P-ISSN: 2338-8617
E-ISSN: 2443-2067

Jurnal Ilmiah PEURADEUN

Vol. 12, No. 3, September 2024

INDEX COPERNICUS INTERNATIONAL
Scopus®
ELSEVIER
sinta 1
Science and Technology Index
Accredited "Sinta 1" by Decree No. 72/E/KPT/2024
Valid Until the May 2027 Edition
Clarivate Analytics
WEB OF SCIENCE™
SCAD Independent
Accreditation by IAO since 2014
JIP
The Indonesian Journal of the Social Sciences
www.journal.scadindependent.org
DOI Prefix Number: 10.26811

JURNAL ILMIAH PEURADEUN
The Indonesian Journal of the Social Sciences
p-ISSN: 2338-8617/ e-ISSN: 2443-2067
www.journal.scadindependent.org

Vol. 12, No. 3, September 2024
Pages: 1071-1098

Acehnese Ethnoscience as an Interdisciplinary Approach in Physics Education: Innovating in the Era of Merdeka Belajar

Saminan Saminan[1]; Irwandi Irwandi[2]; Muhjam Kamza[3]; Mohammad Sattar bin Rasul[4]
[1,3]*Fakultas Keguruan dan Ilmu Pendidikan, Universitas Syiah Kuala Banda Aceh, Indonesia*
[2]*Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Syiah Kuala Banda Aceh, Indonesia*
[4]*Universiti Kebangsaan Malaysia, Malaysia*

Article *in* Jurnal Ilmiah Peuradeun
Available at : https://journal.scadindependent.org/index.php/jipeuradeun/article/view/1277
DOI : https://doi.org/ 10.26811/peuradeun.v12i3.1277

How to Cite this Article
APA : Saminan, S., Irwandi, I., Kamza, M. & Rasul, M.S. (2024). Acehnese Ethnoscience as an Interdisciplinary Approach in Physics Education: Innovating in the Era of Merdeka Belajar. *Jurnal Ilmiah Peuradeun, 12*(3), 1071-1098. https://doi.org/10.26811/peuradeun.v12i3.1277

Others Visit : https://journal.scadindependent.org/index.php/jipeuradeun

Jurnal Ilmiah Peuradeun

The Indonesian Journal of the Social Sciences

doi: 10.26811/peuradeun.v12i3.1277

Publisher: SCAD Independent
Printed in Indonesia

Jurnal Ilmiah Peuradeun
Vol. 12, No. 3, September 2024
Pages: 1071-1098

ACEHNESE ETHNOSCIENCE AS AN INTERDISCIPLINARY APPROACH IN PHYSICS EDUCATION: INNOVATING IN THE ERA OF MERDEKA BELAJAR

Saminan Saminan[1]; Irwandi Irwandi[2]; Muhjam Kamza[3]; Mohammad Sattar bin Rasul[4]

[1,3]Fakultas Keguruan dan Ilmu Pendidikan, Universitas Syiah Kuala Banda Aceh, Indonesia
[2]Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Syiah Kuala Banda Aceh, Indonesia
[4]Universiti Kebangsaan Malaysia, Malaysia
[1]Correspondence Email: saminanfis@usk.ac.id

Received: January 18, 2024	**Accepted:** September 6, 2024	**Published:** September 30, 2024
Article Url: https://journal.scadindependent.org/index.php/jipeuradeun/article/view/1277		

Abstract

Various efforts have been made to improve students' understanding of basic physics concepts, but their mindset in constructing knowledge remains problematic. The learning process has yet to engage long-term memory, preventing meaningful analysis-level understanding. This research aimed to activate students' thinking patterns based on ethnoscience through learning tools such as modules, semester learning plans (RPS), and student worksheets (LKM) that are valid, practical, and efficient. The research used the R&D method with the ADDIE approach, involving 2 expert validators and all Physics Education students at FKIP USK enrolled in basic physics courses in 2022. The results indicated that the ethnoscience-based basic physics learning tools of the Acehnese community, which include modules, RPS, and LKM, effectively supported Merdeka Belajar and have been validated for their validity, practicality, and efficiency. Students were highly motivated and impressed by the concept of measurement in physics, which has long been practiced by the Acehnese community, such as in paying zakat fitrah during Ramadan. The scientifically understood volume-measuring tools used by students were not significantly different from the ethnoscience tools used by the Acehnese community. Ethnoscience facilitates meaningful learning by analyzing context, content, and literacy.

Keywords: *Learning Tools; Ethnoscience; Islamic Physics; Merdeka Belajar; Local Wisdom*

[1]Director of the School Research Center,Universitas Syiah Kuala, Banda Aceh, Indonesia

p-ISSN: 2338-8617
e-ISSN: 2443-2067

A. Introduction

The presence of the Kampus Merdeka program is part of the Merdeka Belajar policy initiated by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia. This program is designed to provide students with the opportunity to develop their skills through their talents and interests through hands-on experience in society. Its main goal is to prepare students with various fields of knowledge that will be useful when entering the workforce. In practice, students are given the freedom to engage in activities outside the classroom for two semesters (Kemdikbud, 2020).

Physics, as a branch of natural science, teaches physical concepts of nature and its environment, ideally applied in everyday life. However, students generally only receive theoretical material without practical application in everyday activities. Research conducted by Dentzau concluded that students are often weak in linking theory to practice. This problem is exacerbated by the lack of integration between concepts obtained from the environment and theories in books or learning materials (Flick et al., 1997).

This issue is reinforced by the findings of Taylor, S. A., & Baker (1994), which show that students struggle to understand scientific concepts due to the influence of their intuitive knowledge about their surrounding environment. In line with this, it suggests that schools should integrate modern science with traditional knowledge through a cross-cultural approach, enriching students' understanding with prior knowledge gained from their environment. This prior knowledge is derived from observations and experiences obtained from their surroundings. This forms the basis for the importance of connecting teaching materials with the cultural context of the local community.

Indonesia is a country rich in culture. Each region in Indonesia has its unique customs and traditions within the local society. Aceh is one of the regions with deeply rooted cultural and traditional practices in the lives of its people (Munzir et al., 2022). The norms, customs, and beliefs in Aceh are closely related to social balance and natural resource management. These norms are evident through the cultural heritage passed down by the community (Kane et al., 2016; Sudarmin et al., 2017).

Considering this relationship, culture becomes a mechanism of control over the behavior of the people in Aceh. The challenges presented by nature and the community's response to them have led to the development of dynamic knowledge within society (Munzir et al., 2022). As new ideas or knowledge continuously emerge to address these natural challenges, the dynamic nature of Acehnese society provides opportunities for culture to evolve (Munzir et al., 2022; Saminan, 2015; Rahmi et al., 2022).

