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# Development of outdoor Science Activity of Biomass Briquette Making as Supplementary Activity in Teaching Heat Transfer

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## ABSTRACT

*The study aimed to develop an inquiry-based lesson plan integrating biomass briquette making as a supplementary activity for teaching heat transfer and related thermodynamic concepts. This aims to enhance Grade 7 learners' academic performance and understanding of students in physics, particularly the concepts of thermodynamics. The participants of the study were 10 (ten) in-service science teachers and 3 (three) graduate students majoring in physics education, selected purposively. This study employed a Research and Development (R&D) design and utilized a quantitative method with qualitative support in developing the 7E lesson plan. Quantitative data was obtained from the panel of evaluators' ratings on the developed lesson using the Likert scale and the rubric. Aiken's V Coefficient was used to assess the content validity of the lesson plan. Qualitative data was obtained through in-depth analysis of the evaluators' comments and suggestions on the developed lesson. The inquiry lesson was enhanced based on the comments and suggestions from evaluators, to ensure that the lesson was aligned with the DepEd learning competencies. The developed inquiry lesson received a "Valid" rating from the 10 In-service Science teachers and 3 graduate students in Physics Education. The positive rating from the evaluators indicates that the lesson with biomass briquette integration has the potential to enhance the Grade 7 academic performance, particularly in comprehending challenging abstract physics concepts such as heat transfer and related thermodynamics concepts. Therefore, this study recommends using inquiry lessons and measuring student learning through pretest-posttest to evaluate their understanding of the topic of heat transfer. Furthermore, explores the long-term impact of the inquiry lesson on learners' behaviors toward physics and their ability to apply the concepts of thermodynamics in different situations.*

**Keywords**: Biomass, Briquette, Heat transfer, Student performance.

## 1. INTRODUCTION

Thermodynamics is a branch of physics that examines temperature, heat, and the way they interact with work and energy. The application of this topic significantly impacts the universe, from the power plants that provide electricity to the refrigerators that preserve our foods to maintain their freshness. Due to its significant uses in our lives, its concepts and principles must be thoroughly understood. Yet, thermodynamics is frequently perceived as a difficult topic for learners globally due to many obstacles that hinder the learning process. Teaching and learning heat can be difficult because it is an abstract concept. Students frequently fail to visualize and comprehend how energy moves without seeing it. Furthermore, the complex connections between heat, temperature, and other physical properties can be challenging to grasp. Camarao and Nava (2017) revealed that students had trouble understanding topics such as thermodynamics, optics, mechanics, and electromagnetism. Numerous studies (Gurcay & Gulbas, 2015; Fenditasari et. al, 2020; Suliyanah et.al, 2018) identified the students' misconceptions about heat and temperature concepts. In addition, Sozbilir (2003) shows that these topics are undoubtedly among the most challenging concepts in the secondary science curriculum. Auditor and Naval (2014) developed and validated physics modules based on the least learned competencies among Grade 10 learners; this includes heat and thermodynamics. Most students have difficulties mastering the concepts of thermodynamics (Mercado, 2020). The traditional "chalk and talk" teaching methods will not give learners the real-world experience, that is necessary to comprehensively understand the topic (LoPresto & Slater, 2016); It may lack precision and it is hardly consistent with modern ideas for science education (Leite, 1999). This approach frequently leads to student inattentiveness and inadequate knowledge retention, which ultimately undermines academic performance (Yap, 2016). The poor performance of Filipino students in national and international assessments of science and mathematics has put the quality of education under scrutiny (Imam, 2016). Magsambol (2020) proved that the performance of Filipino students is significantly lower according to a report on global assessment produced by the Trends in International Mathematics and Science Study (TIMSS) in 2019. In addition, the overall ratings for scientific literacy among Filipino students are continuously low as well, which was verified by the results of the Programme for International Student Assessment (PISA) in 2018. According to Nguyen and Khoo (2009), there is a need for additional support in instruction for further explanation with visualization or representations, mainly when there is an abstract concept that learners find difficult to understand. Supplementary activity has emerged as an effective way of addressing these challenges. Integrating activities in the learning process effectively increases students' understanding and academic performance (Netasit and Chanowan, 2017; Racoma, 2022). Supplementary materials improve learning in difficult subjects like physics, making them more accessible for learners (Decoriña, 2022); they can also improve students' grades and success rates in general chemistry and enhance learning and attitude (Salame and Nazir, 2019). In this study, an inquiry-based approach will be utilized to learn heat transfer and related thermodynamic concepts. Several studies show that an inquiry-based approach has positive effects on students' academic achievement, experiences, perceptions, and attitudes. However, despite the aforementioned benefits, the application of this strategy in education has not been widely recognized. Thus, studies are necessary to further establish the relevance and evidence of using an inquiry lesson. This addresses the problem of learning thermodynamics, such as heat transfer. Uniquely, this study aims to develop an inquiry lesson that incorporates biomass briquette making as a supplementary activity in teaching heat transfer.

