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RESEARCH ARTICLE

Utilization of the Ethno-ISETS Approach in Science Learning during the Traditional Brown Sugar Production Process

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ABSTRACT

The application of 21st-century skills has become an important necessity in the science (IPA) learning process, especially in the context of local culture. The purpose of this research is to examine the application of the Ethno-ISETS (Islamic, Science, Environment, Technology, and Society) approach in science learning, with a focus on the traditional production of brown sugar as a form of local wisdom integrated into science education. This study employs qualitative methods with purposive sampling to understand the process of brown sugar production from an ethno-science perspective. The research results show that the process of making brown sugar involves scientific concepts, such as energy, heat, and phase changes, and enriches students' understanding through cultural and religious contexts. The use of natural fuel from sugarcane bagasse and the application of Islamic principles in material processing demonstrate a close relationship between traditional knowledge and modern scientific concepts. Through this approach, students can actively engage in the learning process, enhance their critical thinking skills, and appreciate local knowledge and technology. The results of this research also contribute to enriching the science education curriculum by linking scientific skills with local cultural practices.

KEYWORDS

Ethno-ISETS; science education; making brown sugar; local wisdom.

1. Introduction

21st-century learning skills are abilities that are increasingly needed by students in this era not only to master academic material but also to handle complex global challenges. These skills encompass several important elements such as active learning, collaboration, problem-solving, and critical thinking (Xu & Zhou, 2022).

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Additionally, 21st-century skills also refer to the needs in the ever-evolving modern world, so students are expected to possess learning and innovation skills, information, media, and technology skills, as well as life and career skills (Atabey & Topcu, 2020).

These skills can be developed through science education (IPA). However, science education (IPA) is often considered separate from the local cultural context. In fact, by combining the two, it can help students understand and relate to the material being taught. In science education, traditional approaches often focus on scientific concepts and universal theories without considering the cultural background or local context of the students. This can result in the material being taught being irrelevant or difficult for students to understand, especially if they cannot relate these concepts to their everyday experiences and knowledge (Mukti et al., 2022). The Ethno-SETS approach (Ethnoscience, Science, Environment, Technology, and Society) provides a new and creative method to integrate traditional knowledge with science learning, thereby enriching students' learning experiences and making science more relevant and contextual. This approach prioritizes understanding local perspectives and practices, as well as how these can be integrated with modern scientific concepts (Sugiharti & Sukowati, 2020).

The integrated learning method known as the SETS approach focuses on four main components: natural sciences (IPA), environment, technology, and society. This approach aims to enhance students' comprehension skills. During this process, teachers can relate the science concepts being taught to societal issues and their surrounding environment. This helps students apply what they learn in school to their daily lives (Firdaus et al., 2020). Learning from everyday life can be obtained from learning based on local wisdom. Learning based on local wisdom greatly supports educational advancement, especially in science subjects. This approach facilitates students' understanding because they can directly observe their surroundings. Local wisdom has the potential to be used as teaching material, which can strengthen students' attitudes and character values. In addition, the application of local wisdom in learning can also enhance students' knowledge and skills (Jufrida et al., 2020).

The processing of brown sugar from sugarcane juice contains scientific values that can be utilized as a learning resource. This locally-based learning resource can play a role in restoring the character values that have begun to fade among students. Traditional brown sugar production, a cultural practice with scientific value, is one

example of using the Ethno-ISETS approach. To provide deeper context and encourage students to learn science, the Ethno-ISETS approach can be used to explain various scientific aspects of the brown sugar production process, including chemistry, biology, and technology. This approach can also help students in many ways, such as actively participating in class, enhancing their understanding of scientific concepts through cultural context, and fostering appreciation for local knowledge and cultural diversity (Fawaida et al., 2023).