One of the cultural heritages of Acehnese society that is still in use today is the concept of measurement units, known as 'takaran'. Takaran (a measurement tool) is a cultural practice used by the people of Aceh to solve various problems that arise within the community. It is also employed by the Acehnese in fulfilling their obligation to pay *zakat* (almsgiving). The cultural use of takaran in Acehnese society is closely related to the community's scientific knowledge, which is known as ethnoscience.

Several types of measurement tools have emerged in Acehnese society, such as volume *(kai, are, naleh, gunca)*, weight *(mayam, paon ringgit, paon rupia)*, area, and length (Munzir et al., 2022). These types of measurement tools are known in basic physics education; however, Acehnese community science has not yet been integrated into scientific learning in schools due to the absence of educational materials and learning tools.

Research by Abidin & Usman (2021) found that in Pidie, traditional measurement tools such as *jumpet, mok, kai, are, naleh,* and *gateng* are still in use, although their use is gradually being abandoned by younger generations. The presence of these tools not only highlights the importance of preserving this traditional knowledge but also reveals how scientific knowledge has been integrated into symbolic messages, cultural customs, and religious and social ceremonies. These two aspects contain scientific concepts that have been passed down through generations within the community, even though they have not been formally recognized as scientific knowledge.

The integration of these traditional measuring tools into physics learning devices can be a strategic step to bridge the gap between theory and practice relevant to everyday life. This integration can be seen as part of an ethnoscience approach, which is an interdisciplinary science that connects human or cultural anthropology with science learning. This approach constructs and enhances the quality of the learning process by utilizing local cultural aspects or indigenous community knowledge (Sudarmin et al., 2017). Ethnoscience helps in understanding scientific knowledge gained through the study of local knowledge contained within a community's or ethnic group's culture (Dewi et al., 2021; Halomoan et al., 2023). It also supports a deeper understanding of social science, which encompasses various scientific fields. Thus, this indigenous and symbolic knowledge is not only preserved as cultural heritage but also utilized as a rich learning resource filled with scientific principles (Sumanti et al., 2024; Manan et al., 2024).

Learning should be done independently, especially on simple and familiar matters, including ethnoscience, as physics is often considered a difficult and boring subject. With this approach, the time spent by students is not only for cultural introduction but also as an experience and concrete knowledge rooted in their culture. Moreover, this learning will produce students who are excellent, critical, creative, collaborative, innovative, and oriented toward local wisdom (Muhith et al., 2023; Amaly et al., 2023).

This research aims to reconstruct the traditional science of the Acehnese community into scientific knowledge through physics learning tools, with the hope that the scientific culture of the Acehnese ancestors (*Indatu* Aceh) will become an effective teaching medium in the future. By using specially designed learning tools, it is expected not only to enhance the understanding of the material but also to strengthen the connection between science and local wisdom. This approach enables students to activate their long-term memory, making the knowledge they acquire more meaningful and applicable.

In addition, this tool supports lecturers and teachers in training students to observe, identify, and analyze phenomena systematically, thus producing graduates who are critical, creative, and innovative. With this approach, it is hoped that the scientific culture of Acehnese ancestors can become an effective learning medium for future generations, inspiring curriculum development and similar learning tools in other regions and enriching the global discourse on the integration of ethnoscience in scientific education.

B. Method

1. Research Design

This research was conducted at Syiah Kuala University, with the subjects being physics education students from FKIP USK who had taken basic physics courses in the 2023/2024 academic year. The study employed the Research and Development (R&D) method with the ADDIE approach, which involved the development of Ethnoscience-based Modules, Semester Learning Plans (RPS), and Student Worksheets (LKM) rooted in the Acehnese community's ethnoscience.

The ADDIE model (Branch, 2009; Dick, W, & Carey, 1996) consists of five stages: Analysis to identify needs based on ethnoscience; Design, which includes the development of Semester Learning Plans (RPS), student worksheets (LKM), and modules based on the APOS theory and scientific approach, as well as validation by experts; Development, involving the preparation and validation of learning tools and revisions based on feedback; Implementation, in the form of testing the tools to assess the achievement of goals and practicality; and Evaluation to measure the effectiveness of the tools.

The instruments used include those developed based on APOS theory and the scientific approach (Walidin et al., 2015). The quality of the tools is assessed using Nieveen's guidelines (1999), focusing on validity, practicality, and effectiveness. Valid tools will undergo field testing, while those requiring revisions will be improved and validated before being tested in the field.

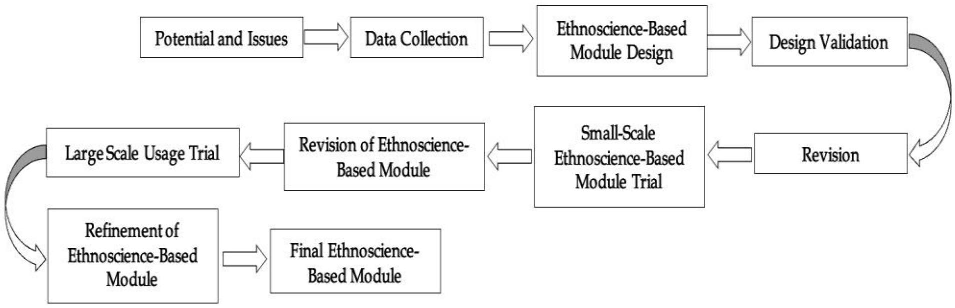

Figure 1. Research Flowchart

2. Product Development

The product developed in this research is a learning device based on ethnoscience, using the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation. In the analysis stage, a need assessment is conducted to identify the requirements for a learning device oriented around APOS theory, including curriculum analysis and user characteristics. The design stage involves selecting the format and initial design of the device based on the results of the analysis.

The development stage realizes the device design based on APOS theory and undergoes validation by experts, followed by revisions according to feedback. The implementation tests the device on students from FKIP Universitas Syiah Kuala to assess its practicality and effectiveness, measured through the improvement of learning outcomes. The evaluation stage collects data on the validity, practicality, and effectiveness of the device, followed by revisions to refine the final product. The interpretation of product feasibility is presented in a table as shown below.

Table 1. Interpretation of Feasibility for RPS, Module, and LKM

Criteria	Virtual Lab Feasibility (%)
Very Valid	81-100
Valid	61-80
Moderately Valid	41-60
Not Valid	21-40
Very Not Valid	1-20

Table 2. Product practicality interpretation

Criteria	Virtual Lab Practicality (%)
Very Practical	81-100
Practical	61-80
Moderately Practical	41-60
Not Practical	21-40
Very Not Practical	0-20

Source: Riduwan, 2021

C. Result and Discussion

The Acehnese community still uses ethno-scientific measuring tools for various needs, such as measuring length, volume, area, mass, and time. Therefore, ethno-science serves as one of the measuring tools that can be introduced to students as a means of familiarizing them with traditional community measuring devices, and it can be used as a comparison with modern measuring tools currently used in the teaching and learning process.

