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Froguts Virtual Dissection: Alternative to Physical Dissection for Biology Basic Education

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Abstract—This study determined the effectiveness of Froguts virtual dissection as an alternative method to physical dissection in teaching animal anatomy and physiology. Froguts virtual dissection is an effective alternative to physical dissection. z-test revealed the significant difference between the pre-test and post-test mean scores of the learners in both groups, with significant improvement in their academic performance. The learners perceived Froguts virtual dissection as effective, more accessible, emotionally acceptable, and informative alternative to physical dissection. ANCOVA revealed further that there is a significant difference in the post-test scores of the two groups revealing Froguts virtual dissection as more effective than physical dissection. Physical dissection was preferred by the learners because of the real, richer experience and data it provided. Further studies to develop and innovate virtual laboratories to address present limitations are recommended. Alternating utilization of virtual and physical dissection is also recommended in the Basic Education Curriculum.

Index Terms— Anatomy, Computer, Dissection, Education, Science, Virtual

1 Introduction

THE study of organisms, including nonhuman animals, is essential to the understanding of the life on earth and even beyond (The National Academies, 2004). In the process of dissecting an animal, the learners explore, see, and touch the various organs in different animal bodies. Seeing and observing the different animal organs and understanding how they work within a single organism allows learners to comprehend how these systems work within many other simpler animals and complex organisms like themselves (Boettcher, 2016). However, the increasing awareness of animal rights, ethnic or cultural sensitivities and technological/pedagogical advancements have led to changes in the structure of practical biology classes (Franklin, Peat, & Lewis, 2001). In the US, the alarming number of euthanized species, the question of the necessity of animal dissection, cultural sensitivities, and many other issues, brought about bigger concerns and issues against the said activity in many educational institutions (The American Anti-Vivisection Society, 2017).

Animal welfare is also a serious social concern in the Philippines. A non-government organization, the Philippine Animal Welfare Society (PAWS) aimed to prevent animal cruelty through education, animal sheltering and advocacy, fights for regulations in keeping animals for research and discouraging animal dissections in schools (Hart, Wood & Hart 2008). The Department of Agriculture Administrative order No. 40 s. of 1999 pursuant to the "Animal Welfare Act of 1998" mandates private and government entity to secure authorization to conduct scientific procedures using animals. The major challenges in carrying out the said activity in schools are leading teachers and students to reconsider the value of these procedures in the classroom (Franklin et. al., 2001).

The focus of dissection activities at the different levels are often adjusted accordingly and with varying levels of difficulty. Animal Dissection in Elementary Schools and Junior High Schools may be modified or simplified to be appropriately carried out for a specific content standard. In the Senior High Curriculum, General Biology 2, is designed to enhance understanding of the principles and concepts in the study of biology, particularly the diversity of living organisms, their structure and function. Dissection is a well-known, effective, exciting exploratory science activity in meeting the learning competencies for these concepts (K-12 Basic Education Curriculum Guide, 2013).

This study emerges from the very need of teachers to effectively and efficiently carry out a learning activity that has been considered important and significant in completing science competencies through time while addressing the pressing need and concerns of the diverse learners. In the Philippines, the effect of the technological trend forces traditional and old proven-helpful activities in science to head up for innovation and modification for the optimum achievement of both teaching and learning goals. The study focuses on animal dissection and the innovations it is heading to as a result of technological and pedagogical evolution, not to mention its ethical and moral criticisms. The opposing and varied opinions on physical dissection led many researchers to explore further and find alternatives. A study on the effectiveness of virtual lab in e-learning revealed that majority of the learners are aware of the virtual labs and are highly appreciated by them. Students prefer computer assisted tools than the textbooks for learning purposes. The study suggest that the virtual labs have to be adopted in schools for making their students think out of the box (Rajendran et al., 2010).