Learning using the ISETS approach is conducted by integrating Islamic values with science and technology, to provide benefits for society and the environment. In addition, this approach can enhance students' spiritual attitudes, facilitate their understanding of lesson materials, and assist them in making decisions related to everyday life issues (Azizah & Astuti, 2020). This approach supports national education in shaping Pancasila-charactered students who are faithful, devout, possess noble morals, and are competent. In science learning, the I-SETS approach helps students understand the material by linking societal issues and solving them based on Islamic values, encouraging student engagement, facilitating their acquisition of knowledge, and developing a scientific attitude (Fazrina et al., 2023).

Previous studies have shown that there is an increase in student understanding and engagement through the incorporation of local knowledge into the science curriculum (Saputri & Desstya, 2023). In the context of making brown sugar, the application of this approach not only helps students understand the scientific process behind brown sugar production but also appreciate the cultural values and local technologies involved (Ayu, 2023). The application of the ethnoscience approach in education can enhance students' problem-solving skills and creativity by connecting scientific concepts with local cultural practices, creating an inclusive and respectful learning environment that values local wisdom, while also equipping students with the skills and knowledge needed to face contemporary challenges (Seerangan & Venkataravi, 2023).

Through this approach, science learning in the traditional process of making brown sugar not only serves as a means to understand scientific processes but also to appreciate and preserve existing cultural knowledge and practices. To understand and practice brown sugar production, learning with the ethno ISETS approach must be conducted by linking the ISETS context (Islamic, Science, Environment, Technology, and Society). Mapping the knowledge and skills in brown sugar production that align with Core Competencies and Basic Competencies is needed,

as well as making a significant contribution to enriching the science education curriculum and connecting students with their cultural heritage.

2. Methodology

Qualitative methods are used in this research to broaden the community's understanding of the traditional brown sugar production process. Ethno-ISETS (Islamic, Science, Education, Technology, and Society) is an approach, and the main objective of this analysis is to understand and comprehend how local communities produce brown sugar, including the knowledge and methods they use.

This study uses the purposive sampling method, which means the sample is deliberately selected according to the research objectives. In this case, the sample consists of individuals or groups who are considered to have in-depth knowledge about the production of brown sugar. This is based on direct participation in production, where the sample observes or directly participates in the process of making brown sugar, even if not professionally, tends to have a fundamental understanding of the main processes involved. In-depth interviews with brown sugar makers, documentation of the brown sugar production process, and direct observation of the process allow researchers to see and record the process firsthand, while documentation helps to record each stage of the process, namely cutting sugarcane, milling, cooking, and drying.All data collected during this research will be analyzed using the ISETS approach, where each step in the production of brown sugar, the use of tools and materials, and the knowledge involved in the production of brown sugar will be categorized into the aspects of Islamic, Science, Education, Technology, and Society, mapping the knowledge and processes found according to the basic competencies in the junior high school curriculum. This aims to integrate traditional knowledge within the context of science and technology education, so it can be utilized in school learning.

3. Results and Discussion

The results of observations and interviews with residents who process sugarcane into brown sugar are presented in Table 1. The steps in the process of heating sugarcane juice into brown sugar are cutting, grinding, cooking, and drying.