1. Result

In this research, a learning device has been developed and implemented by students through the development of basic physics learning devices based on the ethnoscience of the Acehnese community to support Merdeka Belajar. This includes stages such as identifying potentials and problems, designing ethnoscience-based modules, design validation, usage trials, and the development of ethnoscience-based learning modules for physics practicum, particularly in the field of basic physics. The learning devices that have been developed include learning modules, Semester Learning Plans (RPS), and student worksheets (LKM) for experiments on basic physics concepts.

a. Analysis stage

The analysis stage is the initial step taken to produce appropriate learning tools. This stage is used to gather information about the needs or factors that justify whether it is necessary to develop learning tools based on the ethnoscience of Acehnese society to support independent learning. The analysis activities carried out include curriculum analysis, concept analysis, literature analysis, teaching resource analysis, and needs analysis.

b. Design stage

1) Designing the Semester Learning Plan (RPS)

In the stage of designing the RPS, all activities involve creating and modifying learning tools by the discovery learning model based on ethnoscience. At this stage, the researcher determines the indicators to be achieved by students, the methods, teaching materials, learning strategies, and learning media. The RPS includes 1) Providing a stimulus to students, such as asking, "Have you ever seen the Acehnese community using measuring tools in daily life?"; 2) The core activities where students identify problems and make observations by paying attention to the types of measuring tools used by the community in their daily lives through videos and objects demonstrated in the classroom. Students are asked to perform problem statements, data collection, data processing, verification, and generalization. Students are required to present their research results and are allowed to discuss with one another so they can identify the types of measuring tools still traditionally used in rural communities; 3) In the closing session, the lecturer and students reflect on the learning activities regarding traditional physics measuring tools still used in daily life, while also considering the advantages and disadvantages of these tools compared to modern measuring instruments.

Students can identify and analyze the measuring tools that have been used by the community for various needs, especially those related to the measurement of length, volume, area, mass, and time.

Table 3. Types of length measurement tools used by the Acehnese community

No.	Measurement Aspect	Types of Measurement	Description
1.	Length	*Sijarou*	Measurement is equal to the length of one finger
2.	Length	*Sijaroe Dh*	Measurement equal to the width of one finger (approximately 1 cm)

No.	Measurement Aspect	Types of Measurement	Description
3.	Length	*Siatoutjaroe*	Measurement is equal to the length of one finger segment
4.	Length	*Dua Atot Jaroe*	Measurement is equal to the length of two finger segments
5.	Length	*Sipade*	Measurement equal to the width of one finger (approximately 1 cm)
6.	Length	*Sipade Eh*	Measurement approximately the width of a rice grain (± 2 mm)
7.	Length	*Meusenti*	Measurement is equal to the width of a hand when the thumb is stretched out
8.	Length	*Situmbok*	The measurement from the elbow to the tip of the hand when clenched is shorter than *sihah*
9.	Length	*Sijeungkai*	Measurement from the tip of the thumb to the tip of the middle finger with fingers stretched as far as possible, equivalent to a span
10.	Length	*Sijeungkai Telunyok:*	Measurement from the tip of the thumb to the tip of the index finger when both fingers are stretched as far as possible
11.	Length	*Sijeungkai Getiek*	Measurement from the tip of the pinky finger to the tip of the thumb when both fingers are stretched as far as possible
12.	Length	*Sikrunyong*	Measurement from the sole of the foot to the tip of the hand raised vertically above the head, with the body standing upright
13.	Length	*Sihah*	Measurement equal to a cubit, the distance from the tip of the middle finger to the elbow
14.	Length	*Siteuleung*	Measurement from the lower arm, from the elbow to the wrist
15.	Length	*Sidupa*	Measurement from the tip of the left index finger to the tip of the right index finger, with both arms stretched horizontally
16.	Length	*Sideupa Meunara atau Deupa Meulara*	Measurement is determined by the distance between the tips of both fingers when the arms are stretched as far as possible behind the back
17.	Length	*Sitapak*	Measurement from the heel to the tip of the toes
18.	Length	*Silangkah*	Measurement is equal to the length of one step (100 cm)

No.	Measurement Aspect	Types of Measurement	Description
19.	Length	*Siila*	Measurement from the middle of the chest to the tip of the middle finger with arms stretched horizontally, equivalent to half the length of *deupa*
20.	Length	*Sibatee*	Measurement is equal to 1 kilometer or 1000 meters, which can be measured by taking 1000 steps
21.	Length	*Siihah*	Measurement from the base of the armpit to the tip of the middle finger with the arm stretched

Table 4. Types of volume measurement tools used by the Acehnese community

No.	Measurement Aspect	Types of Measurement	Description
1.	Volume	*Sjumpet*	Measurement of the amount taken using three fingers, usually used for cooking spices
2.	Volume	*Sigenggam*	Measurement of the amount held in an adult's fist, commonly used when paying *zakat fitrah* during Ramadan
3.	Volume	*Situmpok*	Measurement of the amount in one pile
4.	Volume	*Saboh plok Nie*	The measurement used by farmers for the volume of rice is equivalent to half a *kai* or the volume of one can of condensed milk
5.	Volume	*Saboh Mok*	Measurement equivalent to one can of condensed milk, often used to count the amount of rice in a sack
6.	Volume	*Sikai*	Measurement used by women to take rice for cooking. The *kai* is made from a halved coconut shell. This measuring tool is used throughout Aceh
7.	Volume	*Sicupak*	Measurement equal to two *kai*, used by women when taking rice for cooking
8.	Volume	*Si are*	A volume measuring tool made from bamboo, used by the Acehnese to measure agricultural produce. One *are*a is equivalent to 2 liters
9.	Volume	*Sigantang*	A measurement equal to 2 or 4 liters is usually used to measure the amount of rice in a sack

No.	Measurement Aspect	Types of Measurement	Description
10.	Volume	*Sinaleh*	Measurement of agricultural produce equal to 16 *are* or 32 liters, commonly used to measure the amount of rice
11.	Volume	*Sigunca*	Measurement of agricultural produce equal to 10 *naleh* or 160 *are* (320 liters), typically used to measure the amount of rice
12.	Volume	*Sikuyan*	Measurement of agricultural produce equal to 10 *gunca*, commonly used to measure the amount of rice

