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Quality Analysis of Rubber Seed Shell Briquettes mixed with Goat Manure and Their Utilization to Construction Science Worksheet Integrated Shared Model on Environmentally Friendly Technology Materials

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Abstract. This study aims to make and test the quality of rubber seed shell briquettes with a mixture of goat manure and utilize the results to construct worksheet that can be used to support integrated science learning shared models on Environmentally Friendly Technology materials. This research method is an experiment in making and analyzing rubber seed shell briquettes mixed with goat manure and utilizing the results to construct worksheet. Data collection techniques are experiments, documentation and literature studies. Data analysis techniques in the following research are quantitative analysis techniques and qualitative analysis. The experimental group was divided into three groups, namely: A1 with a composition of 87% charcoal: 13% adhesive, A2 with a composition of 77% charcoal: 23% adhesive, and A3 with a composition of 97% charcoal: 3% adhesive. The percentage of charcoal is 50% rubber seed shell charcoal and 50% goat manure charcoal. Conclusion: The briquette test showed a ratio of 97% charcoal and 3% adhesive showed the best results with a calorific amount of 6287 kcal/kg. The context of briquettes can be used as science learning materials in the form of worksheet on environmentally friendly technology materials.

Keywords: briquettes, waste, rubber seed shell, goat manure, shared model, LKPD

1. Introduction

Fossil fuels and energy needs today continue to increase [1]. This results in a limited amount of usable fuel. Furthermore, humans are looking for and developing new energy sources that can be used continuously, are widely available in nature and are environmentally friendly. In this case, alternative energy can be a solution to these problems. Because of its very fertile area for agriculture and animal husbandry, Indonesia has the potential to become the world's bioenergy granary. It can be used as biobriquette raw material. Renewable energy has great potential to replace petroleum energy, especially through the utilization of animal waste, markets, and agriculture. The use of agricultural and livestock waste is a fairly good solution in overcoming rising prices and fuel shortages [2].

Alternative energy is renewable energy sourced through nature. An example of such energy is biomass. Biomass is organic matter created in the form of products or waste through the process of photosynthesis [3]. Biomass is the entire biological material sourced through flora and fauna that have economic value, such as agricultural waste, bagasse, and durian skin. One type of agricultural waste that has the opportunity to be used as fuel is rubber waste. In Indonesia, rubber is a popular plantation product. Indonesia's rubber plantation area is approximately 3.6 million hectares, with 20% state-owned or private and 80% in cities. Rubber helped increase the country's foreign exchange [4]. Abundant rubber

seed waste can be utilized into renewable alternative energy. According to [1], the use of biomass as a raw material for briquettes is environmentally friendly and does not contain medical hazards.

The characteristics of natural materials that can be used as briquette charcoal are materials that contain a lot of fiber, one of which is rubber seed shells. Fiber typically contains 5–20% lignin, 20% moisture content, and 60–80% cellulose [1]. It is hoped that this rubber seed shell can be an alternative renewable energy source from rubber waste. According to [5], because rubber seed shell charcoal has the highest combustion rate of 2.12 g per minute at a mass of 30 g and has a calorific value of 332.4 kJ, rubber seed shell charcoal can be used as an alternative fuel sourced from waste.

According to in [6] his research, charcoal briquettes were obtained in the treatment of 75% rubber seed shells and 25% senggani stems, 50% rubber seed shells and 50% senggani stems and 25% rubber seed shells and 75% senggani stems had calorific values of 6123 kcal/kg, 6055 kcal/kg and 5531 kcal/kg respectively, and the best calorific results of 6123 kcal/kg. Seeing this phenomenon, research was conducted on the use of rubber seed shell waste with various other types of materials, such as goat manure to make charcoal briquettes. These briquettes are processed with various material compositions, including tapioca adhesive composition, so it is expected to produce the best quality.

Goat manure or livestock waste, can be processed into biogas and briquettes. The use of livestock waste in becoming fuel is considered so effective to reduce environmental damage caused by waste. As biomass, it is reported that goat manure contains a fairly high energy of 4071.72 kcal/kg and contains a high percentage of *volatile matter* , which is 57.32% so that it has the potential to be used as briquettes [7]. Both biomass materials can be optimized through processing into more practical products such as briquettes.