Table 1. Stages of the Brown Sugar Production Process

Stages	Tools and work processes		
Cutting	Tool	:	Machete, a round-bladed knife.
	Process	:	The long sugarcane with a thick stalk is cut using a machete. Then the top part is leaves and the bottom part is cleaned. Sugarcane of long size is cut into pieces of about 1 meter and the skin is removed to facilitate the milling process. Next, all the sugarcane is collected and dried under the scorching sun to make it softer when put into the grinding machine.
Grinding	Tool	:	The grinding machine uses a motor, bucket, filter, and hose.
	Process	:	The grinding machine serves as the driving force of the milling process, producing sugarcane juice. The sugarcane juice enters the collection barrel through the filter and then flows through the hose to be cooked in a large pan.
Cooking	Tool	:	Three-legged stove or iron stove, large frying pan made of aluminum, firewood, strainer, and stirrer.
	Process	:	The traditional cooking of sugarcane juice at home only uses a large wok. Sugarcane juice is poured into a large pan and heated over a high flame. The cooking process takes five hours. Besides firewood, the material used for burning is sugarcane bagasse. Sugarcane bagasse can also serve as a renewable fuel. (Pasaribu, 2022). The temperature of the sugarcane water, which has reached around 100ºC, forms foam on the surface of the sugarcane water. Using a filter, this foam is collected and discarded. This is done to remove any dirt that may have entered the sugarcane juice.
Drying	Tool	:	Wok the sugarcane juice, which initially filled a large wok,
	Process	:	after being cooked for five hours, reduced to three-quarters of the wok and turned into brown sugar. The reduction process in this cooking is marked by a sweet aroma emanating from the pan. (Fitrianto, & Hudi, 2021). The cooking process on a home scale is only carried out until a thick black syrup forms, not sugar crystals.

Analysis of the Ethno ISETS Approach in the Production of Brown Sugar

The process of making brown sugar will be classified and analyzed in five aspects: Islamic, science, environment, technology, and society.

Islamic

In this section, the production of brown sugar will be analyzed based on Islamic principles, including the processing of materials and the selection of halal sources (Rohmatin & Wahiddatur, 2019). First, we will ensure that the main ingredient, such as sugarcane, comes from halal plants and not from plants that are stolen from someone else's garden, in accordance with Islamic teachings. This includes not only the types of plants but also the methods of planting, harvesting, and processing sugarcane without containing prohibited elements, such as mixing sugarcane juice with drugs, alcohol, and substances that are harmful to health.

Throughout the entire process of making traditional brown sugar, Islamic work ethics are also applied. This process emphasizes the importance of maintaining cleanliness and purity at every phase, from material selection to final processing. Additionally, Islamic work ethics encourage obtaining raw materials in an honest, open, and fair manner, such as ensuring that sugarcane is sourced in a good, legal way, and its origin is clear. Principles like these ensure that brown sugar, the final product, is not only of high quality but also in accordance with Islamic morals and ethics.

Science

There are many Natural Science concepts related to tools, materials, plants, and phases in the process of making brown sugar. The process begins with cutting sugarcane using a round puguh knife. This acts as a lever, cutting the sugarcane stalk with little effort. After the sugarcane is cut, the next step is the milling process using a milling machine. In this process, the concept of energy transformation applies, where the mechanical energy of the machine is used to convert sugarcane into sugarcane juice (Wibowo, 2016). Additionally, the use of grinding tools involves the concept of a rotating wheel, which aids the process by reducing friction (Pandu & Wibowo, 2023).

Sugarcane juice is boiled until it reaches a boil after extracting the sugarcane juice. Heat is transferred to the sugarcane juice during this process, causing water molecules to evaporate and reducing the water content in the sugarcane juice (Suranto, 2011). After heating, the sugarcane juice undergoes a filtration process to remove impurities and sugarcane pulp. The concept of filtration is the core of this process. The sugarcane juice is then filtered and placed into a large container. In this

situation, pressure works because fluids can move from one place to another due to pressure variations. At the final stage, after the sugarcane juice has undergone water reduction, the juice is heated until sugar crystals form. This process is similar to crystallization and evaporation, where the remaining water is continuously evaporated until only sugar in crystal form remains (Muchlisyiyah, et al., 2017). Therefore, every step in the traditional brown sugar-making process involves the application of various basic science concepts. To understand how science affects daily life, we can study it further.

Environment

The production of brown sugar on a household scale is carried out in locations far from crowded centers so that the local community is not exposed to the smoke produced from burning. This is done to maintain air quality in the surrounding environment, and the place for cooking sugarcane juice is located far behind the house so that residents do not directly inhale the smoke produced from burning, especially in densely populated areas.