Table 5. Types of area measurement tools used by the Acehnese community

No.	Measurement Aspect	Types of Measurement	Description
1.	Area	*Sicupek*	Measurement of the area of a small paddy field, much smaller than a regular field, approximately 12.5 meters x 12.5 meters
2.	Area	*Sigupang*	Measurement used to describe a paddy field. A *gupang* has an area of ± *si yok*, approximately 25 meters x 25 meters
3.	Area	*Saboh kubeung*	Measurement of the area of a small paddy field *sicupek* (size, approximately 6 meters). *Keubeung is* typically used for seedling beds
4.	Area	*Silampoh*	Measurement of the area equivalent to a garden (such as a coconut, papaya, or mango garden), although the exact size is unknown. The size is estimated by counting the number of plants in the garden
5.	Area	*Reuweung*	Measurement of the area of a house, based on the number of rooms (*reuweung*), for example, a house with three rooms (*rumoh lhee reuweung*) or four rooms (*rumoh peut reuweung*)
6.	Area	*Si are*	Measurement of paddy field area large enough to plant 1 bamboo of rice seedlings
7.	Area	*Sigantang*	Measurement of paddy field area large enough to plant 2 bamboos of rice seedlings
8.	Area	*Sinaleh*	Measurement of paddy field area large enough to plant 16 bamboo of rice seedlings

No.	Measurement Aspect	Types of Measurement	Description
9.	Area	*Sigunca*	Measurement of paddy field area large enough to plant 10 *naleh* of rice seedlings
10.	Area	*Sikuyan*	Measurement of paddy field area large enough to plant 2 bamboo of rice seedlings
11.	Area	*Sirante*	Measurement of the area of a plot of land, approximately 100 meters x 100 meters.
12.	Area	*Siyok*	Measurement of a paddy field large enough to plant 16 bamboo of rice seedlings or *sinaleh*, approximately 50 meters x 50 meters
13.	Area	*Siyok rayek*	Measurement of a larger paddy field that can be planted with more than 16 bamboo of rice seedlings or *sinaleh*
14.	Area	*Siyok ubit*	Measurement of a paddy field that can be planted with 16 bamboo of rice seedlings or *sinaleh*

Table 6. Types of mass measurement tools used by the Acehnese community

No.	Measurement Aspect	Types of Measurement	Description
1.	Mass	*Simayam*	Mass measurement used by the community to weigh gold, where one *mayam* equals 3 grams of gold
2.	Mass	*Saboh pawon rupia*	Mass measurement used by the community to weigh gold, equivalent to 10 *mayam* or approximately 30 grams of gold
3.	Mass	*Saboh Pawon Ringgit*	Mass measurement used by the community to weigh gold, equivalent to 20 *mayam* or approximately 60 grams of gold

Table 7. Types of Time Measurement Tools Used by the Acehnese Community

No	Measurement Aspect	Types of Measurement	Description
1.	Time	*Beungeh*	Unit of time used by the community for making appointments in the morning
2	Time	*Cot Urou*	Unit of time indicating midday
3.	Time	*Supot*	Unit of time indicating the afternoon
4.	Time	*Malam*	Unit of time indicating the night
5.	Time	*Singeuh*	Unit of time used by the community for appointments the next day

6.	Time	*Barouw*	Unit of time referring to yesterday
7.	Time	*Barousa*	Unit of time indicating the day before yesterday
8.	Time	*Lusa*	Unit of time indicating two days after today
9.	Time	*Lusa raya*	Unit of time indicating three or more days after today
10.	Time	*Sithon*	Unit of time for one year or 12 months

Students will be able to identify and analyze the measuring tools that have been utilized by the community for various needs, especially concerning the measurement of length, volume, area, mass, and time.

To identify the types of measuring tools that were used in the past and are still used by the Acehnese community, this research is exploratory by applying an ethnographic approach. The focus of the ethnographic study in this research includes gathering information about the traditional measurement units used in the daily activities of the Acehnese people. The application of ethnographic study is used to describe, explain, and analyze the concepts of physical measuring tools found in the traditional measurement units used by the Acehnese community.

The subjects for obtaining empirical data are community members and figures who are knowledgeable about terms related to measurements or objects that fall under physical concepts (quantities and units) and still use traditional measuring units to this day. The community figures involved include *tuha peut* (elderly person), *pawang laot* (sea commander), *kejruen blang* (field commander), and *teungku Imum* (mosque imam), who understand the ins and outs of applying traditional measuring units in the Acehnese community.

The data collection techniques to obtain the measuring instruments were carried out through interviews, observation, documentation, and triangulation methods. The interview method was conducted by interviewing several community members who use traditional measurement units in their daily activities. The observation method was done by observing the use of traditional measuring tools in various daily community activities.

p-ISSN: 2338-8617
e-ISSN: 2443-2067

To strengthen the data, this study applies the Miles and Huberman (1994) data analysis model, which consists of the following stages: data collection, data reduction, data presentation, and conclusion drawing.

2) Designing a module

The material presented in the ethnoscience-based learning module is provided in easily understandable language and includes images of measuring instruments used by the Acehnese community. The module covers measuring instruments for length, volume, area, mass, and time. Each type of measuring instrument included in the module is accompanied by an image and a story about its origin, how it is made and used, as well as its benefits for users and where it is still applied by communities in Aceh today.

3) Designing student worksheets (LKM)

The student worksheets (LKM) developed are based on basic physics concepts by applying the measurement units used by the Acehnese community, including measurements of length, volume, mass, and time. In the LKM, there are activities that students complete in groups, where they record their observations both from the module and through empirical practices. The lecturer then provides students with the opportunity to discover the concepts they are learning independently.

The results of the RPS, module, and LKM can be seen in Figure 2 below:

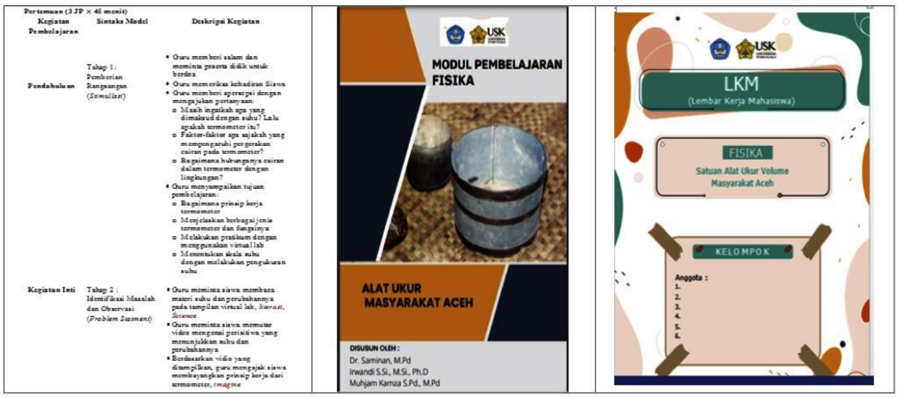

Figure 2. Display of (a) RPS, (b) Module, (c) LKM

c. Development stage

The development stage is the follow-up to the designs that have been created. This stage serves to assess the feasibility of the learning tools that have been designed for practical use. After receiving feedback, the learning tools are revised according to the suggestions from the validators. In this research, the validation results of the learning tools by experts are reviewed based on three types of assessments: the assessment of the RPS, the assessment of the LKM, and the assessment of the ethnoscience-based module. The results of the expert validity assessment can be seen in Figure 3 as follows:

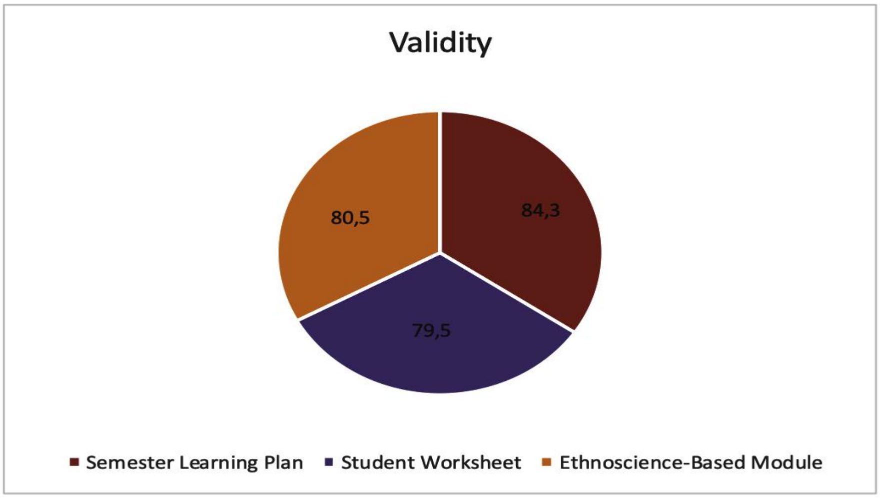

Figure 2. Validity assessment results

The validation results of the learning tools by experts in this research were reviewed based on three types of assessments: the RPS assessment, the LKM assessment, and the ethnoscience-based learning module. Based on the table, the percentage of the RPS assessment is 84.3%, which falls into the "feasible" criteria; the percentage for the LKM is 79.5%, also categorized as "feasible", and the percentage for the ethnoscience-based learning module is 80.5%, which is also considered "feasible". From these three assessments, the total feasibility percentage of the learning tools is 81.9%, which is categorized as "feasible".

d. Implementation stage

The fourth stage of the ADDIE development model is the implementation stage. After the learning tools are deemed feasible by the validators, they are then tested on students. In this stage, the researcher applies all activities within the learning tools, including the RPS, LKM, and the learning module. The trial was conducted with 15 students and carried out in a single session (3x45 minutes).

e. Evaluation stage

The fifth stage of the ADDIE development model is the evaluation stage. This stage aims to determine the practicality of using the learning tools. To assess practicality and effectiveness, student feedback and evaluations of students' cognitive outcomes regarding the developed learning activities are considered. The trial was conducted with 15 students.

1) Practicality results

The operational practicality of the learning tools in the field is determined after they are implemented in the learning process. Practicality information is obtained through observations of the learning activities and students' assessments of the developed learning tools. The practicality of the learning tools can be observed from the students' response scores to the tools used. The student response questionnaire consists of 20 statements. The analysis of the practicality data by the students can be seen in Figure 5 as follows:

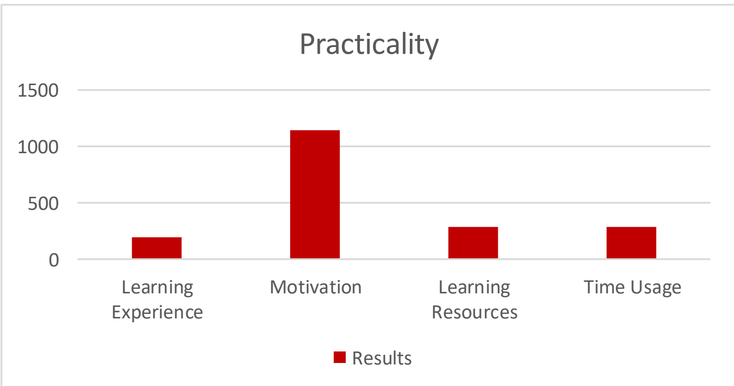

Figure 3. Practicality results of the learning tools

The analysis of student responses in Figure 5 covers the criteria of learning experience, motivation, learning resources, and time management. For the learning experience criteria in this research, based on the analysis conducted with 15 students participating in the practical activities, the learning experience criteria resulted in a score of 195, which falls under the "very practical" category. Through the practical activities, students found it easy to learn, understand, and gain new knowledge about the measurement tools used by the Acehnese community.

For the motivation criteria, the result was 1149, categorized as "very practical". This is reflected in the students' responses, which showed interest, enthusiasm, and enjoyment, all of which are indicators of strong motivation to achieve optimal learning outcomes. Enhancing student motivation in conducting the practical activities was further supported by an attractive design, which helped engage students in using the ethnoscience-based learning tools from the Acehnese community, thus supporting the independent learning approach.

For the learning resources criteria, a score of 289 was achieved, which falls under the "very practical" category. This is evident from the students' responses, indicating that they were able to overcome difficulties in understanding and learning from the ethnoscience-based learning tools. Students could effectively use the learning steps provided during the practical activities as a key resource.

For the time management criteria, a score of 290 was obtained, also in the "very practical" category. According to student responses, their active participation in the practical activities was greatly influenced by efficient time management. During the practical activities, it is crucial for the researcher to have good time management skills to ensure that the practical sessions are completed within the allotted time.

Based on Figure 5, it can be seen that the average percentage of student responses regarding the use of ethnoscience-based learning tools from the Acehnese community to support independent learning was 96.15%. From these results, it can be concluded that the students' responses to the developed learning tools fall into the "very practical" category.

2) Effectiveness results

The effectiveness of the learning tools can be determined by comparing students' cognitive outcomes before and after receiving ethnoscience-based learning. The effectiveness can be concluded from the percentage increase in the results. Therefore, it is necessary to present the learning outcome data as shown in Table below:

Table 8. Data analysis on the effectiveness of learning devices

Average Score		*Normality*		*N-Gain*	*Category*
Pretest	*Posttest*	*Sig. Pretest*	*Sig. Posttest*		
24,57	84,45	0,57	0,19	*0,80*	*High*

Based on the analysis in Table 8, the results of the *pretest* and *posttest* consist of 5 essay questions. This shows that the students' knowledge is predominantly categorized as "High". The difference in *N-gain* serves as a benchmark for success, indicating that students experienced a significant improvement in cognitive knowledge. The learning of basic physics becomes more meaningful when integrated with local culture, as students are more enthusiastic about learning and engaging with the material presented by the lecturer. This is because they gain learning experiences from scientific knowledge rooted in indigenous knowledge. This aligns with Okebukola's (1986) statement that integrating students' indigenous science with school science materials can enhance their academic performance, as traditional beliefs about their surrounding environment provide more meaningful knowledge compared to conventional basic physics education.

