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Talapang: An Augmented and Virtual Reality Frog Simulation Software in Teaching Introductory STEM Biology

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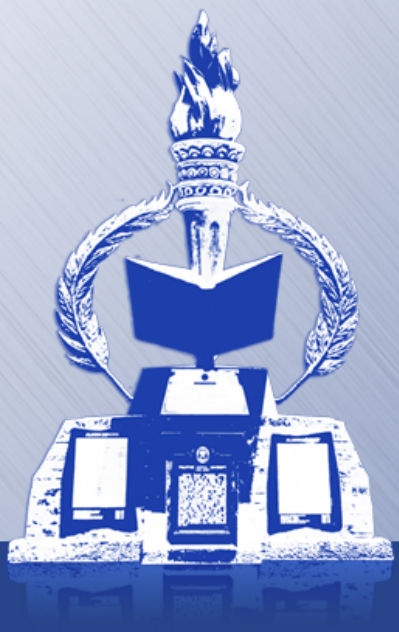

PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education

TALAPANG: AN AUGMENTED AND VIRTUAL REALITY FROG SIMULATION SOFTWARE IN TEACHING INTRODUCTORY STEM BIOLOGY

A Thesis Presented to the Faculty of
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In Partial Fulfillment
Of the Requirements for the Degree of
MASTER OF ARTS IN SCIENCE EDUCATION
Major in Biology

Maria Fatima L. Parro

2021

APPROVAL SHEET

This thesis entitled **"TALAPANG: AN AUGMENTED AND VIRTUAL REALITY FROG SIMULATION SOFTWARE IN TEACHING INTRODUCTORY STEM BIOLOGY"** prepared and submitted by **MARIA FATIMA LINAWAN PARRO** in partial fulfillment of the requirements for the degree of **Master of Arts in Science Education with Specialization in BIOLOGY**, is hereby recommended for approval and acceptance.

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DEDICATION

This study is dedicated to all the students who have encountered difficulties in learning Biology concepts. The researcher hopes that this study may help the struggling STEM Senior High School students to be motivated in studying Biology as their possible course in college.

To the researcher's newborn son, Ryan Parro Glore Jr., for giving her an inspiration to finish this research study. Her son's smiling face allowed the researcher not to give up her endeavors in writing her research manuscript.

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Last but not least, to the Omnipotent, Omniscient, and Omnipresent God, who serves as the researcher's last refuge in times of trials during the conduct of this research study. To Him who is Almighty, this thesis is lovingly dedicated.

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-M.F.L.P-

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ABSTRACT

Name : Maria Fatima Linawan Parro

Title of the Study : Talapang: An Augmented Reality and Virtual Reality Frog Simulation Software in Teaching Introductory STEM Biology

Key concepts : Educational technology, Augmented/ Virtual Reality, Frog Dissection

Degree/Specialization : Master of Science Education Major in Biology

Adviser : Professor Alfons Jayson O. Pelgone, Msc.

The research study seeks to emphasize the utilization of "Talapang" as an alternative for the traditional frog dissection method in order to meet the needs of the 21st century learners as part of the transition from the traditional to the technological advancement in science. At the beginning of the methodological procedure, needs assessment was done and students gave negative feedback on the traditional frog dissection method. Ethical issues in utilizing frogs for dissection was addressed through the development of the "Talapang" software. The software was validated by information technology experts having a mean value of 4.39 ("Very Good") and the biology experts having a mean value of 3.77 ("Very Good"). After validation, data gathering procedure was done among the 75 grade 12 STEM student respondents. According to the results of the study, it was surprising that the VARK results indicate that students who have read/write learning styles prefer using AR/VR and students with kinesthetic learning styles prefer module-based learning. Notably, there was an increase in the scores of students from pre-test to posttest. There was also a significant difference on the pre-test and posttest scores, no significant difference on the posttest only scores, and a significant difference on the students' intrinsic motivation level obtained from the sample groups. Also, positive feedback was obtained from student respondents after the intervention process. Hence, the research study was able to prove that "Talapang" could be an alternative tool in teaching anatomy to STEM students.

CHAPTER 1

THE PROBLEM AND LITERATURE REVIEW

"Virtual Reality is really a new communication platform. By feeling truly present, you can share unbounded spaces and experiences with the people in your life. Imagine sharing not just moments with your friends online, but entire experiences and adventures."- (Zuckerberg, 2014)

I. Background of the Study

The 21st century pedagogy is a requirement in enhancing the 21st century skills which involves three domains of knowledge-foundational (to know), meta (to act), and humanistic (to value). The foundational domain of knowledge focuses on the human brain, an important part of the human body which is responsible for the cognitive learning process. Hoque (2016) emphasized the cognitive domains of learning based from the Bloom's Taxonomy of Learning Domains which focuses on how a learner recalls, comprehend, utilize, distinguish, synthesize, and assess obtained information in the process of learning. This foundational knowledge focuses on core content knowledge, cross-disciplinary knowledge, and information, communications, and technology (ICT) literacy so that learners, who are considering themselves as digital natives, would be able to meet the skill qualifications that are needed in the workplace such as analytical thinking and innovation, active learning and learning strategies, complex problem-solving, critical thinking and analysis, creativity, originality, and

initiative, leadership and social influence, technology use, monitoring, and control, technology design and programing, resilience, stress tolerance, flexibility, reasoning, problem-solving, and ideation (Kereluik et al., 2013, Whiting, 2020). Enhancing the 21st century skills would enable students to become globally competitive as well. The development of an instructional material which would meet the standards of the 21st century skills in the Philippines through visual technology system such as augmented reality and virtual reality (AR/VR) would be highly commendable.

Overview of Augmented Reality and Virtual Reality (AR/VR)

The educational system in the Philippines should utilize some learning modalities that may simulate reality for Science, Technology, Engineering, and Mathematics (STEM) students as an alternative for the traditional frog dissection method. This particular reality is not just about the things that we perceive as real, but we could be able to convert this reality into something that is augmented or virtual. Among the Organization for Economic Co-operation and Development (OECD) countries, China, the leading performing country on the Program for International Student Assessment (PISA) 2018 results in science, has already invested $ 5.8 billion in the year 2020 on AR/VR technologies that they utilized on a classroom setting (Alsop, 2021). The United States of America (USA) has also spent $ 5.8 billion for the AR/VR technologies which is also utilized by the AR/VR schools there such as the Massachusetts Institute of Technology (MIT), Stanford University, University of

Southern California, New York University, Rochester Institute of Technology, Harvard University, among others (Alsop, 2021; Staff, 2021).

The concept of AR/VR in Philippine education is something new since only few schools are utilizing this technological platform in the teaching-learning process, most of which are private schools like the De La Salle University – College of Saint Benilde (DLSU-CSB) which can provide funds for this educational platform (Kolo, 2019). The Philippine Merchant Marine Academy (PMMA) was also able to immerse on AR/VR platform through the "Seaversity" (The Manila Times, 2021). Going with the flow of the technological advancement is a must for the 21st century learners in the Philippines and as part of the "Tech-Based Plans" of the Department of Education (DepEd) during the prevalence of the COVID-19 pandemic, the AR/VR technologies might be considered as part of their investments for the 21st century learners in the Philippines (Ponti, et al., 2021).

Did you know that there are some differences between virtual reality and augmented reality? The concept of virtual reality focuses on three different elements which would eventually make it virtual - visualizing, involving oneself in the medium, and interacting with the virtual world (Kuksa & Childs, 2014; Aczél, 2017). Augmented reality has some similitude with virtual reality but the image that it enhances resembles the real world. This would eventually lift up the pictured image making it realistic and three dimensional (Aniket, 2015; Hilliges et al., 2018). In Figure 1, there is an emphasis

on Paul Milgram and Fumio Kishino's reality-virtuality continuum wherein it emphasizes two opposing continuum- augmented reality (AR) and augmented virtuality (AV). Between AR and AV lies mixed reality which involves immersion on both real and virtual environments (Milgram & Kishino, 1994).

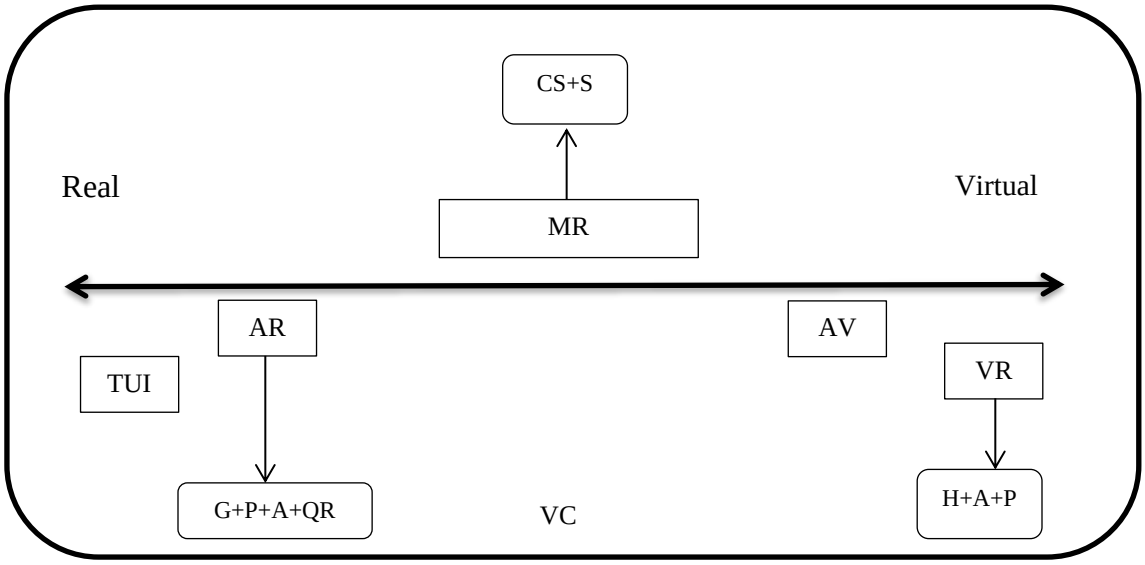

Figure 1. A modified version of Milgram & Kishino's Reality- Virtuality Continuum. *The MR (mixed reality) is in the middle of the real environment and the virtual environment. AR(augmented reality) and TUI (Tangible user interfaces) is closer to the real environment while AV(augmented virtuality) and VR (virtual reality) on the other hand, is closer to the virtual environment which is part of VC (virtual continuum). AR system functions with GG (google glass, P (phone), A (application), and QR (QR code); VR system functions with H (helmet), A (application), and P (phone); MR functions with CS (camera system) as well as S (sensors).*

This particular reality-virtuality continuum model in Figure 1 emphasizes the differences between the AR and VR system. The AR system focuses on the optical and spatial system through the use of spatial AR display and head-mounted display while VR focuses on immersive and semi-immersive system through SIVRD (semi-immersive VR display) and PBS (projection- based system) or HMD. According to

Alqahtani, et al. (2017), the VR system can be classified based on its immersion level-fully-immersive, non-immersive and, semi-immersive. The fully-immersive system enables the user to put on HMD as well as data glove. On the other hand, this so-called non-immersive system (Window on World system) is a desktop VR that does not require HMD for it to function. The semi-immersive system (hybrid system) is the combination of the desktop VR and the data gloves wherein the user had an interaction with the virtual world not only by projecting the image on a computer desktop view but also by wearing VR glasses, data gloves, and using joystick.

In terms of headsets as shown in Figure 2, both AR and MR utilizes Microsoft hololens. In AR system, google glasses, Meta 1 & 2 headset, or ODG headset are commonly utilized while in VR, it should be google cardboard, HTC vive, or Luckey's oculus rift.

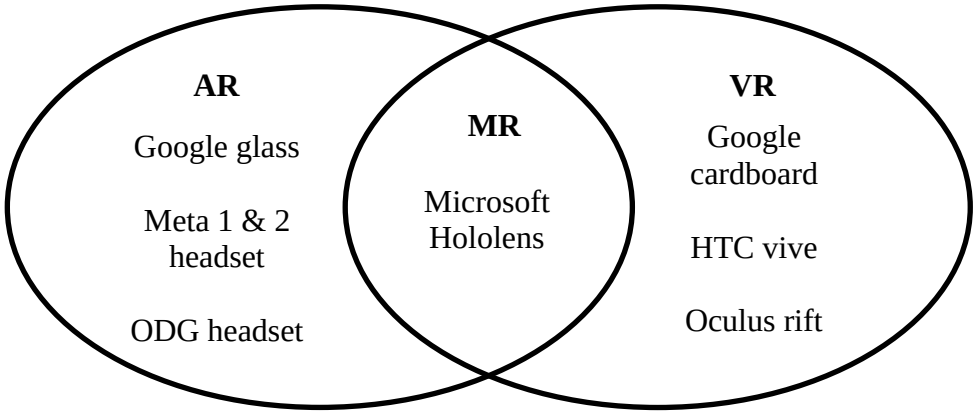

Figure 2. *Venn diagram of the differences among AR, VR, and MR headsets.*

Roots of AR/VR

The AR/VR system at present is a modern breakthrough in technology which came from simple inventions of brilliant people. A glimpse on the work of a 1516 panoramic art, "Sala delle Prospettive" in Villa Farnesina, Rome of the Renaissance painter and architect Baldassarre Peruzzi marks the history of the AR/VR world (Wiltz, 2015). In 1948, computer graphics technology was introduce through the Whirlwind system of Massachusetts Institute of Technology (MIT) during World War II (Peddie, 2013; Redmond et al., 1980).

In 1957, Morton Leonard Heilig, a cinematographer, created the Sensorama simulator, a kind of 3D video device and was able to patent it in 1962 (Brockwell, 2016). Then in 1967, Frederick Phillips Brooks, Jr. , an A.M. Turing awardee became the pioneer maker of the haptic display system (Yoshikawa & Nagura, 2006). After a year, Dr. Ivan Edward Sutherland, a computer scientist and Kyoto Price Laureate Awardee who is known as "the Father of Computer Graphics" created the first head mounted display or HMD system which is named as "Sword of Damocles" as shown in Figure 3 (Kostov, 2015). In 1971, Gouraud shading of 3D objects technique was introduced by Henri Goraud (Phong, 1975) and "Videoplace" by Myron Krueger was the first artificial reality laboratory in 1975 (Krueger et al., 1985). Later on, Jaron Lanier invented the first VPL VR gloves in 1979 then coined the term "virtual reality" in 1987 (Novak, 2011).

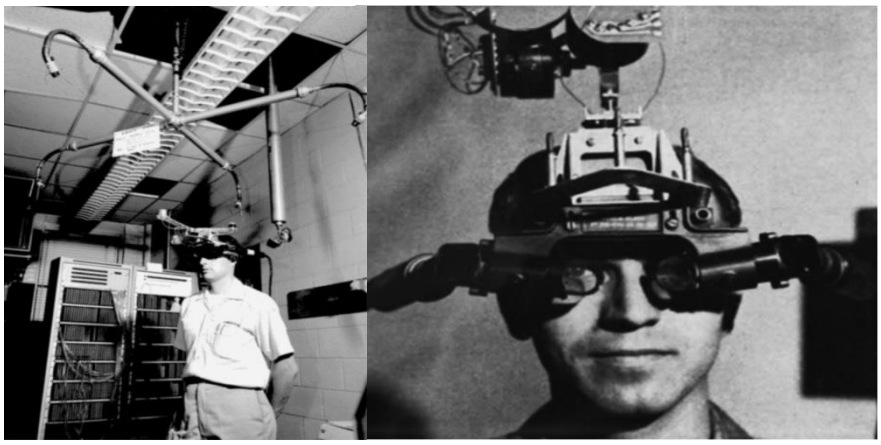

Figure 3. *Dr. Ivan Edward Sutherland's First HMD, Sword of Damocles*

After some time, a group of inventors namely Carolina C. Niera, Thomas A. De-Fanti, and Daniel J. Sandin created the CAVE or Cave Automatic Virtual Environment, a kind of VR theater (Niera et al., 1992). Then, Hirokazu Kato invented the ArToolKit, a tracking library for AR in 1999 (Kuusisto, 2015). In the year 2005, Unity Technologies lead by its CEO, David Helgason created Unity, a game engine platform which aids in the creation of AR/VR applications (Nguyen & Dang, 2017; Takahashi 2012). After this breakthrough was the creation of an affordable VR headset, oculus rift by Palmer Luckey in 2007. Oculus VR was then purchased by Facebook in 2014 for $2 billion (Chafkin, 2015). Recently, Qualcomm was able to launch Snapdragon XR1, a lowcost chipset for AR/VR headset (Matney, 2018). The breakthroughs in the field of AR/VR continuously advances through time from basic to complicated inventions as shown in Table 1.

Table 1
Tabular summary on the history of AR/VR technology.

Year	Summary of AR/VR Evolution
1516	**Baldassarre Peruzzi**: Panoramic Artworks
1948	**MIT**: Whirlwind's Computer Graphic System
1962	**Morton Leonard Heilig**: Sensorama
1967	**Frederick Phillips Brooks, Jr.:** Haptic Display
1968	**Ivan Edward Sutherland:** Sword of Damocles, 1st AR/VR HMD
1971	**Henri Gouraud:** Gouraud shading
1975	**Myron Krueger:** Videoplace
1979	**Jaron Lanier (VPL Research Inc.):** 1st VPL VR gloves
1987	**Jaron Lanier (VPL Research Inc.):** Introduced "Virtual Reality"
1992	**Carolina Cruz- Niera, Thomas De-Fanti, & Daniel Sandin:** 1st Cave Automatic Virtual Environment (C.A.V.E)
1999	**Hirokazu Kato:** ArToolKit
2005	**Unity Technologies:** Unity (Game Engine)
2012	**Palmer Freeman Luckey:** Oculus VR, Oculus Rift
2018	**Qualcomm:** Snapdragon XR1

The history of augmented reality and virtual reality was already presented, but little did we know that the start of this augmented/virtual reality platform in education began when the first VR headsets were commercialized in the market by videogame

companies in the mid-90s despite the fact that Dr. Sutherland's invention of the 1st AR/VR HMD in 1968 (Dede, 2008; Wikimedia Foudation, 2021) took place. These particular technological advancements became popular in mid-2010s due to the presence of festivals that introduces this particular platform (Infomineo, 2021).

Frogs, Dissection, and the Virtual World

Frogs are important part of the ecosystem. They play a key role in controlling pest populations as well as they indicate environmental health. They also aid in the prevention of diseases such as dengue since insects serves as their food. These frogs are also used in educational and medicinal researches. Sy (2014) has reported that frog species are part of the Philippine pet trade such as *Rhinella marina* that are used in dissection. Its taxonomic classification is shown in Table 2. In connection to this, frogs are well- known as one of the key species that are used in dissection.

Table 2
Taxonomic Classification of Rhinella marina (Linnaeus, 1758).

Kingdom	**Animalia**
Phylum	Chordata
Class	Amphibia
Order	Anura
Family	Bufonidae
Genus	*Rhinella*
Species	*Rhinella marina*

Dissection is the process of cutting apart a certain deceased species of animal. This process enables the students to identify frog parts which have some resemblance to the anatomical parts of a human being. Traditional cutting of frog specimen is still prevalent in Philippine school setting up to this moment leading to a demand for frog supply. Sy (2014) reported that there are already recorded 35 exotic frog species in the Philippines including *Kaloula pulchra* (Asian painted frog), *Xenopus laevis* (African clawed frog), and *Hylarana erythraea* (common green frog). These particular species of frogs continue to decline because of human inhumane dissections.

Dissection may present positive and negative impacts on educational outcomes. Based from the research conducted by McWatt, et al. (2020), it was emphasized that when it comes to "deep approaches to learning", "performance on laboratory oral assesments", as well as the mean "final grades" of the student respondents who participated on their research, dissection itself presents a minor but significant positive relationship among the variables which indicates that traditional method is still accepted at this moment for the students to learn better in the concept of anatomy. Another study conducted by Omar, et al. (2019) states that 60.9% of their student respondents and 83.3% of their teacher respondents have positive impact on the interest, motivation, knowledge, and comprehension of the aforementioned respondents. There were 39.1% student respondents and 16.7% teacher respondents who tend to dislike the dissection process due to the suffering that the frogs experience.

Meanwhile, based from the journal presented by Keniston (2021), dissection is the process of exposing the internal parts of the frog, then later on, there would be a feeling of queasiness and dizziness after smelling the formalin. The diseased animal is preserved in formaldehyde which is a chemical that may present harmful effects to the health of the student. There is also an issue on frog extinction can cause a threat in biodiversity and a problem in sustaining ecological balance. Lastly, dissection on a certain point of view teaches students how to be cruel to animals. This emphasized that Biology should not only be focused on studying about life but by teaching learners how to give value and respect to every living creature on earth.

In order to further address the issues on the impacts of traditional frog dissection on biodiversity and educational outcomes, the utilization of an alternative tool such as augmented and virtual reality in schools in order to teach frog anatomy is advised. Through this research, the effectiveness of the utilization of an AR/VR frog software named “Talapang” will be tested based on its effects on the students’ motivation and academic achievement.

II. Literature Review

This part of the research paper discusses about the different theoretical concepts and related literature either local or international which is relevant to the conduct of the study.

The Philosophical Milieu

There are different theories which serve as a basis for augmented reality and virtual reality utilization as a digital instructional tool in teaching students so that they could be able to comprehend the subject matter that they are learning well (Wilson, 2012; Cochrane et al., 2017). Presented below are different literatures which involve the theoretical evidence that support the conduct of this research.

Fleming's VARK Learning Theory. Different students have 4 VARK modalities of learning which involves visual, auditory, read/write, and kinesthetic (Fleming, 2006) as shown in Table 3. This is the reason why, teachers should identify ways on discussing the content of the subject matter in a very interesting way through advanced pedagogy and innovative teaching techniques. The VARK method is utilized by different researchers in order to measure the learning styles of students up to this date (Fahim, et al., 2021).

Based on the study of Chandrasekera & Yoon (2018), the VARK learning style was identified in each respondent to detect the effect of utilizing the

AR/VR system. They found out that visual and kinesthetic learners prefer the use of AR rather than VR. In the study, the technological acceptance value of AR is greater than VR. This particular study generally indicates that AR interface is more recognized and preferred by student respondents having different learning styles than VR interface.

Table 3

VARK Learning Process Tendency as adapted from Othman & Amiruddin (2010)

VARK	Learning Process Tendency
Visual	Looking at visuals like pictures, graphs, and videos. *The student has a difficulty completing notes during the learning acquisition process.*
Auditory	Listening to audio like music, verbal lecture or discussion, and other sounds. *The student prefers aural way of learning.*
Read/Write	Looking on words to acquire information. *The student prefers writing during the acquisition of knowledge.*
Kinesthetic	Moving the body through different engaging activities such as moving, sensing, and grasping objects. *The student prefers practical tasks, hands-on activities and experiential involvements.*

Constructivist Learning. Every student learns constructively through experiences. There are a lot of paper reviews that supports the notion that virtual reality is a constructivist approach. One of which was the study of Onyesolu et al. (2013) wherein

they emphasized that utilizing virtual simulations would support constructivist learning. According to Bilbao et al. (2012), constructivism promotes learning that is not teacher-centered but it should be student- centered so as to emphasize Dewey's Transactional constructivism about perception an influence of an organic response. There is a process of acquiring knowledge through perceived objects in order to develop intrinsic motivation among learners. Teachers' role is just to facilitate learning among students during the entire time of instruction.

Constructivism had a significant influence on virtual design technology which is utilized on the educational setting. Leman et al. (2012) suggests that immersing the students in an active learning of virtual technology application allows student engagement from exposing into the design until processing the content of the design which is typically not present on a real- world setting. This focuses on the learner itself and how the knowledge is transferred from the virtual view to the cognition of the learners itself. According to Černý, et al. (2019), this constructivism approach is true for AR/VR especially in relation to those students having intellectual disability.

Bandura's Model of Observational Learning. From the point of view of Bandura (1976), observational learning focuses on how the observer mimics the behavior of the learner especially in terms of aggression. Take note that Merz-Perez & Heide (2004) emphasized that aggression to animals such as frogs promotes violence against human beings. In order to back up the previous claim, the study of Henry (2004), engages the

students on different kinds of animal cruelty would have some sort of significant relationship with the development of an anti-social behavior. Among the participants of the study, it was reported that among the 26% of the respondents who have observed animal cruelty were able to become cruel to animals as well. The 10% who did not observe cruelty to animals were not involved in acts of animal cruelty. Most of the participants who did acts of cruelty have mimicked the given act from their observation. The highest number of respondents who observed animal violence has an age bracket of 6 until 18 years old.

Blended Learning. AR/ VR system is a digital media simulation (DMS) is a student-centered tool which promotes deeper learning as well as student engagement. This particular DMS is a new concept on blended learning environment (Gandolfi, 2018). Blended learning is an instructional program which incorporates digital tools on traditional classroom instruction. As shown in Figure 4, Mumtaz et al. (2017) presents the framework for blended learning with the use of augmented reality. This particular model have addressed whether utilizing blended learning with AR would convert it into blended AR learning. This also tackles the different learning benefits of utilizing blended AR learning. Based on the study, it was found out that students who are immersed on blended AR learning promote student comprehension as compared to classroom lectures only. Utilizing AR in blended learning was able to enhance the motivation of student respondents. The blended AR learning is proved to be an effective way for students to learn.

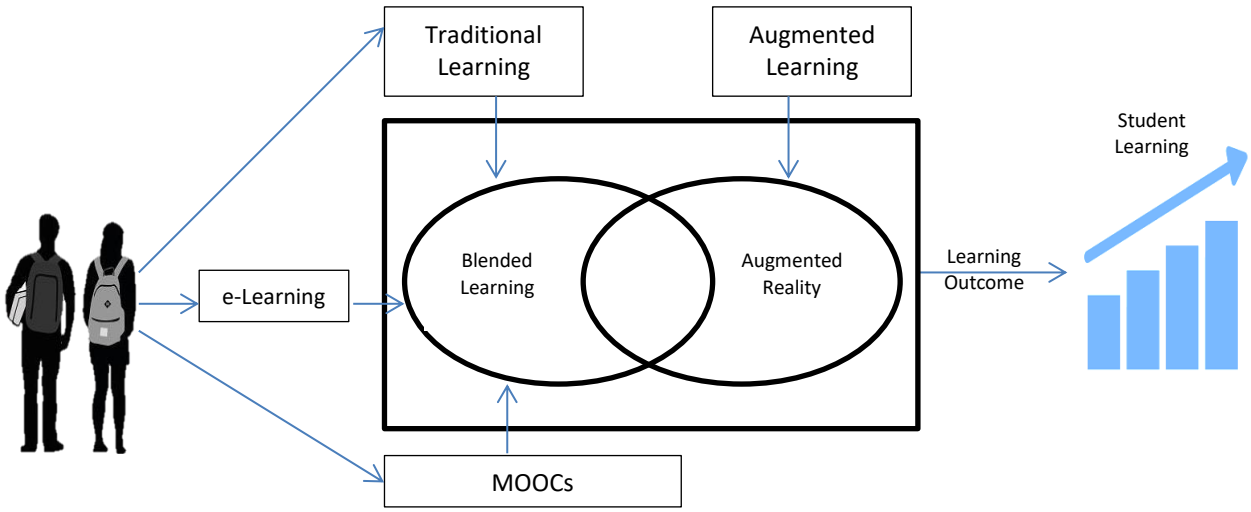

Figure 4. *Blended Learning Framework using AR, Mumtaz et al. (2017)*

Siemens Connectivism. The idea of producing AR/VR software is linked to the concept of connectivism wherein it focuses on the learning that is acquired from the utilization of a technology. Through this particular technology, learning is not idiosyncratic as well as a connection is established from the technology content itself to the receiver of the information which is the learner per se (Siemens, 2004). According to Kropf (2013), there are different ways on how a learner obtains information on the digital age. It can either be through online classrooms (online libraries, MOOCs, or LMS), Social Networks (Twitter, Facebook, Pinterest, You Tube, Blogs, Podcasts, or Videocasts) and Virtual Reality Learning Platform (second life, video games, web conferences, virtual open houses or virtual field trips). This would also indicate that since virtuality is patterned from the connectivism learning theory and/ or instructional theory, there is a notion that utilizing this software would have a significant effect on improving the

higher order thinking skills of learners. On the work of Scavarelli, et al. (2021), the connectivism approach in order to make a theoretical foundation towards the creation of educational frameworks for AR/VR was emphasized there.