The fuel used in the cooking stage comes from the skin and pulp of sugarcane. This process is not only environmentally friendly but also reduces the volume of waste produced. In addition, the ash residue produced from the burning of sugarcane bagasse is not disposed of randomly. Reused as a natural fertilizer for sugarcane plants, this creates a sustainable waste management cycle and maintains soil fertility in sugarcane plantations.

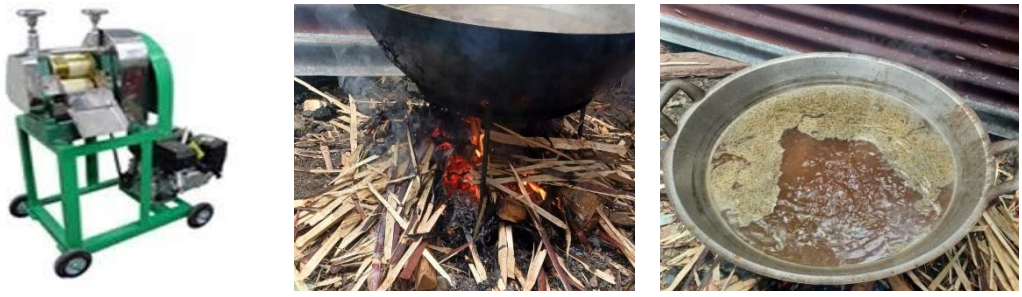
Technology

The tools and techniques used in the process of making brown sugar employ very traditional equipment. However, the use of grinding machines already employs machine technology. This is shown in Figure 2.

Society

The production of brown sugar on a household scale is only carried out by two people to perform specific tasks. The first workers function as sugarcane cutters, cutting the sugarcane stalks from the ready-to-harvest fields. After the sugarcane is cut, they also have to clean the stalks from the attached leaves, making them ready for processing. The workers then bring the cleaned sugarcane to the mill, where the

sugarcane is pressed to produce sugarcane juice. Meanwhile, the second worker is the sugarcane juice cook. After the sugarcane is pressed, the juice is collected and cooked in a large pan over medium heat until it thickens and turns into syrup, a thick liquid. This cooking process requires patience and precision because the sugarcane juice must be cooked for a long enough period to achieve the right thickness.



(a) (b) (c)

Figure 1. The technology used (a) grinding machine, (b) aluminum frying pan, and (c) triangular heating stove

Scientific Study in the Process of Making Brown Sugar

Use of Tools and Materials

The mechanical principle of the sugarcane mill machine with a motor drive allows two or more grinding rollers to move through the motor's rotation. The process begins by inserting the sugarcane stalk into the gap between the two rotating rollers, and the motor drive, which is usually high-powered, provides the energy to move the rollers, causing the sugarcane stalk to be pressed and crushed, resulting in sugarcane juice.

Sugarcane contains organic and inorganic compounds. One of the most abundant disaccharides found in sugarcane is sucrose. Sugarcane juice contains 70-88% sucrose, as well as 2-4% glucose, 2-4% fructose, 1.1-3% carboxylic acids, 0.5-2.5% amino acids, and other substances (Fadhillah, et al., 2023). The three-legged iron stove is used as a furnace, and this furnace does not have a chimney, so the smoke that comes out is carried away by the air.

Smoke is a suspension of small particles called aerosols in the air, produced by the incomplete combustion of fuel (Laili & Sufaidah, 2022). Sugarcane juice evaporates quickly during the cooking process using a large, concave, aluminum pan. Sugarcane is a plant that belongs to the kingdom Plantae, division Spermatophyta, subdivision Angiospermae, class Monocotyledonae, order

Graminalis, family Graminiae, genus Saccharum, and species Saccharum officinarum. (Fawaida et al., 2023).

Cooking

Traditional brown sugar production uses a large triangular stove to create a strong fire. A large fire is very important for this process because it affects how quickly the water from the sap (the liquid from sugarcane or coconut trees) evaporates. The worker continuously monitors the fire to ensure that it is large and stable.