Briquette alternative fuels are made from solid organic materials that look like charcoal and have a higher density [8]. Briquettes have a great opportunity to be developed into alternative fuels because the manufacturing process and raw materials are easily available. The calorific value of briquettes is one of the standards that indicate the quality of briquettes. The calorific value of briquettes is assessed through the use of *a bomb calorimeter*. To make charcoal briquettes, adhesives can be added to make them stronger and denser, improve compaction, and make storage easier. As briquettes become denser, they can be stacked when stored [9]. Tapioca flour has a calorific value that is in accordance with SNI standards, so it is often used as an adhesive.

The purpose of waste treatment is very supportive to be applied in the field of education to improve the ability of learners to be more creative, innovative, and affective. This certainly requires skill efforts in presenting learning [10]. One of the subjects that applies the context of environmentally friendly technology is the Science subject. The 2013 curriculum for science in junior high school has seen a number of changes such as the concept of learning into integrative science subjects or Integrated Science [11]. In general, integrated science is limited to natural phenomena that can be observed and cannot be observed by the five senses. It is a science that includes a systematic set of theories from the fields of chemistry, biology, and physics. Therefore, variety of learning models is required. These variations should allow students to observe and prove what they know based on facts. According to [12], with the lack of availability of integrated teaching materials in schools, teachers should have the ability to adapt their own teaching materials to the needs and characteristics of students. The use of these briquettes can support the application in the field of education, namely in the Integrated Science learning shared model. The *shared model* is a combination of two subjects that complement each other and emphasize concepts, skills, and attitudes that are interrelated and covered in the theme [13]. The use of the following briquette context can support the shared model of Integrated Science learning because there are overlapping relationships between the concepts of biology, chemistry and physics.

Judging from several relevant studies, there is no shared learning model that discusses the concept of briquettes. To maximize the use of rubber seed shells and goat manure as briquettes, the two ingredients are then mixed into various compositions. Briquettes are formed with different charcoal and adhesive compositions because they affect the characteristics of briquettes. The purpose of this study is to create and analyze the quality of briquettes and their use to construct an Integrated IPA WORKSHEET shared model on environmentally friendly technology materials.

2. Method

The following research uses experimental methods in making and analyzing rubber seed shell briquettes mixed with goat manure, and utilizing the results to construct worksheet in Shared Model Integrated Science learning. Data collection is carried out through measurement, documentation, and literature studies. Data analysis techniques in the following research use quantitative and qualitative analysis techniques. The mechanism for making briquettes is:

a. Tools and Materials
   The equipment used in making briquettes is a manual authoring machine, manual smoothing machine, mixing machine, manual printing machine, scales, knives, and trays. While the materials used are rubber seed shells, goat manure and tapioca flour as adhesives.
b. Cultivation, Authoring, and refinement.
   The first process is to find raw materials for making briquettes (rubber seed shells and goat manure), then after enough material is dried in direct sunlight for 2 days until the water content shrinks. After drying, the next step is authoring, the material is put into a closed container. Authoring is carried out for about an hour until the material becomes charcoal. After going through the cooling process, the charcoal is then mashed. At the grinding stage, it can be run through a fine crushing process and then the charcoal powder is sifted until smooth using a sieve.
c. Mixing raw materials
   The fine charcoal is then weighed according to the sample to be made 3 types of briquette samples with different compositions, namely composition A1 with a composition of 87% charcoal: 13% adhesive, A2 with a composition of 77% charcoal: 23% adhesive, and A3 with a composition of 97% charcoal: 3% adhesive. Each sample was made with 200 g of charcoal and 30 g of adhesive. The percentage of charcoal is 50% rubber seed shell charcoal and 50% goat manure charcoal. After the charcoal and adhesive are weighed, then dissolve each concentration of tapioca flour in 200ml of water and then boil until thick. Next, mix together the sample until a homogeneous mass is formed between the adhesive, rubber seed shell charcoal powder, and goat manure charcoal.
d. Briquette Printing
   After the charcoal and adhesive are thoroughly mixed, then the briquettes are printed manually using a mold while pressing until hard. The formed rubber seed shell briquettes are mixed with goat manure and proceed to the next stage, which is drying. Dry in the sun for about 3 days while drying it. Briquettes are ready for use. The steps for making briquettes can be seen in figure 1.