Koehler & Mishra's TPACK. Fragkaki (2020) emphasized the "TPACK Instructional Design Model" which focuses on 3 major domains- Technology Knowledge (TK), Pedagogy Knowledge (PK), as well as Content Knowledge (CK). The PK focuses on the students' comprehension on the subject matter after the utilization of AR/VR educational technology. The PK should go hand in hand with the TK so that the students could be able to utilize the AR/VR well during the learning process. The CK then emphasizes the prior knowledge of the students on the contents of the subject matter that is helpful to them during the intervention process.

The utilization of the AR/VR Application serves as an educational technology which be utilized by the students while learning the subject matter. But before the students could be able to utilize the software well on a classroom setting, the teacher should be able to have a full grasp on how to utilize properly the AR/VR software so that when the time comes that it must be a part of the instruction, the teacher could be able to explain well to the students on how to utilize the given software properly. As mentioned earlier, the PK, TK, and CK must be put into consideration in the AR/VR educational technology which is intertwined on a Venn diagram as shown in Figure 5 (Koehler et al., 2017; Mishra & Koehler, 2006).

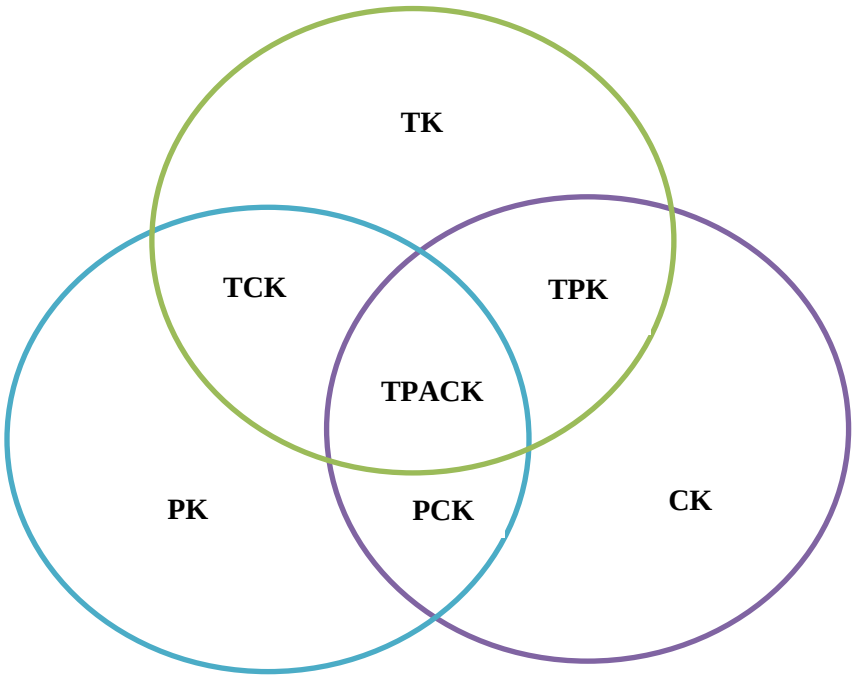

Figure 5. Koehler and Mishra's TPACK*. The TPACK framework focuses on the 3 major domains which are Technological Knowledge (TK), Pedagogical Knowledge (PK) as well as Content Knowledge (CK). The different domains are intertwined resulting to Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Pedagogical Content Knowledge (PCK).This would then be merged into the Technological Pedagogical Content Knowledge (TPACK).*

Puentedura's SAMR. Based from the statements obtained from the study of Romrell et al., (2014), another framework of utilizing technology such as AR/VR on a classroom setting is popularized by Dr. Ruben R. Puentedura. There is a SAMR model of utilizing AR/VR technology. The SAMR model starts with enhancement which focuses on substitution and augmentation. Substitution utilizes the digital technology having no practical effect. Augmentation on the other hand, focuses on the digital technology which is utilized leading to practical development. After the process of enhancement,

there should be transformation which focuses on modification and redefinition. In terms of modification, it focuses on the restructuring of tasks after which would be redefinition which involves the formation of new tasks.

Assessing the Need on AVFDS Development

The implementation of the Senior High School (SHS) program of the Department of Education (DepEd) offers different tracks that would prepare the students for college life. The Science, Technology, Engineering, and Mathematics (STEM) track aligned with the science- related courses in college that the students might enroll in. These STEM students may opt to study science and math-related courses based from CHED (2016) such as Biology, Biotechnology, Physics, Mathematics, Chemistry, Nursing, Medical Technology, Physical Therapy, Pharmacy, Medicine as well as Dentistry or engineering- related courses such as Genetic Engineering, Chemical Engineering, Electronics and Communications Engineering, Mechanical Engineering, Electrical Engineering, as well as Civil Engineering.

Based on the study of Garcia et al., (2017), there is only 1% particularly 1 student among the 91 STEM student respondents of the University of Batangas who wanted to take-up Biology in college because most of them, approximately 63%, wanted to take up a career in Engineering. This is not surprising since there are only few students observed on different schools in the Philippines who are taking up Biology as their

course in college as compared to other courses. Not all STEM students will opt to choose Biology as their course in college which is considered as a preparatory course in Medicine. This is the reason why the STEM students should not be forced to dissect a frog since not all courses in college involves the utilization of frog dissection.

Meyer, et al. (2020) emphasized that choice of college course is affected by student-related variables as well as institution-level variables. These are academic interests, institutional prestige, cost, acceptance, social aspect, and the like. According to Pascual (2014), there are different factors that affect the choice of the students on a college degree. Based on the results of the study, the students prefer to enroll in science-related courses as compared to agricultural-related courses because of the availability of job opportunities after graduating in College. However, it was emphasized in the study that these students lacks motivation because their skills are not patterned on the courses that they wanted to take. It was not emphasized on the study what particular science-related course is mostly preferred by students.

There are different topics which are part of the General Biology II subject of STEM program. This includes Genetics, Evolution and Origin of Biodiversity, Systematics Based on Evolutionary Relationships, Organismal Biology which focuses on Plant and Animal Organ Systems. The Talapang contents will be focusing on Organismal Biology under the General Biology II subject because Tekkaya et al. (2001) proved on his study that 20.7% among the student respondents are having

a difficulty studying the digestive system and 21.2% on circulatory system, 22.6% on excretory system and 15.2 % on respiratory system which are different organ systems under organismal biology. According to the results of the study conducted by Çimer (2011), concepts in Biology are really difficult for students to learn due to the lack of instructional resources. Through the utilization of the Talapang software, there would be a chance of increasing the number of STEM students in choosing Biology as their course in college as well as provide a way to make it easier for Biology students to learn the concepts of Biology specifically Organismal Biology.

Issues with Traditional Frog Dissection

Dissection of frog species like *Xenopus laevis* and *Rhinella marina* are still utilized as part of the dissection process up to this moment (Porro & Richards, 2017; Ynot, et al., 2017). Students were not given a choice whether to dissect or not since it is part of the school curriculum. That is why there are approximately millions of frog species that are dissected per year which may lead to its extinction (Oakley, 2011). The study of Besoluk & Demirhan (2016) had emphasized the perspective of sophomore science teachers who have already experience dissecting frog species. They showed positive reactions such as being curious, interested, and excited in conducting the experiment. Negative reactions were also shown such as the feeling of disgust, stress, fear, sadness, and displeasure. They had also lost their appetite, felt queasy and dizzy, their hands trembled while performing the experiment and their mouth dried. McCollum

(1988) disagreed on the utilization of dissection on a classroom setting not because of the negative feelings of disgust and displeasure but because he gave emphasis on lecture method in teaching anatomy which caused student's scores to increase as compared to dissection process based from the data that he had presented on his research.

Blazer (2015) emphasized that frog dissection is considered an act of animal cruelty though it may be legal to some countries like the Philippines but only for the purpose of research. He also reiterated that according to the People for the Ethical Treatment of Animals (PETA), dissection process is not ethical and not moral. Though this particular dissection process may present some advantages like promoting hands-on involvements to learners, promoting the acquisition of certain skills like time management and task organization, introducing laboratory techniques to students who wanted to pursue Medicine, and last but not the least is promoting real- world experiences with real frog specimen.

Frog dissection may cause emotional disturbance that it causes students. Animals also experience pain like what human beings experiences that is why, animal dissection and/ or vivisection promotes harm to animals as well as the environment. This process also gives students the idea that animals are just disposable organisms. The cost of frog dissection is more expensive as compared to virtual frog dissection. Another common concern of students in dissection experiments would be the exposure to formalin which causes them to have different health problems. Among the 75 responses,

58 students complain about formalin's "unpleasant smell". There are also 43 students who had "runny or congested nose", 38 students had "redness of the eyes" and 34 students had "unusual tiredness or dizziness". Some of the symptoms among students who performed the dissection experiment includes, "excessive lacrimation", "prolonged sleeping time", 'itching or sore eyes", "disturbance of sight", "unusual thirst", "respiratory distress", "dry or sore throat", "nausea", "headache", "disturbed nocturnal sleep", "dry or sore nose", 'low assimilation", "GIT disturbance", "syncope (fainting episode)", 'skins eruption", as well as "itching or sore skin on hands". This particular chemical would eventually cause health hazards on students (Blazer, 2015; Onyije & Avwioro, 2012).

Formalin is an aldehyde which also known as formaldehyde (CH_2O) or methanal (systemic name), a transparent chemical which is used to preserve tissues or cells of different organisms. This particular chemical disinfects parasites, fungi, and bacteria. This is also utilized in the manufacture of resins. It would also be helpful in embalming human cadavers, reducing sweat production or perspiration, as well as a raw material in making Marquis reagent (Reuss et al., 2002; McMurry & Simanek, 2008). The problem with exposure to formaldehyde is its toxicity. Inside the laboratory, students are exposed to the strong smell of formalin. This particular chemical present effects to humans. Some of its short-term effects would be dermatitis, optical damage, respiratory problems such as asthma, nausea and vomiting. It is a well-known

carcinogen which may lead to nasopharyngeal cancer, leukemia, and other respiratory diseases as its long-term health effect (Tang et al., 2009; Onyije & Avwioro, 2012).

Because of these reasons, there are countries which already banned dissection in schools such as Argentina in 1987, Slovakia in 1994, and India in 2001 (Balcombe, 2000). In 1999, Israeli schools also banned the use of dissection (Waltzman, 1999). Also, in 2005, most of schools in Italy have not used dissection in their curriculum. In the United States of America (USA) and Australia, there are certain policies which allows students to choose whether to dissect or not without giving them a penalty in their academic ratings (Balcombe, 2000; Monamy, 2017). These countries are also practicing alternative tools in dissecting a frog like Computer Assisted Instruction (CAI), augmented reality, and virtual reality.

AR/ VR in 21st Century Science Education

From the past researches, it was emphasized that there were alternative ways to teach anatomy without sacrificing the life of an organism and exposing the students to harmful chemicals such as formalin (Balcombe, 2000; Orlans, 1988). Though there are certain censures encountered with respect to the utilization of alternative ways in dissection since it does not promote experiential learning but there were certain studies that prove it otherwise.

Virtual reality and augmented reality in education provides a lot of benefits. One of which is to promote meeting between persons using a particular system even without seeing each other personally (Slater, 2000). Also, Rosenberger (2011) and Walling (2014) had defended the utilization of virtual dissection as an alternative and emphasized that virtual alternatives provide the best way in anatomy education. Merchant, et al. (2014) emphasized that learning outcomes was enhanced through the use of virtual reality- based instruction. With respect to student engagement in dissection, it was reported by Paretti, et al. (2008) that virtual frog dissection had enhanced student engagement in engineering students.

According to the study of Faller (2017), utilizing virtual reality and augmented reality serves as an effective motivation tool for the brain-computer interface (BCI). Virtual reality could be beneficial not only to students but also to people who have suffered emotional trauma specifically post- traumatic stress disorder. In connection to this, it has been proven by Juan et al.(2005) that this system would be an effective tool in treating psychological disorders particularly phobia. They have exposed patients with phobia of cockroaches and found out that the patient was able to conquer the phobia on cockroaches. Because of this, the AR/VR system might also be a cure to Ranidaphobia or students who have fear of frogs. This particular system is also used in psychotherapy trainings and treatments, neurosurgical trainings, and health education,

and SPED education (Beutler & Harwood, 2004; Lányi et al.,2006; Lemole et al., 2006; Ershow et al., 2011).

Immersing oneself on the AR/VR world would enable the students to learn how to know the different concepts in Organismal Biology, it would also help them learn how to do some fun-filled tasks so that they could be engaged on the topics being taught, this would also allow them to learn how to live together in order to build harmony with nature specifically with other living organisms that are abiding this planet. Lastly, this will allow learning to be a valuable tool for the enhancement of the 21st Century skills among Senior High School students.

Debates with regards to the utilization of species dissection or the use of dissection alternatives were presented since the early times. There are stands which go with the utilization of the original dissection process and some go with the alternatives. Osenkowski, et al. (2015) had reported that among their respondents, 76% of students and 84% of teachers are still utilizing dissection of species in their classrooms for the improvement of student performance. Unfortunately, there are certain ethical controversies with respect to utilization of the dissection method; slaying frogs for the sake of a science grade. These frogs also experience difficulties while they are captured and transported in the laboratory. These frogs also experiences pain and stresses especially when they are slain without the use of an anesthesia or any pain reliever (Bishop & Nolen, 2001; Blache, et al., 2008; Kolar, 2006; Oakley, 2009; Rosenberger, 1998; Sapontzis, 1995; Webster, 2014). These are the reasons why, Charles Hume's 3

Rs which are Reduction, Refinement and Replacement in the experimentation of animals or the alternative animal dissection method was proposed (Flecknell, 2002).

Figure 6. *Hume's 3 Rs to Consider in Animal Experimentation.*

Emphasizing on the 3Rs in animal experimentation as shown on Figure 6, the first R is to "Reduce". This indicates that the number of animals that are used in laboratory experiments should be decreased. Also, the second R which is "Replace" emphasizes on the use of alternative tools such as Talapang, the newly developed AR/VR frog dissection software to teach frog anatomy. The last R focuses on the different ways to "Refine" or minimize the pain and stress which the animals experience whenever scientists, researchers, or students conduct experiments using animals (Curzer et al. 2006; Flecknell, 2002; Zurlo et al., 1996)

Just as human beings have human rights, animals also should not be deprived of their animal rights. In the Philippines, we have a law which protects the rights of animals under RA 8485 / RA 10631, the Amended Animal Welfare Act. It emphasizes on the provisions of this Act under Section 6 that:

> *"It shall be unlawful for any person to torture any animal, to neglect to provide adequate care, subject any dog or horse to dogfights or horsefights, kill or cause or procure to be tortured or deprived of adequate care, sustenance or shelter, or maltreat or use the same in research or experiments not expressly authorized by the Committee on Animal Welfare."*

Unluckily, it was also emphasized on RA 8485 / RA 10631 under Section 6 No. 6 that:

> *"The killing of any animal other than cattle, pigs, goats, sheep, poultry, rabbits, carabaos and horses (*"deer" and "crocodiles" were delisted) is likewise hereby declared unlawful except when the animal is killed after it has been used in authorized research of experiments."*

This justifies that up to this moment that utilization of animals as part of laboratory experiments is allowed in the Philippines. That is the reason why, schools either private or public do not ban frog dissection regardless of ethical issues that it

have. Though this might be the case, there are so many Filipinos who are part of animal welfare and protection groups such as People for the Ethical Treatment of Animals (PETA), Earth Island Institute (EII), Philippine Society for the Prevention of Cruelty to Animals (PSPCA), Compassion and Responsibility for Animals (CARA) Welfare Philippines, Animal Welfare Coalition (AWC), Animal Kingdom Foundation (AKF) Inc., World Wildlife Fund (WWF), and Philippine Animal Welfare Society (PAWS) who are promoting the utilization of alternative ways in studying frog anatomy and physiology without sacrificing the frog's life.

Like humans, animals should also be protected and using alternatives would pave a way to promote the well-being of these creatures. Because of this, the Talapang software was carefully created and the contents were patterned based from the needs and the demands of the 21st century learners. The augmented and virtual world would exemplify the preservation of species since their lives would be spared in dissection and they could be able to fulfill their natural roles in the earth's ecosystem.

III. Conceptual Framework

The primary concern of this study was to develop an AR/VR frog software that would serve as an alternative tool in teaching frog dissection to Filipino STEM students. Figure 7 represents the conceptual framework of the study. This particular framework emphasizes the input-process-output model of the study along with the corresponding theories based on the developmental research which was conducted. This clearly depicts the different variables which were involved in the conduct of the study. There was the needs assessment at the start of the study prior to the development of the software. The students' perceptions were needed in qualitatively assessing if there would be a need to develop an AR/ VR software or not. After needs assessment, the software was developed using Unity by an IT expert. After the development of the said software, it was evaluated through different professionals who have expertise in the field of Biology as well as Information Technology. In connection to this, the Survey on the Newly Developed AR/VR software (SNDAVS) was given to the respondents.

The AR/VR software was tested in terms of its effectiveness in teaching Organismal Biology among STEM students in terms of its cognitive as well as intrapersonal domains of the 21st Century skills. Also, it was a requirement to have an assessment on the learning styles of the students - visual, auditory, read/write, or kinesthetic prior to the intervention process. After the assessing the VARK, there was an identification of preference among different STEM students. This process was able to identify if visual

learners prefer AR/VR group or individual learning than module only learning or vice versa. There was also an assessment of the students' perceptions with regards to the advantages and disadvantages of utilizing the AR/VR software. Though this research pathway, there would be an identification of the straight flow through with regards to the effectiveness of the newly developed Talapang software.

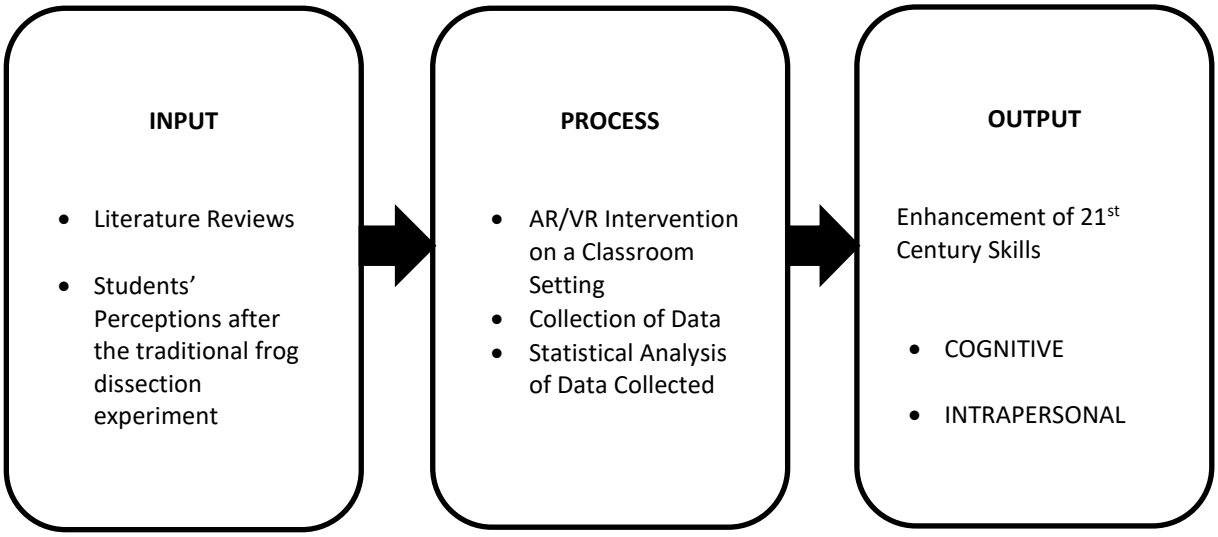

Figure 7. Conceptual Framework of the Study. *The study emphasizes the development and evaluation of the AR/VR Frog Software through the emphasis of the IPO model as the Conceptual Framework of the Study. This also shows the different variables which were part of the study.*

The path model framework as shown in Figure 8 emphasizes a path model which contains the pathways of the study from the needs assessment of developing an alternative instructional material in teaching frog anatomy. The needs assessment shall be based on the perceptions of the students who were able to conduct a traditional frog dissection experiment on a typical laboratory setting. The development of the AR/VR frog

dissection software followed. There were three groups which were involved in the intervention process. The first one was the module only, the second one was the AR/VR individual and the last one was the AR/VR group.

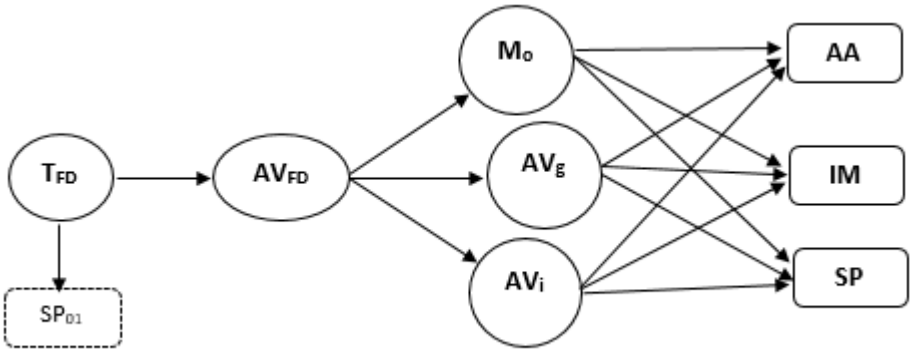

Figure 8. Path Model of the Study. *This illustration shows the needs assessment of Traditional Frog dissection (TFD) through students' perceptions (SP_{01}) which would be the main basis for the development and validation of AR/VR Frog dissection software (AVFD). The AVFD branches into module only (Mo), AR/VR group (AVg) and AR/VR individual (AVi). These concepts branch into academic achievement (AA), intrinsic motivation (IM) as well as students' perceptions (SP).*

The AR/VR software was tested in terms of its effect on the academic achievement (AA), intrinsic motivation (IM), and Students' preferences and perceptions (SPP). The results of the AA, IM, and SPP of the Module only group was compared to that of the AR/VR group and AR/VR individual. Data obtained was analyzed through descriptive and inferential statistics. The results of the given research was interpreted and presented so as to arrive with a conclusion.

IV. Statement of Purpose

This research study was aimed in identifying the effect of utilizing the AR/VR frog dissection software in enhancing the academic achievement as well as student engagement in the study of biology. Specifically, it seeks to address the following purpose:

1. Assess the Needs to develop an AR/VR frog dissection software.
2. Develop and validate the AR/VR frog dissection software.
3. Determine the pre-test scores and the VARK scores of the student respondents.
4. Determine the significant difference between the pre-test and post-test scores obtained from:

   4.1 Module only

   4.2 AR/VR individual

   4.3 AR/VR group
5. Determine the significant difference between the obtained Post Test scores among the Mo, AVi, and Avg groups.
6. Determine the significant difference among the intrinsic motivation (IM) scores among the Mo, AVi, and AVg groups.
7. Identify the student respondents' perceptions after they utilize the newly developed AR/VR frog dissection software.

V. Statement of Hypothesis

Based from the given research purposes, hypothesis are presented which focuses on the possible acceptance of the alternative hypothesis which states that P4 (4.1) H_1 There is a significant difference between the pre-test and the post-test scores obtained from module only; P4 (4.2) H_1 There is a significant difference between the pre-test and the post-test scores obtained from AR/VR individual; P4 (4.3) H_1 There is a significant difference between the pre-test and the post-test scores obtained from AR/VR group; P5 H_1 There is a significant difference between the obtained Posttest scores among the 3 groups (Mo, AVi, and AVg); P6 H_1 There is a significant difference between the obtained intrinsic motivation (IM) scores among the 3 groups (Mo, AVi, and AVg).

VI. Significance of the Study

This study focuses on the utilization of a newly- developed frog dissection software which is "Talapang" on the enhancement of academic achievement and intrinsic motivation which are part of the 21st Century Skills among Science, Technology, Engineering and Mathematics (STEM) senior high school students with different learning styles.

The conduct of the research study shall directly help the students specifically STEM Senior High School students in learning Organismal Biology particularly frog anatomy and physiology. This would eventually promote student-centered learning. Also, this would help teachers in the instruction process which promotes

an alternative tool in frog dissection experiment without risking the health of the students because of formalin. Also, this would eventually allow learners to comprehend the topics in Organismal Biology on a fun-filled way. The parents as the school's stakeholders would also benefit from this research since they could promote students learning to their digital native children even at their respective homes.

The Newly developed AR/VR frog software could also be utilized on museums as well as science exhibits that promote students' learning. The researcher also aims to freely endorse this tool to students not only in urban areas but also in rural areas. Through this software, there would be a change on the perception and motivation of different students under the K-12 program which serves the intention of promoting high quality education in the Philippines.

VII. Scope and Limitations of the Study

The study "Talapang: An Augmented and Virtual Reality Frog Simulation Software in Teaching Introductory STEM Biology" created since there was a need to focus on the scope of frog anatomy and physiology. Since the scope of frog anatomy is very broad, there is a need to limit the scope of the topics which would be part of Talapang software. The contents of Talapang software was also focused on the external and internal frog parts only. Speaking about the external frog parts, the researcher focused on 5 most common anatomical parts namely the snout, external naris, nictitating membrane, tympanic

membrane, sacral hump, thigh, shank, digits of toes and finger. In terms of the internal frog parts, it was mainly focused on the coelom and viscera. Most of the organs on the internal frog parts of the coelom belong to the digestive system. Specific organs of other organ systems which were part of the frog's coelom were also tackled such as the heart, kidneys, lungs, and the like. The human organ counterpart of the frog internal organs were also presented with its corresponding functions so as to compare and contrast human anatomy and physiology with that of frog anatomy and physiology.

The Talapang software can be utilized by students anywhere provided that the aforementioned software was already present on their phones, and they have the required materials like the VR glasses for it to function. The only problem is that the said software shall be passed by the teacher to the learners through the use of "share it" phone application on a close proximity. The Talapang software is difficult to transfer from the phone of the teacher to the phone of the learners on a far proximity. If you are a teacher who would opt to use the Talapang software, it would be better to meet your students first on a close proximity such as inside the classroom so that you can easily transfer the file through "share it". Make sure to transfer the Talapang software to your students first before you conduct your lecture. Also, the said software is only limited to android phones only since it cannot function on ios phones.

The respondents of the were grade 12 STEM Senior High School students taking General Biology II as their subject. Also, the General Biology II subject is offered

to STEM students which is already patterned on their possible course in college. This study could be a stepping stone in encouraging STEM students to choose Biology as their possible course in college.

VIII. Definition of Terms

In order to promote conceptual understanding of the study, the following technical terms are identified and defined:

- **Academic Achievement.** This pertains to the students' academic mastery of the topics that are discussed by the teacher. This measures the cognitive ability of a learner through a test.

- **Anatomy.** This pertains to the branch of science that focuses on the study and identification of different parts of a living organism for instance, a human being.

- **Augmented reality.** This pertains to a technological breakthrough which involves the generation of a real-like 3D image on the viewpoint of the observer.

- **Blender.** This pertains to the software which is used in making 3D models for the purpose of game development.

- **Cognitive.** This pertains to a domain of the 21st century skills which focuses on academic mastery, critical thinking, creativity, and the like.

- **Dissection.** This pertains to the process of cutting apart a deceased organism in order to examine its parts.

- **Extrinsic motivation.** This pertains to a type of motivation wherein the learner is encouraged to perform the activity due to a negative or positive reinforcement which may be a reward or a punishment.

- **Frog.** This pertains to an oviparous amphibian having moist glandular skin, 3-chambered heart, and 2 pairs of limbs for locomotion. These species can thrive both in terrestrial and aquatic environment as it metamorphoses from tadpole to an adult frog.

- **HMD.** This pertains to an acronym which connotes head-mounted display. This is a helmet-like device which is placed on the head in order to view 2D or 3D images.

- **Interpersonal.** This pertains to a domain of the 21st century skills which focuses on communication and collaboration, leadership, global awareness, etc.