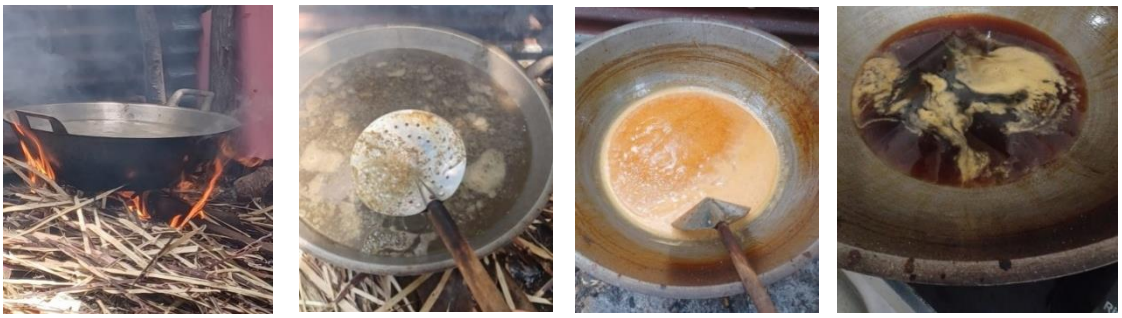
The workers immediately added firewood to the furnace when the fire started to dim or lose intensity. They also blew air towards the fire using a long bamboo pipe to ensure the fire reignited strongly. The more heat is generated, the faster the evaporation process occurs. This is very important because the heat from the fire will speed up the thickening of the sap into brown sugar. This process must be continuously monitored carefully so that the produced sugar meets quality standards with the appropriate texture and viscosity.

Filtration

One of the important steps in the process of separating unwanted substances from a solution is filtration. To make brown sugar, filtration is used to remove impurities or residue from the sugarcane juice after it has been heated. For this process, a frying sieve made of iron with small holes is usually used to filter out the residue, allowing only the clean liquid to pass through. The filtration process is carried out to ensure that the produced brown sugar has good quality, is free from impurities, has a more attractive appearance, and a pure taste. This process also enhances the cleanliness and shelf life of the brown sugar.

Drying

At the drying stage in the home-scale production of brown sugar, the resulting sugar has a thick texture with a deep black color. Initially, the sugar was cooked in large quantities, filling a whole pan, but after drying and shrinking, its volume decreased to about three-quarters of the pan. Finally, the sugar is allowed to cool to room temperature. The cooling process is very important because it allows the sugar to continue thickening until it reaches the desired consistency. After that, the brown sugar is ready to be shaped and used (Figure 2).



(a) (b) (c) (d)

Figure 2. (a) Cooking sugarcane juice, (b) Filtering impurities, (c) Finished sugar, (d) Red sugar that continues to thicken

The Relationship Between Traditional Knowledge and Basic Competencies in the Process of Making Brown Sugar

In the Natural Sciences (IPA) learning at junior high school, the results of interviews and observations will be analyzed and categorized into relevant basic competencies. This basic ability includes students' ability to understand scientific ideas and use this knowledge in real-world situations. This involvement aligns with educational curriculum standards and helps them develop critical thinking and problem-solving skills. To enhance students' understanding of natural phenomena and their applications in daily life, including the traditional production of brown sugar, skills identified through interviews and observations will be incorporated into the learning process.

Learning by connecting what is in the students' environment can have a positive impact because it makes the material being studied more relevant and easier to understand. By connecting the taught ideas with the daily experience they face, students will find it easier to understand and apply the knowledge they have learned. In addition, this approach can increase students' motivation to learn because they feel that the material being taught is connected to the real world (Fatmawati, & Rozin, 2018). The ISETS method helps students understand and relate problems to Islamic values, enhances scientific understanding, and increases piety (Wahyuni, et al., 2017).

