

## OUT OF THE CLASSROOM: IB STUDENTS' EXPERIENCES AND TIPS ON THE USE OF HOME-BASED BIOLOGY EXPERIMENTS FOR INTERNAL ASSESSMENT

**Author's Name:** Megan Mae C. Chu<sup>1</sup>, Eleen Hanna L. Labarez<sup>1</sup>, Lara G. Reños<sup>1</sup>, Jessica Rianne C. Velasco<sup>1</sup>, Dave Arthur R. Robledo<sup>1,2\*</sup>

**Affiliation:** <sup>1</sup>International Baccalaureate Diploma Programme (IBDP), Saint Jude Catholic School

<sup>2</sup>De La Salle University-Manila, Philippines

**E-Mail:** [dave.robledo@sjcs.edu.ph](mailto:dave.robledo@sjcs.edu.ph)

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### Abstract

*Experimentation has been an essential part of teaching and learning biological concepts. Science experiments provide opportunities for students to learn scientific concepts, experience natural phenomena, and explore the world around them. However, this COVID-19 pandemic has disrupted the educational system in the Philippines, particularly science education. School facilities and laboratories are temporarily closed or inaccessible for teachers and students. These events hinder the conventional process of doing experiential learning activities, experiments, and scientific investigations. Because of this major disruption, the International Baccalaureate Organization released a memorandum that encourages teachers and students from IB World Schools to utilize other activities other than laboratory experiments such as online simulations, analysis of secondary data, or doing safe and appropriate experiments at home. In response, the biology students of the International Baccalaureate Diploma Programme (IBDP) of Saint Jude Catholic School utilized home-based biology experiments for their internal assessment. Students investigated the effects of different fruit extracts on gelatin denaturation, effects of kinds of milk on the volume and pH of cheese produced, effects of nutrient solutions on the growth of onion, and effects of the different wavelengths of light on the growth of an aquatic plant. Because of these unpredictable changes in the educational system, it is necessary to document these innovations and practices. This paper aimed to present students' experiences on the use of home-based biology experiments. It was shown that household materials and kitchens can be utilized as alternative laboratories in remote learning. Furthermore, it was also revealed that they had trouble finding literature related to their topic. In the paper, they also emphasized the importance of choosing the right topic which fits your interest. In conclusion, home-based biology experiments are timely, relevant, and appropriate alternatives for the actual laboratory experiments.*

**Keywords:** Home-based biology experiments, Internal assessment, DP Biology

### INTRODUCTION

Doing science experiments has been an important part of the teaching and learning process. Hands-on experiments provide a real-life application of the lessons and concretize students' conceptual understanding (Kolb, 1939). In the diploma program of International Baccalaureate Curriculum, internal assessment refers to an individual investigation where IB students design, perform and write up their biology experiments (IBO, 2016). However, the COVID-19 pandemic has brought us into a situation where access to school laboratories is limited or nearly impossible (Augustin, 2020). Moreover, teachers are being challenged on sudden change of learning modality – from conventional in-person classes to remote learning (Lapada et al.,

2020). With this, the International Baccalaureate Organization (IBO) encouraged teachers and students to carry out activities other than laboratory experiments (IBO, 2020). In response to this challenge, four biology students of the International Baccalaureate Diploma Programme (IBDP) of Saint Jude Catholic School used home-based biology experiments (HBEs) for their internal assessments. Home-based biology experiments refer to the experiential learning activities that use household materials as alternative laboratory tools. Parental and teacher supervision are important factors in the implementation of home-based biology experiments to ensure students' welfare and safety.

Because of these uncertainties and dynamic changes in the educational system, this article aimed to document and share the first-hand experiences of the students and the challenges they encountered on the use of home-based biology experiments. Furthermore, this article also aimed to provide tips and guidance for future IB biology students. Students' sharing and discussion were conducted synchronously via Google Meet and transcripts were prepared using Google document. Generally, students' responses were guided by the following questions: "What is the home-based experiment you implemented? What are the challenges you encountered? How did you address these challenges? What tips and advice would you give to future IB students who would like to use HBEs for their internal assessment? Here are the responses of the students.

**Megan:** "With my knowledge that temperature plays a role in enzyme reactions, I experimented on the effects of varying temperatures on fruits' pH and their catalytic ability in gelatin denaturation experiment. The extracts derived from pineapple (*Ananas comosus*), papaya (*Carica papaya*), and banana (*Musa acuminata*) were first exposed to their respective temperatures, then I measured their effects as catalysts on gelatin denaturation (in volume) and on the change in pH. Gelatin was prepared in 100 mL beakers, and these served as the medium to which the denaturation occurred and was measured as shown in Figure 1.