- **Intrapersonal.** This pertains to a domain of the 21st century skills which focuses on growth mindset, learning how to learn, grit, as well as intrinsic motivation among others.

- **Intrinsic motivation.** This pertains to a type of motivation wherein the learner is encouraged to perform the activity due to personal causes such as self-interest and excitement.

- **Learning style.** This pertains to the different ways on how a student learns. This may either be visual, auditory, reading, or kinesthetic.

- **Oculus rift.** This pertains to a headset which is utilized to view virtual reality applications.

- **Perceptions.** This pertains to the utilization of the different senses of the body which would eventually lead to the cognizance of things.

- **Physiology.** This pertains to the branch of science that deals with the study and identification of each anatomical parts of an organism.

- **QR code.** This pertains to a 2D matrix barcode which serves as a trademark used in viewing 3D images for augmented reality.

- **STEM.** This pertains to an acronym which means Science, Technology, engineering, and Mathematics. This is a track under the Senior High school program of the K-12 Philippine education system.

- **Unity.** This pertains to a platform which aids in the development of 2D and 3D games.

- **Virtual glasses.** A kind of glasses that is worn by a person in order to view images that are three dimensional. This kind of glasses is pattered to view any virtual reality images only.

- **Virtual reality.** This pertains to an interactive computer system which involves a virtual world, immersion, and interaction.

- **Vuforia.** This pertains to a tool which aids in the development of virtual reality applications.

CHAPTER 2

RESEARCH METHODOLOGY

The research conducted is developmental in nature and aimed on the development of a new digital tool to meet the demands of the 21st century teaching and learning and enhance the 21st century skills towards global competitiveness.

I. Research Design

Triangulation method was utilized in this study having both autoethnography qualitative research and quasi-experimental quantitative research. The Initial assessment using the traditional frog dissection procedure was focused on the qualitative section of the research. After the development of the AR/VR software, triangulation method was utilized as shown in Figure 9. Triangulation involves qualitative observation, interview and reflective journal as well as quantitative pre-/post-tests and survey questionnaires.

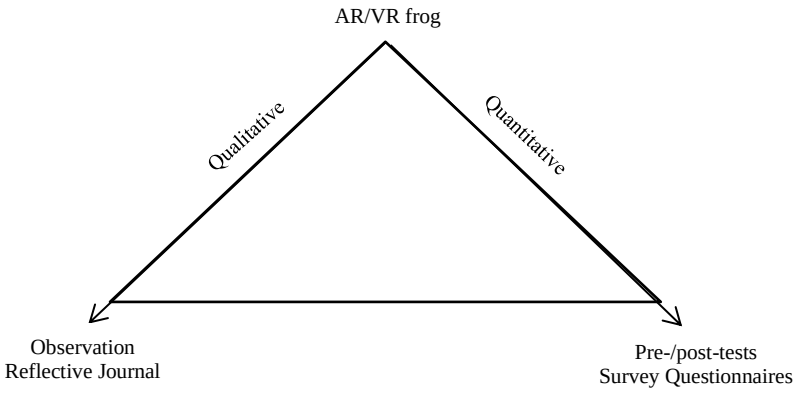

Figure 9. *Triangulation Illustration of AR/VR Frog Research Design.*

II. Research Locale

A. Initial Assessment

The Initial assessment was conducted among 122 grade 12 students from the University of the East, Manila. There were 57 male and 65 female grade 12 STEM students who participated in the initial assessment.

B. Software Development

An IT developer was commissioned to develop the software through Unity. The content of the said software was validated by content experts in biology as well as information technology (I.T.). Specifically, the Frog parts and functions would be verified by biology professionals and the Software itself would be verified by I.T. Professionals through the Survey on the Newly Developed AR/VR Software (SNDAVS).

C. Final Assessment

The effectiveness of the newly developed AR/VR frog software was tested among grade 12 STEM (Science, Technology, Engineering and Mathematics) students from the University of the East, Manila Campus. This is through the utilization of certain survey questionnaires as well as the pre test and post test exam papers which were administered to the aforementioned student respondents after the intervention process.

III. Sampling and Participants

The student respondents who participated in the study were randomly selected. Respondents were grade 12 STEM (Science, Technology, Engineering, and Mathematics) students from the University of the East, Manila. Respondents were heterogeneous having distinct pacing and learning styles. There were a total of 75 student respondents who participated in the study which were divided into 3 groups. This indicates that there were 25 student respondents for each group.

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IV. Instruments Used

There were various instruments which were utilized in the study. The first one was a Reflective Journal paper which was intended to identify the experiences of grade 12 STEM students after conducting their frog dissection experiment. After the development of the software through Unity, it would be validated using the evaluation by content experts in biology and information technology through their survey answers as well as comments and suggestions from the SNDAVS.

After evaluating the newly developed software, it was tested in terms of how it enhances the cognitive skills of student respondents through multiple choice (M.C.) tier pre-test and posttest as well as the intrapersonal skills of students through Intrinsic

Motivation Inventory (I.M.I.). The VARK questionnaire was administered to students to know if what learning style would fit each experimental group category (Mo, AVi, AVg). Last but not the least, a reflective journal was given to the STEM students to identify their perceptions after utilizing the AR/VR Talapang software.

V. Procedure

Initial Assessment of the Traditional Frog Dissection

Prior to the development of the AR/VR software, the researcher conducted the traditional dissection method to 122 grade 12 STEM (Science, Technology, Engineering and Mathematics) students which consists of 57 Male and 65 Female student respondents which are all heterogeneous. This was done per batch (3 batches) in order to identify the students' perception with regards to conducting the traditional dissection experiment in Philippine schools. The students were asked to write a reflective journal which would seek answers to the following questions:

1. What did you feel after you conducted the frog dissection experiment?
2. What did you like about frog dissection?
3. What did you dislike about frog dissection?
4. What are the difficulties that you encountered after conducting the frog dissection experiment?

5. What can you suggest so that other students like you would better learn the concept in frog anatomy?

Development

A. Search for Software Content and Content Writing

There was careful planning prior to the software content writing. The researcher conducted further research so that the word content of the software was considered correct and valid. After consulting with different related literature, the researcher was the one who wrote the contents of the module as well as the AR/VR frog dissection software which may be viewed in the appendices. The contents of the particular software was patterned and organized properly from the introduction, anatomical position, external parts, internal parts- coelom and viscera as well as the functions of each part.

B. Verification of Content

The researcher asked help from different professionals such as biology professors as well as I.T. experts so that the script content of the module as well as the software was verified properly. This is through the SNDAVS. The results obtained from the SNDAVS was analyzed prior to the intervention process so as to verify if Talapang could be utilized as part of the intervention process.

C. Software Development

The researcher asked a professional IT developer using Unity software to finish the development of the software. The overview of the summarized steps in the software development process can be viewed in Figure 10 below. Since the researcher doesn't know anything about the software development process or any of the C# codes, she just let the IT developer create the Talapang Software for her.

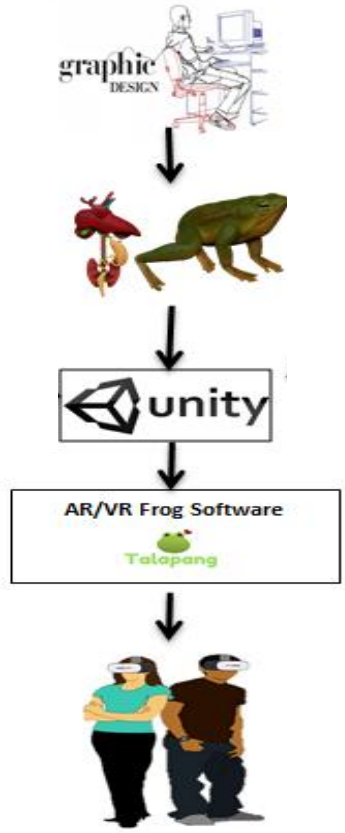

Figure 10. *Example of the Talapang Software Development Process through Unity.*

The software IT developer as well as the researcher signed as agreement that upon turnover of the software, the ownership of the said software would be transferred to the researcher already. Other terms and provisions are attached on the appendices part of this paper. The software would be subjected to further revisions if necessary.

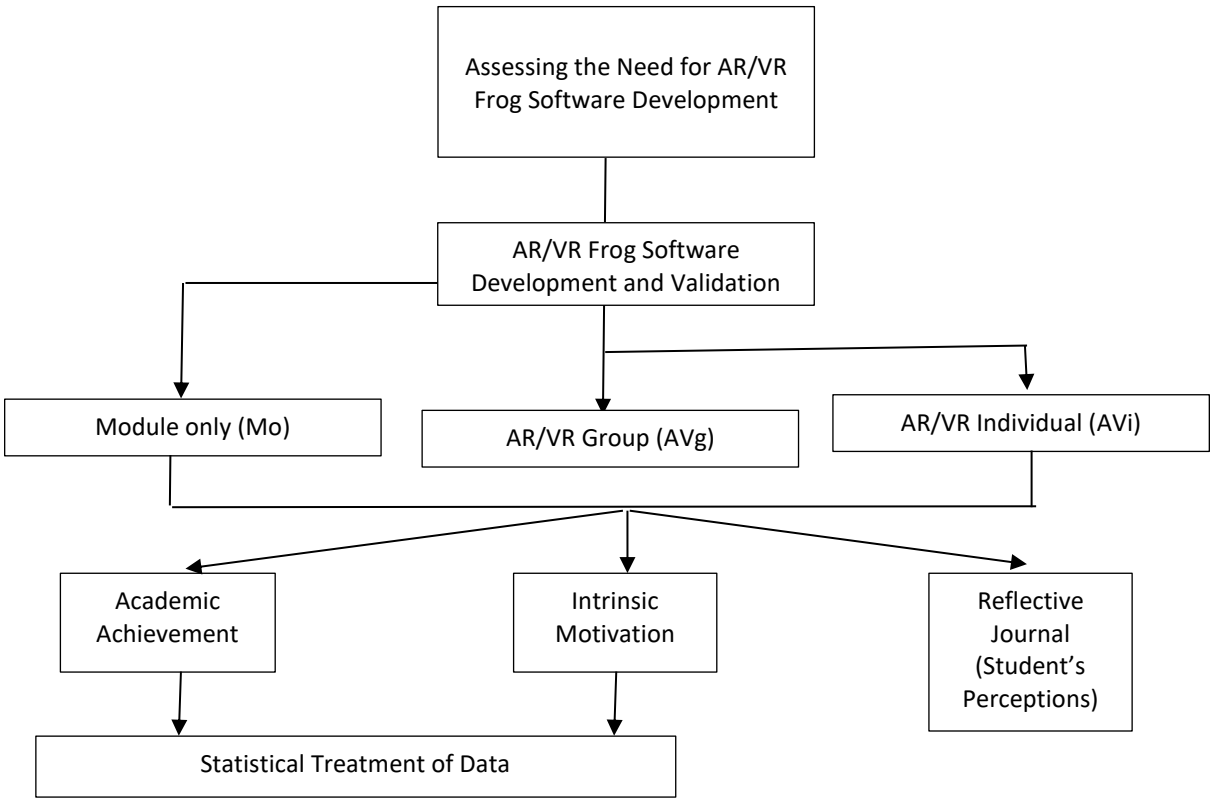

Figure 11. *Schematic Diagram of the Methodology Flowchart*

The developed AR/VR software was utilized on a classroom or laboratory setting. This Talapang software was utilized as an augmented reality application using a cellular phone or utilized as a virtual reality application through a cellphone placed on VR glasses. Take note that the phones that can be utilized using this application are only android

phones. The researcher as well as the respondents were able to interact with each other during the process of learning the concepts of Organismal Biology specifically frog anatomy and physiology. The schematic diagram of the methodology flowchart was shown in Figure 11.

D. Review, Evaluation, and Revision

The Talapang software was validated and evaluated by 3 Biology professors, 5 IT professionals. Revisions were done after the given software was viewed and reviewed by the content experts through their comments and suggestions. Analysis and interpretation of the SNDAVS responses of the content experts was made with the help of the SPSS software and with the guidance of a professional statistician. Once the researcher has an assurance that the newly developed software was ready to be utilized on the learners as an instructional material, there was the administration of a pilot test prior to the real assessment on the effect of Talapang software in enhancing the academic achievement as well as Intrinsic Motivation among STEM Senior High School Filipino students.

E. Software Utilization

This part of the methodology focused on the utilization of the Talapang AR/VR software on a classroom setting as part of the intervention process. First and foremost, the instructor must send the Talapang AR/VR software to the learners on a

close proximity through “share it” prior to the intervention process. Also, the instructor need to make sure that the instructions and precautions that were written on the module must be followed prior to the intervention process.

E.1. Instructions for AR (Augmented Reality Software)

The instructor must follow the instructions which were written on the module for the proper utilization of the augmented reality frog software. Listed below were the AR instructions:

1. Click the AR software on your cellular phone when given the cue.

2. Place the camera of your phone on top of the 2019 paper.

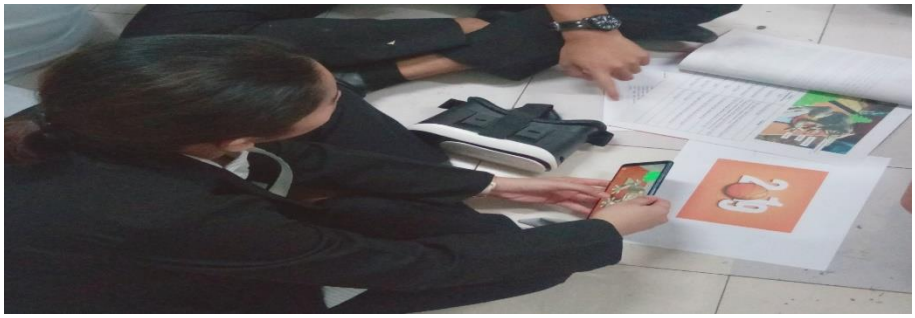

Figure 12. A Student Viewing the Augmented Reality Software. *A student placing the camera of the phone on top of the 2019 paper in order to view the augmented version of the frog.*

3. Wait for the frog to appear.

4. Use the module to guide you while studying the external anatomy of the frog through AR.

5. Exit the AR software once you are finished.

E.2. Instructions for VR (Virtual Reality Software)

The instructor must follow the instructions which were written on the module for the proper utilization of the virtual reality frog software. Listed below were the VR instructions:

1. Click the Talapang VR software on your cellular phone when given the cue.

2. Place the cellular phone on the VR glasses.

3. Place the OTG and mouse' USB on your cellular phone's port.

4. Turn on the mouse.

5. Put the VR glasses on your head but make sure you position your eyes o n the VR screen.

Figure 13. *A student with VR glass on is head.*

6. Move your head so that the dot in the middle of the screen that you see will be pointed on the START button.

7. Wait for the dot to become circle before you click your mouse on the START button.

8. On the screen, you can view already the picture of the frog as well as the TOOLS, PROGRESS, INSTRUCTION, and MENU buttons respectively.

9. Place the dot on the TOOLS button and click it using your mouse when the circle appears.

10. If you see the SCALPEL, click SIMULATE, then click NEXT.

11. If you see the SCISSORS button, click SIMULATE, then click NEXT.

12. If you see the FORCEPS button, click SIMULATE, then click NEXT.

13. Click ANATOMY.

14. You can see the frog's an atomical parts on your right side. Please take note of the organs and where it is located.

15. Then, click ORGAN DETAILS.

16. Move your face to the left so that you can see the organ details.

17. Click each organ and take note of the functions of it. You may use your module as your guide for accomplishing the entire process.

Figure 14. *Talapang VR software organs to be clicked in order to view its functions.*

18. Click the TOOLS again.

19. Click EXPAND to further view the frog parts.

20. Once you are finished learning the internal parts of the frog, click MENU.

21. Then, click EXIT.

22. You may now remove your VR glasses and place it on your table.

23. Remove your phone from the VR glasses and exit the Talapang App.

24. Remove all the accessory materials (OTG and mouse USB) that you place on your phone and place it on the table container where you got it.

25. Wait for further instructions

VI. Statistical Tools

IBM SPSS (Statistical Package for the Social Sciences) was utilized as a statistical tool for the statistical treatment of data. The study involved descriptive statistics as well as inferential statistics. Measurement of the significant difference between the pre-test and posttest scores of the students for each experimental group was measured using parametric paired samples t-test in addressing hypothesis 4 (h4). The significant difference between the three (3) experimental groups for hypothesis 5 (h5) and hypothesis 6 (h6) will be measured using one-way ANOVA. The students' perception was analyzed using thematic approach. When the researcher analyzed and interpreted the data, she asked help and guidance from a professional statistician.

VII. Ethical Issues / Considerations

As a researcher, there should be a governing principle with regards to the avoidance of harm to the respondents as well as other species which would be under the scope of her research. The first part of the research implementation will be focused on the acquisition of the perceptions of students after they conducted the traditional frog dissection experiment. The main ethical concern about this matter is the utilization of preserved frog species. The utilization of frogs in the dissection process would eventually lead to negative effects to the health of the student respondents. This would also present the issue with respect to utilizing animal samples in conducting experiments since these organisms have life and they have the

right to live. As discussed in chapter 1, the research of Flecknell (2002) focused on the Hume's 3Rs (reduction, refinement, and replacement) with regards to the utilization of animal samples in conducting laboratory experiments. This would be the reason why, on this part of the protocol, the need for the acquisition of respondents' perceptions with regards to the utilization of animals in conducting dissection experiments should be done.

On the second part of the research protocol, there would be the development of the augmented reality or virtual reality frog software. This would then require an IT expert and a graphic artist on the development process. The researcher and the developer would have an agreement on the form of a contract so that there would be some sort of intellectual property rights among the researcher as well as the developer itself. There would also a non-disclosure agreement between the different parties concerned.

After the development process would be already finished, there would be the validation of the said software through the responses of the different content experts. The only ethical issue with regards to this matter is the possible falsification of data which would be acquired when the specific data is already collected. Also, the validators might not be able to properly validate the software well, so the researcher must choose validators that are experts in their field of specialization.

If we would proceed to the third part of the research protocol, the implementation process would suggest a careful acquisition of students which would be part of the respondents through random sampling technique. The respondents should be STEM students who are taking up General Biology 2 as their subject. Students having different learning styles as well as different intellectual capacity will be part of the study. Also, the researcher would check if the respondents would have their own smart phones which would be utilized in the study. The only concern about this matter would be the possible bias between the responses of the respondents who would then be part of the research study itself. Also, the technology which would be utilized in the implementation of the study shall be checked so as not to avoid damage on the well-being of the respondents.

The main concern in most researches would be the issue about plagiarism. This would be focused on the process wherein the researcher copies a part of the work of another person without acknowledging the main author of that work. This is the reason why, the researcher herself should ensure that there would be proper citations with regards to the related literature which would be part of the research. Also, the issue on deception which focuses on hiding some data gathered from the research work itself for validity to be retained. That is the reason why, there is a need for a researcher to practice honesty and integrity at all times during the conduct of the research study itself.

On the aforementioned research, there was no conflict of interest involved in the study. Also, the researcher ensured that the data privacy of confidentiality of information was practiced on the entire duration of the said research study. Since the student respondents were senior high school students, a consent form was only given to minors who took part in the research study.

Researches should not only focus on the literature content as well as data presented but it should also focus on the ethical considerations so that there would be authenticity on its content. Researchers should know and identify what is “right” and what is “wrong” in conducting researches because as a researcher, conducting researches comes with ethical responsibilities that would then be the core factor of research manuscripts.

CHAPTER 3

RESULTS AND DISCUSSION

This chapter presents the results and discussions of the research conducted in order to address the specific objectives which were presented in the previous chapters. The respondents who took part on this research study were all Grade 12 STEM (Science, Technology, Engineering and Mathematics) students from the University of the East-Manila.

Phase I. Needs Assessment

Prior to the software development process, there was a need to allow the students to immerse on the traditional frog dissection process as shown in Figure 15.

Figure 15. *STEM 12 students immersing in traditional frog dissection*

After the dissection activity, the students were asked to answer a survey in terms of the traditional frog dissection process and their perceptions were collected based from the following questions:

1. What did you feel after you conducted the frog dissection experiment?
2. What did you like about frog dissection?
3. What did you dislike about frog dissection?
4. What are the difficulties that you encountered after conducting the frog dissection?
5. What can you suggest so that other students like you would better learn the concept in frog anatomy?

Among the 122 grade 12 STEM Senior High School students from the University of the East, Manila, selected answers of the students were chosen in order to prove that there was a need to develop a frog dissection software. Let's focus first of the perception of students for question number 1. Student number 6 said that, *"After the dissection physically I can say I was tired and a bit dizzy due to the smell of the formalin…"* The comment of student number 6 has a resemblance with that of student number 11. Student number 8 also said that, *"after the frog dissection experiment, I felt exhausted and dizzy but also felt satisfied because I was able to complete the task properly…"* Student number 10 said, *" I felt stressed because of the time restriction.*

There were so many tasks to do yet so little time." Student number 12 said, *"Dissecting a frog is new to me, thus, it's my first time to touch a frog to be dissected. As a newbie, it was terrifying since I have to open a frog."* There was this student number 17 who said, *"I actually felt light headed and a bit rugged because of the diffusion of formalin into the air. It's quite nice that I got to experience dissecting a frog but its difficult and I just wanted to experience that once in my lifetime."*

Student number 40 said, *"After the experiment, it feels tiring and kind of feels so bad for the frog."* The perception of student number 44 was really surprising, *"I felt sorry for the frogs we use, because they live to be dissected but, I learn things more about frog's body (external or internal) but, I hope I don't encounter class that dissects animals again. Kinda hurt my heart, Poor frogs."* Another respondent (student number 54) said, *" I felt ecstatic because I was able to identify their parts personally and see the wonders of the frog's body. However, it felt kinda off since I was piqued by my guilt as I partially murdered two frogs just to gain knowledge which I probably won't use in the future."* There was also resemblance with the perception of student number 67, *" I really felt pity towards the frog that I dissected. I feel like the frog does not deserve to be killed for academic purposes. I feel like it totally devalues the importance of life."* Student number 63 said, *"I felt disgusted because I'm not used to seeing animal guts and dissecting them."* Most of the students felt dizzy and cause difficulty of breathing because of the smell of the formalin.

In order to avoid bias, the researcher also asked the students what they liked about traditional frog dissection. Most of the student respondents like *"naming the different parts of a frog"*. Another respondent (student number 9) said, *" The part that I like about frog dissection is not the dissection itself but the part where we have to identify the names of the frogs or in other words label the internal and external parts of the frog itself. "* Surprisingly, student number 44 said, *"There is nothing I like about frog dissection like what I answered from the previous question."* Take note that student number 44 has a sympathy with that of frogs and she does not want to risk the life of a frog just for the purpose of learning Biological concepts. Student number 99 said, *" I did not like anything about having to dissect a frog. It made me realize that I do not like anything related to medicine."*

After asking what students like about frog dissection, they were also asked what they disliked about frog dissection. There were many students who do not want the smell of the formaldehyde because it was irritating to the eyes and nose and it causes dizziness or headache. Specifically, student number 6 said, *" What I dislike about the dissection is the smell of the formalin. It makes me feel dizzy a bit and my eyes were watery and irritated."* Student number 9 said, *" The part that I dislike most about frog dissection is the formalin. Because for me, in the duration of the experiment, I experience having an eye irritation, and on top of that, the smell of the formalin is so strong that even 3 face mask is not enough."* Student number 31 said, *" I don't like about the frog dissection is dissecting the parts of the frog and you can see the blood that flow in their body."* Maybe this student

has a fear in blood. Student number 37 said, *" What I didn't like about frog dissection is the strong smell of formalin because it gave most of us a headache aftermath. It is also making the experiment slow because it affects the performance of the students."* Student number 40 said, *" What I don't like about the frog dissection is pointing and pinning the heart of the frog and cutting its parts into pieces."*

The perception of student number 53 was, *"It is costly & it kills frogs that gives a great help to our environment."* Student number 54 said, *" The guilt that continuously bugging me as I dissect the frog. I don't like feeling like a murderer. I felt cruel."* Student number 67 also said, *"What I dislike most about frog dissection is how we kill frogs who are living peacefully. Just the thought of it makes me a little guilty especially that frogs are most rapid disappearing species in the wild." "Knowing that frogs have their own lives, they shouldn't be captured and cut their body parts for educational purposes. Many frogs are being killed for dissection. Also, the formalin that is used for the preservation of the frog's body is uncomfortable to our eyes and nose."* as reiterated by student number 75.

One of the difficulties that the students experienced while conducting the traditional frog dissection experiment was *"familiarizing the parts of the frog"* as stated by student number 3. Another comment by student number 6 was, *" First is I don't have enough pins to identify the given parts of the frog another is that if you cut open the frog the formalin bursts out and that the activity is time pressured."* Student number 8 also

said, *" The difficulties that we encountered after conducting the frog dissection is getting rid of formalin."* This was the same response of student number 9 and 13. Student number 18 said, *"The pain that I experienced because standing and moving for quite a while and the effect of the experiment to our brains." "I experienced a bit of dizziness after the frog dissection maybe because of the chemical exposure and the focus that the task demands"* as reiterated by student number 22. Student number 72 said, *" I had difficulty locating each part since the frog assigned was a bit small & the utensils (pertaining to dissecting tool like scalpel) I have used was not that sharp."* Lastly, student number 121 said, *"We find locating the internal parts of the frog difficult because they are near each other."*

In orther to address the difficulties that the students experienced when they had their traditional frog dissection experiment, we asked them to give their suggestions in order to identify a technique on how students like them would better learn the concept in frog anatomy. Student number 21 said, *" I think they should watch in VR first, it is like a simulation in virtual reality. After that, they should proceed in dissecting the frog, to see the physical appearances of the systems of the frog."* Student number 61 said, *" I suggest that students must see the activity as a fun activity rather than thinking that they're doing it for requirements."* Student number 97 said, *" Maybe modern technology can be used as an alternative for actual frog dissection."* Student number 117 also said, *"I suggest that they should pinpoint the parts of the frog and use VR so it feels like real to look."*

The perceptions of the students challenged the researcher to seek for an alternative learning tool that would serve as a replacement to the traditional frog dissection experiment. Learning by doing without risking the students' health in a fun and exciting way was the main reason why there was a need to develop an AR/VR frog dissection software. Also, kindly take note that there was no conflict of interest that affected the results of the said research study.

Phase II. Software Validation after the Development Process

After the software development process, there was a need to identify if the software developed passes the standards of the five IT experts as well as three Biology professors. The validators were asked to answer some questions based from their professional profile. The questionnaire was a Likert- scale type having 5 as the highest and 1 as the lowest. The code was 5 for Excellent, 4 for Very good, 3 for Good, 2 for Fair, 1 for Poor.

Prior to answering the questionnaire, the content experts were asked to write their profile. Table 4 presents the summary of the Professional Profile of the content experts for the validation purposes of the AR/VR frog dissection Software. Table 4 presents the Highest Educational attainment of each of the respondents. Most of them finished their Bachelor's degree majoring in their field of specialization. Only one respondent was able to finish his Master's degree.

Table 4

Tabular Representation of the Profile of Respondents for the Validation of AR/VR Software

Code	Affiliation	Gender	Educational Attainment	Utilized AR/VR Software in the Past	Number of years Using AR/VR (code)
IT Expert 1	PNU	F	Bachelor's Degree in IT	NO	0
IT Expert 2	PNU	M	Bachelor's Degree in Computer Science	YES	1-5 YEARS
IT Expert 3	UE Manila	F	Bachelor's Degree in IT	YES	1-5 YEARS
IT Expert 4	PNU	M	Bachelor's Degree in Computer Science	YES	1-5 YEARS
IT Expert 5	PNU	F	Bachelor's Degree in IT	YES	1-5 YEARS
Bio Prof 1	UE Manila	M	Master's Degree in Education	YES	1-5 YEARS
Bio Prof 2	UE Manila	M	Bachelor's Degree in Education	NO	0
Bio Prof 3	UE Manila	F	Bachelor's Degree in Biology	NO	0

Specifically, we noted on each indicator as well as their interpretation based from the responses of the respondents which can be viewed in Tables 5 and 6 respectively. Take note that Table 5 focuses on the responses of IT experts on how they were able to assess the AR/VR software while Table 6 focuses on the responses of Biology professors. Indicators were emphasized below each tabular representation of data. The interpretation was done based from the obtained mean scores as well as standard deviation. These data were necessary in order to emphasize if whether the Talapang software has quality or not.