Table 2. The Relationship Between Traditional Knowledge and Basic Competencies in the Process of Making Brown Sugar

Local Wisdom	Basic Knowledge Competency	Basic Skills Competency	Material
Knowledge about the use of sugarcane as a raw material	Classifying living things and objects based on observed characteristics	Presenting the results of classifying living organisms and objects in the surrounding environment based on observed characteristics	Material on the classification of living beings
Structure or components of brown sugar and the filtering and drying processes	Explaining the concept of mixtures and pure substances (elements and compounds), physical and chemical properties, physical and chemical changes in everyday life	Presenting research findings or works on the properties of solutions, physical changes and chemical changes, or the separation of mixtures	Material temperature and its changes
Sugarcane milling	Explaining the concept of work, simple machines, and their application in everyday life, including muscle work on the human skeletal structure	Presenting the results of research or problem-solving about the benefits of using simple machines in everyday life.	Efforts and simple machines in daily life
Cooking sugarcane juice	Analyzing the concepts of temperature, expansion, heat, heat transfer, and their applications in daily life, including the mechanisms for maintaining body temperature stability in humans and animals.	Conducting experiments to investigate the effect of heat on temperature and the state of matter as well as heat transfer.	subject matter of heat and its transfer
Bagasse and sugarcane husk serve as a source of fuel	Analyzing the occurrence of environmental pollution and its impact on the ecosystem.	Writing an article about ideas for solving pollution problems in the environment based on observations.	Environmental pollution lesson material
Benefits of brown sugar	Explaining various additives in food and beverages, addictive substances, and their impact on health	Writing a paper on the impact of the misuse of additives and addictive substances on health.	Subject matter on additives and addictive substances

One of the goals of education is for students to be able to contribute to society. They learn by applying what they learn in school, which provides a planned learning experience to the community and utilizes the community as their learning resource (Syamsudin, 2020). Learning resources available in the surrounding environment are very important to encourage students to discover various interesting and relevant problems for them. The problem-solving process that involves technology, social aspects, and the environment encourages students to think critically, collaborate, and be creative. They learn more contextually because they not only interact with real-world situations but also study theory. This method can enhance students' science skills. It can include understanding scientific concepts, applying technology, and developing analysis and problem-solving abilities (Berliana, 2024).

According to the mapping results shown in Table 2, the process of making brown sugar can be adjusted to the knowledge and skills of the students. This process can be used as a source of contextual learning, relevant teaching materials, and a learning approach that supports mastery of the subject matter. Therefore, learning about the production of brown sugar based on Ethno-ISETS (Islamic, Science, Environment, Technology, and Society) has the potential to enhance students' understanding of science concepts while also helping to preserve the traditional brown sugar production culture in the community. This method helps students better understand the relationship between science and local culture. They also learn about the importance of preserving local wisdom as part of the national identity. This addition emphasizes the application of Ethno-ISETS that supports the preservation of local and academic culture.

4. Conclusion

The study results show that science learning through the Ethno-ISETS approach helps students understand science, especially in local contexts such as the traditional process of making brown sugar. This method not only enhances students' understanding of scientific concepts but also connects scientific knowledge with local culture, making learning more contextual and relevant. Furthermore, incorporating Islamic values into the learning process provides a strong moral and ethical aspect. The Ethno-ISETS approach also enhances 21st-century skills such as critical thinking, collaboration, and problem-solving. However, continue to respect local knowledge and cultural diversity.

Conflict of interest

The author declares that they have no conflict of interest.

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References

Atabey, N., & Topçu, M. S. (2021). The Relationship between Turkish Middle School Students' 21st Century Skills and STEM Career Interest: Gender Effect. *Journal of Education in Science Environment and Health*, *7*(2), 86-103. https://doi.org/10.21891/jeseh.739586.