This study aims to determine the effectiveness of Froguts virtual dissection using Froguts Inc. Software, in which over the last decade has been a growing trend to foster student learning (Lee, 1999). In the Froguts virtual environment, the students can cut, slice, examine and explore animals' external and internal organs using realistic 3-D images, motion and sound in their own computers or smart phones; and with

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many animal specimens to choose from. Virtual labs have been developed in different disciplines especially for use in introductory biology and animal anatomy classes; and that serve as teaching aids in student's acquisition of practical skills that are traditionally performed in a physical laboratory (Ma & Nickerson, 2006).

It has been observed however that many technologies-based educational tools have been driven by the technology rather than by pedagogical effectiveness (Naida, et. al. 2007). Developers of virtual labs often promote their efficiency, convenience, low cost and the pleasurable nature of the technology rather than the educational objectives of the technology (Feisel & Rosa, 2005). Many virtual laboratory software and programs are available, but the evaluation results of the effectiveness of these different virtual laboratory software and programs may vary considering different factors such as location, respondents, setups, etc. It is on this term that the researcher found a strong reason to investigate the effectiveness of Froguts virtual dissection using a 3D virtual laboratory program developed by Froguts Inc. as an alternative approach to physical animal dissection in teaching Anatomy and Physiology.

2 METHODOLGY

This study made use of a quasi-experimental research. There were two phases in the conduct of the study. Phase I involved the control and the experimental groups' pre-test and post-test result comparison after specific treatment was given in each group. Figure 1 showed the experimental design utilized in this study. After administering the pre-test to each group, learners were exposed to the treatments: Froguts virtual dissection for sections 11-Euclid and 11-Pythagoras (experimental) and physical dissection for sections 11-Pascal and 11-Euler (control). A post-test was then administered to each group for the purpose of evaluating the effectiveness of two dissection approaches – Froguts Virtual Dissection and Physical Dissection; and determination of the effectiveness of FrogutsVirtual Dissection as an alternative approach to Physical Animal Dissection in teaching Anatomy and Physiology for the Grade 11 STEM students of Agusan del Sur National High School for S.Y. 2017-2018.

VD

SE O_1 O_2

----------------------X----------------

SP O_3 O_4

PD

Legend: ES – Experimental Sections; CS – Control Sections; O_1 and O_3 – Pre-test; O_2 and O_4 – Post-test; X – Treatment (Froguts Virtual Dissection or Physical Dissection)

Figure 1. Research design for pre- and post-test experiment

The Phase II of the study involved the determination of the randomly-selected learners' perception on the conduct of the dissection activities through a Focus Group Discussion to gain qualitative data which may strengthen the result of the study.

The learners came from the Grade 11 Science, Technology, Engineering & Mathematics (STEM) sections of Agusan del Sur National High School. Learners from the STEM strand were chosen since this is the only strand that offers General Biology 2 course. The learners of the study were those students from Grade 11 homogenous sections who are taking General Biology 2. All four STEM sections were determined and labelled as comparison groups- experimental and control. Sections 11-Pascal and 11-Euler with ninety students were assigned as the control group; and Section 11-Euclid and 11-Pythagoras with ninety students were assigned as the experimental group. The study was conducted at Agusan del Sur National High School, San Francisco, Agusan del Sur. It has a total student population of approximately 5,234 for S.Y. 2017-2018. One hundred eighty (180) learners were from the Science, Technology, Engineering and Mathematics (STEM) strand. The STEM strand was chosen by the researcher since the Biology courses were only offered to learners in the strand. All four sections in the STEM strand were selected to participate in the experiment. The school is situated at 5 Pan-Philippine Hwy, Barangay 5, San Francisco, Agusan del Sur, 8500 Philippines.

A self-developed 40-item test questionnaire based on the Grade 11 General Biology Competencies of the K-12 Curriculum of the Department of Education was used to determine learners' academic performance in Phase I of the study. The 40-item multiple choice test questionnaire specifically covered the frog and squid dissection topics under General Biology 2, Animal Organs and Function Competency. A table of specifications was prepared to ensure that all the competencies would be included as per curriculum guide of K-12.