## 2. METHODS

### 2.1 Research Design

This study employed a Research and Developmental framework with a mixed method of qualitative and quantitative support in developing the 7E lesson plan. The researcher utilized this research design to outline the process of developing the lesson. Quantitative data was obtained from the panel of evaluators' ratings on the developed lesson using the Likert scale and the reliability test for the different research instruments. Qualitative data was obtained through in-depth analysis of the evaluators' comments and suggestions on the developed lesson.

### 2.2 Research Subjects and Participants

The participants of the study, ten (10) in-service science teachers and three (3) graduate students majoring in physics education in Iligan City, were tasked with evaluating the overall content of the 7E lesson plan. They were selected purposely for their expertise in the said topic.

### 2.3 Data Gathering Procedure

Data gathering took place in a public school in Iligan City, involving the selected in-service science teachers and graduate students majoring in physics education. A formal letter requesting permission to conduct the study was submitted to the School Division Superintendent of Iligan City, and also to the school principal/head before data collection commenced. The researcher provided an informed consent form to be signed by the in-service science teachers and the graduate students. Once approved, the researcher discussed the type of study that was performed with the school principal/head and the science teachers. Before this, ethics approval was required by the College of Education, where the study underwent an evaluation by the ethics committee. Data gathering involved the evaluation of the developed lesson and its component outdoor activities and the trial of the activity in terms of its applicability for implementation. At this trial stage, the researcher made a personal exploration of the activity developed to have a personal feel of the activity to be rolled out.

#### 2.3.1 Preparation Phase



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The data collection process followed a well-organized structure, starting with identifying and analyzing the selected topic, and the student's performance in national and international competitions was also considered. To come up with a scientific evaluation, there was a need to identify the MATATAG science curriculum guide with its content and performance standards, and learning materials to align with the lesson objectives. The topic is thermodynamics, particularly on heat transfer. This was selected based on the gaps found in learning these concepts. Auditor and Naval (2014) found that this topic was considered one of the least learned in physics.

### 2.3.2 Design, Development, and Validation of 7E Lesson Plan

Initially, the arrangement of the activities and instructions for the 7E lesson was carefully planned, emphasizing well-structured lessons and effective teaching methods, in alignment with the principles highlighted by Santos & Boyon (2020). Hence, simultaneous validations and modifications by the advisers and the panel members were incorporated to ensure its effectiveness, before it went through the evaluation process. Subsequently, the finalized 7E lesson plan and the pamphlet (detailing the activity's procedure - biomass briquette steps) were distributed to the participants, along with the adapted rubric from Go (2019) to ensure the accuracy of the content. The rubric contained closed-ended questions specifically designed to assess the overall design aspects of the 7E lesson plan, the usefulness of the developed lesson and strategies, and the usability of the pamphlet for the activity. The questions focused on the clarity and alignment of learning objectives within the 7E framework, the activity's flow, and the relevance of the material used. After reviewing the lesson plan and the pamphlet, participants utilized the rating scale and a rubric to evaluate the overall design and content of the lesson. All recommendations from the evaluators, thesis advisers, and panel members were incorporated into the final development of the 7E lesson plan and pamphlet. The researcher made a total of three revisions to refine and enhance the developed 7E lesson along with the pamphlet.

## 3. RESULTS AND DISCUSSIONS

### 3.1 lesson Preparations

Several recent studies emphasize that thermodynamics is frequently perceived as a challenging topic for learners globally due to many obstacles that hinder both teaching and learning processes. For instance, Auditor and Naval (2014) revealed that the topic heat was among the least learned competencies among Grade 10 learners during their development and validation of physics modules. A study by Camarao and Nava (2017); and Mercado (2020) revealed that learners frequently struggle to understand the concepts of thermodynamics due to its abstract nature. The study indicates that students frequently retain misconceptions, including confusion about the difference between heat and temperature, making it difficult to understand the concepts. Furthermore, learners encounter problems in moving from textbook to real-world application, exaggerating their obstacles in this field.