Table 5

Interpretation of the IT Experts' Responses with regards to the AR/VR frog software

Indicators	$\overline{\chi}$	SD	Interpretation
1. Software originality	4.80	0.447	EXCELLENT
2. Helpful user interface	4.20	0.837	VERY GOOD
3. Easy manipulation	3.60	1.140	VERY GOOD
4. Free of erroneous information	4.80	0.447	EXCELLENT
5. Generation of an emotional reaction particularly excitement and amazement	4.60	0.548	EXCELLENT
6. Organized flow of information	4.00	1.000	VERY GOOD
7. Right placement of tasks	4.20	0.837	VERY GOOD
8. Correct sets of model figures and/ or illustration	4.60	0.894	EXCELLENT
9. Visual display hardware	4.40	0.894	VERY GOOD
10. Interaction and task involvement in the virtual environment	4.60	0.548	EXCELLENT
11. Ability to support multiple human users at the same time	4.00	1.225	VERY GOOD
12. Visual content	4.20	1.304	VERY GOOD
13. Could be used without additional interventions	4.40	0.894	VERY GOOD
14. Consistency of the sensory information of the virtual environment	4.40	0.548	VERY GOOD
15. Ease of usage	4.20	0.837	VERY GOOD
16. Time constraint of using the software	4.60	0.548	EXCELLENT
17. Colors seen on the virtual world	4.60	0.548	EXCELLENT
18. Sounds heard	4.60	0.548	EXCELLENT
19. Retention of information	4.60	0.548	EXCELLENT
20. User- friendly to Filipino students	4.40	0.894	VERY GOOD

Legend:

4.50-5.00	(5)	EXCELLENT
3.50-4.49	(4)	VERY GOOD
2.50-3.49	(3)	GOOD
1.50-2.49	(2)	FAIR
1.00-1.49	(1)	NEEDS IMPROVEMENT

As you can see based from Table 5 on the previous page, most of the responses of the IT experts were "very good" in terms of the helpful user interface, easy manipulation, organized flow of information, right placement of tasks, visual display hardware, ability to support multiple human user at the same time, visual content, utilization without additional intervention, consistency of the sensory information of the virtual environment, ease of usage as well as being user-friendly to Filipino students. There were "excellent" marks as well with regards to the software such as software originality, free of erroneous information, generation of an emotional reaction particularly excitement and amazement, correct sets of model figures and/ or illustration, interaction and task involvement in the virtual environment, time constraint of using the software, colors seen on the virtual world, sounds heard, and retention of information.

Table 6

Interpretation of the Biology Experts' Responses with regards to the AR/VR frog software

Indicators	$\overline{\chi}$	SD	Interpretation
1. Software originality	3.33	0.577	GOOD
2. Free of erroneous information	3.00	1.000	GOOD
3. Generation of an emotional reaction particularly excitement and amazement	4.67	0.577	EXCELLENT
4. Organized flow of information	3.67	0.577	VERY GOOD
5. Proper use of biological terms	3.67	1.155	VERY GOOD
6. Proper use of language of instruction	4.33	0.577	VERY GOOD
7. Right placement of tasks	4.00	0.000	VERY GOOD
8. Correct placement of labels	4.67	0.577	EXCELLENT
9. Correct sets of model figures and/ or illustration	4.33	0.577	VERY GOOD
10. Ability to support multiple human users at the same time	3.33	1.155	GOOD

11. Visual content	4.00	0.000	VERY GOOD
12. Comprehensible terms	4.00	0.000	VERY GOOD
13. Could be used without additional interventions	2.67	0.577	GOOD
14. Ease of usage	3.00	1.000	GOOD
15. Time constraint of using the software	3.67	0.577	VERY GOOD
16. Colors seen on the virtual world	3.67	0.577	VERY GOOD
17. Content applicable to SHS students	4.67	0.577	EXCELLENT
18. Audio quality	4.00	1.000	VERY GOOD
19. Software quality	3.67	0.577	VERY GOOD
20. Accessibility among Filipino students	3.00	0.000	GOOD

Legend:

4.50-5.00	(5)	EXCELLENT
3.50-4.49	(4)	VERY GOOD
2.50-3.49	(3)	GOOD
1.50-2.49	(2)	FAIR
1.00-1.49	(1)	NEEDS IMPROVEMENT

Based on the survey assessment in Table 6 made by the Biology professors, it seemed that they have a high standard in assessing the AR/VR frog software. They denoted that there were “good”, “very good”, and “excellent” points of the software. The “good” points were the software originality, free of erroneous information, ability to support multiple human users at the same time, utilization without additional intervention, ease of usage, and accessibility among Filipino students. The “very good” points noted were organized flow of information, proper use of biological terms and language of instruction, right placement of tasks, correct sets of model figures and/or illustration, visual content, comprehensible terms, time constraint of using the software, colors seen on the virtual world, audio quality as well as software quality. There were only few indicators which focuses on “AR/VR” as “excellent”. These were

generation of an emotional reaction particularly excitement and amazement, correct placement of labels, as well as content applicable to Senior High School students.

The researcher was able to obtain total value from the data gathered from SNDAVS. It shows that the mean value of the respon ses of IT experts in total was 4.39 or we can round it off to “4” which was equivalent to “very good” in terms of the software content of the developed Talapang AR/VR frog dissection software. On the other hand, the mean value of the responses of Biology professors with regards to the Biology contents of the Talapang software was 3.77 or we can round it off to “4” which was equivalent to “very good” in terms of the accuracy of the biological terms which were included in the AR/VR software. Figure 16 shows the summary of the average responses per question of the content experts.

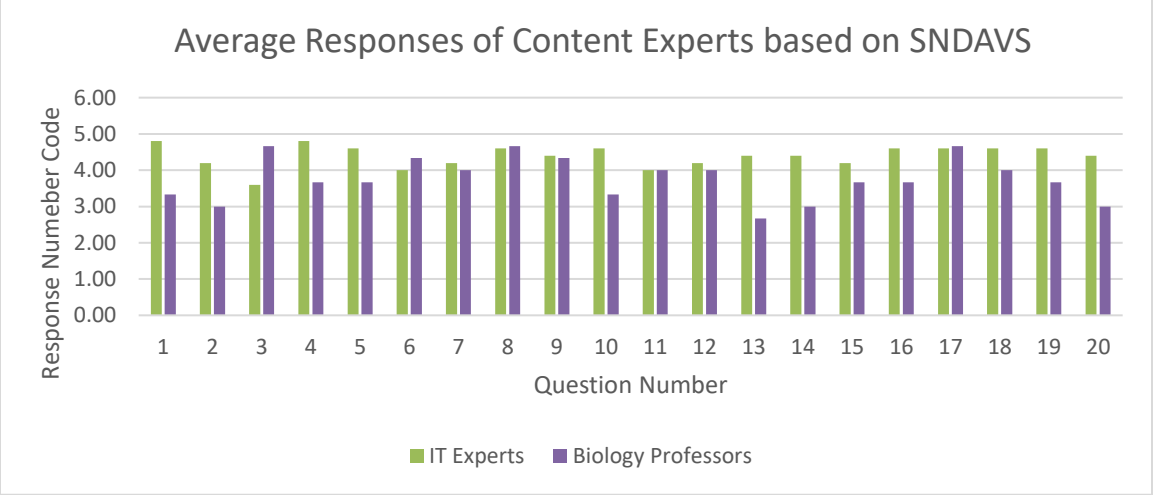

Figure 16. *Distribution of the Average Responses of the Content Experts based from SNDAVS*

Also, the comments, suggestions and recommendations of each of the content experts were also noted. The first part of the questionnaire was to enable the content experts identify the good points that they noticed after they utilized the frog dissection software. One of the IT experts said, *"It is unique to the students. I never encountered this kind of educational yet exciting game."* Another IT expert emphasized, *"It will be very helpful for students especially for those students that are afraid of real frogs."* Another IT expert stated, *"That through this software, users can dissect and learn the anatomy of the frog without needing to kill one. Another good point is that the users with no experience in VR will be exposed to this kind of technology. I think that it will be very fun for them and this may broaden their interest in the new technology."*

The points for improvement were also noted based on the comments of the IT content experts. One IT expert said, *"I think the user interface could be much better given enough time for development. The organization of objects could also be much cleaner so that it will be easier for the user to navigate."* Another IT expert stated that, *"If possible, I suggest for this system to be improved so that the digesting or the steps that it is trying to provide for the students will be much more realistic."*

Last but not the least, the IT content experts were asked if they will recommend the use of the software to be utilized by the students inside the classroom. One IT expert said, *"Yes, because this will be more efficient than trying to catch a real*

frog. It will be less hassle for the students because almost all of us now do have our own mobile phones that is one of the major requirements of the system." Another IT expert said, *"Yes, because it is a big step for Filipino educators to incorporate technology especially VR/AR Technology. It could also be an inspiration for other educators to think of new effective ways of teaching."* As commented by another IT expert, *"Yes. An improved version of this learning app can be very helpful. Well, they won't have to catch frogs and cut through their stomachs. And they can use the app repeatedly until they've absorbed all the information they needed. Also, technology is exciting. It can help boost their enthusiasm in learning the anatomy of frogs or just learning in general."*

The same set of questions were asked to the Biology professors. Focusing on the good points of the software, it was stated by a Biology professor that, *"It is appealing to students and it will be useful for classroom discussions."* Another professor said, *"The good points that I have noticed are the ff: 1-You don't have to use live frogs, 2-It's very easy to use & very easy to handle/to learn how to use, 3-it's not time consuming."* For the points for improvement, a professor noted, "*Improvement on the animation during dissection."* Another one said, *"As noticed, it was not as easy to navigate. The graphics can still be improved. User accessibility and controls can also be improved further. Interaction while going through the app can be an added feature."* The last part was to identify if the Biology professors would recommend this software to be utilized by the students, someone said, *"Yes, it will be useful during discussions."*

It was emphasized by the content experts that there should be minor and major revisions on the said software which should done prior to the intervention process.

Phase III. Test Item Analysis

The multiple choice (MC) exam was written and validated prior to the intervention process. The examination was rechecked by a content expert and there were several revisions done. Also, each item in the given examination was analyzed in order to assess the easiness or difficulty of each of the test questions. The Table 7 below show the summary of the tabulated test item analysis for the multiple-choice examination prepared for the students.

Table 7
Item Analysis of the Frog MC exam

Question	Diff	Diff	Disc	Disc Index	P	Q	PQ
Q1	84	VERY EASY	0.50	VERY GOOD ITEM	0.84	0.16	0.13
Q2	90	VERY EASY	0.50	VERY GOOD ITEM	0.90	0.10	0.09
Q3	78	EASY	0.33	GOOD ITEM	0.78	0.22	0.17
Q4	30	DIFFICULT	0.67	VERY GOOD ITEM	0.30	0.70	0.21
Q5	52	AVERAGE	0.50	VERY GOOD ITEM	0.52	0.48	0.25
Q6	84	VERY EASY	0.17	POOR ITEM	0.84	0.16	0.13
Q7	70	EASY	0.50	VERY GOOD ITEM	0.70	0.30	0.21
Q8	54	AVERAGE	0.50	VERY GOOD ITEM	0.54	0.46	0.25
Q9	54	AVERAGE	0.67	VERY GOOD ITEM	0.54	0.46	0.25
Q10	46	AVERAGE	0.83	VERY GOOD ITEM	0.46	0.54	0.25
Q11	68	EASY	0.83	VERY GOOD ITEM	0.68	0.32	0.22
Q12	36	DIFFICULT	0.17	POOR ITEM	0.36	0.64	0.23
Q13	48	AVERAGE	0.00	POOR ITEM	0.48	0.52	0.25
Q14	66	EASY	0.50	VERY GOOD ITEM	0.66	0.34	0.22
Q15	62	EASY	0.83	VERY GOOD ITEM	0.62	0.38	0.24
Q16	36	DIFFICULT	0.33	GOOD ITEM	0.36	0.64	0.23
Q17	44	AVERAGE	0.83	VERY GOOD ITEM	0.44	0.56	0.25
Q18	30	DIFFICULT	0.33	GOOD ITEM	0.30	0.70	0.21
Q19	46	AVERAGE	0.50	VERY GOOD ITEM	0.46	0.54	0.25
Q20	44	AVERAGE	0.17	POOR ITEM	0.44	0.56	0.25
Q21	44	AVERAGE	1.00	VERY GOOD ITEM	0.44	0.56	0.25
Q22	32	DIFFICULT	0.50	VERY GOOD ITEM	0.32	0.68	0.22

Q23	32	DIFFICULT	0.83	VERY GOOD ITEM	0.32	0.68	0.22
Q24	34	DIFFICULT	0.00	POOR ITEM	0.34	0.66	0.22
Q25	50	AVERAGE	0.83	VERY GOOD ITEM	0.50	0.50	0.25
Q26	48	AVERAGE	0.67	VERY GOOD ITEM	0.48	0.52	0.25
Q27	30	DIFFICULT	0.33	GOOD ITEM	0.30	0.70	0.21
Q28	56	AVERAGE	0.67	VERY GOOD ITEM	0.56	0.44	0.25
Q29	36	DIFFICULT	0.50	VERY GOOD ITEM	0.36	0.64	0.23
Q30	60	AVERAGE	0.83	VERY GOOD ITEM	0.60	0.40	0.24
Q31	36	DIFFICULT	0.67	VERY GOOD ITEM	0.36	0.64	0.23
Q32	64	EASY	0.67	VERY GOOD ITEM	0.64	0.36	0.23
Q33	38	DIFFICULT	0.50	VERY GOOD ITEM	0.38	0.62	0.24
Q34	54	AVERAGE	0.83	VERY GOOD ITEM	0.54	0.46	0.25
Q35	56	AVERAGE	0.00	POOR ITEM	0.56	0.44	0.25
Q36	34	DIFFICULT	0.00	POOR ITEM	0.34	0.66	0.22
Q37	46	AVERAGE	1.00	VERY GOOD ITEM	0.46	0.54	0.25
Q38	32	DIFFICULT	0.50	VERY GOOD ITEM	0.32	0.68	0.22
Q39	44	AVERAGE	0.33	GOOD ITEM	0.44	0.56	0.25
Q40	30	DIFFICULT	0.50	VERY GOOD ITEM	0.30	0.70	0.21
Q41	54	AVERAGE	0.83	VERY GOOD ITEM	0.54	0.46	0.25
Q42	50	AVERAGE	1.00	VERY GOOD ITEM	0.50	0.50	0.25
Q43	48	AVERAGE	0.50	VERY GOOD ITEM	0.48	0.52	0.25
Q44	50	AVERAGE	0.33	GOOD ITEM	0.50	0.50	0.25
Q45	30	DIFFICULT	0.00	POOR ITEM	0.30	0.70	0.21
Q46	62	EASY	0.67	VERY GOOD ITEM	0.62	0.38	0.24
Q47	58	AVERAGE	0.83	VERY GOOD ITEM	0.58	0.42	0.24
Q48	48	AVERAGE	0.67	VERY GOOD ITEM	0.48	0.52	0.25
Q49	48	AVERAGE	0.83	VERY GOOD ITEM	0.48	0.52	0.25
Q50	44	AVERAGE	0.50	VERY GOOD ITEM	0.44	0.56	0.25
Mean	**49.40**	**AVERAGE**	**0.54**	**VERY GOOD EXAM**	**0.49**	**0.51**	**0.23**
variance	89.28						
PKR20	0.89						
SEM	3.13						

As shown in Table 7, the computed mean value for the MC exam was equivalent to 49.40 which was an “average” or a “very good” exam which was acceptable because it means that the test was not that hard and not that easy for the students to answer. Also, there were no diff values that fall below 30 for each of the test question. That’s why, each of the test question was acceptable and have passed the item analysis standards. The said exam question can already be administered to the student respondents prior to and after the intervention process.

Phase IV. Immersing on ARVR

After the content validation process, the data gathering procedure was required. The data was gathered from 75 student respondents from the University of the East- Manila which were divided into 3 groups. The first group consists of 25 students who were given the task to read the module only. Group 2 immersed in ARVR individually while group 3 immersed in ARVR by group.

1. Visual, Aural, Read/Write, and Kinesthetic (VARK) Results

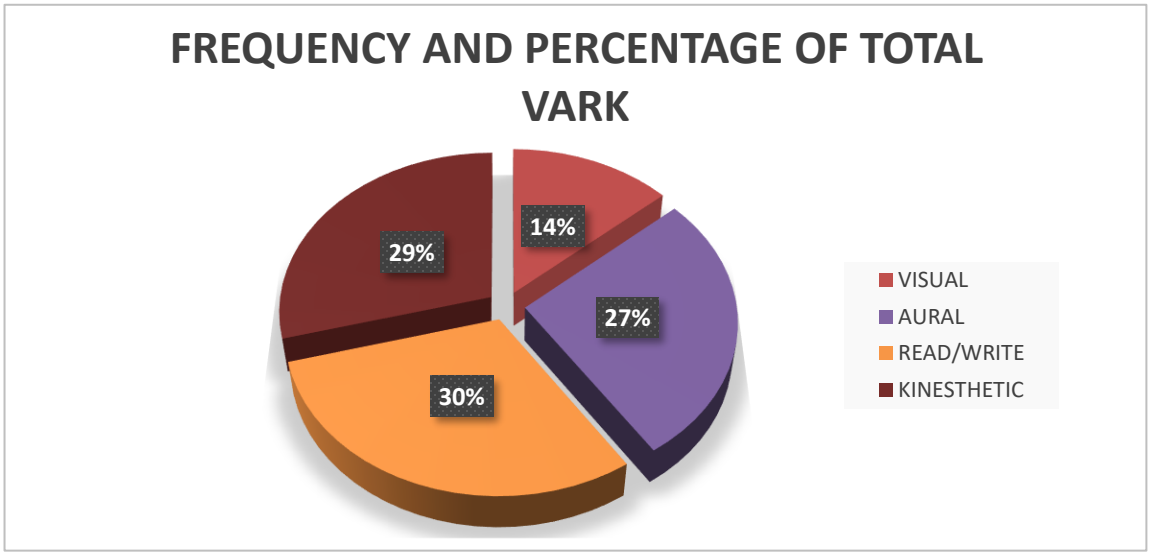

Figure 17. *Frequency and Percentage Distribution of Respondents' Total VARK*

The learning style of students were identified based on whether they were visual, aural (or auditory), read/ write, and/or kinesthetic. Since most of the students

displays multimodal learning preference, the researcher decided to identify the highest scores they obtained and the students were grouped based from their learning styles. After which, the researcher identifies the particular learning style that will generate the highest mean scores for each category presented. As you can see on figure 17, the pie chart contains the total count of the learning styles of the students for the 3 experimental groups (excluding the control group). Take note that there were some students wherein their learning styles overlap with each other. Based on Figure 17 on the previous page, most of the students prefer Read/ Write as their learning style. Second among the list was Kinesthetic having 29%, Aural having 27% and last but not the least Visual having 14%. Knowing that Visual learners were only few among the list, the identification of the correlation between each learning style on each category with the differences between the pretest and the post test scores of the student respondents would be necessary.

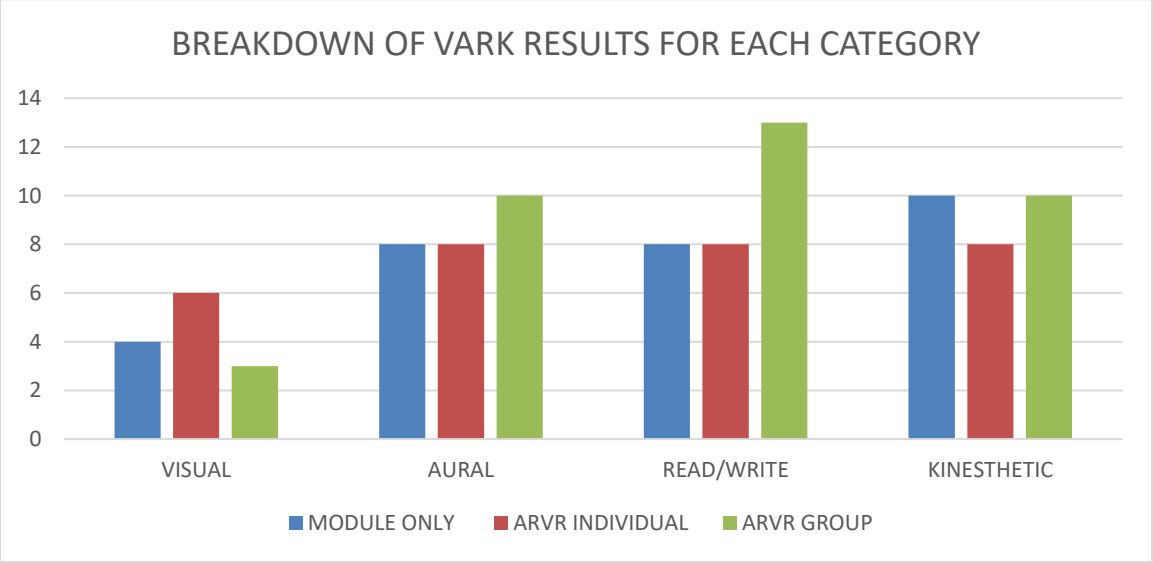

Figure 18. *Bar graph of the breakdown of VARK results for each category*

The learning preference of each student respondent through VARK is shown in Figure 18. For the module only group, 4 students prefer Visual as their learning style, 8 students prefer Aural, 8 students prefer Read/ Write, and 10 students prefer Kinesthetic as their way of learning any concepts as reflected through their VARK results. In ARVR- Individual group, 6 students prefer Visual learning, 8 students prefer Aural, 8 students again prefer Read/Write, and 8 students prefer Kinesthetic learning technique. Lastly, the ARVR-Group shows that 3 students prefer Visual, 10 students prefer Aural, 13 students prefer Read/ Write, and 10 students prefer Kinesthetic.

Take note that the data gathered were focused only among the highest scores which was obtained in VARK scores by the 75 students between each of the experimental groups. There was an overlap between the highest VARK scores obtained by some students. In module only group, there were 4 students who have overlapping VARK scores namely student number 3 who have both Aural and Kinesthetic learning styles, student number 5 who have Visual, Aural, and Read/Write learning styles, student number 13 who have Visual and Read/Write learning styles, and lastly, student number 16 who have both the Visual and Kinesthetic learning styles.

In ARVR- Individual group, there were also 4 students who have multiple learning styles. This was true among student number 2 (Read/Write and

Kinesthetic Learning styles), 9 (Aural and Read/Write Learning styles), 10 (Visual and Oral Learning styles), and 23 (Visual, Aural, and Read/ Write learning styles). Aside from this, there would be 10 students who were found to have multiple learning styles from the ARVR-Group. They were student number 1 (Aural and Kinesthetic Learning styles), 3 (Aural and Read/Write Learning styles), 10 (Visual, Read/Write and Kinesthetic Learning styles), 13 (Read/Write and Kinesthetic Learning styles), 15 (Read/Write and Kinesthetic Learning styles), 16 (Read/Write and Kinesthetic Learning styles), 20 (Visual and Read/Write Learning styles), 22 (Visual and Read/Write Learning styles), 23 (Aural and Read/Write Learning styles), and 24 (Read/Write and Kinesthetic Learning styles).

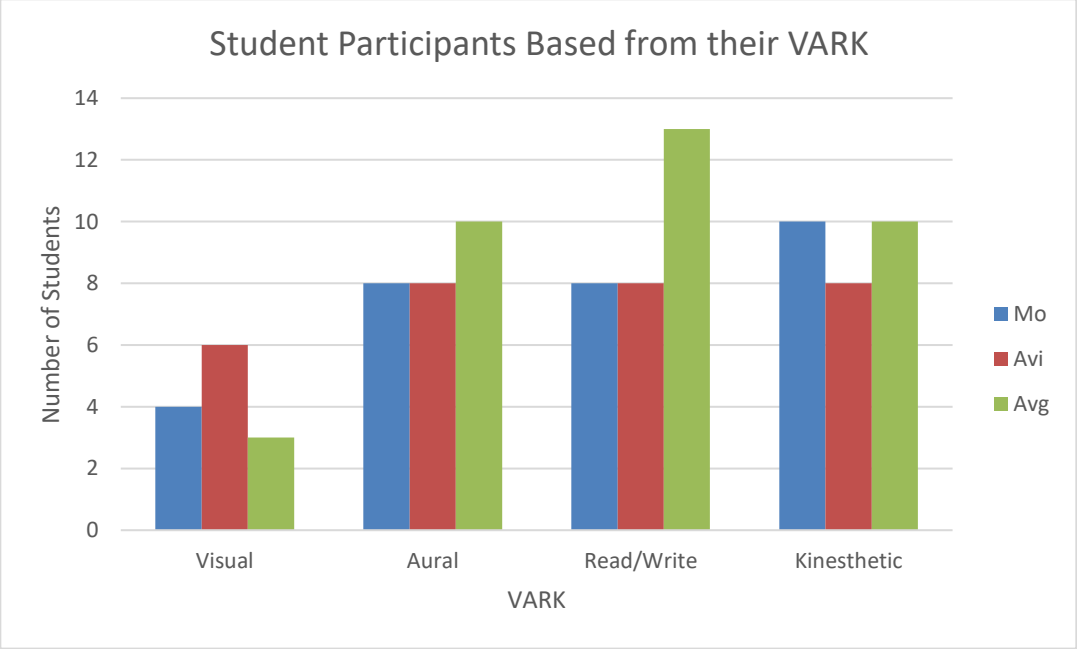

Figure 19. *Graph Showing the Number of Student Participant for Each Group Based from their VARK Results*

Based from the data gathered, it was found out that most of the students who immersed in the module learning were mostly kinesthetic learners. On the other hand, most of the students who immersed in AR/VR individual learning were mostly aural, read/write, and kinesthetic learners. In terms of AR/VR group, most of the students who participated were read/write learners. The data was reflected in Figure 19.

2. Pre-test and Post Test Results

2.1 Module Only Group

2.1.1 Pre-Test & Post Test Graphical Comparison

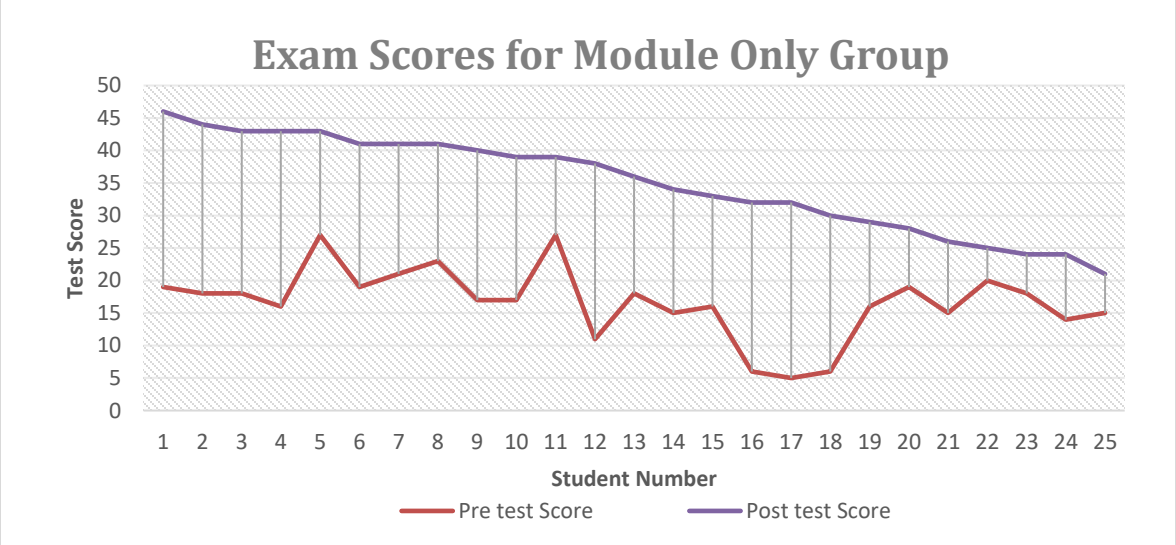

Figure 20. *Graph Showing the Difference between the Exam Scores of Student Respondents for Module Only Group*

In order to identify the level of increase from the pre-test to the post test after utilizing the module for learning frog anatomy on a classroom setting, the

researcher made a graph between the pre-test and posttest group as shown in Figure 20. You can see in Figure 20 the scores of the students who took the pre-test and it was indicated that the student who got the highest score for the pretest were student numbers 5 and 11 who both got 27 points. The lowest score for the pretest was also noted and it was student number 17 who got only 5 points.