The basic physics learning device based on the ethnoscience of Acehnese society to support independent learning is considered successful due to the increase in students' interest in learning. This heightened interest is driven by their fascination with understanding scientific concepts in conjunction with cultural knowledge, which strengthens the research. The developed learning device can serve as a supplementary tool in the teaching and learning process by emphasizing cultural values and is effectively applied to enhance students' interest in basic physics. Students will easily grasp the material while also increasing their knowledge of the local culture. The development of the learning device also helps improve memory retention of local wisdom and fosters enthusiasm for the ongoing preservation of regional culture.

2. Discussion

a. Ethnoscience in teaching

The term ethnoscience refers to knowledge possessed by a nation or tribe. According to Sudarmin et al. (2017), ethnoscience is defined as a set of knowledge held by a specific community, tribe, or nation, acquired through particular methods that are part of that community's, tribes, or nation's tradition, and whose truth can be empirically tested and justified. Vlaardingerbroek (1990) identifies ethnoscience as the study of knowledge within a cultural context, seen as a cultural adaptation to one's place of residence, and practiced in daily life. The local culture within a community can be utilized for educational purposes or learning (Sudarmin et al., 2017; Emawati et al., 2024).

Sudarmin et al. (2017) mention three areas of ethnoscience research. These three areas are: 1) ethnoscience that emphasizes the culture of the social situation being faced. This research area highlights phenomena that are considered important to the community and the ways in which these phenomena are organized through the community's existing knowledge. 2) Ethnoscience that focuses on research aimed at revealing the culture present in society, encompassing both forbidden and permitted values and norms, as well as the development of technology. 3) Ethnoscience that focuses on culture as an event that brings people together and influences everyday behavior. The third area of research is the one most frequently used as a subject of study in the scientific community.

Wisdom usually describes a phenomenon that is characteristic of a particular community or region. The approach of local wisdom can be utilized by educators in the learning process. According to Sartini in Sudarmin, some functions of local wisdom in the current global era include: 1) conservation, which refers to efforts to manage the use of the biosphere to gain benefits while renewing and protecting natural resources for future generations; 2) human resource development; 3) development of culture and knowledge; 4) as a source of lessons, beliefs, literature, and taboos; and 5) equipping individuals to understand social life, ethics, morals, and politics (Sudarmin et al., 2017; Fithriani et al., 2021).

Sudarmin identifies three areas of ethnoscience research. These areas are: 1) ethnoscience that focuses on the culture of the social situations being encountered. This research area explores phenomena that are considered important by the community and how these phenomena are organized through their existing knowledge. 2) Ethnoscience that emphasizes research aimed at revealing the culture present in society, including both prohibited and permissible values and norms, as well as technological development. 3) Ethnoscience that highlights culture as an event that can bring people together and influence daily behavior. The third area of research is the one most commonly used as a subject of study in the scientific community (Sudarmin et al., 2017).

Wisdom typically describes a phenomenon that is characteristic of a particular community or region. The approach of local wisdom can be utilized by educators in the learning process. Some of the functions of local wisdom in the global era include: 1) conservation, which refers to efforts to manage the use of the biosphere for benefit while renewing and protecting natural resources for future generations, 2) human resource development, 3) the development of culture and knowledge, 4) as a source of lessons, beliefs, literature, and taboos, and 5) equipping individuals to understand social life, ethics, morals, and politics.

Indigenous scientific knowledge present in society takes the form of symbolic messages, culture, customs, religious ceremonies, and social practices that contain scientific concepts passed down through generations but have not been formally recognized in scientific terms. Indigenous science refers to knowledge, symbolic messages, customs, and socio-cultural aspects that encompass fields such as chemistry, biology, physics, agriculture, and others, containing scientific principles and concepts that have not yet been formally established (Sudarmin et al., 2017).

Formal science is taught within educational institutions commonly known as schools or universities. Indigenous scientific knowledge in society represents the community's perception of a phenomenon, which develops through continuous transmission from generation to generation in an unstructured, informal, and localized manner. In contrast, formal science, also referred to as scientific knowledge, is understood scientifically using structured scientific methods. As a result, scientific knowledge is objective and accountable. To transform society's perception of indigenous science into accountable knowledge, it is necessary to take steps to reconstruct and/ or transform indigenous science into formal scientific knowledge.

Indigenous science within the community is then reconstructed and/ or transformed into formal scientific knowledge. The process of forming scientific knowledge based on local culture begins with the conceptual description of forming scientific knowledge from local communities through activities such as identification, verification, formulation, and conceptualization of scientific knowledge through processes of accommodation, assimilation, and interpretation. The key principles to consider in the education of indigenous science within the context of local culture are: 1) there must be a connection between culture and science that becomes the object of study, 2) indigenous scientific knowledge should have practical benefits in daily life, 3) indigenous knowledge should have a place within science education content, 4) traditional indigenous knowledge includes an understanding of natural phenomenology, and 5) the methodology used should be able to bridge conventional knowledge with scientific knowledge. These five principles serve as guidelines for reconstructing indigenous knowledge into formal scientific knowledge.

b. Science learning

Learning is the process of interaction between students and their environment, which can lead to positive changes in attitudes and behaviors. These changes are crucial, considering that students are the future generation who will contribute to building society. Learning involves a set

p-ISSN: 2338-8617
e-ISSN: 2443-2067

of actions designed to support the learning process of students, taking into account external events that play a role in the series of internal events experienced by students. In the implementation of physics learning, educators must be able to stimulate students to develop scientific attitudes such as curiosity, skepticism (always seeking evidence), openness to other opinions, honesty, objectivity, fidelity to data, thoroughness, cooperation, and persistence.

Physics is considered the most fundamental of the sciences because it studies the basic principles of the universe. The beauty of physics lies in its ability to use a few concepts, equations, and fundamental assumptions to transform and expand our understanding of the world around us. One approach that can improve the quality of the learning process is by incorporating aspects of local culture or indigenous knowledge, known as ethnoscience.