**Table 1 Aligning the 7E Lesson Plan with the DepEd MATATAG Curriculum Guide**

| CONTENT | CONTENT STANDARDS | LEARNING COMPETENCIES |
|---|---|---|
| **Heat transfer** | The learners learn that: | The learners… |
| | • Scientists and engineers conduct innovative research to find solutions to the current global energy crisis by seeking renewable energy solutions. | • Explain the difference between heat and temperature;<br>• Identify advantageous and disadvantageous examples of conduction, convection, and radiation;<br>• Explain in terms of the particle model the processes underlying convection and conduction of heat energy; and<br>• Gather information from secondary sources to identify and describe examples of innovative devices that can be used to transform heat energy into electrical energy. |



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### 3.2 Instructional Materials

**Table 2** *Outline of the 7E Lesson Plan*

| PHASE | ACTIVITY | TIME (in day) | MATERIALS |
|---|---|---|---|
| **Elicit** | (Eliciting the prior knowledge)<br>Questions include:<br>1. While drinking coffee, have you tried heating your palms by holding the mug/cup? Why do you think our hands burn when we touch a hot surface?<br>2. Why do you feel warm when you walk under the sun?<br>3. What can you say about how heat travels from a hot stove to a pot of water on it? | Day 1 | Pictures |
| **Engage** | Demonstration of how to make coffee.<br><br>Watch a 3.46-minute video on how to make a biomass briquette utilizing their local resources. | | Cup, water, two different spoons (plastic & metal) |
| **Explore** | Introduce the first Activity.<br>"Igniting Charcoal Safely"<br>(give some briquettes and let them ignite it) | | Activity Sheet and pen |
| **Explain** | Teacher discussion (mini-lecture)<br>● reviewing heat and temperature (Briefly define heat and temperature, highlighting the differences.)<br>● methods of heat transfer (Explain conduction, convection, and radiation with examples)<br><br>Introducing the concepts of biomass as an alternative energy source.<br>● Define biomass and its role as a renewable energy source<br>● Explain the concept of heat generation from biomass<br><br>Heat output comparison (Explain why they have higher/ lower heat output)<br>● Materials with Higher Heat Output (*Wood twigs and branches, Banana materials, Corn stalks and rice husks, etc.)*<br>● Materials with Lower Heat Output (*Weeds and leaf debris, grasses, etc.)* | Day 2 | PowerPoint Presentation<br><br>Whiteboard<br><br>Markers |
| **Elaborate** | learners make their own biomass briquettes.<br><br>The teacher will give instructions to students about the activity.<br>Distribute the student pamphlet | Days 3-19 | Local biomass, mortal & pestle, starch, gloves, water, strainer, pamphlet with the rubric, and the video |
| | After making the briquettes, students participated in the second activity '**Let's Get Hot**!'. | Day 20 | Aluminum, iron, and steel pots (same size), Water 1000 ml,<br>Thermometer,<br>Developed Biomass briquette,<br>Stopwatch,<br>Matches/Lighter |



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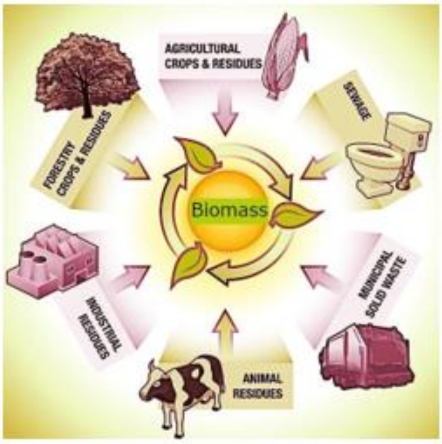
| | | | |
|---|---|---|---|
| **Evaluate** | Written responses to essay questions | Day 21 | Paper and pen |
| **Extend** | Encourage the learners to sell the briquettes (package and market) | | Briquettes (final product) |

### 3.2.1 Developed Pamphlet

BIOMASS BRIQUETTE MAKING: A SUSTAINABLE ENERGY SOURCE

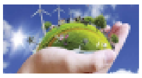
(STUDENT PAMPHLET)




PRACTICAL ACTIVITIES ON HEAT APPLICATION

*(A Guided Inquiry Approach)*

1



Have you ever wondered how we can reduce reliance on fossil fuels and protect our planet? One way is by exploring *alternative energy sources*. Today, we will be scientists and engineers as we create biomass charcoal briquettes. *Biomass briquettes* are a sustainable fuel made from compressed plant waste. By designing and developing these briquettes using locally available materials, we can contribute to a cleaner and greener future.

