Biology at Home: The Six Attributes of Home-based Biology Experiments (HBEs) for Remote Authentic Learning

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ABSTRACT

Home-based biology experiments are activities that utilize household materials that have been adapted for the remote learning environment and are aligned to standard learning competencies. Recognizing the households and kitchens as extensions of laboratories, HBEs can be used to deliver authentic learning experiences for the students at home. Furthermore, there are several attributes of HBEs that should be considered before the implementation of the activity. These attributes are, it is ethical and safe to perform, it produces tangible products, encourages students to reflect, promotes collaboration, materials are easy-to-find and affordable and lastly, home-based biology experiments are modifiable. Also, HBE encourages students to work independently under the supervision of their parents and teachers. Parents and guardians, as collaborators, should ensure students' safety, monitor their child's progress, provide a safe environment and conducive work area, and should report all cases of accidents and problems to the subject teacher. In conclusion, home-based biology experiments are one of the emerging teaching tools for remote authentic learning in the new normal. Moreover, HBEs could also be used to address the problem of the lack of hands-on activity in remote learning. Further studies should be conducted on the effectiveness of HBEs in different topics in biology.

Keywords
Home-based learning, Home-based biology Experiments, Remote Experiential Learning, Teaching Biology

Introduction

"*Learning science by doing science*." – This has been the guiding principle in science education curriculums as this promotes authentic learning opportunities for the students to think, act and reflect like scientists [1]. However, educational institutions nowadays have been greatly challenged by the onslaught of the COVID-19 pandemic. School laboratories and facilities are temporarily closed, chemicals and laboratory tools are inaccessible, and the teachers and students are now doing remote teaching and learning from their homes [2]. These academic disruptions delay the efforts of science educators to deliver authentic learning among their students. Simulations, online games, and virtual learning materials are being used to replace the conventional practical learning activities in science class [3]. Some of these online learning materials are PhetSims, BioInteractive, iBiology, Kahoots, and many more. Furthermore, teachers and students are now being challenged by the integration of technology in the remote teaching and learning process [4]. But do these activities provide an authentic learning experience for the students? To answer this question, let us go back to the definition of authentic learning by Revington (2016), he defined authentic learning as an approach to learning that encourages students to create a tangible, useful, quality product to be shared with their community or peers [5]. Moreover, biology, as a field of learning, is a practical science that requires high-quality, authentic, and appropriate experiments that enhance students' learning [6]. Therefore, online activity is not authentic when the students are just manipulating the controls of the virtual environment without producing tangible and authentic outputs and products.

In this time of uncertainty, where the educational system is unstable and unpredictable, it is necessary to innovate new teaching methods and strategies to address these concerns. One of the potential tools to deliver authentic learning remotely is the use of home-based biology experiments where households and kitchens would serve as alternative laboratories.

What is a Home-based Biology Experiment?

To address these aforementioned concerns, schools must extend science laboratories to students' homes. This may sound expensive or nearly impossible, but there are several ways to attain this. One way is the use of Home-based Biology Experiments (HBEs) in the teaching and

learning process. "***Home-based biology Experiments***" (HBEs) refers to the practical activities or experiments that utilize readily available household materials and tools that can be used in teaching and learning biology in both synchronous and asynchronous modalities. Additionally, an HBE is an emerging tool that can be used to deliver an authentic learning experience to students. As shown in Figure 1, teachers, as developers of curriculum materials, should consider the following attributes when they plan to develop home-based biology experiments for their class.