On the other hand, there was a progress seen on all the posttest scores after immersing on the modular approach to frog anatomy and physiology. The highest scorer for the posttest was student number 1 who got 46 points out of 50 points. The lowest score noted was the score of student number 25 who got only 21 points. The student who displayed a big progress on his score from pre-test to posttest were student numbers 1, 4,12, and 17 who were able to have 27-points of increase on their scores from pre-test to post test. Based from the Table 8, the mean value for the Pre-test was 16.64 having the standard deviation of 5.476 while the mean for the post test was 34.88 having the standard deviation of 7.418.

Table 8
SPSS Analysis for Pre-Test and Post Test (Module only)

		Mean	N	SD	Std. Error Mean
Pair 1	Pre-Test	16.6400	25	5.47631	1.09526
	Posttest	34.8800	25	7.41800	1.48360

2.1.2 Paired Samples T Test for the Pre-Test & Post Test Results

To determine if there was a significant difference between the pre-test, and post test scores of the students as stated in Objective 4.1, there was a need to utilize the paired samples t-test for the statistical treatment of data.

Table 9
SPSS Analysis for Paired Sample T Test Results (Module only)

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	**Lower**	**Upper**	t	df	Sig. (2-tailed)
Pair 1 Pre-Test-Posttest	-18.2400	7.40090	1.48018	-21.29494	-15.18506	-12.323	24	.000

Will the alternative hypothesis be accepted or rejected? Will the intelligent guess done by the researcher correct or not? As you can see in Table 9, the analysis done through SPSS indicates that the t value was -12.323 having the df value of 24. Since the p value or significance value “0.000” was lower than “0.050”, the null hypothesis must be rejected and the alternative hypothesis must be accepted. This clearly indicates that there was a significant difference between the pre-test and the post-test scores in module only group.

2.2 AR/VR Individual

2.2.1 Pre-Test & Post Test Graphical Comparison

The researcher also noted the difference between the scores of the students who immersed in the AR/VR (Individual) frog dissection process. It shows that there was an increase of the students' scores knowing that the software was new to the students.

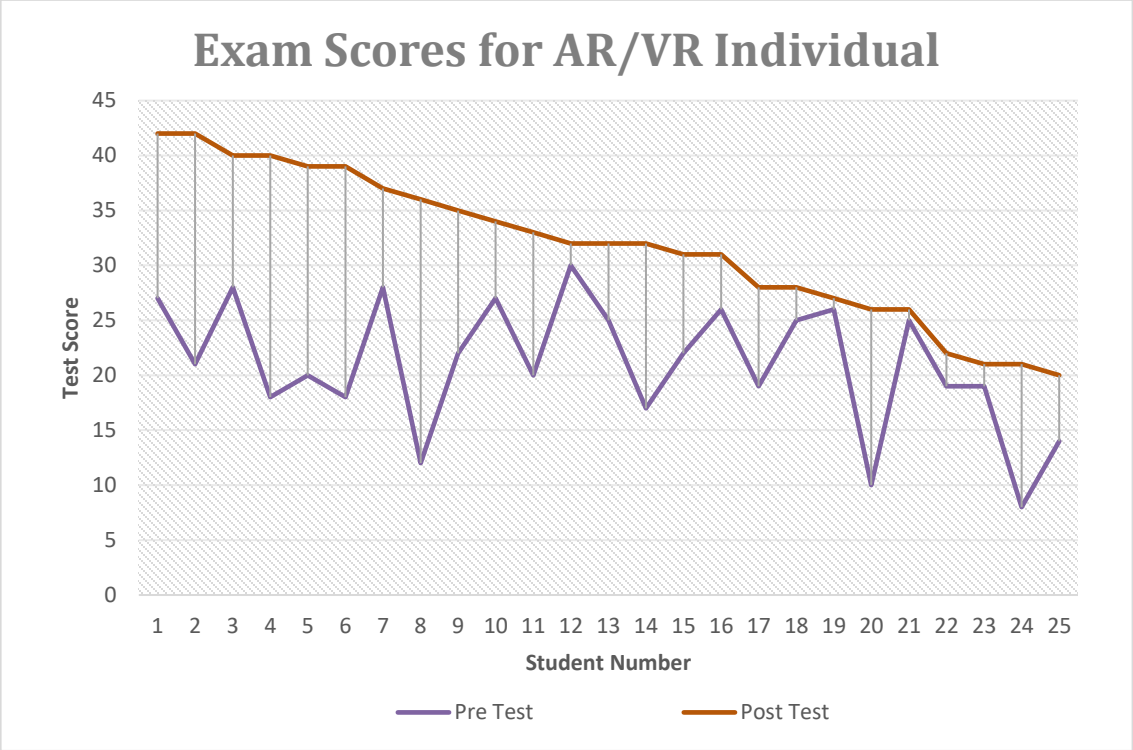

Figure 21. *Graph Showing the Difference between the Exam Scores of Student Respondents for AR/VR-Individual*

As shown in Figure 21, among the student respondents for AR/VR individual, it was noted that the person who got the highest score for the pre-test was student number 12 who got 30 points. Meanwhile, the lowest scorer for the pre-test

was student number 24 who got only 8 points. The graph also shows the student who got the highest when they took their posttest. They were students 1 and 2 who both got 42 points. The lowest recorded score was obtained from student number 25 who only got 20 points. The highest increase of score was obtained from student number 8 who got an increase of 24 points from his pre-test score up to his posttest score.

Table 10

SPSS Analysis for Pre-Test and Post Test (AR/VR Individual)

		Mean	N	SD	Std. Error Mean
Pair 1	Pre-Test	21.0400	25	5.84152	1.16830
	Posttest	31.7600	25	6.75944	1.35189

It was pointed out in Table 10 that the mean value for the Pre-test was 21.04 having a standard deviation of 5.841 and the mean value for the posttest was 31.76 having a standard deviation of 6.759.

2.2.2 Paired Samples T Test for the Pre-Test & Post Test Results

To identify if there was a significant difference between the pre-test as well as the posttest result for the AR/VR individual cluster, there was a need to utilize again the paired samples t-test with SPSS. Focusing on the results, Table 11 shows a t value of -7.527 and df of 24. The p value was “0.000” which indicates that there

was a need to reject the null hypothesis and a strong acceptance of the alternative hypothesis. This reiterates that there was a significant difference between the pre-test and the posttest scores among students who utilized AR/VR as part of their intervention individually which was able to unlock the key to objective 4.2.

Table 11

SPSS Analysis for Paired Sample T Test Results (AR/VR Individual)

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	**Lower**	**Upper**	t	df	Sig. (2-tailed)
Pair 1 Pre-Test-Posttest	-10.72000	7.12110	1.42422	-13.65944	-7.78056	-7.527	24	.000

2.3 AR/VR Group

2.3.1 Pre-Test & Post Test Graphical Comparison

Last but not the least, there was a need to tackle the graphical comparison between the pre-test and post test results for the students who utilized AR/VR frog software by group. As shown in Figure 22, among all the student respondents who utilized the AR/VR frog dissection software by group, the highest score obtained when they had their pre-test was 23 which was the score of student number 13. Meanwhile, student numbers 3 and 24 got the lowest scores of 5. In terms of the posttest scores of the students, student numbers 1 and 2 got the highest score of 42

and student number 25 got the lowest having the score of 21. In terms of the difference between the pre-test as well as the posttest scores, student number 3 got the highest improvement of score.

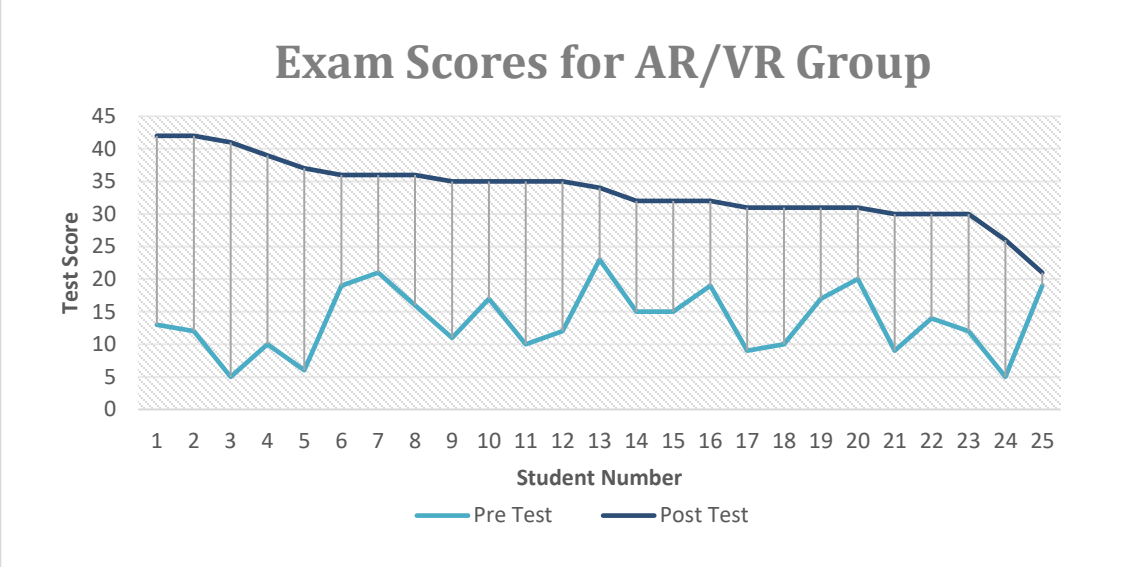

Figure 22. *Graph Showing the Difference between the Exam Scores of Student Respondents for AR/VR-Group*

There's a 36-point difference between the pre-test score and posttest score of student number 3. This was higher as compared to the module only cluster as well as the AR/VR individual cluster. Take note also that the mean value for the pre-test results for the AR/VR Group was 13.56 and the mean value for the posttest was 33.60 as shown in Table 12.

Table 12
SPSS Analysis for Pre-Test and Post Test (AR/VR Group)

		Mean	N	SD	Std. Error Mean
Pair 1	Pre-Test	13.5600	25	5.02560	1.00512
	Posttest	33.6000	25	4.79583	0.95917

2.3.2 Paired Samples T Test for the Pre-Test & Post Test Results

The last group to be analyzed using the paired samples t-test through SPSS would be the respondents who utilized AR/VR by group. As shown in table 13 below, the t value was -13.395 and the df was 24. The p value was "0.000" which was below "0.050" which denotes the acceptance of the alternative hypothesis which emphasizes that there was a significant difference between the pre-test scores and the posttest scores of student respondents who utilized the AR/VR frog dissection software by group. This addresses objective 4.3 of the study.

Table 13
SPSS Analysis for Paired Sample T Test Results (AR/VR Group)

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	**Lower**	**Upper**	t	df	Sig. (2-tailed)
Pair 1 Pre-Test-Posttest	-20.04000	7.48042	1.49608	-23.12777	-16.95223	-13.395	24	.000

3. Significant difference between the obtained Post Test scores among the 3 groups (Mo, AVi, and AVg)

Based from the given data in Figure 23, the comparison between the posttest scores among the 3 different groups were emphasized. It is clearly seen that the student who got the highest posttest score of 46 came from the module only group while the student who got the lowest posttest score of 20 came from the AR/VR individual cluster.

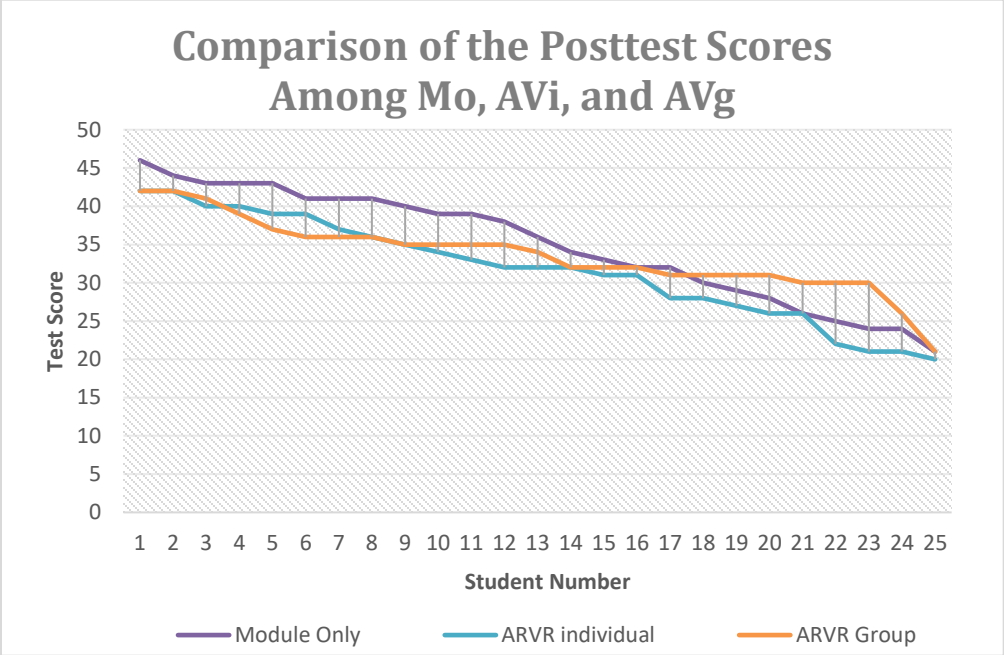

Figure 23. *Graph Showing the Comparison of the Posttest Scores among Mo, AVi, and AVg*

Also, the comparison among the test scores among the 3 experimental groups were noted using one-way Analysis of Variance (ANOVA). As shown in Table 14, the p value was approximately "0.23" which was higher than "0.05". This indicates that there was a need to accept the null hypothesis and reject the alternative hypothesis. Furthermore, the F value of 1.49 was lesser than the Fcrit value which was 3.12. Since the F value does not fall on the rejection region, it states that there was no significant difference between the mean value of the 3 groups which were utilized in the study (Mo, AVi, and AVg).

Table 14
ANOVA for the AA of the 3 Experimental Groups (Mo, AVi, AVg)

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	122.9867	2	61.49333	1.491149	0.231982	3.123907449
Within Groups	2969.2	72	41.23889			
Total	3092.187	74				

4. Intrinsic Motivation Results

4.1 Module Only

The intrinsic motivation of the student respondents was obtained through the Intrinsic Motivation Inventory (IMI). The intrinsic motivation was subdivided into 6 categories- interest/ enjoyment, perceived competence, effort/importance, pressure/ tension, perceived choice, and value/usefulness. The scores were identified based on each category. Table 15 below shows the IMI Results of Students per category along with its interpretation.

Table I5
IMI results of Student Respondents (Module Only)

Indicators	$\bar{\chi}$	SD	Interpretation
I. Interest/Enjoyment			
1. I enjoyed doing this activity very much.	5.12	0.93	SOMEWHAT AGREE
2. This activity was fun to do.	4.96	1.10	SOMEWHAT AGREE

3. I thought this was a boring activity. (R)	4.76	1.33	SOMEWHAT AGREE
4. This activity did not hold my attention at all. (R)	4.08	1.12	NEITHER AGREE/ DISAGREE
5. I would describe this activity as very interesting.	5.00	1.04	SOMEWHAT AGREE
6. I thought this activity was quite enjoyable.	4.76	0.88	SOMEWHAT AGREE
7. While I was doing this activity, I was thinking about how much I enjoyed it.	4.56	1.19	SOMEWHAT AGREE
II. Perceived Competence			
8. I think I am pretty good at this activity.	4.88	0.88	SOMEWHAT AGREE
9. I think I did pretty well at this activity, compared to other students.	4.72	0.94	SOMEWHAT AGREE
10. After working at this activity for a while, I felt pretty competent.	4.80	1.00	SOMEWHAT AGREE
11. I am satisfied with my performance at this task.	5.12	1.13	SOMEWHAT AGREE
12. I am pretty skilled at this activity.	4.72	1.24	SOMEWHAT AGREE
13. This was an activity that I couldn't do very well. (R)	4.16	1.31	NEITHER AGREE/ DISAGREE
III. Effort/Importance			
14. I put a lot of effort into this.	5.16	1.03	SOMEWHAT AGREE
15. I didn't try very hard to do well at this activity. (R)	4.16	1.25	NEITHER AGREE/ DISAGREE
16. I tried very hard on this activity.	5.04	1.02	SOMEWHAT AGREE
17. It was important to me to do well at this task.	5.24	0.88	SOMEWHAT AGREE
18. I didn't put much energy into this. (R)	4.00	1.58	NEITHER AGREE/ DISAGREE
IV. Pressure/Tension			
19. I did not feel nervous at all while doing this. (R)	5.20	1.44	SOMEWHAT AGREE
20. I felt very tense while doing this activity.	3.52	1.56	NEITHER AGREE/ DISAGREE

21.I was very relaxed in doing these. (R)	5.36	1.15	SOMEWHAT AGREE
22.I was anxious while working on this task.	3.60	1.41	NEITHER AGREE/ DISAGREE
23.I felt pressured while doing these.	3.68	1.55	NEITHER AGREE/ DISAGREE
V. Perceived Choice			
24.I believe I had some choice about doing this activity.	4.40	0.96	NEITHER AGREE/ DISAGREE
25.I felt like it was not my own choice to do this task. (R)	4.56	0.96	SOMEWHAT AGREE
26.I didn't really have a choice about doing this task. (R)	4.12	1.24	NEITHER AGREE/ DISAGREE
27.I felt like I had to do this. (R)	4.84	1.28	SOMEWHAT AGREE
28.I did this activity because I had no choice. (R)	4.28	1.24	NEITHER AGREE/ DISAGREE
29.I did this activity because I wanted to.	4.68	0.99	SOMEWHAT AGREE
30.I did this activity because I had to. (R)	5.24	1.01	SOMEWHAT AGREE
VI. Value/ Usefulness			
31.I believe this activity could be of some value to me.	5.40	0.87	SOMEWHAT AGREE
32.I think that doing this activity is useful for learning biology concepts specifically about frog anatomy and physiology.	5.68	0.90	MOSTLY AGREE
33.I think this is important to do because it can help me comprehend the topics in biology.	5.68	0.85	MOSTLY AGREE
34.I would be willing to do this again because it has some value to me.	5.36	0.95	SOMEWHAT AGREE
35.I think doing this activity could help me to score high on my exams.	5.48	0.87	SOMEWHAT AGREE
36.I believe doing this activity could be beneficial to me.	5.48	0.87	SOMEWHAT AGREE
37.I think this is an important activity.	5.56	0.82	MOSTLY AGREE

Legend:			
	6.50-7.00	(7)	ENTIRELY AGREE
	5.50-6.49	(6)	MOSTLY AGREE
	4.50-5.49	(5)	SOMEWHAT AGREE
	3.50-4.49	(4)	NEITHER AGREE/DISAGREE
	2.00-3.49	(3)	SOMEWHAT DISAGREE
	1.50-2.49	(2)	MOSTLY DISAGREE
	1.00-1.49	(1)	ENTIRELY DISAGREE

Based from Table 15, there were varied responses per indicator group. Say for instance, in measuring the interest/ enjoyment of students who utilized module only as their intervention, they "Somewhat Agree" if asked if they enjoyed doing the activity very much having a mean value of 5.12. In terms of perceived competence, the students "Somewhat Agree" if after working at the activity for a while, they felt pretty competent. In terms of effort/ importance, they "Somewhat Agree" on placing a lot of effort on the said activity. Speaking about pressure/ tension, they "Somewhat Agree" that they did not feel nervous at all while doing the activity. For the perceived choice, the respondents "Somewhat Agree" to the statement, "I did this activity because I wanted to." Lastly, in measuring value/ usefulness, students "Mostly Agree" to the statement, "I think this is important to do because it can help me comprehend the topics in Biology."

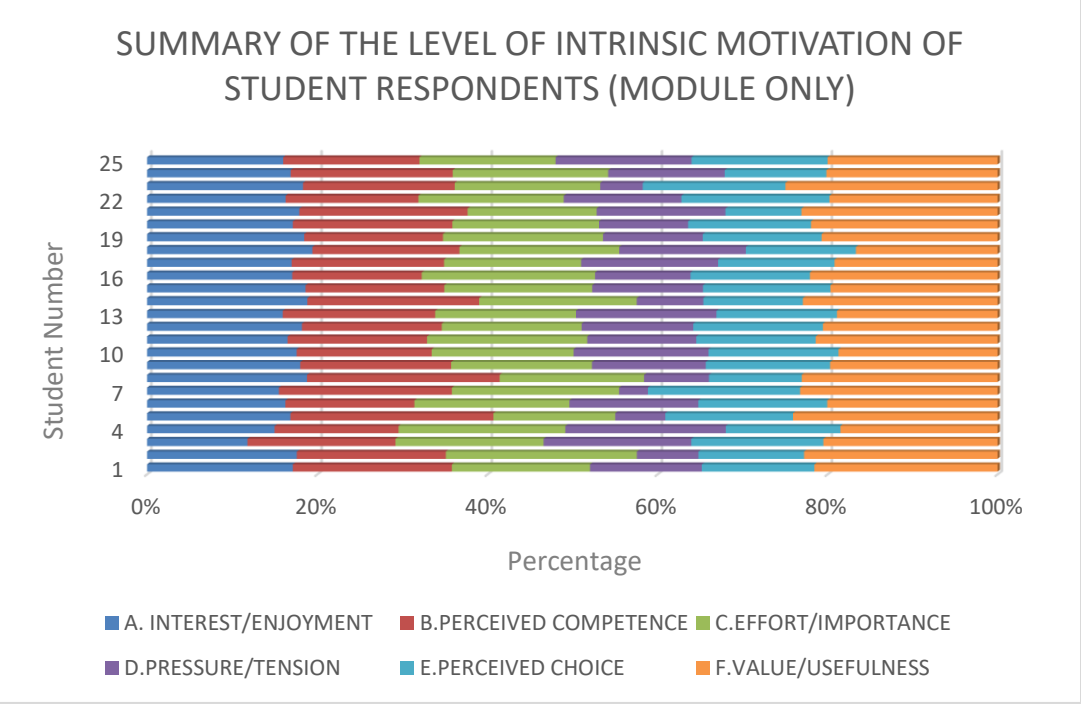

Figure 24. *Summary of the Level of Intrinsic Motivation of Student Respondents for Module Only Group*

Figure 24 shows the summary of the level of intrinsic motivation of student respondents for module only group. The mean value for interest/ enjoyment was 4.51 round it off to "5" which indicates "Somewhat Agree". Therefore, the students "Somewhat Agree" that they had interest in the activity and they enjoyed the activity as well. For the perceived competence, the mean value was 4.68 round it off to "5". The students "Somewhat Agree" on the perceived competence during the conduct of the activity. For the effort/ importance, the mean value was 4.66 round off to "5". The respondents "Somewhat Agree" on the effort required and the importance of the said activity. On the other hand, in terms of pressure/ tension, the mean score obtained was "3.25" which was rounded off to "3". This indicates that the student respondents somewhat disagree if they experienced pressure/ tension during the conduct of the said activity. For the perceived choice, 3.72 was the mean score round it off to "4" or "Neither Agree/Disagree". Lastly, for the value/ usefulness, the score was "5.52" round it off to "6" wherein the respondents "Mostly Agree" to the value/ usefulness of the given module.

4.2 AR/VR Individual

There was also a need to identify the intrinsic motivation per group based from the scores which were obtained from the AR/VR Individual cluster. Table 16 shows the summary of the results of the intrinsic motivation per area as measured using the Intrinsic Motivation Inventory (IMI) survey questionnaire.

Table I6

IMI results of Student Respondents (AR/VR Individual)

Indicators	$\overline{\chi}$	SD	Interpretation
I.Interest/Enjoyment			
1. I enjoyed doing this activity very much.	5.56	1.64	MOSTLY AGREE
2. This activity was fun to do.	5.80	1.35	MOSTLY AGREE
3. I thought this was a boring activity. (R)	4.72	1.40	SOMEWHAT AGREE
4. This activity did not hold my attention at all. (R)	3.92	1.73	NEITHER AGREE/ DISAGREE
5. I would describe this activity as very interesting.	5.72	0.94	MOSTLY AGREE
6. I thought this activity was quite enjoyable.	5.68	0.99	MOSTLY AGREE
7. While I was doing this activity, I was thinking about how much I enjoyed it.	5.56	1.00	MOSTLY AGREE
II.Perceived Competence			
8. I think I am pretty good at this activity.	5.32	1.07	SOMEWHAT AGREE
9. I think I did pretty well at this activity, compared to other students.	4.76	1.09	SOMEWHAT AGREE
10.After working at this activity for a while, I felt pretty competent.	5.12	1.05	SOMEWHAT AGREE
11.I am satisfied with my performance at this task.	5.48	1.33	SOMEWHAT AGREE
12.I am pretty skilled at this activity.	5.08	1.19	SOMEWHAT AGREE
13.This was an activity that I couldn't do very well. (R)	3.88	1.64	NEITHER AGREE/ DISAGREE
III. Effort/Importance			
14.I put a lot of effort into this.	5.48	1.05	SOMEWHAT AGREE
15.I didn't try very hard to do well at this activity. (R)	3.76	1.36	NEITHER AGREE/ DISAGREE
16.I tried very hard on this activity.	5.44	0.87	SOMEWHAT AGREE
17.It was important to me to do well at this task.	5.28	0.74	SOMEWHAT AGREE
18.I didn't put much energy into this. (R)	4.20	1.58	NEITHER AGREE/ DISAGREE
IV.Pressure/Tension			
19.I did not feel nervous at all while doing this. (R)	5.24	1.51	SOMEWHAT AGREE
20.I felt very tense while doing this activity.	4.16	1.84	NEITHER AGREE/ DISAGREE
21.I was very relaxed in doing these. (R)	5.24	1.59	SOMEWHAT AGREE

22.I was anxious while working on this task.	4.12	2.01	NEITHER AGREE/ DISAGREE
23.I felt pressured while doing these.	4.12	1.90	NEITHER AGREE/ DISAGREE
V. Perceived Choice			
24.I believe I had some choice about doing this activity.	5.08	1.08	SOMEWHAT AGREE
25.I felt like it was not my own choice to do this task. (R)	4.32	1.65	NEITHER AGREE/ DISAGREE
26.I didn't really have a choice about doing this task. (R)	4.04	1.59	NEITHER AGREE/ DISAGREE
27.I felt like I had to do this. (R)	4.64	1.55	SOMEWHAT AGREE
28.I did this activity because I had no choice. (R)	3.92	1.55	NEITHER AGREE/ DISAGREE
29.I did this activity because I wanted to.	5.32	1.14	SOMEWHAT AGREE
30.I did this activity because I had to. (R)	4.72	1.67	SOMEWHAT AGREE
VI.Value/ Usefulness			
31.I believe this activity could be of some value to me.	5.84	1.03	MOSTLY AGREE
32.I think that doing this activity is useful for learning biology concepts specifically about frog anatomy and physiology.	5.88	1.01	MOSTLY AGREE
33.I think this is important to do because it can help me comprehend the topics in biology.	5.88	1.01	MOSTLY AGREE
34.I would be willing to do this again because it has some value to me.	5.72	1.21	MOSTLY AGREE
35.I think doing this activity could help me to score high on my exams.	5.80	1.00	MOSTLY AGREE
36.I believe doing this activity could be beneficial to me.	5.88	0.97	MOSTLY AGREE
37.I think this is an important activity.	6.04	0.93	MOSTLY AGREE

Legend:			
	6.50-7.00	(7)	ENTIRELY AGREE
	5.50-6.49	(6)	MOSTLY AGREE
	4.50-5.49	(5)	SOMEWHAT AGREE
	3.50-4.49	(4)	NEITHER AGREE/DISAGREE
	2.00-3.49	(3)	SOMEWHAT DISAGREE
	1.50-2.49	(2)	MOSTLY DISAGREE
	1.00-1.49	(1)	ENTIRELY DISAGREE

The interpretation for the results for the AR/VR individual group shows that in the interest/enjoyment part, the students "Mostly Agree" that they described the activity as "Very Interesting", but there were some students who "Somewhat Agree" that the activity was boring. These were 2 contradicting results under the interest/ enjoyment part. In terms of perceived competence, the student respondents "Somewhat Agree" that they were satisfied on their performance on the given task. For effort/ importance, students "Somewhat Agree' that they put a lot of effort in this activity.