OBJECTIVE

The students will be able to design and develop biomass briquettes utilizing locally available biomass waste as a potential alternative fuel source.

POSSIBLE RESOURCES

| | | |
|---|---|---|
| Biomass (banana materials, leaf debris, wood twigs, weeds, etc.) | Starch | Water |
| Mortar & pestle | Gloves | Strainer |
| Moulder (Hulmahan) | Container | |

FRIENDLY REMINDER!

"ALWAYS USE YOUR GLOVES"


2

BIOMASS CHARCOAL BRIQUETTE MAKING STEPS

STEP 1: BIOMASS REDUCTION

This involves the collecting, drying, and shredding processes.

(Pagkolekta, ipa-uga sa init, dayon pinuha)

STEP 2: PARTICLE BONDING

Bind the shredded biomass with the binder such as starch or cassava porridge in a suitable container.

(Isagol sa pino nga biomass ang gewgaw o harina o nilugaw na balanghoy)

3

STEP 3: BIOMASS DENSIFICATION/FORMING BRIQUETTES

Shape the biomass-binder mixture into briquettes. Allow the briquettes to dry under the sun.

(Pormaha ug pataas nga hugis ang giusa nga sangkap og ibulad sa adlaw)

STEP 4: BIOMASS CARBONIZATION

It involves placing dried briquettes in a controlled environment, such as a metal drum, and briefly igniting them.

(Ulinga ang nauga nga briquette)

4

STEP 5: PULVERIZING CHARCOAL

It involves crushing: Once cooled, pulverize the charcoal briquettes into fine charcoal powder.

(Himuang pino ang bugnaw nga uling)

STEP 6: SHAPED CHARCOAL

It involves mixing charcoal powder with a binder again, molding it into the desired shape, drying it thoroughly, and storing it in a dry, airtight container to maintain the quality.

(Pormaha ang pino nga uling sa imong gusto nga hugis ug ibulad sa adlaw. Ibutang sa sudlanan nga dili masudlan ug hangin aron mapadayon ang kalidad niini.)

5

RUBRIC FOR EVALUATING STUDENTS' OUTPUT

| CRITERIA | OUTSTANDING (4) | VERY SATISFACTORY (3) | SATISFACTORY (2) | UNSATISFACTORY (1) | SCORE |
|---|---|---|---|---|---|
| Appearance | Briquette looks nice and even. | Briquette seems mostly okay but might have a few bumps. | Briquette looks messy or uneven. | The briquette doesn't look like a briquette at all. | |
| Strength | Briquette is very strong and doesn't break easily. | Briquette is strong but might break a little if you squeeze it hard. | Briquette breaks easily when you touch it. | Briquette falls apart as soon as you make it. | |
| Burning Quality | Briquette burns evenly and doesn't make a lot of smoke. | Briquette burns pretty evenly but might make a little smoke. | Briquette burns unevenly or makes a lot of smoke. | Briquette doesn't burn at all. | |
| Fines Generated | Produces minimal fines during handling and storage. | Produces a moderate amount of fines. | Produces a significant amount of fines. | Produces excessive fines and crumbles easily | |
| Ash Content | Produces minimal ash during combustion. | Produces a moderate amount of ash. | Produces a significant amount of ash. | Turns to ash easily. | |
| Overall Quality | Briquette meets all of the above criteria and is a high-quality product. | Briquette meets most of the criteria and is a good product. | Briquette meets some of the criteria but has significant flaws. | Briquette does not meet any of the criteria and is a poor product. | |

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BIOMASS BRIQUETTE ACTIVITY TIMELINE

| DAY | TASKS |
|---|---|
| 1 | Biomass Collection and Drying |
| 2 | Biomass Shredding |
| 3 | Biomass Sieving |
| 4 | Mixing with Binder and Forming Briquettes |
| 5-13 | Biomass Briquette Drying |
| 14 | Biomass Briquette Carbonization |
| 15 | Pulverizing Charcoal |
| 16 | Mixed again with the binder, Shaped charcoal |
| 17 | Charcoal Drying |

7

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The pamphlet contained the budget of work for the entire duration of activity of the students. Some of the activities were done outside the class period. The pamphlet reflected the results of the trial exploration of the researcher.