Ayu, I. P. (2023). Pengembangan Etnovlog Multilungual Pembuatan Gula Jawa Sebagai Sumber Belajar IPA Pada Materi Klasifikasi Materi Dan Perubahannya (Doctoral dissertation, IAIN KUDUS). http://repository.iainkudus.ac.id/10372/

Azizah, N., & Astuti, B. (2020). Pengembangan bahan ajar fisika berbasis I-SETS (Islamic, Science, Environment, Technology, Society) terkomplementasi kearifan lokal dan muatan karakter. *UPEJ Unnes Physics Education Journal*, *9*(2), 164-177. https://doi.org/10.15294/upej.v9i2.41924

Berliana, M. B. (2024). Pengaruh Metode Pembelajaran Outdoor Learning Terhadap Kemampuan Berpikir Kreatif Peserta Didik Pada Mata Pelajaran Ipa Kelas V Madrasah Ibtidaiyah Negeri 1 Tanggamus (Doctoral dissertation, UIN Raden Intan Lampung). http://repository.radenintan.ac.id/35299/

Fadhillah, N., Surbakti, C., Lubis, M. F., & Juwita, N. A. (2023). Training and Hedonic Survey Test of Lemon Candy Using Natural Sweetener from Sugarcane Water as an Odors. *ABDIMAS TALENTA: Jurnal Pengabdian Kepada Masyarakat*, *8*(2), 957-961. https://doi.org/10.32734/abdimastalenta.v8i2.10841

Fatmawati, R., & Rozin, M. (2018). Peningkatan minat belajar siswa dengan menggunakan metode ceramah interaktif. *Journal Focus Action of Research Mathematic (Factor M)*, *1*(1), 43-56. https://doi.org/10.30762/factor_m.v1i1.963

Fawaida, U., Sudarmin, S., Saptono, S., & Ridlo, S. (2023, June). Analisis Ethno-ISETS Pada Pembuatan Gula Merah. In *Prosiding Seminar Nasional Pascasarjana* (Vol. 6, No. 1, pp. 858-863). https://proceeding.unnes.ac.id/snpasca/article/view/2230

Fazrina, H. N., Hidayat, O. S., & Hasanah, U. (2023). Pengaruh Pendekatan I-SETS (Islamic-Science, Environment, Technology, Society) terhadap Hasil Belajar IPA Siswa Sekolah Dasar. *Jurnal Basicedu*, *7*(2), 1348-1355. https://doi.org/10.31004/basicedu.v7i2.5130

Firdaus, F. Z., Suryanti, S., & Azizah, U. (2020). Pengembangan multimedia interaktif berbasis pendekatan sets untuk meningkatkan kemampuan berpikir kritis siswa sekolah dasar. *Jurnal Basicedu*, *4*(3), 681-689. https://doi.org/10.31004/basicedu.v4i3.417

Fitrianto, A., & Hudi, L. (2021). Effect of Post-Cutting Sugarcane and Sucrose Concentrationon Characteristic Jelly Drink. *Journal of Tropical Food and Agroindustrial Technology*, *2*(01), 22-27. https://doi.org/10.21070/jtfat.v2i01.1579

Jufrida, J., Basuki, F. R., & Destinanda, A. (2020). Analisis dan integrasi kearifan local Lubuk Larangan Tantang Sakti dalam pembelajaran sains. *Edufisika: Jurnal Pendidikan Fisika*, *5*(01), 32-38. https://mail.online-journal.unja.ac.id/EDP/article/view/9583

Laili, M. N., & Sufaidah, S. (2022). Pendeteksi Asap Berbasis Internet of Things. *Exact Papers in Compilation (EPiC)*, *4*(4), 623-628. https://doi.org/10.32764/epic.v4i4.816

Muchlisyiyah, J., Laeliocattleya, R. A., & Putri, W. D. R. (2017). *Kimia Fisik Pangan*. Universitas Brawijaya Press.