Speaking about pressure/ tension, the students "Somewhat Agree" that they feel relaxed in doing the said activity. The perceived choice of the students indicates that they "Somewhat Agree" that they did the activity because they wanted to. Lastly, for value/ usefulness, they "Mostly Agree" that the activity was beneficial to them.

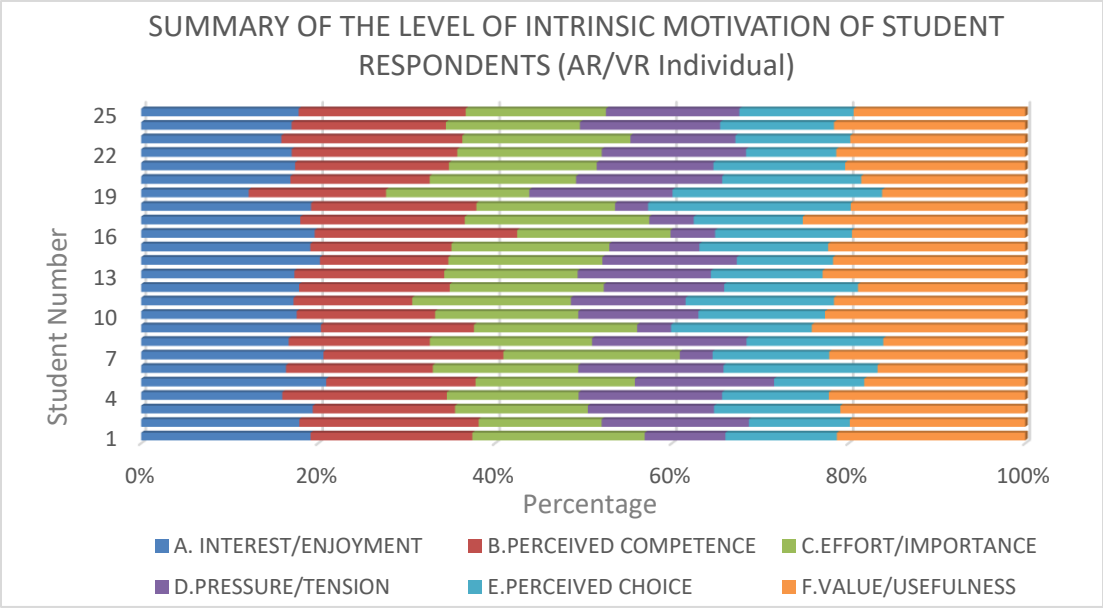

Figure 25. *Summary of the Level of Intrinsic Motivation of Student Respondents for AR/VR Individual*

It was shown in Figure 25 that in terms of interest/ enjoyment of the student respondents, the mean value was 5.10 or round it off to "5" which codes for "Somewhat Agree". For the perceived competence, its mean value was 4.98 or it can be rounded off to "5" which designates "Somewhat Agree". Meanwhile, effort/importance has a mean value of 4.85 which was also rounded off to "5" as "Somewhat Agree". For pressure/ tension, the mean value was 3.58 which was rounded off to "4". This was equivalent to "Neither Agree/Disagree". Speaking about the perceived choice, the mean value was 4.11 rounded off to "4" which was coded for "Neither Agree/Disagree". Lastly, for value/ usefulness, the mean value was 5.86 which was rounded off to "6". This was equivalent to "Mostly Agree".

4.3 AR/VR Group

The 3rd group was focused on the utilization of AR/VR on a group setting. Table 17 shows the summary of the IMI results for the AR/VR frog dissection software for the students who were divided into groups.

Table I7
IMI results of Student Respondents (AR/VR Group)

Indicators	$\overline{\chi}$	SD	Interpretation
I.Interest/Enjoyment			
1. I enjoyed doing this activity very much.	4.88	1.13	SOMEWHAT AGREE
2. This activity was fun to do.	5.00	0.91	SOMEWHAT AGREE
3. I thought this was a boring activity. (R)	4.76	1.27	SOMEWHAT AGREE
4. This activity did not hold my attention at all. (R)	3.88	1.45	NEITHER AGREE/ DISAGREE
5. I would describe this activity as very interesting.	5.16	0.99	SOMEWHAT AGREE

6. I thought this activity was quite enjoyable.	4.64	1.15	SOMEWHAT AGREE
7. While I was doing this activity, I was thinking about how much I enjoyed it.	4.64	0.91	SOMEWHAT AGREE
II.Perceived Competence			
8. I think I am pretty good at this activity.	4.68	1.07	SOMEWHAT AGREE
9. I think I did pretty well at this activity, compared to other students.	4.32	1.03	NEITHER AGREE/ DISAGREE
10.After working at this activity for a while, I felt pretty competent.	4.32	0.99	NEITHER AGREE/ DISAGREE
11.I am satisfied with my performance at this task.	4.56	1.19	SOMEWHAT AGREE
12.I am pretty skilled at this activity.	4.32	1.03	NEITHER AGREE/ DISAGREE
13.This was an activity that I couldn't do very well. (R)	3.88	1.39	NEITHER AGREE/ DISAGREE
III. Effort/Importance			
14.I put a lot of effort into this.	5.08	1.08	SOMEWHAT AGREE
15.I didn't try very hard to do well at this activity. (R)	4.04	1.70	NEITHER AGREE/ DISAGREE
16.I tried very hard on this activity.	4.88	1.13	SOMEWHAT AGREE
17.It was important to me to do well at this task.	5.00	1.15	SOMEWHAT AGREE
18.I didn't put much energy into this. (R)	4.00	1.55	NEITHER AGREE/ DISAGREE
IV.Pressure/Tension			
19.I did not feel nervous at all while doing this. (R)	5.04	1.54	SOMEWHAT AGREE
20.I felt very tense while doing this activity.	4.12	1.45	NEITHER AGREE/ DISAGREE
21.I was very relaxed in doing these. (R)	5.08	1.32	SOMEWHAT AGREE
22.I was anxious while working on this task.	3.92	1.61	NEITHER AGREE/ DISAGREE
23.I felt pressured while doing these.	3.96	1.88	NEITHER AGREE/ DISAGREE
V.Perceived Choice			
24.I believe I had some choice about doing this activity.	4.84	1.28	SOMEWHAT AGREE
25.I felt like it was not my own choice to do this task. (R)	4.28	1.57	NEITHER AGREE/ DISAGREE
26.I didn't really have a choice about doing this task. (R)	4.60	1.68	

			SOMEWHAT AGREE
27.I felt like I had to do this. (R)	4.96	1.21	SOMEWHAT AGREE
28.I did this activity because I had no choice. (R)	4.40	1.78	NEITHER AGREE/ DISAGREE
29.I did this activity because I wanted to.	4.92	1.32	SOMEWHAT AGREE
30.I did this activity because I had to. (R)	5.04	1.37	SOMEWHAT AGREE
VI.Value/ Usefulness			
31.I believe this activity could be of some value to me.	5.48	1.00	SOMEWHAT AGREE
32.I think that doing this activity is useful for learning biology concepts specifically about frog anatomy and physiology.	5.56	0.92	MOSTLY AGREE
33.I think this is important to do because it can help me comprehend the topics in biology.	5.52	1.05	MOSTLY AGREE
34.I would be willing to do this again because it has some value to me.	5.28	1.24	SOMEWHAT AGREE
35.I think doing this activity could help me to score high on my exams.	5.00	1.47	SOMEWHAT AGREE
36.I believe doing this activity could be beneficial to me.	5.20	1.38	SOMEWHAT AGREE
37.I think this is an important activity.	5.08	1.19	SOMEWHAT AGREE

Legend:			
	6.50-7.00	(7)	ENTIRELY AGREE
	5.50-6.49	(6)	MOSTLY AGREE
	4.50-5.49	(5)	SOMEWHAT AGREE
	3.50-4.49	(4)	NEITHER AGREE/DISAGREE
	2.00-3.49	(3)	SOMEWHAT DISAGREE
	1.50-2.49	(2)	MOSTLY DISAGREE
	1.00-1.49	(1)	ENTIRELY DISAGREE

The Table 17 shows the varied responses of students from the AR/VR group wherein in the interest/enjoyment part, most of the student respondents answered “Somewhat Agree” like that of question number 5 which focuses on how enjoyable the said activity is. For the perceived competence, many students “Somewhat Agree” that they were pretty good in conducting the activity. In terms of the effort/ importance, many students “Somewhat Agree” that they put a lot of effort into immersing in AR/VR.

Next would be effort/ importance, the students “Somewhat Agree” that it was important for them to do well in the given task. How about pressure/ tension? The students “Somewhat Agree” that it was very relaxing to do the said activity. For the perceived choice, students “Neither Agree/ Disagree” in doing the said activity because they had no choice. Last but not the least would be value/ usefulness. Students “Mostly Agree” that doing the said activity was useful for them to learn Biology concepts specifically about frog anatomy and physiology.

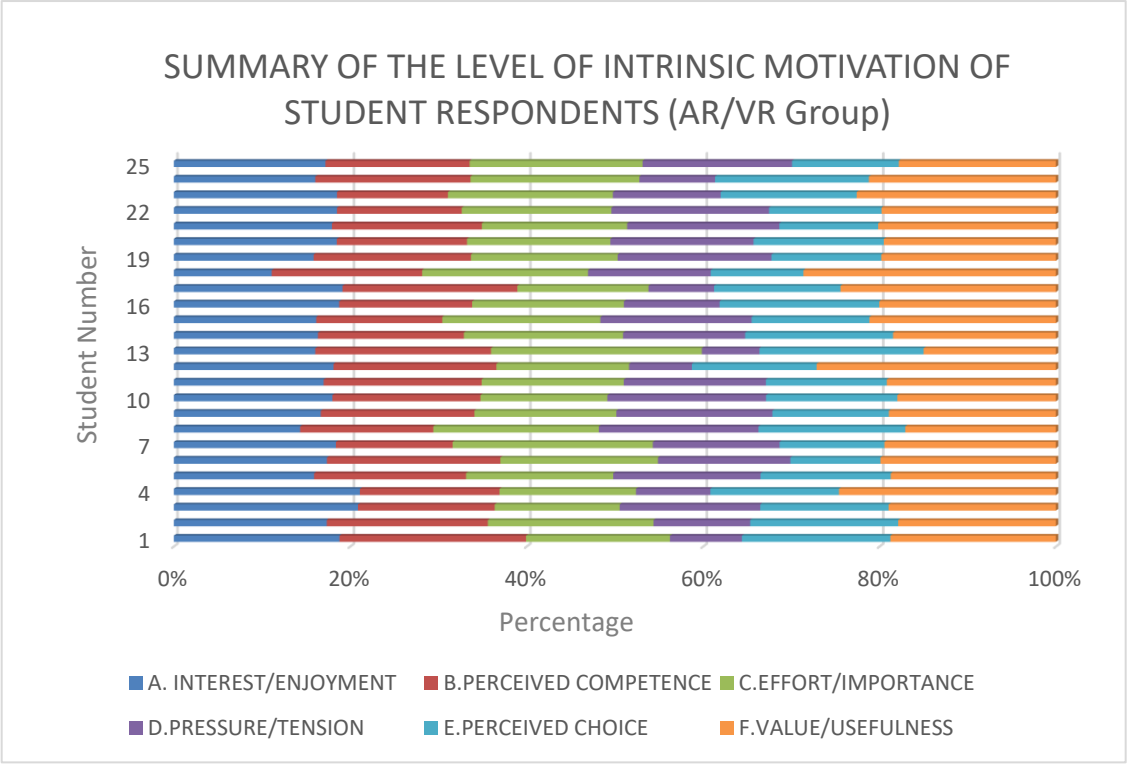

Figure 26. *Summary of the Level of Intrinsic Motivation of Student Respondents for AR/VR Group*

The summarized mean value for the AR/VR group was presented in Figure 26. Focusing on the interest/ enjoyment of the student, respondents, the mean value was 4.53 that was rounded off to “5” that’ equivalent to “Somewhat Agree”. For the

perceived competence, the mean value was 4.39 which was rounded off to “4” that was tantamount to “Neither Agree/ Disagree”. The effort/importance of the AR/VR software was noted to have a mean value of 4.58 or “5”. This implies that the “Somewhat Agree” answer was related to effort/ importance. For the pressure /tension, the mean value was 3.58 or “4”. The student respondents neither agree/ disagree about it. Focusing on the AR/VR software as a perceived choice of the student respondents, the mean value of 3.78 was identified having a rounded of value of “4” which indicates “Neither Agree/ Disagree”. For the value/ usefulness, the students “Somewhat Agree” having a mean value of 5.30 which was rounded off to “5”.

5. Significant difference between the obtained intrinsic motivation (IM) scores among the 3 groups (Mo, AVi, and AVg)

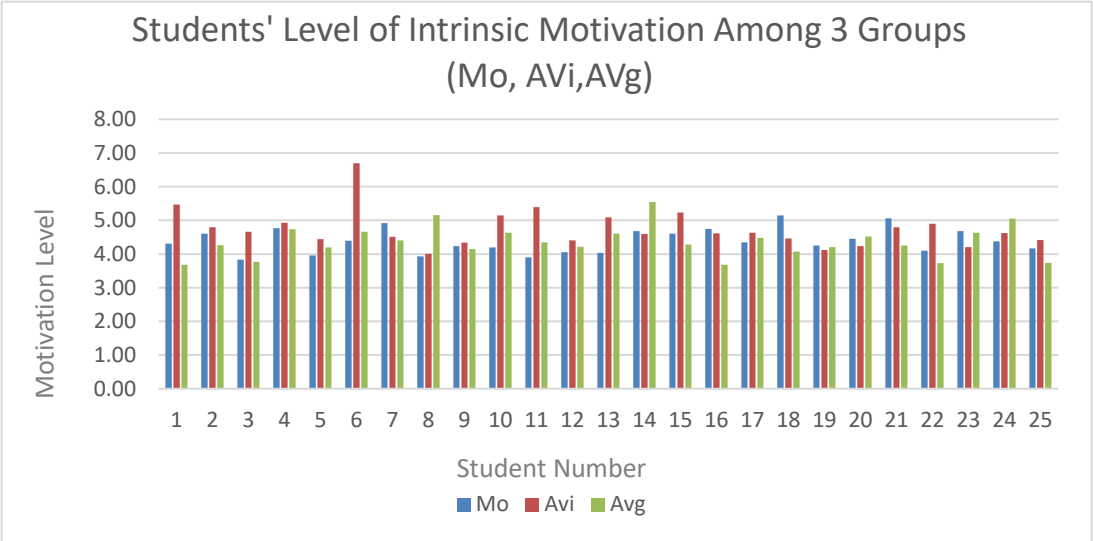

Figure 27. *Students’ Level of intrinsic Motivation Among Mo, AVi, and AVg*

As shown in Figure 27, there was a variation in terms of the mean value for the average responses for the students on the 3 given groups- Mo, AVi, and AVg. The breakdown of responses was shown in Table 15, 16, and 17 respectively. Focusing on the significant difference between the IM scores among the 3 different groups (Mo, AVi, and AVg), one-way analysis of variance was utilized as shown in Table 18 below.

Table 18

ANOVA for the Intrinsic Motivation of the 3 Experimental Groups (Mo, AVi, AVg)

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.323667036	2	1.161833518	5.221899592	0.00762574	3.123907449
Within Groups	16.01946032	72	0.222492504			
Total	18.34312735	74				

Based on the ANOVA table, the p value was approximately “0.0076” which was below “0.05”. Also, the F value of 5.22 was higher than the Fcrit value of 3.12. This means that the F value falls on the rejection region that will lead to the acceptance of the alternative hypothesis and the rejection of the null hypothesis. This states that there was a significant difference between the average motivation level of each student from the 3 different groups (Mo, AVi, and AVg).

6. Learning Style of the Students with the highest Posttest Results

After the conduct of the said study, the researcher wanted to find out what was the learning style of the highest scorer of the posttest for each group. For the module only group, the highest grade for the posttest was 46 points and the student who got the highest score has an aural learning style. Meanwhile, for the AR/VR individual cluster, there were 2 persons who got the highest score of 42. The first person has a visual learning style and the second person has read/ write and kinesthetic learning styles. For the AR/VR group, there were 2 students who got the highest score of 42. The first highest scorer has aural and kinesthetic learning style while the second highest scorer has kinesthetic learning style only. Focusing on the 2 AR/VR groups, there was a realization that students who immerse in AR/VR learn best when they have kinesthetic learning style.

7. Students' Perceptions

The students were asked to answer specific questions after they were immersed on a specific intervention. The first group who were given a reflective journal was the module only group. Each of the questions will be presented and the answers of the students will be analyzed through thematic approach.

For the first question, what did you feel after you utilized the frog module as an alternative tool for traditional frog dissection? Student 9 said, *"I felt that we can also learn about frog even if we don't go to laboratories to have an experiment."*

Student 11 emphasized, *"I feel that I have learned something new about frogs. The newly-gained knowledge can be beneficial."* Based from the answer of student number 23, *"It was easier to understand because everything has an image, label, and definition."*

The second question focuses on the things that the students liked about after learning something using the frog module. Student number 1 said, *"It has general knowledge about frog and frog dissection."* Student number 3 said, *"It is informative and the information presented is easily understood through the use of tables and figures."* Student number 5 also said, *"What I like is that the important parts of the frog were highlighted which made it easier for me to comprehend the topic."* Based from the answer of student number 15, *"I like the lesson and the content of the module because it is very helpful to each student especially for STEM students."* The students were also asked to identify the things that they dislike about the frog module. Student 7 said, *"Nothing. I like the frog module, and I would like to do it again sometime."* Student number 15 also said *" I don't have any dislike to this module because it is very useful and it can teach each student who is taking Biology subj. to learn the parts and functions of the frog and the benefit of it to our environment."* On the contrary, student number 16 said, *" ...I wanted to do it in actual coz it'll be more fun, interesting and add to my knowledge."*

For the part wherein the students were asked about the difficulties that they experienced while using the frog module, Student number 5 said, "*There's nothing*

difficult about it." While student number 25 said, *"Visualization."* For the last question, the students were asked to suggest on how to improve the module. Student number 2 said, *"I think none because it is already detailed."* But, student number 14 said, *"The information are okay but it is better if we get to dissect a frog."*

Since the students wanted to dissect a frog without risking their health because of the formalin, they were given the chance to immerse on Talapang which was an AR/VR frog dissection software. The perceptions of the students who used AR/VR individually was combined with the perceptions of the students who used the AR/VR frog software by group. The first question is, what did you feel after you utilized the AR/VR frog software as an alternative tool for traditional frog dissection? Student number 4 said, *"I find it cool, and I felt excited while doing the activity, because I'm not really sure if I can hold a frog."* Student number 6 emphasized, *"It feels fun and educational at the same time. Using this tool helps us as we don't need to physically dissect the frog anymore."* Student number 8 said,"*I feel happy because I see internal part of a frog."* Student number 9 said, *"It is quite fun. It seems real."* Also, student number 21 said, *"I feel so great to use such advanced technology. I feel happy to experience the AR/VR software."* Meanwhile, Student number 23 said, *"I felt amazed because without actually doing it in person, I actually learned a lot and explore the frog for the first time."* Lastly, student number 28 said, *"It is really enjoyable to do this task and I think it would be a great alternative to traditional frog dissection."*

For the second question, what did you like about the AR/VR frog software? There were series of answers that the students stated such as, *"It was trendy and in with the new"*, by student number 2. Based on the statement of student number 4, *"It is provided by the professor and it is safe rather than the actual dissection."* Based from the statement of student number 6, *"It explains the different functions of the organs of frog and how it looks was also shown."* Based from the statement of student number 7, *"It was easy to use. I understand already in one single direction."* As student number 15 had stated, *"I like it because in this app, students don't need to do the experiment in the actual frog. It is very animated but I think there is a lot of things we need to improve."* Student number 20 said, *"It seems real, like there, it's not necessary to dissect a real frog anymore."*

Based from the statement of student number 21, *"I felt good because someone got to come up with that idea. A wonderful idea."* In terms of the statement of student 29, *"It was colorful and very interactive which made it enticing for the audience who will be utilizing it."* Based from the perception of student number 36, *"I like it because it can help me comprehend the topics and it is also beneficial."* For student number 39, *"I like the part where we use technology for learning."* Based from the answer of student 41, *"It brings frog dissection to your mobile."* As written in question number 3, the student respondents were asked on what were the things that they dislike about the AR/VR frog dissection software. As stated by student number 20, *"It's hard to look around and keep moving."* Based from student number 40, *"It is*

a little difficult to set up." Also, student number 46 said, *"It is kind of hard to control."* Focusing on question number 4, focuses on the difficulties that the student respondents encountered while immersing on the AR/VR frog software. Based from the answer of student number 4, "*I don't find any difficulties, it is easy to understand."* While student number 8 said, *"laggy phone."* Student number 14 said, *"There were too much words to comprehend."* Virtual reality is not that effective to use inside the classroom because of the difficulty experienced by student number 49 about, *"The 3D effect because I feel like dizzy."*

The end part of the essay-type questionnaire was to enable the student respondents to give suggestions on how to improve the AR/VR frog dissection software. As stated by student number 11, *"Use a better programming software."* As requested by student number 21, *"I suggest that you can get a VR for those who have blurry eyes".* Also, *"Make the graphics more realistic and the dissection more realistic"*, from the statement of student number 32. Student number 33 said, *"to make it more easy to utilize"* while one of the suggestions that should be emphasized was with that of student number 40, *"That it can be accessible in all types of phone whether it is iphone or ios and the app be available to download by everyone."* Lastly, student number 49 said, *"Nothing, it is all good"*. Among all the statements of the student respondents, there was a non-disclosure of their names. Instead of stating their names on the interpretation of results, the researcher utilized "student number" so as to respect the privacy of the identity of each of the respondents.

CHAPTER 4

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter focuses on the findings of the study, its summary along with the conclusions and recommendations that comes with it. Through this chapter, you could have a brief overview with regards to the corresponding results of the study.

I. Summary of the Study

This study is focused on the development of an AR/VR frog dissection software which is named Talapang. This particular term “Talapang” came from the Bicol’s rinconada dialect which means frog. This software is intended to address the difficulties of the students in the traditional frog dissection method.

Based from the results of the research study, it was emphasized that dissecting a frog would enable students to feel that it is alright to hurt animals. Also, there were some negative emotions which were emphasized such as feeling dizzy and exhausted were noted among the student respondents. Because of this, the idea of having an alternative method of dissecting frogs through the augmented reality/virtual reality application was conceptualized.

An IT expert was commissioned to develop the Talapang software. The software was validated by the content experts through the SNDAVS. The MC exam was also made and validated prior to the intervention process. IMI is used to measure the intrinsic motivation of students. VARK was also measured through the VARK questionnaire. In order to measure the students' perception, a reflective journal was also given.

There were 3 groups (Mo,AVi, and AVg) having 25 respondents per group that participated in the study. Each students were given a pre-test then the VARK questionnaire. After which, the Mo group used module only as part of the intervention process. There were 2 groups which utilized AR/VR. The first group of AR/VR used the software individually while the second group of AR/VR used the software by group. After immersion, the students were asked to answer a posttest followed by the IMI and the Reflective journal.

At the end of the data gathering process, the researcher would address the following objectives:

1. Assess the Needs to develop an AR/VR frog dissection software.
2. Develop an AR/VR frog dissection software.
3. Determine the pre-test scores and the VARK scores of the student respondents.

4. Determine the significant difference between the pre-test and post-test scores obtained from:
   a. Module only
   b. AR/VR individual
   c. AR/VR group
5. Determine the significant difference between the obtained Post Test scores among the Mo, AVi, and Avg groups.
6. Determine the significant difference among the intrinsic motivation (IM) scores among the Mo, AVi, and AVg groups.
7. Identify the student respondents' perceptions after they utilize the newly developed AR/VR frog dissection software.

The statistical treatment of data used in the study for the numerical data were parametric paired samples t test and one way ANOVA while the qualitative data or the students' perceptions on the utilization of the Talapang software was analyzed through thematic approach.

II. Summary of the Results

These are the summary of the results which addresses the specific objectives presented.

1. **Assess the Needs to develop an AR/VR frog dissection software**

The student respondents were asked to immerse in the traditional frog dissection experiment. After which their opinions about traditional frog dissection were gathered. Based from the statement of student number 75, *"Knowing that frogs have their own lives, they shouldn't be captured and cut their body parts for educational purposes. Many frogs are being killed for dissection. Also, the formalin that is used for the preservation of the frog's body is uncomfortable to our eyes and nose."* The statement of student number 99 should also be emphasized, *" I did not like anything about having to dissect a frog. It made me realize that I do not like anything related to medicine."*Also, many students are complaining about the formalin like that of student number 17, *"I actually felt light headed and a bit rugged because of the diffusion of formalin into the air. It's quite nice that I got to experience dissecting a frog but its difficult and I just wanted to experience that once in my lifetime."*

Because of these reasons, there is really a need to develop and AR/VR frog dissection software as stated by student 97, *"Maybe modern technology can be used as an alternative for actual frog dissection."*

2. **Develop and validate the AR/VR frog dissection software.**

An IT expired was commissioned to create the Talapang software which was validated by 5 IT experts and 3 Biology professors. The mean rating given by the IT expert to the said AR/VR frog software was 4.39 or "4". They gave the software the assessment of "Very Good". Meanwhile, the Biology professors gave a lower score. When you calculate the mean score that they gave to the software, it is 3.77 but when you round it off, it is equivalent to "4" or "Very Good" as well. There are also comments given by the experts on the said software such as, *"It is unique to the students. I never encountered this kind of educational yet exciting game" and "that through this software, users can dissect and learn the anatomy of the frog without needing to kill one. Another good point is that the users with no experience in VR will be exposed to this kind of technology. I think that it will be very fun for them and this may broaden their interest in the new technology."*

3. **Determine the pre-test scores and the VARK scores of the student respondents.**

The mean pre-test scores of the student respondents for each group will only be emphasized. With regards to the Mo group, the mean pre-test score of the

student respondents is 16.64. For the AVi group, the mean pre-test score is 21.04 while the mean pre-test score for the AVg group is 13.56.

There are diverse learning styles of the students and through VARK, they will be able to identify if they are, visual, auditory, read/write, or kinesthetic learners. For the Mo group, there are 4 visual, 8 aural, 8 read/write, and 10 kinesthetic learners. For the AVi group, there are 6 visual, 8 aural, 8 read/write, and 8 kinesthetic learners. Lastly, for AVg, there 3 visual, 10 aural, 13 read/write, and 13 kinesthetic learners. Take note that the total value exceeds the sample size. This is due to an overlap of the VARK since many students have multimodal learning styles.

4. Determine the significant difference between the pre-test and post-test scores obtained from:

a. Module only

Based from the results obtained from the paired samples t-test results, having a p value of "0.000", indicates acceptance of the alternative hypothesis which indicates that there is no significant difference between the pre-test and posttest scores for the module group only. Please refer to Table 9 for reference.

b. AR/VR individual

A p value result of "0.000" for the AR/VR individual cluster shows that we need to accept the alternative hypothesis. Because of this, we can say that there is no significant difference between the pre-test and posttest scores for the AR/VR individual cluster. Kindly look at Table 11 on page 80.

c. AR/VR group

Lastly, Table 13 shows a p value of "0.000" for the AR/VR group. This shows the need to reject the null hypothesis and accept the alternative hypothesis. So, there is a significant difference between the pre-test and the post test scores on the AR/VR group.