### 3.2.2 Validity of the developed lesson plan in terms of lesson presentation, content, and usefulness and strategies.

The developed lesson was subjected to evaluation to establish its soundness in terms of parameters that a good learning material must possess.

#### 3.2.2.1 Lesson presentation

The result of the evaluation from the in-service science teachers and graduate students who were trained for inquiry-based teaching on the lesson presentation of the developed lesson is shown in Table…The result revealed that the lesson presentation was valid with a validity coefficient of 0.93. Under this category, the developed lesson plan demonstrated high validity, particularly in its ability to encourage students' engagement and when it came to its objective as being SMART (Specific, Measurable, Attainable, Reliable, and Time-bounded) with a validity coefficient of 0.97. Within this category's evaluation, providing sufficient student practice received a considerably lower rating with a validity coefficient of 0.87.

It was also shown in the study that the 7E lesson plan had an appropriate assessment activity designed to measure student learning.

The results indicated that the 7E lesson plan was valid as evaluated by the participants. This supported Jonassen's (2011) view that materials should captivate students' attention and interest. Similarly, in line with Lucas & Corpus (2013), it highlights the importance of well-defined and attainable learning objectives for effective instruction.



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#### 3.2.2.2 Content

In this study, it was revealed that the lesson plan's content category demonstrated a remarkably high validity ranging from 0.90-1.00. Under this category, the selection of locally relevant materials, the appropriate use of words for the learners, and the lesson plan's integration of real-life applications attained perfect validity coefficients of 1.00 based on the participants' evaluation, suggesting that the content exceptionally aligns with the target audience and their surroundings. Similarly, the context was appropriate with a validity coefficient of 0.97, indicating a strong alignment with the student's environment. Moreover, the lesson plan's appropriateness of technical term choices received 0.9 of coefficient validity, which was also highly valid.

The participants assessed the lesson plan as valid with an overall validity of 0.97 for the entire evaluation of the content category. This signifies that the lesson plan's content aspect was perceived by evaluators as highly relevant, having adequate and complete topic coverage, which aligns with Romizsowski's (2008) statement that the instructional material's content should be complete.

#### 3.2.2.3 Usefulness and Strategies

Based on the evaluator's ratings, the overall usefulness and strategies of the developed 7E lesson plan were highly valid with a coefficient of 0.92. The study also revealed that the developed lesson was useful to the teacher, including its activities with a validity of 0.90. The evaluators also agreed that the developed lesson could catch the attention and interest of the learners.

The results imply that the developed lesson was agreed upon by the evaluators as useful and its strategies were helpful to the teachers. This means that the developed lesson has the potential to motivate and engage the learners by catching their interest and empowering teachers to deliver effective teaching using the study's specified approach.

**Table 2 Results for Lesson Plan Evaluation**

| Assessment Indicators | Validity coefficient | Interpretation |
|---|---|---|
| **1. LESSON PROPER** | | |
| a. Is/are the objective of the lesson SMART? | 0.97 | Valid |
| b. Are the steps in the lesson presentation clear? | 0.93 | Valid |
| c. Do the activities encourage learners' engagement? | 0.97 | Valid |
| d. Does the lesson provide sufficient practice for the learners? | 0.87 | Valid |
| e. Is the assessment for the activity appropriate? | 0.93 | Valid |
| **Average Score** | **0.93** | **Valid** |
| **2. CONTENT** | | |
| a. Is the use of context appropriate? | 0.97 | Valid |
| b. Are the materials selected locally relevant? | 1 | Valid |
| c. Are the words used appropriate for the learners? | 1 | Valid |
| d. Is the choice of technical terms appropriate? | 0.9 | Valid |
| e. Is/are the problem/s involve/s significant concepts in a related field (real-life application)? | 1 | Valid |



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| | | |
|---|---|---|
| **Average Score** | **0.97** | **Valid** |
| **3. USEFULNESS OF THE DEVELOPED LESSON AND STRATEGIES** | | |
| a. Do you think teachers will find this strategy useful? | 0.9 | Valid |
| b. Do you think the learners will find this strategy interesting? | 0.97 | Valid |
| c. Are the lessons and activities useful to teachers? | 0.9 | Valid |
| **Average Score** | **0.92** | **Valid** |
| **GENERAL AVERAGE** | **0.94** | **VALID** |

*Validity coefficient interpretation:* $\geq 0.6-$ *Valid,* $<0.6-$ *Invalid*

In Table 2, it can be seen that items 2b, 2c, and 2e had the highest validity coefficient. On the other hand, the lesson provided sufficient practice for the learners and had the lowest validity of 0.87, but this item was still valid. The data showed that the developed lesson plan was valid regarding lesson proper, content, usefulness, and strategies. It had an overall validity coefficient of 0.94.