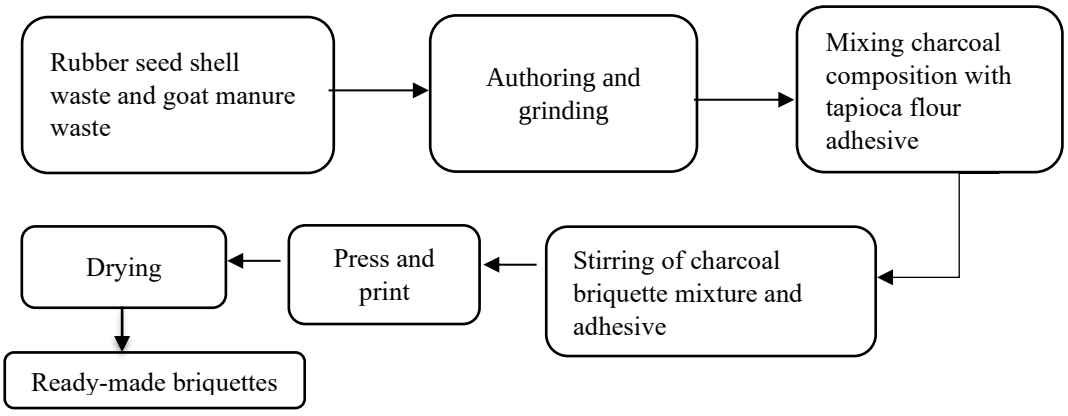


Figure 1. Briquette manufacturing Step chart.

The variables measured in the following research are composed of: water content value, ash content and calorific value, including:

1. Water content, expressed as percent and calculated using ASTM standards D-3173-17a where the equation is:

$$\text{Up to air (\%) . } 100\% = \frac{A-B}{A} \quad (1)$$

   Where A as mass of sample before drying (kg), B as mass of sample after drying (kg).

2. Ash rate is a mineral found in dense fuel which is a substance that does not burn after the burning stage. Ash rate can be calculated using the standard ASTM D 3174-12 (2018) e1 with the equation:

$$\text{Up to abu (\%)} = \frac{B}{A} . 100\% \quad (2)$$

where A as mass of sample before heating (kg), B as mass of sample after heating (kg).

3. Calorific value, the measurement of calorimeter value is carried out through the use of *Bomb calorimeter* [14]. The calorific value is calculated using the ASTM D 5865-19 standard with the equation:

$$Q = m.c.\Delta T \quad (3)$$

where Q as Kalor (J), m as Mass (kg), c as Specific heat capacity (J/kg℃), ΔT as temperature change (℃).

Analysis data related to briquettes can be used as learning material. Learning materials are made by looking at and analyzing science material in the 2013 curriculum for junior high school students, because the Merdeka learning curriculum requires students not only to learn concepts but there are things that students can make (skills) so that the models that are approached are *Problem Based Learning* and *Project Based Learning.* The problem is the problem of alternative energy, in this case the alternative is to use briquettes. Furthermore, the project demands by making briquette products. So the learning material developed is WORKSHEET to support the learning of environmentally friendly technology. The material studied will be mapped according to the related basic competencies.

3. Results and Discussion

This study aims to make and test the quality of rubber seed shell briquettes mixed with goat manure and utilize the results to construct worksheet on environmentally friendly technology materials. In its implementation, there are still research limitations. Limitations in this study such as the traditional briquette manufacturing mechanism and other limitations are different adhesive compositions based on previous research and a mixture of briquette materials only waste materials and adhesives.

Briquettes are solid fuels as an alternative energy source that can provide solutions to the high demand and depletion of fossil fuels. Charcoal briquettes made from agricultural waste and livestock waste. Making briquette charcoal requires an adhesive in the form of tapioca flour. The results of briquettes that have been made can be observed in Figure 2.

(a) (b) (c)

Figure 2. A1 briquette samples of 87% charcoal composition and 13% adhesive (a), 77% and 23% adhesive charcoal composition briquette samples (b) and 97% and 3% adhesive charcoal composition briquette samples (c).

Table 1. Briquette charcoal burning test results.

Sample Code	Treatment		
	Inherent moisture (%)	Ash content (%)	Kalor (kcal/kg)
A1	9,21	20,53	6036
A2	9,04	20,08	6119
A3	8,63	24,01	6287

Test the quality of charcoal briquettes rubber seed shell mixture of goat manure using 3 types of samples with different compositions, namely composition A1 87% charcoal: 13% adhesive, composition

A2 77% charcoal: 23% adhesive and composition A3 97% charcoal: 3% adhesive. Briquette testing was carried out at PT Sucofindo Bengkulu. Based on the results of the briquette charcoal combustion test, several data were shown in table 1.

a. *Inherent Moisture*

The moisture content contained in briquettes will affect the calorific value. High moisture content creates a smaller calorific value [15]. The results of the moisture content test on briquettes are shown in figure 2.