Mukti, H., Suastra, I. W., & Aryana, I. B. P. (2022). Integrasi Etnosains dalam pembelajaran IPA. *JPGI (Jurnal Penelit. Guru Indones., vol. 7, no. 2, pp. 356–362*. http://dx.doi.org/10.29210/022525jpgi0005

Pandu, M., & Wibowo. (2023). Optimasi Parameter Mesin Hammer-Disc Mill Untuk Produksi Tepung Glukomanan Menggunakan Metode Taguchi. http://digilib.unila.ac.id/74507/

Pasaribu, M. (2022). Produksi Biobriket dari Limbah Ampas Tebu Industri Gula dengan Metode Pirolisis. *Journal of Agro-Industry Engineering Research*, *1*(2), 7-10. https://doi.org/10.61844/jaier.v1i2.351

Rohmatin, F., & Wahiddatur, W. (2019). Produksi Gula Merah Kelapadi Desa Purbosari Kecamatan Seluma Barat Kabupaten Seluma Ditinjau Dari Ekonomi Islam (Doctoral dissertation, IAIN BENGKULU). http://repository.iainbengkulu.ac.id/3508/

Saputri, A. N., & Desstya, A. (2023). Implementasi Pembelajaran IPA Sekolah Dasar Berbasis Kearifan Lokal di Kabupaten Sragen. *ELSE (Elementary School Education Journal): Jurnal Pendidikan dan Pembelajaran Sekolah Dasar*, *7*(2), 154-165. https://doi.org/10.30651/else.v7i2.18280

Seerangan. C. & Venkataravi. R. (2023). Integrating Traditional Knowledge With Modern Education In The Kolli Hills. International Journal of Business and Administration Research Review. Vol.10 (2), 46-58. https://www.researchgate.net/profile/C-Seerangan/publication/382361851_INTEGRATING_TRADITIONAL_KNOWLEDGE_WITH_MODERN_EDUCATION_IN_THE_KOLLI_HILLS/links/6699ba974a172d2988ad3b41/INTEGRATING-TRADITIONAL-KNOWLEDGE-WITH-MODERN-EDUCATION-IN-THE-KOLLI-HILLS.pdf

Sugiharti, R. E., & Sukowati, T. Z. (2020). Pendekatan Science Environment Technology Society (Sets) Sebagai Alternatif Dalam Meningkatkan Hasil Belajar Ipa Pada Materi Cahaya Di Sekolah Dasar. *Pedagogik: Jurnal Pendidikan Guru Sekolah Dasar*, *8*(2), 10-15. https://garuda.kemdikbud.go.id/documents/detail/2979005

Suranto, A. S. A. (2011). *Terapi Enzim*. Penebar PLUS+.

Syamsudin, S. (2020). Problem Based Learning dalam mengembangkan kemampuan berpikir kritis dan keterampilan sosial. *ELSE (Elementary School Education Journal): Jurnal Pendidikan dan Pembelajaran Sekolah Dasar*, *4*(2), 81-99. https://doi.org/10.30651/else.v4i2.4610

Wahyuni, A. I., Astuti, B., & Yulianti, D. (2017). Bahan ajar fisika berbasis I-SETS (islamic, science, environment, technology, society) terintegrasi karakter. *UPEJ Unnes Physics Education Journal*, *6*(3), 17-25. https://doi.org/10.15294/upej.v6i3.19309

Wibowo, A. (2016). Perancangan sistem pembangkit kogenerasi pada pabrik gula kapasitas 4.000 tcd, studi kasus revitalisasi pabrik gula modjo sragen. *Jurnal Teknik Mesin Indonesia*, *11*(2), 98-103. https://doi.org/10.36289/jtmi.v11i2.61

Xu, S. R., & Zhou, S. N. (2022). the Effect of Students' Attitude Towards Science, Technology, Engineering, and Mathematics on 21St Century Learning Skills: a Structural Equation Model. Journal of Baltic Science Education, 21(4), 706–719. https://eric.ed.gov/?id=EJ1363782.