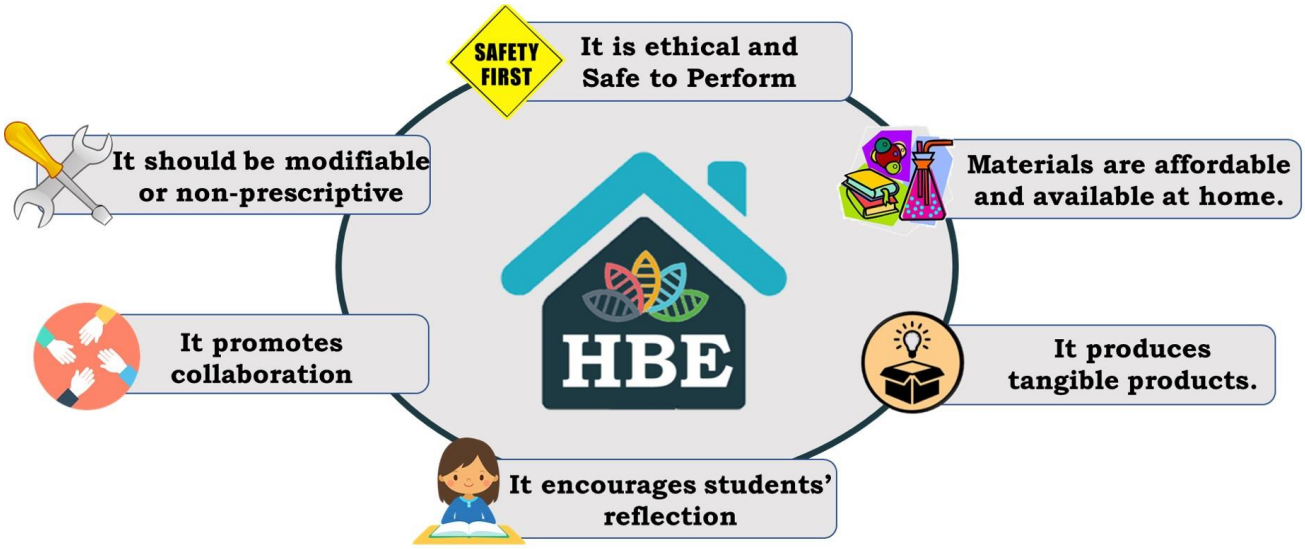

Figure 1. Six Attributes of Home-based Biology Experiment

Attribute 1: The experiment should be ethical and risk-free.

Safety first! – Whenever you experiment, you should prioritize your student's safety and welfare. The teachers should avoid assigning experiments that utilize lethal objects or toxic chemicals. Furthermore, body fluids such as saliva, blood, urine, etc. should not be used as these may carry or contain pathogens or diseases. Experiment procedures should be clear, comprehensive, and appropriate for the student's level. As shown in Figure 2, usage of plants for experimental studies is highly encouraged however, experiments involving animals must be based solely on observation and measurement of animal behavior. The experiment should not cause stress or pain on any animal, vertebrate, or invertebrate. Moreover, the administration of drugs or chemicals to animals is strictly prohibited. Any experimentation involving humans must be with their written permission and must follow the above guidelines. For the selection of work areas at home. Parents must ensure there is a well-lit, well-ventilated space or area that is an ideal location for doing the messier work involved in a biology lab course.

Figure 2. Home-based Mesocosm
(by Ian Stanley A. Yang)

Attribute 2: Materials are affordable and available at home.

The materials in the activity should be available at home or, at least affordable for the students. It should not require expensive tools or devices. Students are highly encouraged to modify or improvise, or look for alternatives if materials are not available. For example, instead of buying plastic containers or measuring cups, they can use recyclable containers at home. Also, the student should inform the teacher if the materials are unavailable or difficult to acquire due to the travel restrictions brought by the COVID-19 pandemic. In figure 3, students used oreo cookies as the nucleus and colored sprinkles represent the chromosomes. If oreo cookies are not available, students should think of another material available at home.

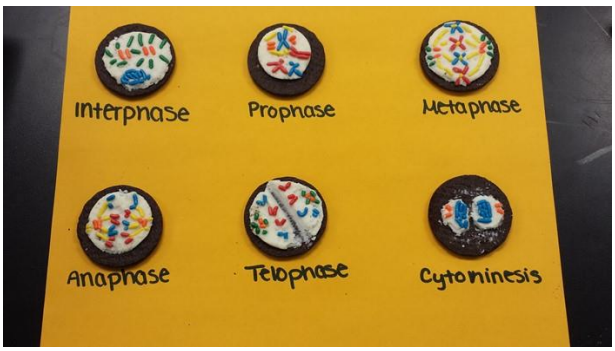

Figure 3. Oreo Cell Cycle Model
(by Drake Creek Middle School)

Attribute 3: Students must be able to perform, create, or produce tangible products.