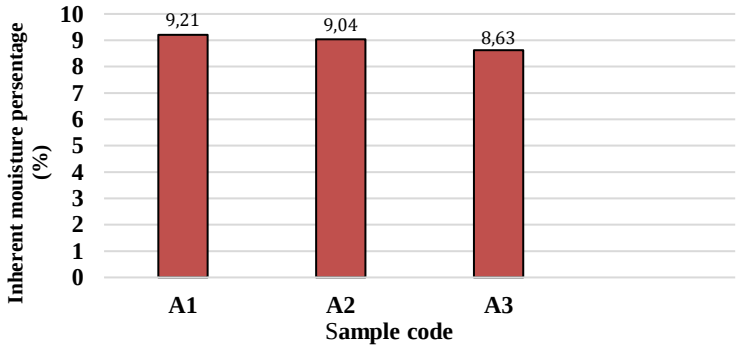


Figure 2. Briquette behavior graphic with water rate.

Figure 2 shows the moisture content value of each briquette treatment. The lowest value can be seen from the composition of the mixture of 97% charcoal and 3% adhesive) which is 8.63% this condition shows that the water content has met the SNI briquette standard, this is in accordance with the statement [15], that the water content that meets the SNI 01-6235-2000 briquette standard is a maximum of 8%. This condition is caused by briquettes that are less dense during the printing process, which causes the evaporated water level to be not fixed. Then, the manual cooling process in open spaces is still influenced by outside air [9]. The other thing is caused by the long drying time of raw materials so that the moisture content in the briquettes is less.

b. *Ash Content*

The part that remains after burning is called ash. The higher the ash content in briquettes, the worse the quality of the briquettes and vice versa. Figure 3 shows the results of measuring briquette ash content.

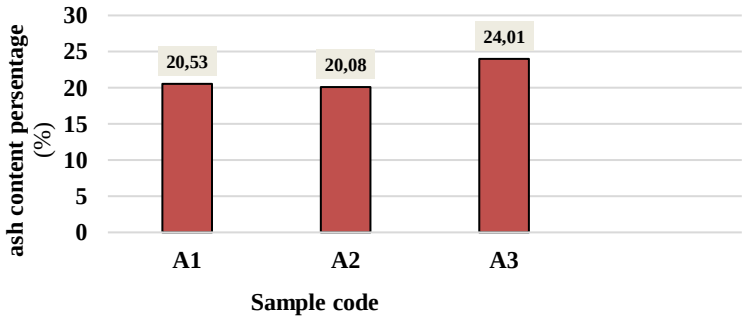


Figure 3. Briquette Behaviour Graphic with Ash content

The ash content of each mixture can be observed in Figure 4 where all mixture compositions, there is the highest ash content value in a mixture of charcoal and adhesive 97% : 3% which is 24.01%, while the lowest ash content value is in the mixture composition of 77% : 23% of 20.08%. Through the ash content obtained in each treatment not according to the SNI 01-6235-2000 briquette standard is up to 8%. The ash content of briquettes rises as the quantity of charcoal increases [16]. When the pyrolysis stage occurs, the mass of water and other volatile substances escapes or evaporates, resulting in a

reduced overall mass of the material. Conversely, the mass of raw materials does not decrease, so the ash content, that is, the ratio of ash mass to the mass of raw materials increases. Other factors may be due to the presence of particles or other materials that enter the authorship.

c. *Calorific Value*

Calorific value greatly affects the quality of briquettes; The calorific value is influenced by the moisture content and ash of briquettes, the higher the moisture content and ash of briquettes, the lower the calorific value produced. The results of calorific value testing on briquettes are shown in figure 4.

