivist principle that deep competence development requires progressive reorganization and application of knowledge within increasingly complex professional contexts (Apriliyanti, 2020).

b. Design of Training Strategy

The training adopted a participant-centered strategy using discovery learning, positioning teachers as active agents rather than passive recipients. This responds directly to weaknesses identified in Indonesian professional development literature (Revina et al., 2023): many programs have historically failed by treating teachers as passive receivers of mandated content rather than active professional learners with existing knowledge and contextual expertise. The discovery learning approach fosters active exploration, reflection, and collaborative knowledge construction.

c. Design of Product Evaluation

The evaluation design follows the Kirkpatrick (1994) model. Level 1 (Reaction) uses a 30-item satisfaction questionnaire (1-7 scale). Level 2 (Learning) uses pretest/posttest instruments (5 essay questions) and document assessment sheets for skills competency evaluation.

3. Development

a. The 5R Training (Core Training)

The 5R Training guides teachers through five sequential phases of ethnoscience identification, analysis, and pedagogical translation. The Remind phase activates participants' prior knowledge of their habitual material development strategies through structured Reminder Sheets completed before the training. The Reflect phase engages systematic evaluation through self-assessment (15 indicators spanning curriculum analysis, representation use, diagnostic assessment, and ethnoscience integration) and peer assessment of colleagues' materials. The Record phase documents identified deficiencies and improvement solutions using a structured two-column Identification and Solution Sheet. The Research phase builds new knowledge through facilitated inquiry using curated resources.

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The Redesign phase synthesizes insights into modified material development strategies incorporating diagnostic assessment outcomes, multirepresentation, and ethnoscience analysis.

The 5R Training's deliberate alignment with Indonesia's familiar scientific inquiry approach minimizes cognitive load by enabling teachers to apply a well-internalized inquiry schema to the new domain of ethnoscience integration. This is supported by Zidny et al. (2020), who argued that effective ethnoscience education must be epistemologically coherent, connecting indigenous ways of knowing to formal science inquiry processes.

b. PERMAC (Accompanying Training)

PERMAC directly addresses the most persistently documented failure mode of Indonesian teacher professional development: the absence of sustained follow-up support (Revina et al., 2023; Tupamahu et al., 2025). The Perception phase develops teachers' understanding of high-quality materials' role in student achievement. The Empathy phase cultivates motivational engagement by connecting material quality to students' learning experiences. The Reflection phase structures individual professional growth goal-setting. The Mastery phase builds problem-resolution skills through realistic scenario practice. The Action phase develops semester-long implementation plans. The Community phase establishes a collaborative professional learning community for ongoing peer review, coaching, and implementation documentation — transforming professional development from a discrete event into a sustained professional practice (Rasmitadila et al., 2024).

4. Limited Trial

Meeting 1 opened with limited trial initiation, trainer-participant introductions, and explanation of objectives. Session 1 collected Reminder Sheets and facilitated discussion, followed by a structured presentation on material development strategies, multirepresentation techniques, and ethnoscience integration with worked examples. Participants then completed self-assessment instruments and conducted peer assessment of each other's materials. Session 2 analyzed assessment results, produced Identification and Solution Sheets, and facilitated guided Research activities. Meeting 2, Session 1 commenced Redesign activities, with modification planning completed within the session due to time constraints. Session 2 implemented the full PERMAC sequence, culminating in participants establishing a learning community and developing their semester-long action plans. This limited trial served as the primary vehicle for validating program feasibility prior to full-scale implementation, which is planned for a subsequent research phase.

5. Limited Trial Evaluation

a. Participant Satisfaction (Level 1)

The 30-item satisfaction questionnaire yielded an average score of 6.89 out of 7.00, corresponding to a satisfaction rate of 98.43% — classified as 'Very Satisfactory'. This

exceeds satisfaction benchmarks reported in comparable Indonesian teacher training studies: Sriyati et al. (2025) reported 92.7% agreement in ethnoscience design training for biology teachers; Sanova et al. (2022) reported strong satisfaction with a local wisdom-based module development workshop.