A Focus Group Discussion was facilitated with thirteen expert-validated FGD questions used to randomly selected learners to determine their perception on the conduct of the dissection activities after being exposed to the two dissection approaches in Phase II. The researcher intended to explore and investigate the perception of the learners on the conduct of dissection according to Bloom's three (3) Learning Domains (Krathwohl, et. al.,1973). A survey instrument was also used to solicit the dissection approach preference (virtual or physical dissection) of the one hundred and eighty learners coming from the control and the experimental groups. The questionnaires were validated by experts from Philippine Normal University-Mindanao and science master teachers from the Agusan del Sur National high School , Department of Education – Agusan del Sur Division, Philippines. The consistency of the pre-test and post-test scores shows its reliability - it yielded approximately the same result upon repeated administration. The reliability of the instrument was measured by Kuder Richardson Formula 20 (KR20) on SPSS 16.0, where the computed reliability coefficient was .75. The test items were valid and reliable. The validated test had its pilot testing with homogeneously grouped Grade 11 STEM Sections, 11-Pythagoras with 45 learners and 11-Euler with 45 learners, in Agusan del Sur National High School, San Francisco, Agusan del Sur. The researcher used the Virtual Dissection Online Program of Froguts Incorporated, particularly the Frog and Squid Specimens, which were representative of the two major groups: vertebrates and invertebrates. The website www.froguts.com was the main web address to access the virtual laboratory in this study.

The data gathering process involved two phases. The first phase for the pre-test and post-test experiment and the second phase for the perception data gathering. Initially, the two randomly assigned homogenous groups, namely Sections 11-Pascal and 11-Euler with ninety students (Control Group) and Sections 11-Euclid and 11-Pythagoras with ninety students (Experimental Group) were identified. In Phase I, before any treatment was given, a forty-item pre-test about Frog and Squid Anatomy and Physiology was administered to the Control and Experimental Groups who were Grade 11 learners who would be taking lessons on animal organ systems and functions. The said test included all the competencies in animal anatomy and physiology competencies according the K-12 curriculum. After the control and experimental groups have answered the pre-test, the result was computed and recorded accordingly. Next, the groups were given lessons on animal organ system and functions; then, required to perform a dissection activity using the approaches assigned to carry out the competency. The control group carried out physical dissection and the experimental group utilized Virtual Dissection – Froguts Inc. Online Program in animal dissection. At the end of the activity and lesson, the same forty-item test was given to the control and experimental groups as a post-test. The results were computed and recorded and served as data to determine the difference in the academic performance of the learners when exposed to physical and Froguts virtual dissection approaches. The evaluated result gave data to determine the effectiveness of Froguts virtual dissection as an alternative approach to physical dissection in teaching anatomy and physiology.

In Phase II, the learners in the control group were exposed to Froguts virtual dissection approach, and the learners in the experimental group were exposed to physical dissection approach, respectively. This time, all 180 learners in the experiment from control and experimental group were already exposed to both virtual and physical dissection. This was intended by the researcher to gather data through a Focus Group Discussion participated by eight randomly (simple random sampling) selected learners in four different groups about their perceptions on the over-all conduct of the dissection activities. Simple random sampling was done to take thirty-two learners out of 180 total learners to participate in the Focus Group Discussion in four separate sessions. Eight learners were taken from the control group and Eight from the experimental group. The researcher as the moderator with a secretary facilitated the Focus Group with the eight learners, in the discussion of the thirteen pre-identified and validated FGD questions. The focus group questions were categorized into engagement, exploration and exit questions respectively. The focus group took about two hours for each group. The focus group moderator assumed the responsibility to adequately cover all prepared questions within the time allotted. He also had the responsibility to get all learners to talk and fully explain their answers; paraphrase and summarize long, complex or ambiguous comments, whiling remaining neutral to any comment made by the learners. The assistant moderator was responsible for audio and video recording the session and taking notes. The Learners' recorded responses served as the qualitative data used in determining the perception of the learners on the conduct of the two dissection activities. A survey instrument was also used to solicit the dissection approach preference (virtual or physical dissection) of all thirty-two learners who participated in the experiment coming from the control and the experimental groups in four separate sessions.