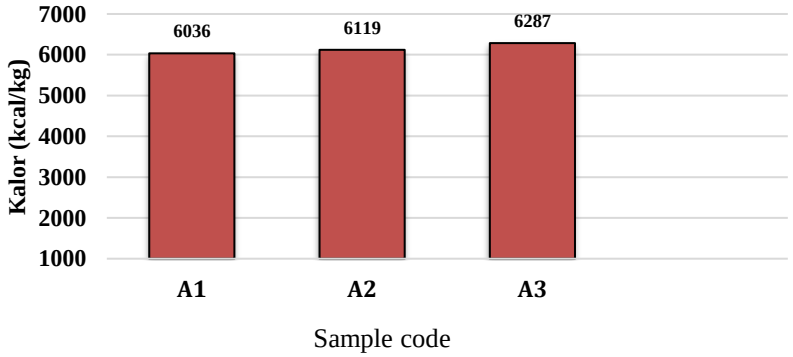


Figure 4. Briquette Treatment Graph with Calorific Value

Through the test results that have been carried out, heat results were obtained with A3 samples with a ratio of 93% charcoal: 3% adhesive has a higher calorific value of 6287 kcal/ kg**.** The standard calorific value of SNI 01-6235-2000 is >5000 kcal/kg [17], it also proves that the basic material of rubber seed shells has a good chance to be developed into briquettes. Rubber seed shell briquettes mixed with goat manure produce a very high calorific value, therefore rubber seed shell briquettes mixed with goat manure can be used as good fuel.

The calorific value obtained is influenced by the water content and ash content. Briquettes with lower moisture and ash content are of higher quality, which is indicated by the increased calorific value produced from them [8]. Judging from the test results, the water content and ash content and calorific value have not been balanced. In the A3 sample with a ratio of 97% charcoal and 3% adhesive, the lowest moisture content and the highest calorific value were obtained but the ash content value was high. However, rubber seed shell briquettes mixed with goat manure produce a very high calorific value, therefore rubber seed shell briquettes mixed with goat manure can be used as fuel.

3.1. *Integrated Science learning model Shared Model*

The shared type of integrated learning model is known as the sharing model, which is a combination or combination between two subjects that complement each other. In both teaching and planning, this model puts a focus on concepts, abilities, and attitudes [18]. One of the advantages of an integrated science learning model is that it shows that science fields are integrated in terms of concepts, skills, attitudes, and more contextual learning materials. Using the integrated science model sharing model, science teaching materials (chemistry, physics, biology, and IPBA) are created by combining two science disciplines [13]. The chart of the shared learning model can be seen in figure 5.

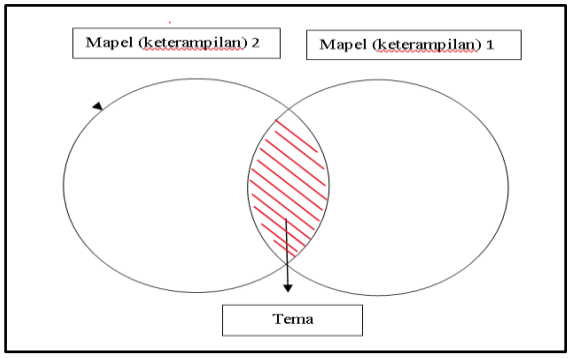


Figure 5. Shared model integrated learning design.

Figure 5 is the design of the Shared integrated learning model. The characteristic of the following model is that two subjects (competencies) that have similarities with three aspects can be combined and combine each other in terms of the concept of learning material.

3.2. *Utilization of Briquette Test Results as Learning Material for Integrated Science Shared Model*
The results of the briquette quality test can be packaged into integrated science learning materials by adjusting several basic competencies (KD) in the independent curriculum. Curriculum merdeka is an educational policy that aims to give freedom to teachers and adapt it to the needs of students and the local context. The merdeka curriculum encourages more relevant and contextual learning Material analysis and KD based on the merdeka curriculum syllabus in science lessons grades VII, VIII and IX. Based on the results of the syllabus analysis related to the context material, rubber seed shell briquettes, a mixture of goat manure (CBK-KB) can be integrated into class VII science material, energy material and its changes, and class IX science environmentally friendly technology material. The results of KD analysis based on the merdeka curriculum related to the briquette concept are shown in table 2.

Table 2. Analysis of KD and science materials based on an merdeka curriculum on the principles and concepts of CBK-KB briquettes.

Class	Basic Competency (KD)		Materi IPA	Briquette Concept Analysis
VII	3.5	Analyze the concept of energy, various energy sources and changes in energy forms in everyday life.	1. Energy sources 2. Changes in the form of energy	1.1 CBK-KB briquettes include renewable energy sources. 1.2 Changes in the energy form of CBK-KB briquettes
	4.5	Displays the results of experiments regarding energy changes, including briquettes		
IX	3.10	Analyze environmentally friendly technology processes and products for sustainable living.	1. The principle of environmentally friendly technology. 2. Eco-friendly technology products in the energy sector.	1.1 CBK-KB briquettes apply the principle of environmental conservation. 1.2 CBK-KB briquettes facilitate human needs. 1.3 CBK-KB briquettes are environmentally friendly technology products.
	4.10	Featuring works on simple technological processes and products that are environmentally friendly		