### 3.2.2.4 Revision of the Developed Lesson Based on the Evaluators' Suggestions

The developed lesson underwent revision based on the suggestions of the in-service science teachers and graduate students. The evaluators gave some suggestions to enhance the overall lesson plan despite the good result of the evaluation. Table 3 presents the evaluators' comments and the corresponding revisions implemented.

**Table 3** ***Revisions of the lesson plan Based on the comments of evaluators***

<table>
<tr><td colspan="2">Comment: "As this is intended for Grade 7, one or two objectives are the usually attainable objectives for a day. "</td></tr>
<tr><td>Pre-evaluation</td><td>Revised</td></tr>
<tr><td>By the end of the lesson, students will be able to:<br>1. Differentiate heat and temperature,<br>2. Describe the necessary conditions for heat transfer to take place;<br>3. Make a biomass briquette that demonstrates heat doing work; and<br>4. Cite some application of heat that will transfer to another</td><td>By the end of the lesson, students will be able to describe the necessary conditions for heat transfer to take place</td></tr>
<tr><td colspan="2">The evaluators' comment pointed out that fewer objectives are typically more realistic and achievable within a day for a lower level. The revised objective allows for a more in-depth exploration to ensure students can more thoroughly and effectively grasp the key concept within the allotted time, aligning with Fink's (2005) statement that fewer learning objectives are more practical and increase feasibility.</td></tr>
<tr><td colspan="2">Comment: "In the eliciting part of the lesson plan, give some possible answers in the learners' activity for reference"</td></tr>
<tr><td>Pre-evaluation</td><td>Revised</td></tr>
<tr><td>Answers may vary.</td><td>1. The students will answer the questions based on their</td></tr>
</table>



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| | |
|---|---|
| | experiences/insights.<br>2. Yes, ma'am! Maybe because the heat from that surface is, like, jumping onto my hand.<br>3. Yes ma'am.<br>4. The heat from the sun warms our skin and makes us feel hot ma'am. |
| It is important to note that the lesson plan must include the possible answers to the learners' activity because it offers teachers a clear benchmark for evaluating student responses and recognizing valid and complete answers, especially when assessing open-ended questions. Furthermore, it can reduce learners' anxiety since it provides a sense of clarity and direction. This supports Wiggins' (1998) emphasis on the importance of clear expectations in effective assessment. | |
| Comment: "*It might be beneficial to connect the questions to their previous years*" | |
| Learners will be asked these questions:<br>1. While drinking coffee, have you tried heating your palms by holding the mug/cup?<br>2. When you go to a beach/resort/ river to swim, do you want the heat from the sun warming your face?<br>3. Why do you feel warm when you walk under the sun?<br>5. While cooking, have you experienced getting burned by accidentally touching the stove/ casserole? | In your grade 4, you understood how heat travels.<br>1. What can you say about how heat travels from a hot stove to a pot of water on it?<br>2. While drinking coffee, have you tried heating your palms by holding the mug/cup? Why do you think our hands burn when we touch a hot surface?<br>3. When you go to a beach/resort/ river to swim, do you want the heat from the sun warming your face?<br>4. Why do you feel warm when you walk under the sun?<br>5. While cooking, have you experienced getting burned by accidentally touching the stove/ casserole? |
| It is important to establish a strong connection between existing knowledge and the new concepts being introduced for the learners to effectively activate their existing schema. Linking to prior knowledge or experience enhances the amount of information that is accessible for use when learning new information (Mazano, 2007). | |
| Comment: *"Provide time (how many minutes) and attach the link for the video on biomass briquette making"* | |
| **Pre-evaluation** | **Revised** |
| The learners will watch a video on how to make a biomass briquette utilizing their local resources. | The learners will watch a 3:46-minute video on how to make a biomass briquette utilizing their local resources, with this link: https://drive.google.com/file/d/1a_ggG9kU_ch5gts5ONesDzRvZkoTIxzb/view?usp=drive_link |
| It is very important to specify the exact duration to ensure that both teacher and learners can effectively manage their time. Also, attaching the direct link eliminates any confusion or frustration associated with accessing the video. Providing learners with clear cues and minimizing unnecessary cognitive load greatly enhance students' ability to process and retain information (Mayer, 2008). | |
| Comment: "For activity 1, provide the objective, the duration for that activity, and emphasize the 'safety caution'." | |
| **Pre-evaluation** | **Revised** |
| **STUDENT ACTIVITY SHEET**<br>*Activity 1: Igniting Charcoal Safely*<br>**Group Name:________**<br>**Materials:** Briquettes, matches/lighter, and heat-resistant gloves, ruler<br>Procedure:<br>1. *Safety First:* Choose a safe location away from flammable materials like dry grass or overhanging branches. | **STUDENT ACTIVITY SHEET**<br>*Activity 1: Igniting Charcoal Safely*<br>**Group Name:________**<br>**I. Objective:** To determine if charcoal combustion. produces heat.<br>**II. Materials:**<br>Briquettes<br>Matches/lighter<br>Heat-resistant gloves |