To validate the 40-item test, weighted mean was used to test the validity of the 40-item test and the perception questionnaire as rated by the validators using a likert scale (5-Very Appropriate, 4-Appropriate, 3-Appropriate but needs improvement, 2-Not appropriate, Should be revised and 1-Totally inappropriate) with affixed comment in each item. The reliability of the 40-item questionnaire was measured by Kuder Richardson Formula 20 (KR20) on SPSS 16.0, where the computed reliability coefficient was 0.75, indicating that the instrument was reliable.

3 Results and Discussion

3.1 Academic Performance

The academic performance of each group of Grade 11 Senior High School learners exposed to virtual and physical dissection approaches in frog and squid dissection was measured in terms of pre-test and post-test. Table 2 revealed that both groups showed improvement in the performance after being exposed to the two different approaches respectively. Specifically, Table 2 presented the mean scores of the pre-test and post-test administered to both control and experimental groups. Table 2 also showed an increase in the pre-test and post-test mean score of the control group from 21.48 to 24.96. On the other hand, there was also an increase in the pre-test and post-test mean score of the experimental group from 21.27 to 27.40. This suggested that the two approaches are both capable of improving the learners' performance in frog and squid dissection.

Table 2. Mean Performance and Standard Deviation

Group	Pre-test		Post-test		Gained score
	Mean	σ	Mean	σ	Mean
Experimental (Virtual Dissection)	21.27	3.79	27.40	4.16	6.13
Control (Physical Dissection)	21.48	3.23	24.96	3.44	3.48

The low standard deviation values also indicated the closeness of the pre-test and post-test scores of the two groups, having scores near the mean value meant that the test result was precise and reliable since the learners' scores were not greatly varied or not far from each other. A study on the comparison of a virtual laboratory Program V-Frog to Physical Dissection also revealed increasing pre-test and post-test scores of both methods, with higher learning (post-test scores) in Froguts virtual dissections but with no differences found for retention (Lalley, et. al. 2009). The findings suggested that Froguts Virtual Dissection can improve the academic performance of the learners in animal dissection activities in Senior High School Biology courses. As an alternative approach to Physical Dissection, Froguts Virtual Dissection could also interactively simulate and expand scientific exploration for learners with different learning styles and with multiple intelligences in technology-mediated learning environment and instruction. Different media such as Social networking software that allow students to take control of their learning experience offer ways to truly personalize their learning experience (Jisc, 2017).

Table 3 shows the z-test value of both experimental and control groups which were the basis for the hypothesis testing. Since the z stat value (-10.34) of the experimental group fell into the left critical region (z<-1.96), it suggested that the null hypothesis be rejected and concluded that "There was a significant difference between the pre-test and the post-test mean scores of the subjects in the Experimental Group". More specifically, the post-test mean score was significantly higher than the pre-test. It suggested that there was a significant increase or improvement of subjects' academic performance.

The findings revealed that leaners exposed to virtual dissection approach gained high average scores in the pre-test and post-test. There are varying conditions and factors in a technology-mediated learning environment that could contribute to quality learning. Virtual reality technology, for example, allows users to interact with computer-generated effects, such as video, audio or graphics but presents them in a real-world setting. Immersive media such as virtual laboratories potential lies in the future. Learning how and where best to use it, as well as using it with care and according to an agreed-upon set of standards, will be key to further development and success of Virtual technologies (Loughlin, 2017). This new trend, as supported by the findings of this study, presented an important educational paradigm.

The z stat value (-6.99) of the control group fell into the left critical region (z<-1.96), which led to the rejection of the null hypothesis and conclusion that there was a significant difference between the pre-test and the post-test mean scores of the subjects in the Control Group. More specifically, the Post-test mean score was significantly higher than the pre-test. It suggested that there was a significant increase or improvement of subjects' academic performance. Animal Dissection is a known effective method and deeply rooted classroom tradition; and has been used for biology instruction in American classrooms since the 1920s; and it remains a prevalent practice, with 84% of educators reporting use of dissection as a teaching tool at any point during the past school years according to a 2014 National Association of Biology Teachers Survey (Osenkowski, et. al., 2015). Continuous effort from educators and animal welfare advocates to find equally effective alternatives that are morally and ethically acceptable; and that include less invasive procedures such as the approach and tool investigated in this study is potentially changing the paradigm of science education.