The result data and several procedures that have been carried out are designed as integrated science learning materials. The analysis of the material obtained will be mapped according to the related basic competencies. Shared model integrated learning proposed by Robin Fogarty, the following model

directs teachers to learning activities using two subjects combined into one. Two different science materials classes for example Energy materials and environmentally friendly technology have overlapping concepts, skills and attitudes that produce one theme, namely briquettes. The emerging theme will add insight to students to think broadly because they can relate two subjects. This is in the context of briquettes, briquettes are an example of renewable energy and also as an environmentally friendly technology product in the energy sector. An overview of integrated science learning, shared models, energy concepts and their changes, and environmentally friendly technologies can be seen in figure 6.

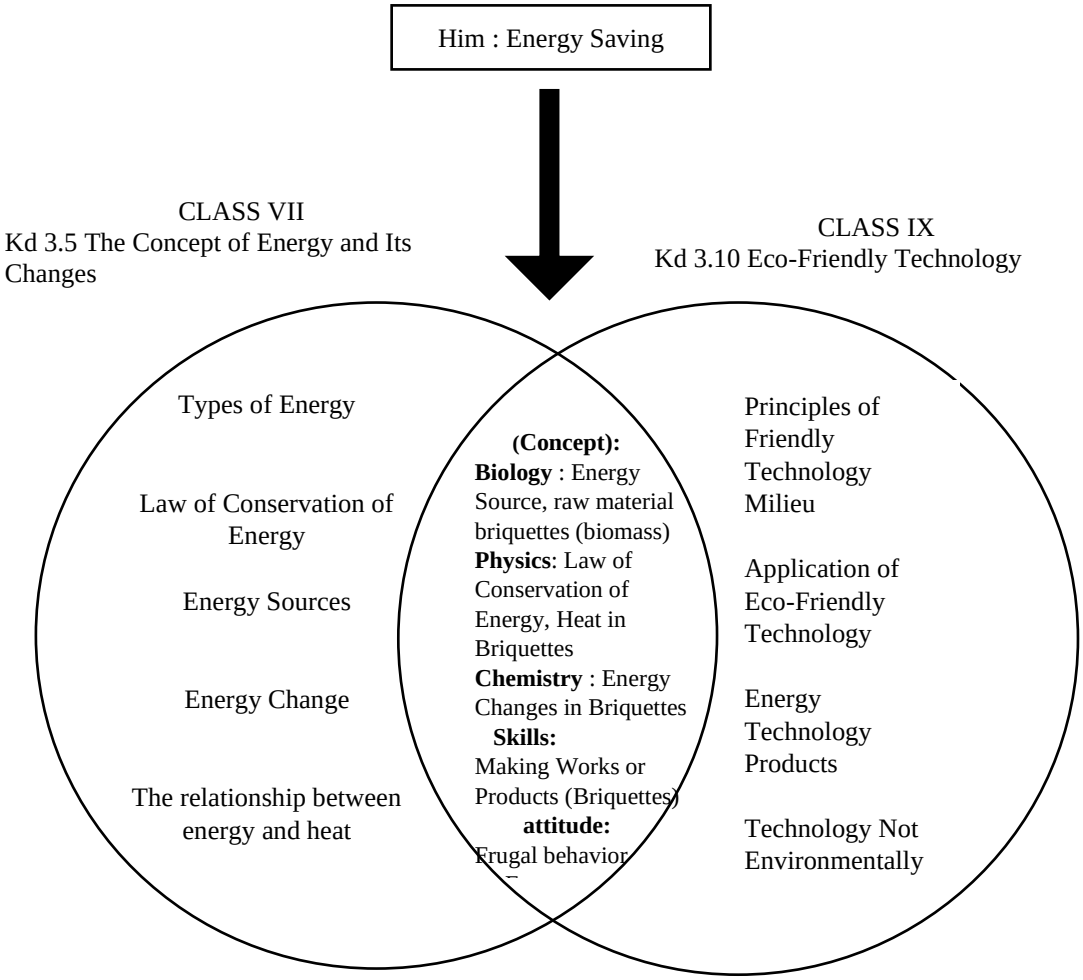


Figure 6. Shared model unified learning chart.

In Figure 6, the learning theme used in this study is energy-saving behavior. This research studies the concept of energy and its changes, as well as environmentally friendly technologies and energy-saving behavior (attitude concept). Any action that lowers costs for various uses of energy-consuming appliances is referred to as energy-efficient behavior. Actions such as reducing use, carrying out maintenance of equipment that uses energy, using alternative energy, or buying more environmentally friendly products [19].