5. Determine the significant difference between the obtained Post Test scores among the Mo, AVi, and Avg groups.

Using one way ANOVA, it was found out that the p value is "0.232" which indicates that there is a need to reject the alternative hypothesis and accept the null hypothesis. Therefore, there is no significant difference between the obtained Posttest scores among the 3 groups (Mo,AVi, and AVg). Take note as well the the F value of "1.491" is lower than the Fcrit value of "3.123".

6. **Determine the significant difference among the intrinsic motivation (IM) scores among the Mo, AVi and AVg groups.**

The intrinsic motivation level of students was divided into specific categories. The mean score for each category was identified for module group only. For the Interest or enjoyment, a mean score of 5 signifies that the students "Somewhat Agree" that they enjoyed the given activity. A mean score of 5 ("Somewhat Agree") for perceived competence, 5 ("Somewhat Agree") for effort/ importance, 3 ("Somewhat Disagree") for pressure/ tension, 4 ("Neither Agree/Disagree") for perceived choice, and 6 ("Mostly Agree") for value/usefulness. For AR/VR individual, the Interest/ enjoyment is 5 ("Somewhat Agree"), the perceived competence is 5("Somewhat Agree"), the effort/ importance is 5("Somewhat Agree"), the pressure/tension is 4("Neither Agree/Disagree"), the perceived choice is 4 ("Neither Agree/Disagree"), and the value/usefulness is 6 ("Mostly Agree").

The students who were grouped while utilizing AR/VR has varied motivation level per category. In terms of the interest or enjoyment, they show a mean value of 5 ("Somewhat Agree"), 4 ("Neither Agree/Disagree") for perceived competence, 5 ("Somewhat Agree") for effort/ importance, 4 ("Neither Agree/Disagree") for pressure/ tension, 4 ("Neither Agree/Disagree") for perceived choice, and 5 ("Somewhat Agree") for value/usefulness.

In identifying the significant difference between IM scores, one way ANOVA was used. The p value obtained was “0.0076” which is below “0.05”. Therefore, there is a need to reject the null hypothesis and accept the alternative one. The data shows that there is a significant difference between the obtained IM scores among the 3 groups (Mo, AVi, and AVg). Take note that the Fcrit value of 3.12 falls below the F value of 5.22.

7. **Identify the student respondents’ perceptions after they utilize the newly developed AR/VR frog dissection software.**

Thematically, the perceptions of the students were analyzed and presented on this part of the results of the study. The response of student 11 indicates, *“I feel that I have learned something new about frogs. The newly-gained knowledge can be beneficial.”*

In terms of the AR/VR frog software, student 4 said, *“I find it cool, and I felt excited while doing the activity, because I’m not really sure if I can hold a frog.”* According to student number 21, *“I feel so great to use such advanced technology. I feel happy to experience the AR/VR software.”*

III. Limitations of the Study

The study was conducted to develop an educational technology as an alternative to the traditional dissection method. The study was limited for STEM (Science, Technology, Engineering, and Mathematics), SHS (Senior High School) students only who were taking up General Biology 2 as their subject for the second semester.

The contents of the said software were limited to the external and internal (coelom and viscera) parts of the frog only. Due to the complexity of the software development process through Unity, the muscular system as well as the skeletal system are excluded on the software. The software can only be utilized by students who have android phones. Internet connection is not necessary for viewing the software contents. The results of the study were limited to the objectives that needs to be addressed.

IV. Conclusions

Looking back on the results and discussion part of this research study, the researcher found out that there is a significant difference between the pre-test and post test score for the students who utilized module only. Using the frog module inside the classroom can enhance the students' exam scores. Also, there is a significant

difference between the pre-test and the post test score for the students who utilized AVi. Using AR/VR individually inside the classroom can significantly increase the students' test scores and there is a significant difference between the pre-test and post test score for the students who utilized AVg. Using AR/VR by group inside the classroom can also increase the students' test scores significantly. There is no significant difference for the post test scores between Mo, AVi, and AVg. Meaning, the mean result of the post test scores among the 3 experimental groups are almost the same. There is a significant difference between the instrinsic motivation of students among the 3 experimental groups (Mo, AVi, and AVg). This means that the students have varied levels of motivation per group. It was surprising that the student who has an aural learning style got the highest result for the post test on the module only group while most of the kinesthetic learners got the highest score for the posttest after they utilize the AR/VR frog dissection software. The student respondents gave positive feedback on the AR/VR frog dissection software, but there is a need to improve the contents of the said software if it will be used in a classroom setting.

V. Recommendations

In terms of the salient results of this research study, the researcher presents the following recommendations for the improvement of the said research study:

1. Recommendation for the Improvement of the AR/VR Frog Dissection Software

a. The developed AR/VR software should be improved in terms of its contents as well as ease of usage.
b. The VR glasses should be utilized on a computer laboratory having one VR glass per student.
c. The AR/VR software should be modified so that any kind of cellular phone can view it.
d. Include other organ systems of the said software and make it more detailed.
e. Make the frog software more realistic.

2. If similar studies shall be conducted, future researchers must

a. Collect data from different schools and compare the results of the study.
b. Try to request other teachers to be the one who will demonstrate the usage of the given software to the class, the researcher will just observe.
c. Measure other variables like extrinsic motivation, test anxiety, persistence level, Biology readiness and the like

3. The result of the study proves that AR/VR enhances the academic achievement and the students and enable the students to be motivated in learning the different concepts in Biology specifically Anatomy and Physiology. Utilization of the AR/VR frog dissection software along with its module is highly recommended to be utilized on a classroom setting as an alternative tool for the traditional frog dissection experiment.

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APPENDICES

Appendix 1. *Documentation*

Figure 28. Dorsal View of the Frog used in Dissection

Figure 29. Ventral View of the Frog used in Dissection

Figure 30. Traditional Frog Dissection on a Laboratory Setting

Figure 31. AR/VR Frog Dissection Software Overview

Appendix 1. *Documentation*

Figure 32. Module and Other AR/VR Materials

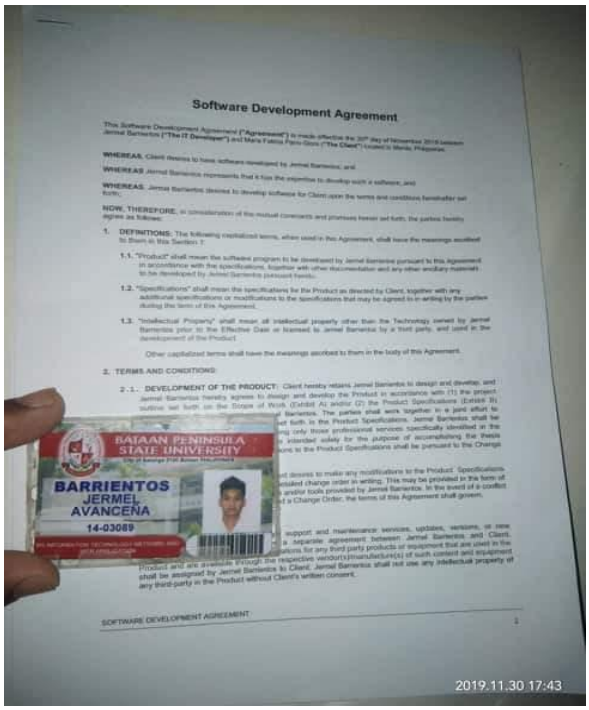

Figure 33. Signed SDA and ID of the IT Developer

Figure 34. Pre-test of the Student Respondents

Appendix 1. *Documentation*

Figure 35. Augmented Reality Application Utilized by STEM Students

Figure 36. Virtual Reality Application Utilized by The STEM Student

Figure 37. Posttest of Students with IMI, and Reflective Journal

Appendix 2. *Survey On Newly Developed AR/VR Software (Biology Professors)*

Philippine Normal University
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Manila, Philippines

Dear Sir/Madam:

May I request you to kindly fill-up this survey questionnaire as well as the set of questions that is attached herewith. This would eventually help the researcher in validating the newly developed software and would serve as a basis for the improvement of the AR/VR software together with its module through the suggested revisions and recommendations. Thank you.

MARIA FATIMA L. PARRO
MASEd Biology student

I. PROFILE

Name : _____

Affiliation: _____

Designation: _____

Biological Gender O (1) Male O (2) Female	Utilized AR/VR software in the past O (1) Yes O (2) No
Highest Educational Attainment O (1) No Educational Attainment O (2) Primary O (3) Secondary (JHS/SHS) O (4) Technical/Vocational in _____ O (5) Bachelor's Degree in _____ O (6) Master's Degree in _____ O (7) Doctorate Degree in _____ O (8) Postdoctorate Degree	Number of years using AR/VR O (1) None O (2) 1 to 5 years O (3) 6 to 10 years O (4) 11 to 15 years O (5) 16 to 20 years O (6) 21 to 25 years O (7) 26 to 30 years O (8) Above 30 years

II. SURVEY ON NEWLY DEVELOPED AR/VR SOFTWARE (BIOLOGY PROFESSORS)

Instructions: This survey contains the different criteria in connection to the newly developed AR/VR software. On each of the given statements below, shade your corresponding answer on each statement. Rate each item from 1 to 5 based on the level of quality (5=excellent, 4=very good, 3=good, 2=fair and 1- needs improvement).

AR/VR Software Content	5	4	3	2	1
1. Software originality	[ ]	[ ]	[ ]	[ ]	[ ]
2. Free of erroneous information	[ ]	[ ]	[ ]	[ ]	[ ]
3. Generation of an emotional reaction particularly excitement and amazement	[ ]	[ ]	[ ]	[ ]	[ ]
4. Organized flow of information	[ ]	[ ]	[ ]	[ ]	[ ]
5. Proper use of Biological terms	[ ]	[ ]	[ ]	[ ]	[ ]
6. Proper use of language of instruction	[ ]	[ ]	[ ]	[ ]	[ ]
7. Right placement of tasks	[ ]	[ ]	[ ]	[ ]	[ ]
8. Correct placement of labels	[ ]	[ ]	[ ]	[ ]	[ ]
9. Correct sets of model figures and/ or illustration	[ ]	[ ]	[ ]	[ ]	[ ]
10. Ability to support multiple human users at the same time	[ ]	[ ]	[ ]	[ ]	[ ]
11. Visual content	[ ]	[ ]	[ ]	[ ]	[ ]
12. Comprehensible terms	[ ]	[ ]	[ ]	[ ]	[ ]
13. Could be used without additional interventions	[ ]	[ ]	[ ]	[ ]	[ ]
14. Ease of usage	[ ]	[ ]	[ ]	[ ]	[ ]
15. Time constraint of using the software	[ ]	[ ]	[ ]	[ ]	[ ]
16. Colors seen on the virtual world	[ ]	[ ]	[ ]	[ ]	[ ]
17. Content applicable to SHS students	[ ]	[ ]	[ ]	[ ]	[ ]
18. Audio quality	[ ]	[ ]	[ ]	[ ]	[ ]
19. Software quality	[ ]	[ ]	[ ]	[ ]	[ ]
20. Accessibility among Filipino students	[ ]	[ ]	[ ]	[ ]	[ ]

Signature over printed name

Reference:

Chertoff, D., Goldiez, B., & LaViola Jr., J. (2010). Virtual experience test: a virtual environment evaluation questionnaire. Waltham, Massachusetts: Research Gate.

III. COMMENTS, SUGGESTIONS, AND RECOMMENDATIONS

Instructions: Answer the following questions honestly.

1. What are the good points that you noticed after you utilized the newly developed AR/VR frog software?

_____
_____
_____
_____
_____
_____
_____
_____

2. What are the points for improvement that you suggest after you utilized the newly developed AR/VR frog software?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

3. Will you recommend this software to be utilized by students on a classroom setting? Why or why not?

_____
_____
_____
_____
_____
_____
_____
_____

Appendix 3. *Survey On Newly Developed AR/VR Software (I.T. Experts)*

Philippine Normal University
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Manila, Philippines

Dear Sir/Madam:

May I request you to kindly fill-up this survey questionnaire as well as the set of questions that is attached herewith. This would eventually help the researcher in validating the newly developed software and would serve as a basis for the improvement of the AR/VR software together with its module through the suggested revisions and recommendations. Thank you.

MARIA FATIMA L. PARRO
MASEd Biology student

IV. PROFILE

Name : _____

Affiliation: _____

Designation: _____

Biological Gender O (1) Male O (2) Female	Utilized AR/VR software in the past O (1) Yes O (2) No
Highest Educational Attainment O (1) No Educational Attainment O (2) Primary O (3) Secondary (JHS/SHS) O (4) Technical/Vocational in _____ O (5) Bachelor's Degree in _____ O (6) Master's Degree in _____ O (7) Doctorate Degree in _____ O (8) Postdoctorate Degree	Number of years using AR/VR O (1) None O (2) 1 to 5 years O (3) 6 to 10 years O (4) 11 to 15 years O (5) 16 to 20 years O (6) 21 to 25 years O (7) 26 to 30 years O (8) Above 30 years

V. SURVEY ON NEWLY DEVELOPED AR/VR SOFTWARE (IT EXPERTS)

Instructions: This survey contains the different criteria in connection to the newly developed frog dissection software. On each of the given statements below, shade your corresponding answer on each statement. Rate each item from 1 to 5 based on the level of quality (5=excellent, 4=very good, 3=good, 2=fair and 1- needs improvement).

AR/VR Software Content	5	4	3	2	1
1. Software originality	[ ]	[ ]	[ ]	[ ]	[ ]
2. Helpful user interface	[ ]	[ ]	[ ]	[ ]	[ ]
3. Easy manipulation	[ ]	[ ]	[ ]	[ ]	[ ]
4. Free of erroneous information	[ ]	[ ]	[ ]	[ ]	[ ]
5. Generation of an emotional reaction particularly excitement and amazement	[ ]	[ ]	[ ]	[ ]	[ ]
6. Organized flow of information	[ ]	[ ]	[ ]	[ ]	[ ]
7. Right placement of tasks	[ ]	[ ]	[ ]	[ ]	[ ]
8. Correct sets of model figures and/ or illustration	[ ]	[ ]	[ ]	[ ]	[ ]
9. Visual display hardware	[ ]	[ ]	[ ]	[ ]	[ ]
10. Interaction and task involvement in the virtual environment	[ ]	[ ]	[ ]	[ ]	[ ]
11. Ability to support multiple human users at the same time	[ ]	[ ]	[ ]	[ ]	[ ]
12. Visual content	[ ]	[ ]	[ ]	[ ]	[ ]
13. Could be used without additional interventions	[ ]	[ ]	[ ]	[ ]	[ ]
14. Consistency of the sensory information of the virtual environment	[ ]	[ ]	[ ]	[ ]	[ ]
15. Ease of usage	[ ]	[ ]	[ ]	[ ]	[ ]
16. Time constraint of using the software	[ ]	[ ]	[ ]	[ ]	[ ]
17. Colors seen on the virtual world	[ ]	[ ]	[ ]	[ ]	[ ]
18. Sounds heard	[ ]	[ ]	[ ]	[ ]	[ ]
19. Retention of information	[ ]	[ ]	[ ]	[ ]	[ ]
20. User- friendly to Filipino students	[ ]	[ ]	[ ]	[ ]	[ ]

Signature over printed name

Reference:

Chertoff, D., Goldiez, B., & LaViola Jr., J. (2010). Virtual experience test: a virtual environment evaluation questionnaire. Waltham, Massachusetts: Research Gate.

VI. COMMENTS, SUGGESTIONS, AND RECOMMENDATIONS

Instructions: Answer the following questions honestly.

1. What are the good points that you noticed after you utilized the newly developed AR/VR frog software?

_____
_____
_____
_____
_____
_____
_____
_____

2. What are the points for improvement that you suggest after you utilized the newly developed AR/VR frog software?

_____
_____
_____
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_____
_____

3. Will you recommend this software to be utilized by students on a classroom setting? Why or why not?

_____
_____
_____
_____
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_____
_____
_____

Appendix 4. *Scope and Sequence Chart (SSC)*

FROG ANATOMY AND PHYSIOLOGY- SCOPE AND SEQUENCE CHART

Subject/Unit: **General Biology 2** Period: **Second Semester**
School Year: **2019- 2020** Grade Level: **Grade 12**
Day/Time: **Friday (1:00 – 3:00 p.m)** Strand: **STEM**
Duration: **2 days**

General Objective: The students in the process of learning shall develop proper knowledge and skills in studying frog anatomy and physiology.

Learning Competency: The students will be able identify the frog organ system as well as its organs and functions of each organ.

Major Topic/ Sub-Topic	Specific Objectives	Concepts	Approaches/ Strategies	Assessment Strategies
I. Organismal Biology A. Animal Organ System (Frog)	1. Describe a frog. 2. Identify the different anatomical positions of a frog. 3. Identify the major divisions of the frog's bodily structure. 4. Differentiate a male and a female frog. 5. Identify the external frog parts and its functions. 6. Identify the internal frog parts and its functions (coelom and viscera).	1. A frog is an oviparous amphibian which spends a part of its life on terrestrial and aquatic environment. 2. Frogs exhibits external fertilization which reproduces by amplexus. 3. Fertilized frog eggs undergo cleavage until it turns into a tadpole and metamorphose into an adult frog. 4. Ventral, dorsal, anterior, posterior, superior, inferior, medial, lateral, external, internal are the most commonly used anatomical positions of a frog. 5. The frog bodily structure is divided into axial (head and trunk) as well as appendicular (limbs).	➢ AR/ VR frog software ➢ Discovery Approach ➢ Blended Learning	➢ Scoring rubrics ➢ VCQ MC Two tier Questions (Pre-test/ Post test)

		6. A female frog has diffused skin pigmentation and swollen thumb while a male frog has darkly pigmented skin as well as swollen thumb. 7. The external parts of the frog are the snout, external naris, nictitating membrane, tympanic membrane, sacral hump, thigh, shank, digits of toes and fingers. 8. The viscera of the frog are esophagus, stomach, small intestine, mesentery, pancreas, liver, gallbladder, large intestine, anus, heart, lungs, kidney, spleen, corpora adiposa, urinary bladder, vertebral column (spine), testes (Male) and ovary (Female).		

[a] Major Topic *Target date of Instruction/ Immersion: [b 1] Day 1 & 2
[b] Sub-topic * Target date of Pre-test and Post-test: Day 1 & 2

Prepared by:

Ms. Maria Fatima L. Parro
Researcher

Recommending Approval:

Prof. Alfons Jayson O. Pelgone
Thesis Adviser

Appendix 5. *Learning Plan*

LEARNING PLAN IN GENERAL BIOLOGY 2
ORGANISMAL BIOLOGY

LEARNING OUTCOMES:

VALUE FOCUS	"Honesty and Integrity" -Telling the truth and doing the right thing even if nobody is looking. "Responsibility" -Accomplishing the task well independently
CONTENT FOCUS	ANIMAL ORGAN SYSTEM (FROG)
PERFORMANCE FOCUS	FROG DISSECTION
Reference Materials	Starr, C., Taggart, R., Evers, C., & Starr, L. Biology: The unity and diversity of life.
METHODOLOGY	**COPYING OF CONCEPT NOTES (15 minutes)**
	UNLOCKING (10 minutes)
	• Classroom Routine (Opening Prayer, Checking of attendance) • Pre-Test
	UNPACKING/EXPLAINING (5 minutes)
	• Presentation of instructions/ Guidelines in utilizing the TALAPANG AR/VR frog software
	EXPANDING/DEEPENING (30 minutes)
	• Talapang Module Only utilization (Day 1) • Talapang Augmented Reality utilization (Day 2) • Talapang Virtual Reality utilization (Day 2)
	UNIFYING AND VALUING (5 minutes)
	1-2-3 1- One thing that you like about the activity 2- Two things that you dislike from the activity 3- Three important concepts that you learned today
	EVALUATING (25 minutes)
	• Post Test • Administration of Survey questionnaires • Administration of reflective journal

COACHING INPUTS: (Mentor's Feedback)

Best Features of the Plan:	**Items for consideration/Enhancement:**
Teacher's Reflections/ Insights/ Learning/Other Plans:	***Lesson Plan for 2 days implementation**

Prepared by:

Ms. Maria Fatima L. Parro
General Biology 2 Teacher

Appendix 6. *Request Letter*

Philippine Normal University
Manila

January 6, 2019

FOR	:	**DR. NIEVA J. DISCIPULO** BED Principal, UE Manila
THRU	:	**PROF. FLORMAY OCAMPO-MANALO** STEM SHS Coordinator, UE Manila
NOTED BY	:	**PROF. ALFONS PELGONE** Thesis Adviser, PNU
FROM	:	**MRS. MARIA FATIMA PARRO- GLORE** MASEd Biology Student, PNU
SUBJECT	:	**REQUEST FOR THE ADMINISTRATION OF THESIS DATA GATHERING PROCEDURE IN UE MANILA**

Greetings of peace!

I am **Maria Fatima Parro – Glore**, a Master of Arts in Science Education Major in Biology student of the Philippine Normal University. I am currently writing my thesis entitled, "Talapang: an AR/VR Frog Software in Teaching STEM Biology" in partial fulfilment of my requirements in (TW) Thesis Writing subject.

In lieu with this, may I request from you to allow me to administer the data gathering procedure of my thesis at the University of the East-Manila. Also, may I request to obtain my respondents from the said university and excuse them from their classes on their scheduled intervention time. May I also be allowed to utilize a classroom with its corresponding equipment for 2 consecutive days (February 7-28, 2020). I have attached in this letter the methodology of my thesis for your reference.

Hoping for your kind consideration and approval regarding this request. Thank you so much!

Appendix 7. *Academic Examination*

QUESTIONNAIRE

Directions: Answer the given questions about frog dissection. Shade the letter that corresponds to your answer on your answer sheets. Please do not write anything on this questionnaire. Cheating is strictly prohibited.

1. Which particular group of organisms do frogs belong?
   A. Reptiles
   B. Mammals
   C. Amphibians
   D. Marsupials

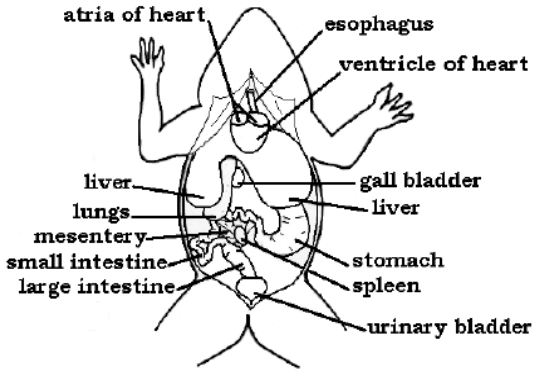
2. Which among the following could classify a frog based on its mode of reproduction?
   A. It is internal
   B. It is external
   C. It is viviparous
   D. None of the above

3. What significant contributions do frogs play on the environment?
   A. It controls pest populations that may cause diseases in humans
   B. It serves as a display on a scientific exhibit
   C. It cleans the water from pollutants and other contaminants
   D. It processes and releases oxygen that plants need

4. What part of the frog releases alkaloid secretions which protects it from predators?
   A. Poison glands
   B. Mucous glands
   C. Tympanic membrane
   D. Nictitating membrane

5. Most of the frog that you see around you is green in color. Which among the following justifies this claim?
   A. Frogs contain chlorophyll pigment inside their chloroplasts that absorbs red and blue light from the sun and reflects green light
   B. Frogs emits green fluid secretion that when dried would give it its green color
   C. Frogs have green melanin which is released by the mucous glands
   D. Frogs have dermal chromatophores which would enable them to have green color

Student ZipGrade ID
20001



6. Which is shown on the frog illustration above?
   A. External parts of the frog
   B. Internal parts of the frog
   C. Axial parts of the frog
   D. Appendicular parts of the frog

7. Which particular structure is used by frogs in order for them to be able to hear?
   A. Nictitating membrane
   B. Tympanic membrane
   C. Ears
   D. External naris

8. Referring to the figure above, which among the following statements is NOT correct?
   A. The stout is at the tip of the frog's head.
   B. The external naris aids in frog respiration.
   C. The tympanic membrane is the frog's flat circular eardrums.
   D. The nictitating membrane is the transparent portion of the frog's eyes which protects it from injury.

9. What do you think is wrong with the given figure above?
   A. The number of digits of toes. There should be 5 digits of toes and 4 digits of fingers.
   B. The number of digits of fingers. There should be 4 digits of toes and 5 digits of fingers.
   C. The number of digits of toes and fingers. There should be 5 digits of toes and 5 digits of fingers.
   D. Nothing is wrong with the given figure.

10. Which among the following structures is a protuberance near the median dorsal line of the frog?
    A. Thigh
    B. Shank
    C. Sacral hump
    D. Snout

11. The external naris of the frog consists of how many small valvular openings?
    A. 1
    B. 2
    C. 4
    D. 6

12. Which among the following characteristics can describe a male frog?
    A. A male frog has a diffused skin pigmentation and swollen thumb
    B. A male frog has a diffused skin pigmentation and unswollen thumb
    C. A male frog has a darkly pigmented skin and unswollen thumb
    D. A male frog has a darkly pigmented skin and swollen thumb

13. Which characterizes the shank?
    A. It is the frog's longer hind limb on the upper ankle part of the knee
    B. It is the frog's longer hind limb on the lower ankle part of the knee
    C. It is the frog's shorter hind limb on the lower hip part of the knee
    D. It is the frog's shorter hind limb on the upper hip part of the knee

14. What can you see on the tip of the frog's head?
    A. Stout
    B. Spout
    C. Snout
    D. Smout

15. Which equipment is used to make an incision on the abdomen of the frog in order to view its internal parts?
    A. Push pin
    B. Scalpel
    C. Spatula
    D. Stirring rod

16. Which term is used to describe the general body cavity of the frog?
    A. Peritoneal cavity
    B. Viscera
    C. Coeloner
    D. Endometrial cavity

17. What is the difference between the small intestine of the frog and a human being?
    A. The frog's small intestine is made up of duodenum and jejunum while the human's small intestine is made up of ileum and jejunum
    B. The frog's small intestine is made up of ileum, duodenum and jejunum while the human's small intestine is made up of ileum and duodenum
    C. The frog's small intestine is made up of duodenum and jejunum while the human's small intestine is made up of ileum, duodenum, and jejunum
    D. The frog's small intestine is made up of duodenum and ileum while the human's small intestine is made up of duodenum, ileum, and jejunum

18. How many lobes are there on a frog's liver?
    A. 4
    B. 3
    C. 2
    D. 1

19. Which among the following statements is NOT true about the frog's heart?
    A. The frog's heart is made-up of right and left atria and a thick-walled ventricle
    B. The frog's heart is 3-chambered
    C. The frog's heart is made-up of right and left ventricle and a thick-walled atria
    D. The role of the frog's heart is to pump blood

20. Which frog organ attached to the mesentery is responsible for the rupture of the old blood cells?
    A. Pancreas
    B. Corporal adiposa
    C. Spleen
    D. Gallbladder

21. What male reproductive organ produces frog's sperm?
    A. Testes
    B. Epididymis
    C. Cloaca
    D. Amplexus

22. You can locate mesorectum on which particular frog organ?
    A. Small intestine
    B. Large intestine
    C. Rectum
    D. Anus

23. Which statement is NOT true on the lungs of a frog?
    A. The frogs lungs is anterior to the abdominal cavity
    B. The frog's lungs is 2-lobed
    C. The frog's lungs serves for the exchange of gases within the frog's body
    D. The frog's lungs is posterior to the stomach and superior to the heart

24. What organ stores bile?
    A. Pancreas
    B. Gallbladder
    C. Spleen
    D. Liver

25. What do you call the fat storage structures of frogs?
    A. Corpora adiposa
    B. Zona pellucida
    C. Adiposa cellula
    D. Corona radiate

26. Which is NOT the function of the frog's anus?
    A. Secrete fecal matter
    B. Secrete urine
    C. Secrete filtered blood
    D. Secrete reproductive cells

27. What characterizes the stomach of the frog?
    A. It is mango- shaped
    B. It is inferior to the diaphragm
    C. It has four regions (fundic, cardiac, corpus and pyloric)
    D. It consists of a cardiac end, pyorus, greater curvature, lesser curvature, regae, and mesogastrium

28. What part of the frog is a web-like structure that attaches to the small intestine in order to keep it in place?
    A. Pylorus
    B. Mesentery
    C. Corpus
    D. Pericardium

29. Which organ of the frog is NOT made up of 3 parts?
    A. Liver
    B. Heart
    C. Small intestine
    D. All the given organs have 3 parts

30. Which organ encloses the frog's brain and spinal cord?
    A. Vertebral column
    B. Skull
    C. Joint
    D. Ligament

31. What is the difference between frog's heart and liver?
    A. Frog's heart is 3-chambered and frog's liver is 3-lobed while human heart is 4- chambered and human liver is 2-lobed
    B. Frog's heart is 2-chambered and frog's liver is 4-lobed while human heart is 3- chambered and human liver is 3-lobed
    C. Frog's heart is 3-chambered and frog's liver is 2-lobed while human heart is 4- chambered and human liver is 3-lobed
    D. Frog's heart is 3-chambered and frog's liver is 3-lobed while human heart is 2- chambered and human liver is 2-lobed

32. What is the end hole of the frog's digestive system?
    A. Rectum
    B. Anus
    C. Cloaca
    D. Appendix

33. How will you know if it is human esophagus?
    A. Human esophagus is 3 cm straight tube inferior to the pharynx
    B. Human esophagus is 25 cm tube located at the inferior part of the larynx and posterior part of the trachea
    C. Human esophagus is located midway between the coricoid cartilage and 9^{th} cervical vertebra
    D. Human esophagus is posterolateral to the stomach

34. Which organ secretes insulin?
    A. Spleen
    B. Gallbladder
    C. Pancreas
    D. Kidney

35. Where can chime be found?
    A. Esophagus
    B. Small intestine
    C. Stomach
    D. Large intestine

36. Maria saw a 2- lobed, thin walled spongy organ which is located anterior to the abdominal cavity after she dissected a frog. What do you think is the function of the structure that she was able to identify?
    A. Filter blood
    B. Pump blood
    C. Exchange gases
    D. Secrete bile

37. Fernando needs to locate the pancreas of the frog. Which characteristic of the frog pancreas would help her locate the said structure?
    A. The pancreas is beige colored. It is located medial to the stomach and duodenum along the hepatoduodenal omentum and gastroduodenal omentum.
    B. The pancreas is green in color. It is located posterior to the stomach's greater curvature.
    C. The pancreas is brown in color. It is located inferior to the hepatoiliac omentum and gastroiliac omentum.
    D. The pancreas is flesh in color. It is spongy and is located median to the medial lobe and right lobe of the liver.