Figure 1. Megan's Experimental Setup

The essential idea was that fruit enzymes under room temperature would deliver the best results since the condition was like that of the human body (37°C). Comparably, fruit enzymes exposed to the highest temperature would not be optimally active, hence resulting in minimal changes in volume for measuring denaturation. Additionally, I utilized the topic and took the opportunity to also study the relationship between temperature and pH by using a pH meter to test the pH values of the fruit samples before and after they were exposed to the assigned temperatures. The materials I used included a chopping board, kitchen knife, pH meter, digital weighing scale, blender, and an oven.

During the implementation of the experiment, a challenge I encountered was having 75 trials in total, which consumed a huge portion of my time. However, I kept in mind that the number of trials was necessary because having repeated trials would eliminate random errors and strengthen the study's reliability. Another challenge I faced was the insufficient sources for studies on the effect of temperature on pH. I felt that my discussion would have come out stronger had I cited more sources about it. To future IB Biology students, my advice is to first gather sufficient and reliable sources before writing your IA. Finalize your topic, then create an outline for the procedure and the variables to guide you through the process."

**Lara:** "Coming from a family with an interest in home gardening, I'm always keen to gain a better understanding of taking care of our home plants. At some point, my mom struggled with growing the indoor plants, particularly the aquatic ones. Although our indoor plants were getting sunlight, they struggled especially that it was the winter season. This made me wonder about the sustainability of artificial light to grow indoor plants and whether the color would matter. In an attempt to find answers, this led me to conduct an investigation entitled 'The Effects of Varying Light Wavelengths on the Photosynthetic Activity of *Hydrilla verticillata*'. Knowing that visible light drives the synthesis of sugar molecules in plants, I investigated the light wavelengths of the visible spectrum and identified the most suitable light wavelength in the growth of Hydrillas. Since I did not have the technology to directly measure the growth of Hydrillas, I rather measured the pH of water and amount of water displaced as a way of quantifying as shown in Figure 2. The apparatuses that I used were mainly beakers, LED strip lights, test tubes, funnels, a digital pH meter, a blackout box, and bundles of living Hydrillas.



**Figure 2. Lara's Experimental Setup**

Although I deem the experiment as successful, there were a couple of setbacks that I experienced and wished I knew beforehand. Firstly, it was a struggle looking for research studies that supported my findings. With that, it would be preferable if you choose a topic backed up with a plethora of research studies from credible scientific journals. Secondly, allotting an hour per trial limited the ability of the experiment to provide more data. For this, I suggest exploring more than three light wavelengths and allotting a longer time duration for a



worthwhile experiment. Most importantly, I strongly encourage future IB students to choose an investigation in which they are or can be strongly engaged in. Your genuine interest will be evident which will make your paper stand out from the rest.”

**Jessica:** “This experiment entitled “The Effects of Citric Acid on Protein Denaturation during Milk Coagulation” made use of cow, soy, and powdered milk which were either heated on its own or mixed with citric acid, specifically lemon juice, to enhance the coagulation process used to produce cheese. The mass (in grams) and the pH level of the “cheese” were obtained to determine which among the kinds of milk yielded the largest amount and the least acidic form of cheese. As shown in Figure 3, this experiment follows a simple procedure and does not require any complex lab apparatus since it mostly made use of cooking pots, cups, and a stove in heating the milk. Such simple procedures also entailed challenges. For instance, there is very little literature about using soy and powdered milk in cheese-making since most of the cheese was made using different kinds of animal milk. Because of this, I struggled in finding the necessary evidence from different literature sources to support my findings of the study. Despite this, there were sufficient journal articles that were found and hopefully may be beneficial in future research. Another challenge faced was the limited acquisition of the kinds of milk. Given that the pandemic has restricted outdoor movement, I had to make do with what was readily available in the local supermarket. Not only that, the use of only one type of citric acid may have limited the generalization of the findings, hence the need for more research with other modifications like the type of coagulating agent used in cheese-making. To those who are starting on their internal assessment for IB Biology, my advice for you is to select a topic that not only interests you as a researcher but also can be applied to other areas of knowledge. Aside from that, coming up with a feasible procedure will also ensure a smoother writing process and a successful scientific research paper.”