The concept of briquettes is in accordance with the concept of class VII science, namely in KD 3.5 analyze the concept of energy, various sources of energy and changes in energy in everyday life. In this material, the context of briquettes is an example of renewable energy, which is renewable energy and its stock will not run out. Furthermore, the briquette concept also contains the concept of class IX science, namely environmentally friendly technology material in KD 3.10 analyzing environmentally friendly technology processes and products for sustainable life. This material contains environmentally

friendly technology principles and products that are in accordance with the briquette concept. Researchers chose the material because of the overlapping concepts of matter, namely the concepts of biology, chemistry and physics.

The concept of biology is in the form of a definition of environmentally friendly technology, principles of environmentally friendly technology, various energy sources and materials used in making briquettes. Briquettes are biologically made from biomass raw materials, namely rubber seed shells and goat manure. Biomass is all biological material derived from plants or animals that can be used as fuel or substitute for fossil-based products and materials [20].

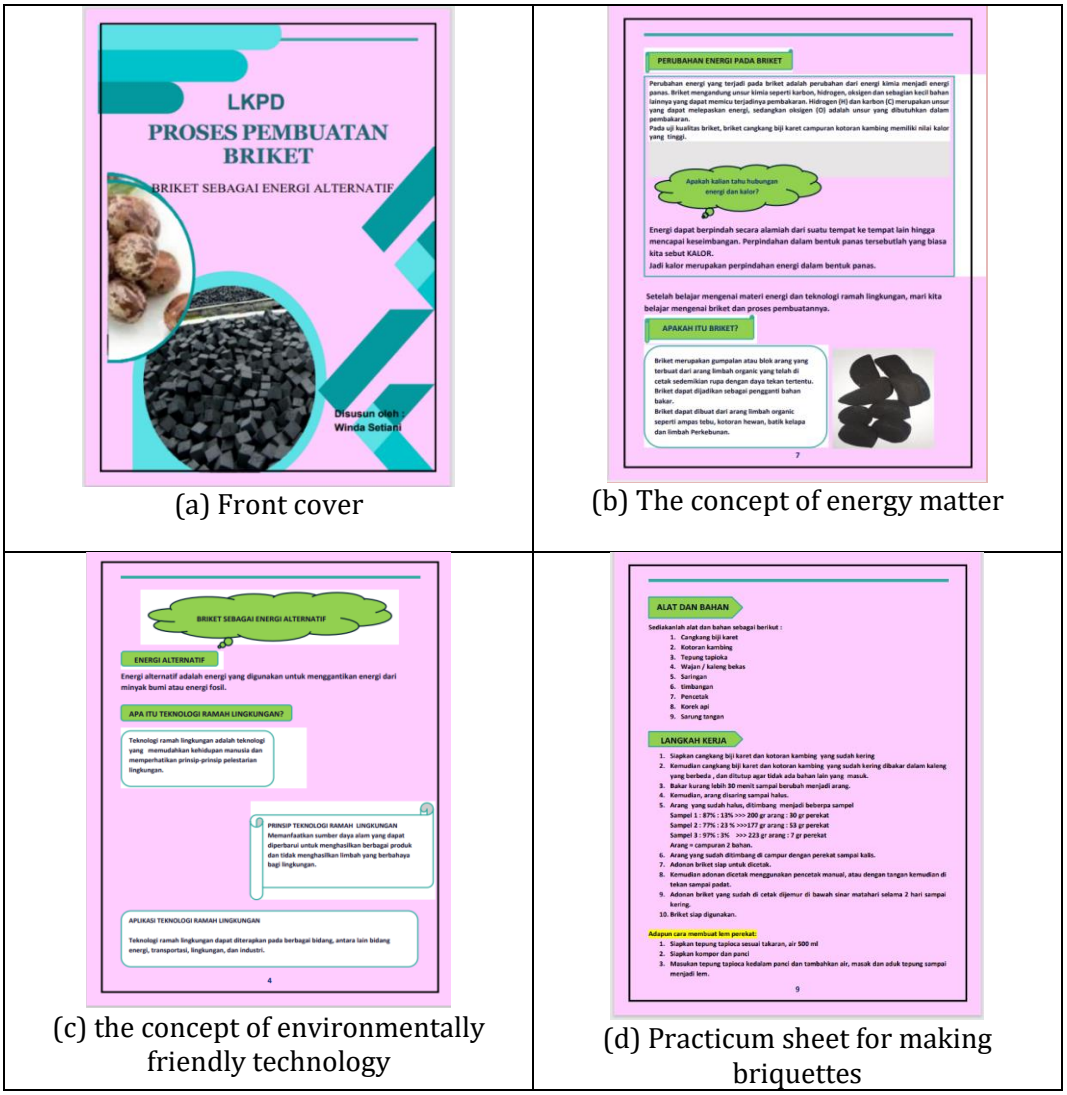
Physical concepts in the form of briquette quality test results, such as moisture content value, ash content and calorific value and the law of conservation of energy. Briquettes can physically produce heat as evidenced by some briquette testing data in Table 1. Heat is thermal energy and is a form of energy [21]. The physics concept of briquettes is also the law of conservation of energy, which states that energy cannot be destroyed but can be transformed into other forms. It is that briquettes are an example of renewable energy created for the benefit of energy. In heat testing there is a special device called *the bomb calorimeter,* which is used to measure temperature in this case in briquette testing.