As an authentic learning tool, the student should be able to produce or create a tangible output after experimenting. The product can be a prototype, a document, model, or setup of the activity. Students' outputs must reflect their learnings and understanding of the scientific concepts used in the activity. For example, in the "Edible Cell Model Activity", students should be able to create an edible cell model made up of food materials such as bread, cupcakes, candies, etc as shown in Figure 4. Additionally, the process and the output should be documented properly. For online learning modality, students can video record the entire process of activity while for asynchronous sessions or module-based modality, students can use pictures or images to create a narrative report or scrapbook. Lastly, the teacher should use a validated rubric to assess the outputs and to provide feedback.

Figure 4. Home-based Edible Cell Model Activity
(by Kyla Ilagan)

Attribute 4: The experiment should encourage the student to reflect.

Since the activity is to be performed at home, students will work independently. This encourages the student to reflect and examine his performance. This practice of self-reflection allows them to review their work and reflect on their learning progress. Furthermore, this helps the students to improve their performance and take ownership of their learning [7]. More importantly, students should be able to articulate their ideas, hypotheses, or opinions on the topic and they should also acknowledge how failures and mistakes affect their learning experience. Here are some of the sample questions for students reflection;

1. Now that it's over, what are my first thoughts about this overall activity? Are they mostly positive or negative?
2. If positive, what comes to mind specifically? Negative?
3. What were some of the most interesting discoveries I made while working on this activity? About the problem? About myself? About others?
4. What were some of my most challenging moments and what made them so?
5. What were some of my most powerful learning moments and what made them so?
6. What is the most important thing I learned personally in this activity?

Attribute 5: The experiment should promote teacher-student-parent collaboration

Parental involvement is positively associated with a child's academic performance [8]. With this, home-based biology experiments should specify the roles of the parents or guardians in the implementation to promote parental engagement. Likewise, there should be constant communication between the parents and teachers to ensure safety, coordination of tasks and to immediately report accidents. The teacher should conduct an online orientation with the students and the parents to discuss all the instructions and concerns. *What are the roles and responsibilities of the parents and guardians in the implementation of HBEs?* Parents should at least do the following;

1. **Monitor their child's progress**: Parents might ask the following questions; *What resources do you need? What can I do to help? How far did you get in your experiment today? What did you discover?*

2. **Establish a routine:** develop a flexible and attainable routine

3. **Choose a good place to work:** Select or set up space or location specifically for school-focused activities. Make sure it is quiet and free from distractions

4. **Help students 'own' their learning**: Encourage, provide necessary support and expect your children to do their part. Don't help too much.

5. **Supervise.** Ensure the safety of the student and cleanliness of the work area.

6. **Stay in touch.** Teachers will be communicating regularly through our online platforms and virtual conferencing tools. Report all issues, problems, and incidents to the subject teacher.

Attribute 6: The experiment should be modifiable and non-prescriptive.

The last attribute of the home-based experiment is modifiability. Modifiability refers to the non-prescriptive characteristic of HBE that allows modification following the needs, context, or locality of the student. Furthermore, it will also encourage students' resourcefulness and creativity. The principle is very simple; "if the material is not available, look for alternative materials and modify the experiment" but of course it should be approved by the parents and the teacher. Students are also encouraged to use local materials to contextualize the activity. For example, in "seed germination activity", seeds from the local markets or farms can be used to save money and to promote local crops. Moreover, there should be no racial, ethnic, socioeconomic, or gender discrimination in the implementation of HBE.

CONCLUSION

To summarize, home-based biology experiments (HBEs), as instructional material, have the potential to help students enhance their learning amidst this pandemic. This could also address the issue of the lack of hands-on activity on remote learning by providing experiential learning opportunities for the students. Before the implementation of HBE, parents and teachers should be guided by the following questions which are patterned on the six attributes of home-based biology experiments.

1. Is it ethical and safe to perform?
2. Are the materials available and affordable?
3. Does the experiment produce a tangible product?
4. Does the experiment allow the student to reflect?
5. Does the experiment promote parental involvement?
6. Is the experiment modifiable?

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