Table 3. z-Test: Two Sample for Means of Experimental and Groups

Variables	Experimental Group		Control Group	
	Pre-test	Post-test	Pre-test	Post-test
Mean	21.26	27.4	21.48	24.96
Known Variance	14.33	17.32	10.43	11.86
Observations	90	90	90	90
Hypothesized Mean Difference	0		0	
Z	-10.34		-6.99	
z Critical two-tail	±1.96		±1.96	

To determine if the data have met the assumptions for the analysis of covariance (ANCOVA), normality and homogeneity tests were performed to the pre-test and post-test data in both control and experimental groups through One-Sample Kolmogorov-Smirnov Test. The result indicated that the test distributions were normal for the pre-test and post-test in both control and experimental groups. The p-values higher than .05 in all four groups indicated attainment of the assumptions for ANCOVA; that is, for all groups to be normal and with equal variances. The data in this study met the assumptions for the analysis of covariance (ANCOVA). Table 4 presented the results of the ANCOVA, where the Academic Performance of the Grade 11 Senior High School learners exposed to Physical and Froguts Virtual Dissection Approaches differed significantly. The observed p-value which was less than 0.000 was less than the significant value of 0.05 which led to the rejection of the null hypothesis. This suggested that there was a significant difference on the learners' academic performance when exposed to the two dissection approaches. Between the two approaches, the learners performed better when exposed to virtual animal dissection than when they were exposed to physical animal dissection in terms of pre-test and post-test results as presented by the gained score in Table 4.

Table 4. Analysis of Covariance (ANCOVA) of Post-test Mean Scores

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	760.859[a]	2	380.429	31.982	.000
Intercept	1215.148	1	1215.148	102.154	.000
Pretest	491.970	1	491.970	41.359	.000
Group	291.015	1	291.015	24.465	.000
Error	2105.452	177	11.895		
Total	126216.000	180			
Corrected Total	2866.311	179			

a. R Squared = .265 (Adjusted R Squared = .257)

The covariate, pre-test showed that the scores of the experimental group and control group were also significantly different, which specifically showed higher mean scores from the experimental group. Overall, there was a significant difference between the pre-test and the post-test mean scores. Furthermore, there was also a significant difference between the post-test mean scores of the experimental (Froguts virtual dissection) and control group (physical dissection). More specifically, the Froguts Virtual dissection method (control group) was more effective than the Physical dissection method (Experimental group) because post-test mean score of the Experimental group was significantly higher than that of the Control group. Virtual learning environments are now utilized in several educational institutions to structure, manage and deliver learning activities and content not only for science courses but also for mathematics, humanities and many other disciplines. Some virtual learning environments such as the virtual laboratory and virtual dissection program used in this study, are even recognized as having strength not only in achieving learning competencies in student but also tracking and managing online assessment by the teachers (Jisc, 2017).

3.2 Perception of students on the conduct of animal dissection

Varying thoughts of the learners about the conduct of animal dissection are synthesized, presented and discussed in this section. In a study, there are significant differences in motivation, academic performance, and proclivity to be self-directed learners who access technology-mediated instructional strategies and should therefore be incorporated into course instructional designs (Gabrielle, 2016). The learners' perception revealed further the areas that might have affected their motivation and performance, specifically in the cognitive, affective, and psychomotor domains.

Theme 1: Cognitive domain.

The learners in this study perceived the effectiveness of alternative approaches, such as Froguts virtual dissection in terms of learning and understanding Anatomy and Physiology lessons. Froguts Virtual Dissection was perceived to be an effective alternative to physical dissection due to its accessibility, details and ethical and moral acceptability. The confidence reported by the learners on the alternative approaches opens doors for more trials, application and use of this method in Anatomy or Science classes.