In physics education, creating a pleasant and engaging atmosphere is essential, as many students perceive physics as a difficult and tedious subject. The time students spend learning provides them with concrete exposure to culture, experiences, and knowledge within traditional communities. During the teaching of physics, educators must stimulate students to adopt scientific attitudes such as curiosity, skepticism (always seeking evidence), openness to other opinions, honesty, objectivity, fidelity to data, thoroughness, cooperation, and perseverance. Learning physics requires an understanding through mastery of key concepts.

c. Merdeka belajar

Education is a crucial aspect of human life. It should bring about various changes for individuals, one of which is the transformation of social status, where access to education must be equal and evenly distributed. To achieve the national educational goals, such as fostering an intelligent nation and promoting social justice, the system must be supported by an integrated structure that is collectively built. Education should not only focus on academic achievement but also ensure that it creates equitable opportunities for all, allowing individuals to improve their lives and contribute to society.

The implementation of education must continuously evolve in line with the advancements of the times, as education is an essential tool for individuals to navigate an increasingly advanced and developing world. In response to this, the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia, Nadiem Anwar Makarim, introduced the Merdeka Belajar program, aimed at addressing the educational needs in the era of the Industrial Revolution 4.0. This program is designed to provide greater flexibility and autonomy in learning, preparing students to face the challenges of modern times and fostering innovation and creativity in the educational system (Wardani et al., 2023).

The main requirement of the Industrial Revolution 4.0 era is the mastery of integrated literacy and numeracy. To optimize this mastery, breakthroughs in the field of education are necessary, one of which is the Merdeka Belajar Kampus Merdeka program. This program aims to enhance graduates' competencies, both in soft skills and hard skills, to ensure they are better prepared and relevant to the demands of the time, equipping them to become future leaders of the nation who are excellent, moral, and ethical (Suhartoyo et al., 2020; Wardiyah et al., 2023). The essence of Merdeka Belajar lies in providing students with the freedom to think independently or in groups, so that in the future, it can produce students who are outstanding, critical, creative, collaborative, innovative, and participative.

The hope is that the Merdeka Belajar program will lead to increased student engagement in learning (Siregar et al., 2020; Samsudi et al., 2024). The goal of the Merdeka Belajar-Kampus Merdeka policy, specifically the "right to learn for three semesters outside of the study program", is to enhance graduates' competencies, both in soft skills and hard skills, making them more prepared and relevant to the needs of the times, and preparing them as future leaders of the nation who are excellent and possess strong character. Flexible experiential learning programs are expected to facilitate students in developing their potential according to their passion and talents.

D. Conclusion

At this stage, the development of basic physics learning devices based on the ethnoscience of Acehnese society to support the Merdeka Belajar program has been successfully carried out, with the trial of these learning devices tested to be valid, practical, and effective. The developed learning tools include a learning module, student worksheets for basic physics based on Acehnese ethnoscience, and a semester learning plan (RPS). These learning devices can serve as a reform for the data collection system in education, helping students engage in meaningful learning. Data collection using measuring tools available in Aceh society can be done directly through observations by students.

Additionally, the collected data can be measured and compared using both Acehnese traditional measurement units and scientific measurement units, enabling students to gather complete and comprehensive data accurately. This study also involved the application of entrepreneurial practice activities by students through the development of products aimed at supporting the Merdeka Belajar-Kampus Merdeka (MBKM) program during the COVID-19 pandemic, enhancing students' creativity and entrepreneurial skills by allowing them to create and promote their products on various digital platforms.

Acknowledgment

We sincerely appreciate the cooperation of the students pursuing their Physics Education Degree at Universitas Syiah Kuala who participated in this research study.

Bibliography

Abidin, Z., & Usman, J. (2021). Analyzing Aceh Cultural Heritage: Mathematical Tools and Language Use. *Jurnal Ilmiah Peuradeun*, *9*(3), 661–680. https://doi.org/10.26811/peuradeun.v9i3.574.

Albanese, V. & Perales, F.J. (2015). Enculturation with Ethnomathematical Microprojects: From Culture to Mathematics. *Journal of Mathematics and Culture*, *9*(1), 1–11. http://hdl.handle.net/10481/35285.

Amaly, A. M., Herdiana, Y., Ruswandi, U., & Arifin, B. S. (2023). The Necessity and Reality of Islamic Religious Education in Schools. *Jurnal Ilmiah Islam Futura*, *23*(1), 1–19. https://doi.org/10.22373/jiif.v23i1.13190.

Bishop, A. (1994). Cultural Conflicts in Mathematics Education: Developing a Research Agenda. *Learning of Mathematics*, *14*(2), 15-18. https://www.jstor.org/stable/40248109.

Branch, R.M. (2009). *Instructional Design: The ADDIE Approach*. New York: Springer. https://doi.org/10.1007/978-0-387-09506-6.

Dewi, C.A., Erna, M., Martini, M, Haris, I., & Kundera, I.N. (2021). Effect of Contextual Collaborative Learning-Based Ethnoscience to Increase Student's Scientific Literacy Ability. *Journal of Turkish Science Education*, *18*(3), 525–541. https://doi.org/10.36681/tused.2021.88.

Dick, W, & Carey, L. (1996). *The Systematic Design of Instruction (4nd Ed)* (Gleview (Ed.). London: Scot, Foresman and Company.

Donovan, D. (2016). Mental health nursing is stretched to breaking point. *Nursing Standard (Royal College of Nursing (Great Britain): 1987)*, *30*(25), 33. https://doi.org/10.7748/ns.30.25.33.s40.

Emawati, E., Zulfikar, T., Habiburrahim, H., Akmal, S., & Sundusiyah, A. (2024). Locating Learner-Centered Instruction in Islamic Boarding Schools' Classrooms: Prospects and Challenges. *Jurnal Ilmiah Islam Futura*, *24*(1), 241–260. https://doi.org/10.22373/jiif.v24i1.13284.

Fithriani, F., Syabuddin, S., Gunawan, G., Zainuddin, T., & Sulaiman, S. (2021). Teacher as a Role Model in the 2013 Curriculum Development. *Jurnal Ilmiah Islam Futura*, *21*(2), 240–256. https://doi.org/10.22373/jiif.v21i2.7516.

Flick, L.B., Keys, C.W., Westbrook, S.L., Crawford, B.A., & Cames, N.G. (1997). *Perspectives on Inquiry-Oriented Teaching Practice: Conflict and Clarification*, *150*. https://eric.ed.gov/?id=ED407255.

Gerdes, P. (1994). Reflections on Ethnomathematics. *For the Learning of Mathematics*, *14*(2), 19–22. https://www.jstor.org/stable/40248110.

Ismail, I., Permanasari, A., & Setiawan, W. (2016). STEM Virtual Lab: An Alternative Practical Media to Enhance Student's Scientific Literacy. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 239–246. https://doi.org/10.15294/jpii.v5i2.5492.

Halomoan, I. S., Moeis, I., & Yakubu, A. (2023). An Overview of the

Strength of Implementing Democratic Values in an Islamic Boarding School Atmosphere. *Nazhruna: Jurnal Pendidikan Islam*, *6*(2), 190–206. https://doi.org/10.31538/nzh.v6i2.2865.