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<table>
<tr>
<td>
2. Have a water source or fire extinguisher nearby in case of emergency.<br>
3. Arrange the Briquettes: Carefully arrange the briquettes on the fireproof surface, leaving some space between them for air to circulate.<br>
4. Ignite the Briquettes: Using long matches or a lighter, carefully light one or two briquettes.<br>
5. Be patient! It may take a few minutes for the flames to catch.<br>
6. Place your hand away from the briquette. Slowly bring your hand closer to the briquette until you feel the warmth, then measure the distance every two minutes interval.<br>
7. Record the distance below.
</td>
<td>
Ruler<br>
III. Duration: 15 minutes<br>
V. Procedure:<br>
Safety First: Choose a safe location away from flammable materials like dry grass or overhanging branches. Have a water source or fire extinguisher nearby in case of emergency.<br>
1. Arrange the Briquettes: Carefully arrange the briquettes on the fireproof surface, leaving some space between them for air to circulate.<br>
2. Ignite the Briquettes: Using long matches or a lighter, carefully light one or two briquettes.<br>
3. Be patient! It may take a few minutes for the flames to catch.<br>
4. Place your hand away from the briquette. Slowly bring your hand closer to the briquette until you feel the warmth, then measure the distance every two minutes interval.<br>
5. Record the distance below.
</td>
</tr>
</table>

To fully grasp the intended learning outcomes and enable learners to effectively focus on what they are doing, clearly defining the objectives must be the priority. This aligns with the principles of goal-oriented learning of Locke & Latham (2002). Students effectively manage their time and maintain engagement when there is an estimated duration for the specific activity, which is vital for them to complete the task on time (Claessens et al., 2007). Furthermore, the emphasis on safety measures is vital for securing the learners while offering a responsible learning environment. As stated by the National Science Teaching Association (NSTA, 2013), safety should be the primary priority in all activities in science.

# 4 CONCLUSION AND RECOMMENDATION

This study successfully developed and validated an inquiry-based 7E lesson plan integrating biomass briquette making as a supplementary activity to enhance the learners' understanding of heat transfer. The developed lesson was carefully reviewed by 10 (ten) in-service science teachers and 3 (three) graduate students, majoring in physics education, and achieved a "valid" rating across lesson proper, content, and usefulness and strategies. This validation verifies that the 7E lesson effectively aligns with the DepEd learning competencies which offers a complete and sufficient coverage of the intended topic. The positive rating from the evaluators implies that integrating biomass briquette-making, within an inquiry framework, has the potential to improve the academic performance of the Grade 7 learners, particularly in comprehending challenging abstract physics concepts such as heat transfer. The findings show that educators can develop and implement 7E lessons that integrate biomass briquette-making to enhance the learners' understanding of the topic of heat transfer. It is also recommended to design and create a briquette drying system that is suitable for areas with frequent rainfall being an emerging problem within the process of development. Moreover, future researchers could explore the long-term impact of this 7E lesson on the attitudes of learners toward physics and their ability to apply the concepts of thermodynamics in various practical scenarios.

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