Most of the learners believed that there were effective alternative approaches to physical animal dissection such as the virtual animal dissection in learning anatomy and physiology. A learner verbalized, "For me, it's okay because the main aim of dissection is to know the different organs and their functions. Virtual dissection provides information and images." The alternative was perceived to be more accessible, emotionally and morally acceptable, informative, and could serve its educational purposes well. One learner verbalized, "I think virtual is effective. It can be done fast, online and accessible." On the other hand, the second most frequent response showed that some learners believed that the alternative approaches to physical animal dissection, such as the virtual animal dissection, were not effective as they don't provide real experience to the learners and that the computerized images could not give complete details of the real organs, not to mention its interactive and simulative feature limitations. A learner verbalized, "I prefer physical dissection to virtual because the experience is different when we do actual dissection. The virtual may provide a lot of information so it may be used alternately. However, it should not replace the physical dissection." There were also learners who were uncertain about the effectiveness of alternatives but have seen the advantages and disadvantages of the two approaches in varied scenarios. One said," It depends on the specimen…We can't say actual is bad. In the virtual, I cannot say but I can have a better alternative."

Theme 2: Affective domain.

The learners preferred the Physical Dissection approach because of the real, richer experience, measurements and data it can give them; and perceived the conduct of dissection would be exciting, enjoyable and nerve-wracking. The learners were excited and happy to conduct virtual animal dissection. Excitement and happiness reported indicated willingness and motivation to do the performance tasks among learners. Data revealed that the learners found the Froguts virtual dissection activity difficult. This indicated presence of hindrances, reported to be technology-related. The identified limitations of the virtual laboratory hindered learners' learning. While other learners reported ease and comfort in performing the task, the technology-related issues would continue to cause challenges if not modified, innovated and eliminated. The learners were happy and satisfied after the conduct of the virtual animal dissection. The result of the performance task gave feelings of happiness and satisfaction to the learners. Despite the reported physical discomfort after the activity, the learners were still happy and satisfied of the result and experience. Before the conduct of Physical Dissection, the learners were excited and nervous. Excitement could be an expression of motivation, while nervousness may occur normally when doing new things. While disgust is felt by few learners, feeling of excitement to do the dissection activity was an indicator of interest and motivation among learners to perform tasks. Data also revealed that the learners were pitiful and excited during the conduct of the physical animal dissection. The feeling of pity toward the specimen could be an indicator of reluctance and unwillingness to perform the task. This might also imply ethical and moral concerns among learners. On the other hand, excitement might motivate the learners to perform. Moreover, the learners were happy after the conduct of the physical dissection activity. This implied satisfaction in the learning task. While few still felt pity and sad for performing euthanasia, the success of the activity still brought about happiness and satisfaction among the learners.

Before the conduct of Froguts virtual dissection.
The learners were excited and happy before the conduct of the virtual animal dissection. Excitement was felt by the learners, learning that the activity will be done on a computer, and that they can participate without having to worry about fear of the specimens while doing the process in a proper and organized way. A learner verbalized, "Happy because there are many parts that I already learned based on parts and functions. Yes (I know it will be done using computer)." The second most frequent response showed that some learners felt indifferent as one verbalized, "I feel nothing because I have already done that in my elementary days. So, I already expect what will be in the virtual." A small portion of the learners were skeptical and curious about the process while a small portion got annoyed about the possible assessment afterwards.

Before the conduct of physical dissection.
The senior high school learners were excited and nervous before the conduct of the physical dissection activity. Most frequent response revealed that the learners were excited about opening a live specimen's body, seeing actual internal organs with their own eyes, and touching the parts with their own hands. A learner verbalized, "Excited and nervous, sir. Excited because we are finally dissecting and will see the actual parts; because it is very different in the virtual and in actual, where you can see it with your own two eyes. Nervous, because I hate frogs." On the other side, some were nervous because of fear and anxiety of handling live specimen and working on their internal organs. The second most frequent response revealed that there was also perceived disgust in handling the specimen; happiness, for having the opportunity to try the activity; and anger, as well as pity for the live specimen. One learner verbalized, "I felt disgusted because I don't like frogs, its skin…"