Kane, S.N., Mishra, A., & Dutta, A.K. (2016). Preface: International Conference on Recent Trends in Physics (ICRTP 2016). *Journal of Physics: Conference Series*, *755*(1), 011001. https://doi.org/10.1088/1742-6596/755/1/011001.

Kemdikbud. (2020). *Buku Panduan Merdeka Belajar-Kampus Merdeka*. https://doi.org/10.31219/osf.io/ujmte.

Manan, A., Kamarullah, K., Husda, H., Rasyad, R., & Fauzi, F. (2024). The Unity of Community in Cemetery: An Ethnographic Study of The Islamic Burial Rituals in Aceh, Indonesia. *Jurnal Ilmiah Islam Futura*, *24*(1), 21–50. https://doi.org/10.22373/jiif.v24i1.14965.

Miles, M., & Huberman, A. (1994). *Qualitative Data Analysis*. Sage Publications.

Muhith, A., Dwiyono, Y., Munawati, S., Mustofa, A., & Haryanto, S. (2023). Challenges of Islamic Boarding School Organizational Culture in The Millennial Generation and The Digital Era 4.0. *Nazhruna: Jurnal Pendidikan Islam*, *6*(3), 457–474. https://doi.org/10.31538/nzh.v6i3.4231.

Munzir, S., B., S., & Arif, S. (Eds.). (2022). Etnomatematik dan Etnosains (Issue 1). Banda Aceh: Syiah Kuala University Press.

Nurhasanah, F., Kusumah, Y.S., & Sabandar, J. (2017). Concept of Triangle : Examples of Mathematical. *International Journal on Emerging Mathematics Education*, *1*(1), 53–70. http://dx.doi.org/10.12928/ijeme.v1i1.5782.

Okebukola, P.A. (1986). The Influence of Preferred Learning Styles on Cooperative Learning in Science. *Science Education*, *70*(5), 509-17. https://eric.ed.gov/?id=EJ341897.

Pais, A. (2011). Criticisms and Contradictions of Ethnomathematics. *Educational Studies in Mathematics*, *76*(2), 209–230. https://doi.org/10.1007/s10649-010-9289-7.

Pais, A. (2013). Ethnomathematics and the Limits of Culture. *For the Learning of Mathematics*, *33*(3), 2–6. https://www.jstor.org/stable/43894853.

Rosyidah, A.N., Sudarmin, & Siadi, K. (2013). Pengembangan Modul IPA Berbasis Etnosains Zat Aditif dalam Bahan Makanan untuk Kelas VIII SMP Negeri 1 Pegandon Kendal. *USEJ – Unnes Science Education Journal*, *2*(1), 133–139. https://journal.unnes.ac.id/sju/usej/article/view/1765.

Rahmi, M., Saminan, S., Syukri, M., Yusrizal, Y., Khaldun, I., Artika, W., & Huda, I. (2022). Development of a Virtual Lab in Science-Physics Learning Based on the STEM Approach. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 2351–2355. https://doi.org/10.29303/jppipa.v8i4.1660.

Riduwan, R. (2021). *Fundamentals of Statistics*. Bandung: Alphabeta

Saminan, S. (2015). Internalisasi Budaya Sekolah Islami di Aceh. *Jurnal Ilmiah Peuradeun*, *3*(1), 147–164. http://www.journal.scadindependent.org/index.php/jipeuradeun/article/view/60.

Samsudi, S., Supraptono, E., Utanto, Y., Rohman, S., & Djafar, T. (2024). Unraveling the Merdeka Curriculum: Exploring Differentiated Instruction's Impact on Student Learning. *Jurnal Ilmiah Peuradeun*, *12*(2), 517–538. https://doi.org/10.26811/peuradeun.v12i2.1131.

Siregar, N., Sahirah, R., & Harahap, A.A. (2020). Konsep Kampus Merdeka Belajar di Era Revolusi Industri 4.0. *Fitrah: Journal of Islamic Education*, *1*(1), 141-157. https://doi.org/10.53802/fitrah.v1i1.13.

Stanley, W.B., & Brickhouse, N.W. (2001). Teaching Sciences: The Multicultural Question Revisited. *Science Education*, *85*(1), 35-49. https://doi.org/10.1002/1098-237X(200101)85:1%3C35::AID-SCE4%3E3.0.CO;2-6.

Sudarmin, S, Febu, R., Nuswowati, M., & Sumarni, W. (2017). Development of Ethnoscience Approach in the Module Theme Substance Additives to Improve the Cognitive Learning Outcome and Student's Entrepreneurship. *Journal of Physics: Conference Series*, *824*(1), p. 012024. https://doi.org/10.1088/1742-6596/824/1/012024.

Suhartoyo, E., Wailissa, S.A., Jalarwati, S., Samsia, S., Wati, S., Qomariah, N., Dayanti, E., Maulani, I., Mukhlish, I., Azhari, M.H.R., Isa, H.M., & Amin, I.M. (2020). Pembelajaran Kontekstual dalam Mewujudkan Merdeka Belajar. *Jurnal Pembelajaran Pemberdayaan Masyarakat (JP2M)*, *1*(3), 161-164. https://doi.org/10.33474/jp2m.v1i3.6588.

Sumanti, S. T., Nunzairina, N., & Salminawati, S. (2024). The Evolution of Islamic Educational Institutions in North Sumatra Indonesia. *Nazhruna: Jurnal Pendidikan Islam*, *7*(1), 1–19. https://doi.org/10.31538/nzh.v7i1.4419.

Taylor, S.A., & Baker, T.L. (1994). An Assessment of the Relationship between Service Quality and Customer Satisfaction in the Formation of

Consumers' Purchase Intentions. *Journal of Retailing*, *70*(2), 163–178. https://doi.org/https://doi.org/10.1016/0022-4359(94)90013-2.

Walidin, W., Idris, S., & Tabrani ZA. (2015). *Metodologi Penelitian Kualitatif & Grounded Theory*. Banda Aceh: FTK Ar-Raniry Press.

Wardani, H. K., Sujarwo, S., Rakhmawati, Y., & Cahyandaru, P. (2023). Analysis of the Impact of the Merdeka Curriculum Policy on Stakeholders at Primary School. *Jurnal Ilmiah Peuradeun*, *11*(2), 513–530. https://doi.org/10.26811/peuradeun.v11i2.801.

Wardiyah, J., Budianti, Y., Al Farabi, M., Sirojuddin, A., & Fatikh, M. A. (2023). Merdeka Belajar Activity Unit at Madrasah Aliyah: Program Evaluation Study Using CIPP Method. *Nazhruna: Jurnal Pendidikan Islam*, *6*(1), 119–138. https://doi.org/10.31538/nzh.v6i1.2633.