Qualitative analysis identified four thematic clusters of positive feedback: (1) the practical, step-by-step 5R structure transformed abstract ethnoscience integration into a concrete, manageable process, resonating with Widiyawati et al. (2023) who found teachers are motivated but constrained by absent practical frameworks; (2) training examples grounded in West Javanese cultural practices enhanced program relevance and ownership, consistent with O'Leary et al. (2020) on culturally responsive faculty development; (3) the collaborative, peer-learning atmosphere was highly valued; and (4) the prospect of continued PERMAC coaching reduced participants' anxiety about independent application. Areas identified for improvement included enhanced material clarity, more balanced content-practice allocation, and more precise scheduling.

b. Knowledge Competency (Level 2)

The average pretest score was 50.83, reflecting significant baseline knowledge gaps, particularly in ethnoscience integration (20.83) and multirepresentation strategies (29.17). The average posttest score reached 98.00, representing a raw improvement of 47.17 percentage points. The average N-gain of 0.99 falls firmly in the 'High' category (Hake, 1998), with all six individual participants achieving N-gain values in the 'High' category.

Table 4. Knowledge Competency of Training Participants

Indicator	Pre	Post	N-gain	Criteria
Steps of material development	66.67	95.00	0.85	High
Material development from diagnostic assessment	83.33	95.00	0.70	High
Analyzing material completeness	54.17	100.00	1.00	High
Integrating ethnoscience into materials	20.83	100.00	1.00	High
Multirepresentation strategies	29.17	100.00	1.00	High
Average	50.83	98.00	0.99	High

The most significant improvements occurred in ethnoscience integration (N-gain = 1.00) and multirepresentation (N-gain = 1.00) — precisely the dimensions where participants demonstrated the greatest pre-training deficits and which 100% had never received prior professional development. These results substantially exceed benchmarks in comparable Indonesian intervention studies: Kariani et al. (2025) reported N-gain of 0.764 for ethnoscience-based physics materials; Shofiyah et al. (2020) reported N-gain of approximately 0.44 for a local wisdom-based science materials workshop; Nazara et al.

(2026) reported N-gain of 0.78 for a STEM-based 5E intervention. The interpretive limitation of the very low pre-assessment baseline producing ceiling N-gain values must be acknowledged; a quasi-experimental design with a comparison group and larger sample is needed to produce more generalized effectiveness estimates.

c. Skills Competency

Document analysis of all training worksheets confirmed progressive competence development. Recall Sheet analysis revealed consistent gaps in teachers' habitual practices: no diagnostic assessment results were used as material design inputs; no ethnoscience potential was analyzed; multirepresentation was used without systematic understanding.

Self-assessment results (Table 5) revealed that all teachers demonstrated foundational competency in curriculum analysis, material determination, and content sequencing. However, significant challenges emerged: 50% struggled to determine appropriate content breadth and depth; 50% lacked comprehensive understanding of multirepresentation; only 50% conducted diagnostic assessments (once per semester); and no teacher had analyzed ethnoscience potential for material development — despite 50% reporting some degree of ethnoscience integration, suggesting superficial cultural references rather than systematic analysis (Zidny et al., 2020).

Table 5. Self-Assessment — Selected Key Indicators

Indicator	Finding
Curriculum analysis	All teachers capable
Content breadth and depth	Some difficulty; occasional content overload
Multirepresentation	50% lack comprehensive understanding
Diagnostic assessment use in material development	Only 1 teacher uses results as design input
Ethnoscience potential analysis	No teacher has conducted analysis
Ethnoscience integration	50% integrate to some degree (largely superficial)

Peer assessment findings confirmed these patterns. Among teachers' six instructional material samples: only 2 had defined learning outcomes; none included initial competency references; only 1 integrated the Pancasila learner profile; 50% lacked provoking questions; none included graphical representations; and none integrated ethnoscience. Provoking questions are particularly important for activating prior knowledge and developing critical thinking (Pandu et al., 2023). The complete absence of ethnoscience integration across all materials confirms that what teachers describe as 'ethnoscience integration' consists of incidental cultural references rather than the systematic curriculum-mapped integration the Merdeka Curriculum envisions.