Figure 3. Jessica's Experimental Setup

**Eleen:** “Having a family business that involves onions, I decided to investigate the effects of

various hydroponic solutions on the growth of red onion (*Allium cepa*). The nutrients I used include potassium sulfate, calcium nitrate, and urea, all of which were in salt form and dissolved in distilled water. As shown in Figure 4, the onions sit atop the containers' covers in which there is a small hole enough for the bottom of the onion to be submerged in the solution. After every week, I measured the growth in leaves, roots, and bulbs, having a total of four weeks to ensure that the onions had enough time to grow.

The plastic containers I used were pre-used and repurposed for this experiment to promote environmental sustainability and the nutrients I used are common fertilizers that can later be used for house plants. The procedure of this investigation is very simple which makes it very suitable for a home-based biology experiment. This experiment can be done anywhere if there is available natural sunlight, and the setups can be protected from external factors such as typhoons or insects which can affect plant growth. Additionally, since one of my dependent variables is the root length, I had to measure every root of every onion which was very time-consuming and tedious. The major problem I encountered is that many times I would lose track of which roots I have already measured and would have to start from scratch again. I eventually got used to this and developed my technique of separating the measured and unmeasured roots. But a tip that may help with this problem is to cut off the initial roots of the onion as they can grow with just the bottom being submerged. Moreover, I had trouble finding studies similar to mine, so make sure to explore something that you know can be sufficiently supported by other studies and literature”.



Figure 4. Eleen's Experimental Setup

In summary, students implemented their experiments at home using common household materials such as onion, milk, gelatin, and indoor plants. This means that household kitchens can be utilized as alternative laboratories in remote learning. For the challenges they encountered, it was revealed that they had trouble finding literature related to their topic. Moreover, students emphasized the importance of choosing the right topic which fits your interest. In conclusion, home-based biology experiments are timely, relevant, and appropriate alternatives for the actual laboratory experiments. These activities provided opportunities for the students to design, explore, and investigate their topic of interest under the supervision of their parents and teacher. Figure 5 summarizes the students' experiences, tips, and advice for

future IB biology students if they decided to use a home-based biology experiment for their internal assessment.

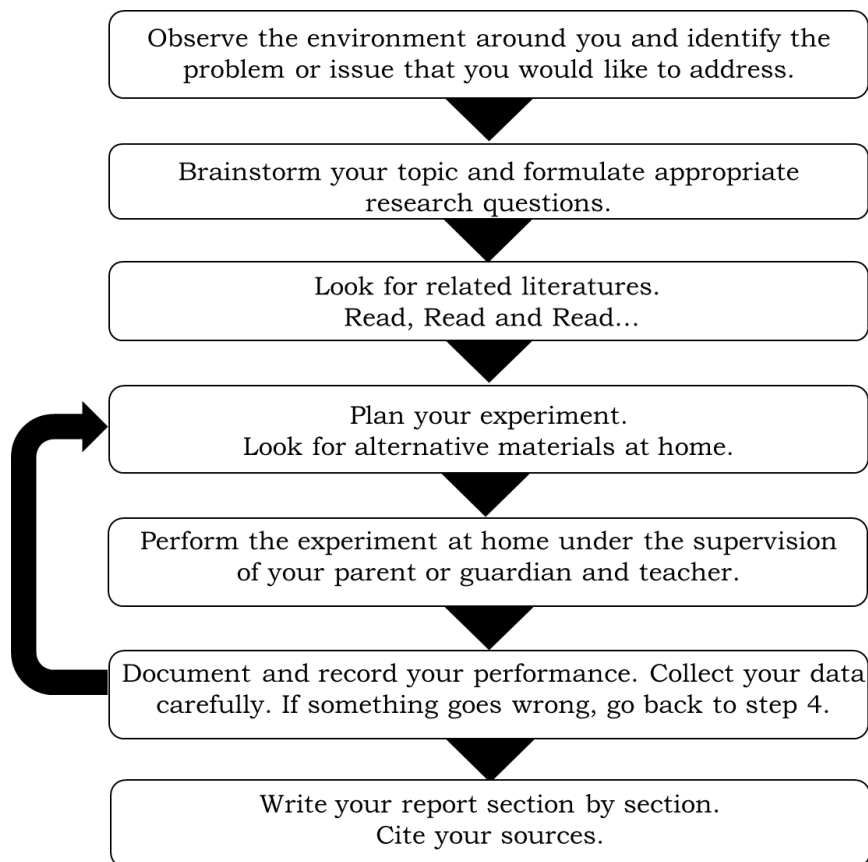


Figure 5. Tips and Guide for the Implementation of Home-based Biology Experiments

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