During the conduct of Froguts virtual dissection.
During the conduct of the Froguts virtual dissection activity, the learners reported difficulty Small parts of the specimen were difficult to locate on the computer, there was no way to control the process freely and some computers were slow. One said, "It was difficult to find the parts. they were small and there was a lot of it, so it's difficult to find. Then, it was so scary, especially the frog, I'm so scared." For some, having the second most frequent response, the dissection was easy and satisfying because of the narration, written instruction on the screen and details about the process and the specimen. A learner said, "For me, it was easy; but the internet connection also was very slow. It is easy if you read the instruction at the bottom; but the selection icons of the laboratory apparatuses were difficult to identify." The third most frequent response still revealed learners' fear of looking at the virtual specimen and disappointment due to the limited control and interactive feature of the software.

During the conduct of physical dissection.
The learners were pitiful at the same time excited during the conduct of the physical animal dissection. A feeling of pity for the live laboratory specimen being euthanized and opened up wherein some were even pregnant; and excitement to finally get a hands on and first-hand view of the real external and internal anatomy of the specimen. A learner verbalized, "I feel pity for the frog because they killed it. I feel nervous about the outcome and success of our activity." The second most frequent response showed that nervousness and worry for the success or failure of the activity were felt by the learners. A learner said, "I feel nervous… because what if we fail?" The third most frequent response revealed that few learners were amazed of the activity and find it cool seeing in actual internal organs of specimens; some were uncomfortable and found double pithing to be too harsh; some got angry with specimen euthanized; and some felt disgusted with foul smell from it.

After the conduct of Froguts virtual dissection.
The senior high school learners were happy and satisfied after the conduct of the virtual animal dissection. The success of the procedure gave thoughts that it is no longer necessary to do physical dissection. A learner verbalized, "I feel happy because it's done, even though it took me 2 hours because the internet and our laptop lags a lot and crashed often." Physical discomfort was reported as the second most frequent response due to prolonged exposure to computer screen and sitting. The rest of the learners reported that they were challenged in doing the activity as it requires active decision from the user before he can proceed to another step in the process.

After the conduct of dissection.
The learners were happy for the success of the conduct of the physical dissection activity; while few learners felt pity and sad for the euthanized specimen. One learner verbalized, "I feel relieved after the dissection because it is finally done. After the dissection I just feel relieved."; while another one said, "I also feel happy and pitiful because of the eggs that we removed." The third most frequent response revealed that some learners were motivated and were excited to have more dissection activities.

Dissection approach preference.
Seventy-eight out of one hundred eighty learners preferred Froguts Virtual Dissection. They preferred the approach because of the simplified process, detailed content, elaborate images and for the fact that they won't have to feel bad about killing a specimen. A learner verbalized, "Virtual is better because I admit I am not very familiar with many parts. In the

virtual, there are guides that make identification of the parts easy especially those that I do not know yet." The survey conducted to all learners in the study also revealed that Froguts virtual animal dissection was least preferred. Most learners preferred physical animal dissection over virtual animal dissection because of the real, richer experience, measurements and data it can give them. A learner said, "Actual is better because experience is the best teacher. Although virtual is informative, I don't think it is effective in giving rich experience." Furthermore, a few preferred both depending on the focus and priority learning area of the learner.

Theme 3: Psychomotor domain.

The students perceived the conduct of the dissection activity as an activity that was challenging physically but effective in giving experiential and hands-on learning. The table further revels that the challenges and difficulties encountered by the learners in the conduct of the virtual animal dissection were mostly technology-related issues. The challenges in the multimedia environment was reported to have caused delays and confusions among learners in analyzing important details to complete the performance tasks. While solutions to these technical issues were available, these will continue to cause hindrances in virtual learning when unaddressed. The challenges and difficulties experienced by the learners in the conduct of physical animal dissection were mostly related to the specimen and procedure. The reported challenges were expected in exploratory activities like dissection. There were very few reports of emotional or ethical issues. The reported challenges and difficulties were part of the performance tasks and learning process, allowable and could be easily corrected; and tolerable.