Problem-solving assessment yielded an average score of 85 (Very High category) across all four dimensions (diagnostic assessment, Pancasila profile integration, multirepresentation, ethnoscience integration), demonstrating robust transfer of acquired competencies to novel professional scenarios — a critical indicator of effective PD (Rasmitadila et al., 2024).

d. Factors Influencing Ethnoscience Integration

Analysis of Modification Sheets revealed that all participants successfully developed ethnoscience-integrated material modification plans, but the quality and contextual relevance of integration were significantly mediated by three factors. First, birthplace and cultural upbringing: teachers born and raised in West Java demonstrated richer, more contextually appropriate Sundanese cultural integration, while a teacher with East Javanese roots integrated Reog Ponorogo — culturally authentic but potentially less relevant to West Javanese students. The pedagogical principle that ethnoscience should prioritize customs present in students' teaching environment is paramount (Arfianawati et al., 2021): materials drawing on unfamiliar cultural contexts risk undermining the meaningful relevance that makes ethnoscience-integrated learning distinct.

Second, age: younger teachers demonstrated greater difficulty identifying and analyzing local ethnoscience potential, reflecting limited exposure to traditional practices as globalization accelerates cultural displacement (Agustin, 2011; Wulandari et al., 2023). Third, these findings imply that PD programs cannot assume uniform cultural knowledge baselines; structured ethnoscience field investigation activities, curated cultural knowledge resources, and technology-supported inquiry must be explicitly incorporated to build cultural knowledge among participants who lack deep personal familiarity with local practices.

Post-training reflection identified residual professional development needs including developing Merdeka Curriculum modules, formulating diagnostic assessments, and enhancing technological literacy. Participants proposed attending In House Training (IHT), self-directed learning, and additional training — confirming that the program successfully cultivated growth-oriented professional mindsets and concrete professional agency.

CONCLUSION

This study developed a professional development program — comprising the 5R Training (Remind, Reflect, Record, Research, Redesign) and PERMAC (Perception, Empathy, Reflection, Mastery, Action, Community) — to enhance junior high school science teachers' competence in analyzing and integrating ethnoscience into instructional materials, completing the Analysis, Design, and Development stages of the ADDIE model. Expert validation confirmed the program's validity with CVI scores of 0.89 and 0.92. A limited trial with six teachers yielded a 98.43% satisfaction rate and an average N-gain of 0.99 (High category). Skills competency assessment confirmed successful development of ethnoscience-integrated modification plans and strong problem-solving capability (average 85, Very High). The Implementation and Evaluation stages of the ADDIE model are planned as

subsequent research phases, wherein the program will be deployed at broader scale with a larger participant group and longitudinal assessment.

A significant additional finding is that teachers' capacity for ethnoscience integration is substantially mediated by birthplace, cultural upbringing, and age — requiring PD programs to explicitly address cultural knowledge gaps through structured field investigation, curated resources, and technology-supported inquiry. The 5R Training's alignment with Indonesia's national scientific inquiry framework, combined with PERMAC's sustained coaching and collaborative learning community structure, addresses the two most persistently documented weaknesses of Indonesian teacher PD: the absence of practical ethnoscience integration frameworks and the lack of sustained follow-up support. Future research should execute the Implementation and Evaluation stages of the ADDIE model at broader scale, incorporating longitudinal assessment of classroom practice change and investigating impacts on student learning outcomes across Indonesia's diverse cultural contexts.

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