The chemical concept is in the form of energy changes in briquettes, namely briquettes are changes in the form of chemical energy into thermal energy. Briquettes consist of chemical elements such as carbon, hydrogen, oxygen, and a small part of other materials that can trigger combustion. The elements that can release energy are carbon (C) and hydrogen (H), while the element needed for combustion is oxygen (O). Briquettes have a process of chemical energy change, namely dehydration and carbonization. The carbonization process occurs when composing rubber seed shell waste and goat manure, while dehydration occurs during the drying or drying process of raw materials. Furthermore, also in the briquettes there is a relationship of energy and heat. Energy can move naturally from one place to another until it reaches equilibrium. The transfer in the form of heat is what we usually call heat. So heat is the transfer of energy in the form of heat.

The skill aspect in environmentally friendly technology materials is related to the concept of briquettes, namely briquettes are environmentally friendly technology products in the form of energy. In this aspect of skills, students can experiment by presenting or making simple technology products (practicum) that are environmentally friendly, for example briquettes, rubber seed shells and goat manure as alternative energy to replace fuel. This is in accordance with the demands of the Merdeka Belajar curriculum, namely learning not only focuses on concepts (material) but there are also things that students can make or do. So that not only *Problem Based Learning* but also the demands of *Project Based Learning* are products in the form of briquettes and worksheet as learning materials. The use of this briquette context can be used as learning material. The learning materials developed are in the form of WORKSHEET. The design model of learning materials in the form of worksheet can be seen in figure 7.

This learning material is in the form of worksheet Integrated Science Shared Model *environmentally* friendly technology material. In the worksheet design model entitled briquette manufacturing process (briquettes as alternative energy) there are 13 pages arranged in detail by explaining briquettes as energy and environmentally friendly technology. This learning material consists of the initial part in the form of a cover, foreword, basic competencies and learning objectives. Then the next page contains material related to alternative energy, environmentally friendly technology and energy, as well as important information related to briquettes. Then the worksheet contains the work steps for making briquettes and briquette quality test practicum activities and ends with evaluation questions so that students better understand the material taught.

It is hoped that the information contained in this worksheet-shaped learning material can increase students' knowledge on energy materials and their changes and environmentally friendly technology materials. So the concept of briquettes is that briquettes are examples of renewable energy and briquettes are environmentally friendly technology products in the energy sector and can achieve Basic Competence (KD) 3.10, namely analyzing environmentally friendly technology processes and products for sustainable life.



(a) Front cover

(b) The concept of energy matter

(c) the concept of environmentally friendly technology

(d) Practicum sheet for making briquettes

Figure 7. Worksheet briquette design model as a learning material for environmentally friendly technology materials for students.

4. Conclusion

Rubber seed shell briquettes mixed with goat manure produce the best heat test with a ratio of 97% charcoal and 3% adhesive of 6287 kcal/kg, this has met the briquette heat standard of 5000 kcal/ kg. However, the treatment of ash content and moisture content values has not met SNI standards. The use of the briquette context can be used as an integrated science learning material Shared Model that combines class VII material the concept of energy and its changes and class IX science material the concept of environmentally friendly technology, becoming worksheet. Suggestions in making briquettes further to pay attention to the materials and equipment, as well as steps in burning and making charcoal flour so that no other ingredients enter the process of making briquettes so that the briquettes are more precise. And designs can be developed for other integrated IPA models such as *connected, sequenced* and other models.

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