Challenges and difficulties with Froguts virtual dissection and physical dissection.

The learners' challenges and difficulties in the conduct of the Froguts virtual animal dissection were mostly technology-related issues, such as slow internet connection, computer's capability to run the program, screen resolution and size. A learner verbalized, "Our difficulties were, my laptop won't play froguts, internet was slow, so I connected to other Wi-Fi source. It was not ready to run the froguts app because it didn't have an adobe reader. Yes (we were able to continue)." The second most frequent response showed that some learners had problems with the program narration and instructions while the rest reported no difficulties during the conduct of the activity. A learner said, "The difficulties are that other computers were not working well, and the internet connection was slow. It's good (identification of parts) but the text or the information is too fast. Especially that we don't have a good speaker." The learners' challenges and difficulties in the conduct of physical animal dissection were mostly related to the specimen and procedure. The size of the specimen, and the process of cutting open, locating and identifying the real parts. A learner verbalized, "In squid dissection, my challenge is that I can't accept the fact that it was smelly and it's dirty that's why you cannot really see the parts. In the frog dissection, the most challenging part is that because our frog is pregnant, so the parts are spread out, it was difficult for us to separate the ovary from others." The second most frequent response showed that learners had issues with some apparatuses and equipment being blunt, blurred and in poor condition; as well as emotional issues such as feeling of fear and disgust in handling or touching real specimen. Another learner verbalized, "We had problems with the apparatuses in the dissecting kit. The scalpels were blunt and scissors were blunt; and the magnifying lens was blurred. Our specimen was also a bit small."

4 Conclusion

From the findings in this study, it can be concluded that Froguts Virtual Animal Dissection is an effective alternative to Physical Animal Dissection. The Froguts Virtual Animal Dissection Approach was more effective than the Physical Animal Dissection Approach and the learners perceived that there were effective alternative approaches to physical animal dissection such as the Froguts virtual animal dissection in learning anatomy and physiology. These alternatives can be more accessible, emotionally and morally acceptable, informative, and educational. However, majority of the learners preferred physical animal dissection over virtual animal dissection because of the real, richer experiences and data the approach provides; and the technical/technology-related problems and limitations reported by the learners as downside of the Froguts virtual dissection method.

The alternatives to physical animal dissection approaches can be adopted in science dissection activities by science teachers. The varied approaches, such as virtual animal dissection provides more effective, accessible, emotionally and morally acceptable and informative way of learning Anatomy and Physiology. The alternative activity could serve its educational purposes well, eliminating unnecessary risks of chemical and physical hazards, animal welfare act violations, and psychological and emotional distresses among learners. Science teachers should utilize Information and Communication Technology (ICT) as it is an important means of learning among millennial learners, anchored in the K-12 curricular paradigm. To better realize efficient utilization, the teachers should be given training, seminars and continuing courses to identify, acquire or develop or participate in developing virtual laboratories or Computer-aided instruction materials such as science computer applications by the government or non-government Organizations (NGOs) to improve and create more realistic, interactive and innovative computerized programs like virtual laboratories for scientific learning and instruction. The schools are the main training grounds of teachers. Thus, school administrators should enhance ICT services particularly in the secondary schools and allow inter-disciplinary utilization to maximize its purpose.

Pursuant to the Animal Welfare Act (R.A. 8485) in the Philippines, it is highly suggested that science teachers, other educators and school administrators be informed about the advantages of alternative methods of animal dissection and experiments to Animal Welfare and Human Welfare. Future researchers are in the frontline in investigating alternatives. They should investigate and evaluate further different virtual laboratories as to their completeness and suitability for a specific scientific instruction and study. Finally, since physical dissection approach was preferred by the learners over Froguts virtual dissection, alternating use of the physical and Froguts virtual dissection approaches in teaching anatomy and physiology is highly recommended by the researcher, as the two approaches both pose promising effects on improving learners' academic performance in science and biology classes.

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