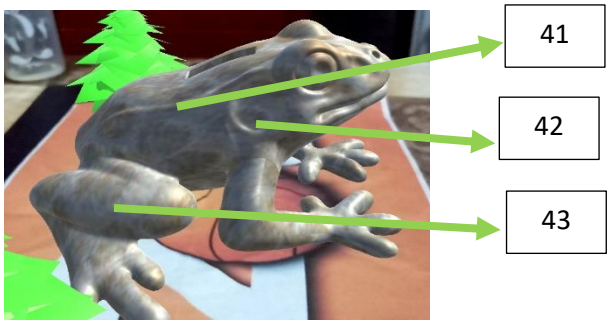
38. Rosalinda is dissecting a frog. She can't find the gallbladder. What specific characteristic anatomical location of the gallbladder would help her locate it easily?
    A. The gallbladder is green in color. It is located medial to the median lobe and right lobe of the liver.
    B. The gallbladder is green in color. It is located inferior to the sternum on the frog's chest.
    C. The gallbladder is brown in color. It is located inferior to the frog's pharynx.
    D. The gallbladder is brown in color. It is located posterior to the stomach's greater curvature.

39. Fred saw a frog organ which he describes as yellow orange fingerlike structures which seems to be connected to the frog's reproductive organ. What do you think is this organ?
    A. Ovary
    B. Corpora Adiposa
    C. Mesentery
    D. Spleen

40. Which is NOT a reason why frogs are used as a specimen for dissection in vitro?
    A. Frogs are species which have anatomical parts that have resemblance with human anatomical parts
    B. Frogs are small and are easy to dissect
    C. Frogs species are readily available
    D. Frogs are easy to dispose

For questions 41- 50, you need to label the frog anatomical parts of the frog by choosing the letter of the correct answer.

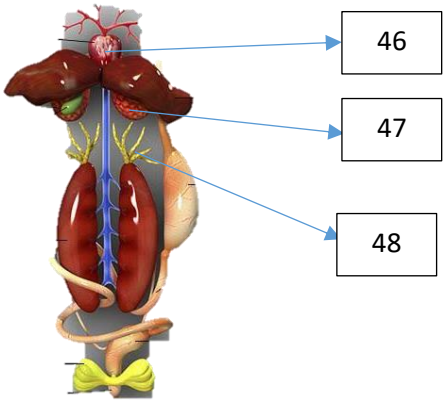
I. External Anatomy



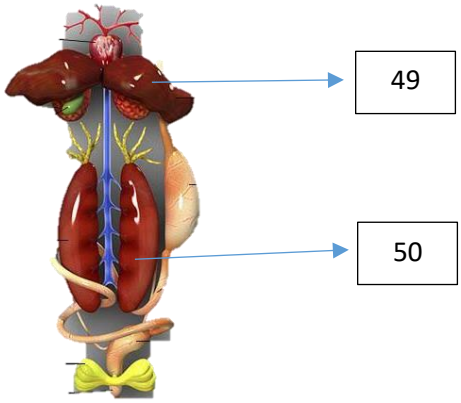
A. Tympanic membrane
B. Shank
C. Thigh
D. Sacral hump

A. External naris
B. Tympanic membrane
C. Nictitating membrane
D. snout

II. Internal Anatomy



A. Corpora adiposa (fat bodies)
B. Liver
C. Lungs
D. Heart



A. Stomach
B. Liver
C. Spleen
D. Kidney

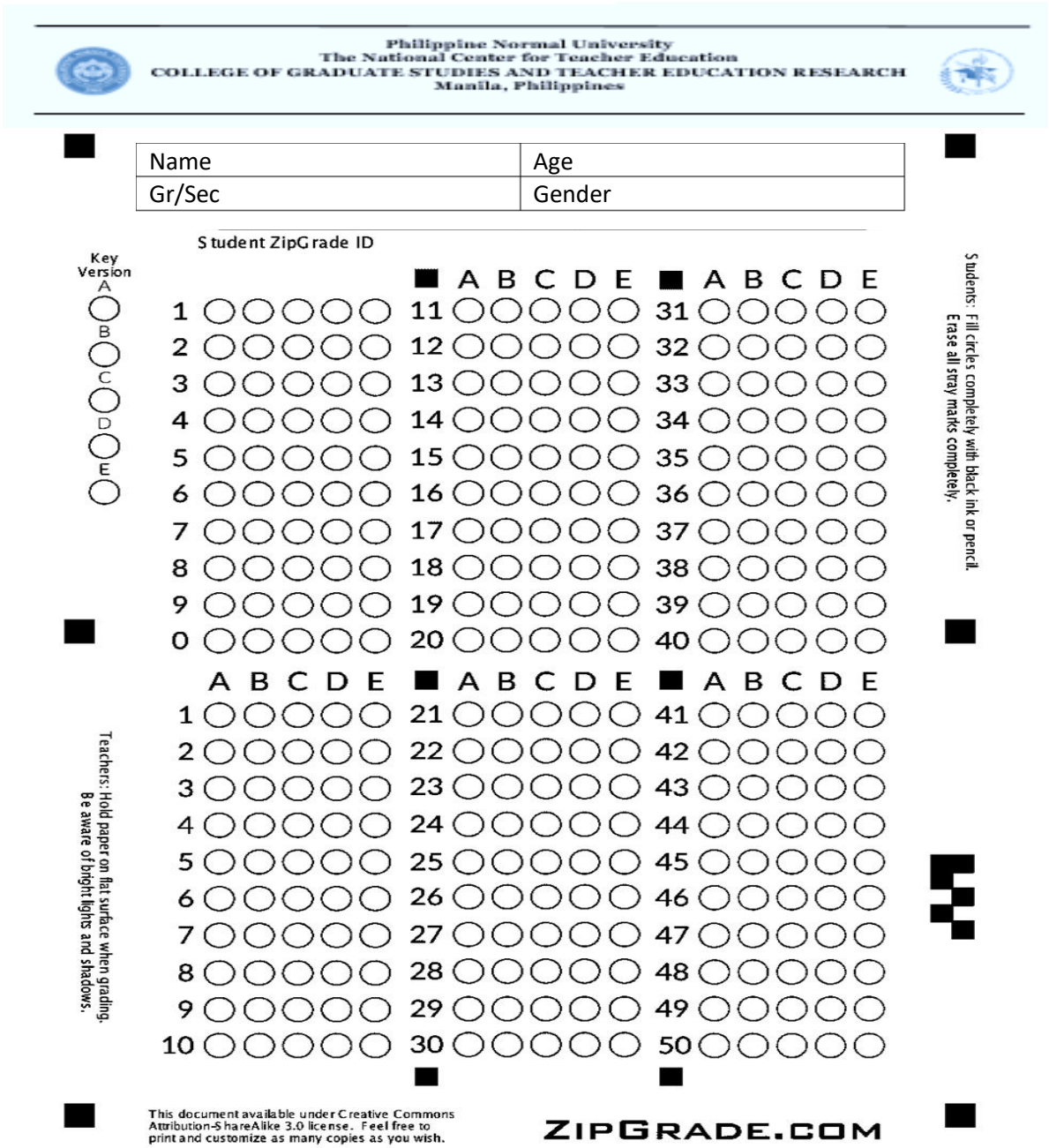
---end---

Appendix 8. *Academic Examination Key to Corrections*

Key to Corrections for the MC Frog Exam:

1.C
2.B
3.A
4.A
5.D
6.B
7.B
8.A
9.A
10.C
11.B
12.D
13.B
14.C
15.B
16.A
17.D
18.B
19.C
20.C
21.A
22.B
23.D
24.B
25.A
26.C
27.D
28.B
29.C
30.A
31.A
32.B
33.B
34.C
35.B/C
36.C
37A
38.A
39.B
40.D
41.D
42.A
43.B
44.C
45.A
46.D
47.C
48.A
49.B
50.D

Appendix 9. *Academic Examination Answer Sheet*



Philippine Normal University
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Manila, Philippines

Name	Age
Gr/Sec	Gender

Student ZipGrade ID

Key Version
A
B
C
D
E

	A	B	C	D	E		A	B	C	D	E		A	B	C	D	E
1	○	○	○	○	○	11	○	○	○	○	○	31	○	○	○	○	○
2	○	○	○	○	○	12	○	○	○	○	○	32	○	○	○	○	○
3	○	○	○	○	○	13	○	○	○	○	○	33	○	○	○	○	○
4	○	○	○	○	○	14	○	○	○	○	○	34	○	○	○	○	○
5	○	○	○	○	○	15	○	○	○	○	○	35	○	○	○	○	○
6	○	○	○	○	○	16	○	○	○	○	○	36	○	○	○	○	○
7	○	○	○	○	○	17	○	○	○	○	○	37	○	○	○	○	○
8	○	○	○	○	○	18	○	○	○	○	○	38	○	○	○	○	○
9	○	○	○	○	○	19	○	○	○	○	○	39	○	○	○	○	○
0	○	○	○	○	○	20	○	○	○	○	○	40	○	○	○	○	○

	A	B	C	D	E		A	B	C	D	E		A	B	C	D	E
1	○	○	○	○	○	21	○	○	○	○	○	41	○	○	○	○	○
2	○	○	○	○	○	22	○	○	○	○	○	42	○	○	○	○	○
3	○	○	○	○	○	23	○	○	○	○	○	43	○	○	○	○	○
4	○	○	○	○	○	24	○	○	○	○	○	44	○	○	○	○	○
5	○	○	○	○	○	25	○	○	○	○	○	45	○	○	○	○	○
6	○	○	○	○	○	26	○	○	○	○	○	46	○	○	○	○	○
7	○	○	○	○	○	27	○	○	○	○	○	47	○	○	○	○	○
8	○	○	○	○	○	28	○	○	○	○	○	48	○	○	○	○	○
9	○	○	○	○	○	29	○	○	○	○	○	49	○	○	○	○	○
10	○	○	○	○	○	30	○	○	○	○	○	50	○	○	○	○	○

Students: Fill circles completely with black ink or pencil.
Erase all stray marks completely.

Teachers: Hold paper on flat surface when grading.
Be aware of bright lights and shadows.

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Appendix 10. *Intrinsic Motivation Inventory (IMI)*

Philippine Normal University
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Manila, Philippines

INTRINSIC MOTIVATION INVENTORY QUESTIONNAIRE (IMI)

Name: _____
School : _____
Strand/Grade/ Section : _____ Biological gender: ( ) Male ( ) Female Age : _____

Dear Respondent:

May I request you to kindly fill-up this survey questionnaire as well as the set of questions that is attached herewith. This would eventually help me in assessing the effectivity of the Talapang software along with its module. Your participation in this survey is voluntary. You can refuse to answer the given survey anytime for any reasons. Rest assured that I will ensure the privacy of information that I will gather. Your participation is appreciated. Thank you.

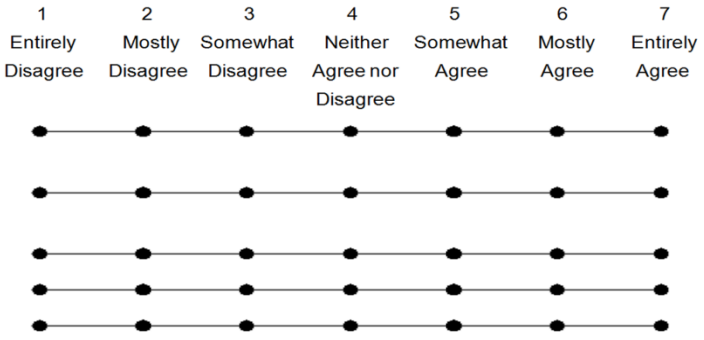
MARIA FATIMA L. PARRO
MASEd Biology student

I. The Post-Experimental Intrinsic Motivation Inventory

Listed below are questions obtained and modified from IMI which measures intrinsic motivation after immersing oneself in augmented reality or virtual reality application. Encircle the dot which corresponds to your answer on each given question.

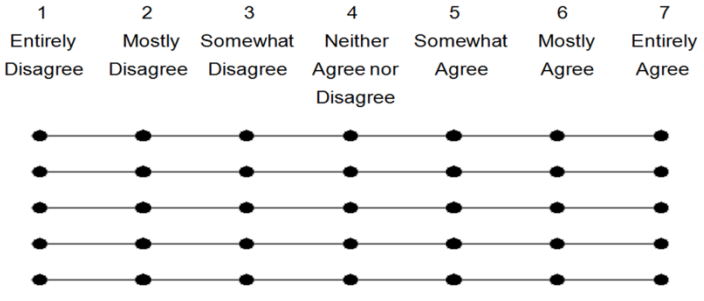
	1 Entirely Disagree	2 Mostly Disagree	3 Somewhat Disagree	4 Neither Agree nor Disagree	5 Somewhat Agree	6 Mostly Agree	7 Entirely Agree
A. Interest/ Enjoyment							
1. I enjoyed doing this activity very much.	●	●	●	●	●	●	●
2. This activity was fun to do.	●	●	●	●	●	●	●
3. I thought this was a boring activity. (R)	●	●	●	●	●	●	●
4. This activity did not hold my attention at all. (R)	●	●	●	●	●	●	●
5. I would describe this activity as very interesting.	●	●	●	●	●	●	●
6. I thought this activity was quite enjoyable.	●	●	●	●	●	●	●
7. While I was doing this activity, I was thinking about how much I enjoyed it.	●	●	●	●	●	●	●

B. Perceived Competence



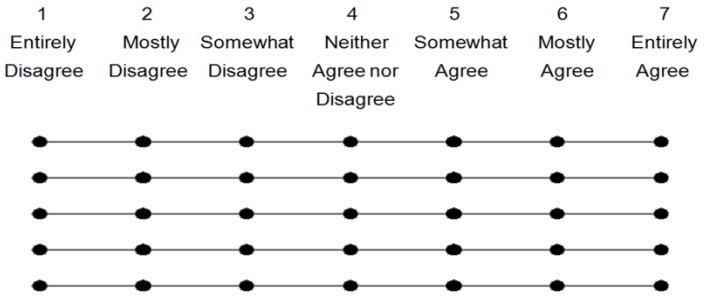
8. I think I am pretty good at this activity.
9. I think I did pretty well at this activity, compared to other students.
10. After working at this activity for a while, I felt pretty competent.
11. I am satisfied with my performance at this task.
12. I am pretty skilled at this activity.
13. This was an activity that I couldn't do very well. (R)

C. Effort/ Importance



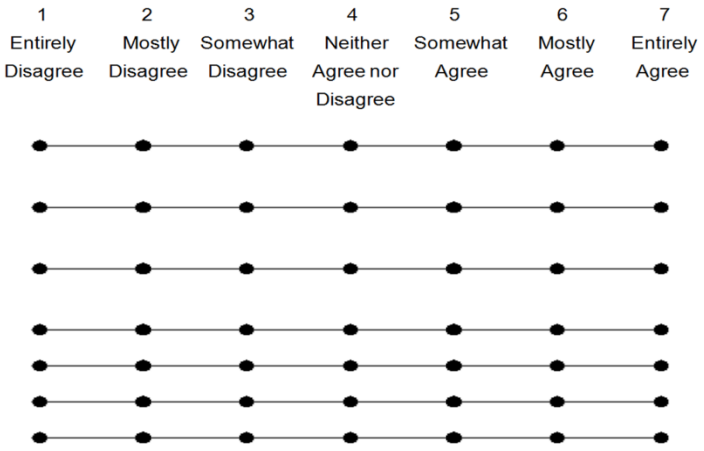
14. I put a lot of effort into this.
15. I didn't try very hard to do well at this activity. (R)
16. I tried very hard on this activity.
17. It was important to me to do well at this task.
18. I didn't put much energy into this. (R)

D. Pressure/ Tension



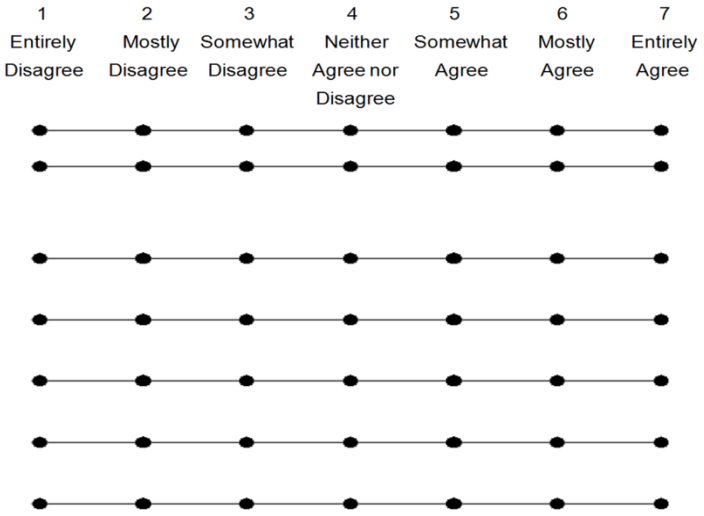
19. I did not feel nervous at all while doing this. (R)
20. I felt very tense while doing this activity.
21. I was very relaxed in doing these. (R)
22. I was anxious while working on this task.
23. I felt pressured while doing these.

E. Perceived Choice



24. I believe I had some choice about doing this activity.
25. I felt like it was not my own choice to do this task. (R)
26. I didn't really have a choice about doing this task. (R)
27. I felt like I had to do this. (R)
28. I did this activity because I had no choice. (R)
29. I did this activity because I wanted to.
30. I did this activity because I had to. (R)

F. Value/ Usefulness



31. I believe this activity could be of some value to me.
32. I think that doing this activity is useful for learning biology concepts specifically about frog anatomy and physiology.
33. I think this is important to do because it can help me comprehend the topics in biology.
34. I would be willing to do this again because it has some value to me.
35. I think doing this activity could help me to score high on my exams.
36. I believe doing this activity could be beneficial to me.
37. I think this is an important activity.

INTRINSIC MOTIVATION INVENTORY (IMI) SCORING

To score this instrument, you must first reverse score the items for which an (R) is shown after them. To do that, subtract the item response from 8, and use the resulting number as the item score. Then, calculate subscale scores by averaging across all of the items on that subscale. The subscale scores are then used in the analyses of relevant questions.

A. Interest/ Enjoyment	1	2	3 (R)	4 (R)	5	6	7
B. Perceived Competence	8	9	10	11	12	13 (R)	
C. Effort/ Importance	14	15 (R)	16	17	18 (R)		
D. Pressure/ Tension	19 (R)	20	21 (R)	22	23		
E. Perceived Choice	24	25 (R)	26 (R)	27 (R)	28 (R)	29	30 (R)
F. Value/ Usefulness	31	32	33	34	35	36	37

References:

Deci, E. L., Eghrari, H., Patrick, B. C., & Leone, D. (1994). Facilitating internalization: The selfdetermination theory perspective. *Journal of Personality*, 62, 119-142.

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Appendix 11. *Reflective Journal (Traditional Frog)*

Philippine Normal University
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Manila, Philippines

REFLECTIVE JOURNAL

Name: _____
School : _____
Strand/Grade/Section : _____ Biological gender: ( ) Male ( ) Female Age : ____

I. Students' Perceptions on Traditional Frog Dissection

Listed below are questions that you need to answer honestly after you conducted the traditional frog dissection experiment.

1. What did you feel after you conducted the frog dissection experiment?

_____
_____
_____
_____
_____
_____
_____

2. What did you like about frog dissection?

_____
_____
_____
_____
_____
_____
_____

3. What did you dislike about frog dissection?

_____
_____
_____
_____
_____
_____
_____

4. What are the difficulties that you encountered after after conducting the frog dissection?

_____
_____
_____
_____
_____
_____
_____
_____

5. What can you suggest so that other students like you would better learn the concept in frog anatomy?

_____
_____
_____
_____
_____
_____
_____

Appendix 12. *Reflective Journal (Module Only)*

Philippine Normal University
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Manila, Philippines

REFLECTIVE JOURNAL

Name: _____
School : _____
Strand/Grade/Section : _____ Biological gender: ( ) Male ( ) Female Age : ____

I. Frog Module Students' Perceptions

Listed below are questions that you need to answer honestly after you utilize the Frog Module.

1. What did you feel after you utilized the Frog Module as an alternative tool for traditional frog dissection?

_____
_____
_____
_____
_____
_____
_____

2. What did you like about the Frog module?

_____
_____
_____
_____
_____
_____
_____

3. What did you dislike about the Frog Module?

_____
_____
_____
_____
_____
_____
_____
_____

4. What are the difficulties that you encountered after immersing on the Frog Module?

_____
_____
_____
_____
_____
_____
_____
_____

5. What can you suggest for the improvement of the Frog Module?

_____
_____
_____
_____
_____
_____
_____

Appendix 13. *Reflective Journal (AR/VR Frog)*

Philippine Normal University
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Manila, Philippines

REFLECTIVE JOURNAL

Name: _____
School : _____
Strand/Grade/Section : _____ Biological gender: ( ) Male ( ) Female Age : ____

I. AR/VR Frog Students' Perceptions

Listed below are questions that you need to answer honestly after you utilize the Augmented Reality / Virtual Reality Frog Software.

1. What did you feel after you utilized the AR/VR Frog Software as an alternative tool for traditional frog dissection?

_____
_____
_____
_____
_____
_____
_____

2. What did you like about the AR/VR Frog Software?

_____
_____
_____
_____
_____
_____
_____

3. What did you dislike about the AR/VR Frog Software?

_____
_____
_____
_____
_____
_____
_____

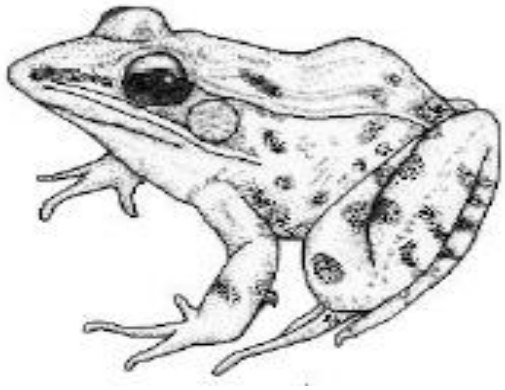
4. What are the difficulties that you encountered after immersing on the AR/VR Frog Software?

_____
_____
_____
_____
_____
_____
_____

5. What can you suggest for the improvement of the AR/VR Frog Software?

_____
_____
_____
_____
_____
_____
_____

Appendix 14. *Frog Module*



What is a frog?

A frog is an amphibian which spends a part of its life on terrestrial and aquatic environment. Frogs exhibits external fertilization which reproduces by amplexus. Fertilized frog eggs undergo cleavage until it turns into a tadpole and metamorphose into an adult frog. Frogs are important part of the ecosystem because they play a key role in controlling pest populations that may cause human illnesses. This species also aids in the cycling of nutrients among terrestrial and aquatic environment.

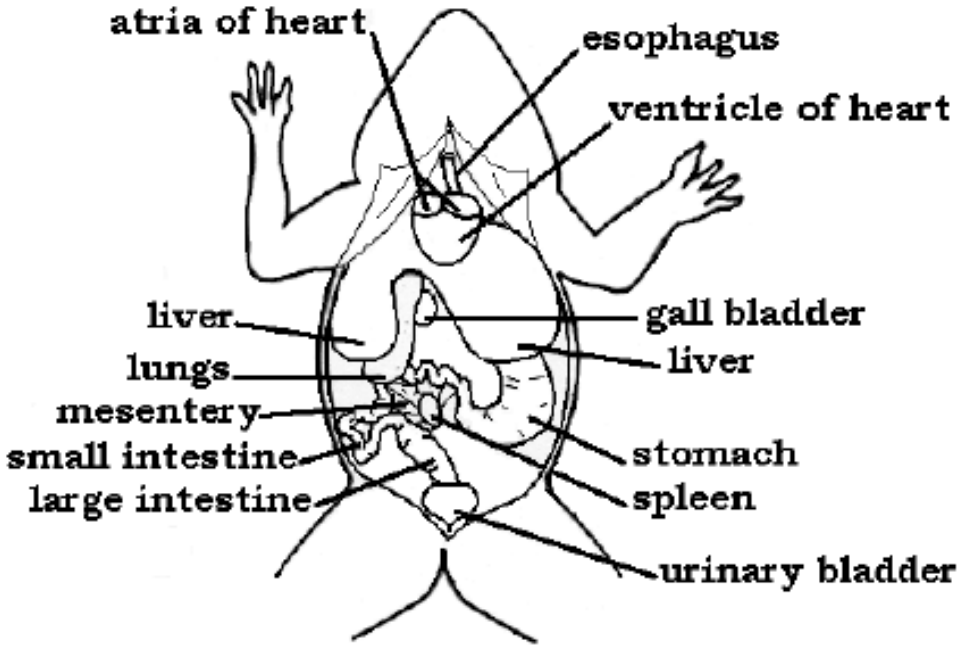
Frogs are smaller than human beings. Naturally, they have moist, slippery skin which is due to the fluid secretion of its mucous glands. There are frogs which have poison glands which emits thick alkaloidal secretions that protect it from predators. Some frogs have dermal chromatophores which give its distinctive green color.

FROG ANATOMICAL POSITIONS

Position	Description
VENTRAL	Posterolateral direction headed to the frontal region
DORSAL	posterolateral direction headed to the back region
ANTERIOR	Direction leading to the ventral region
POSTERIOR	Direction leading to the dorsal region
SUPERIOR	Upper region
INFERIOR	Lower region
MEDIAL	Towards the center
LATERAL	Away from the center
EXTERNAL	Outer part
INTERNAL	Inner part
AXIAL	the head and the trunk
APPENDICULAR	the limbs

Function	Answer (Anatomical Part)
The tip of frog's head.	snout
This consists of 2 small valvular openings located on the snout of the frog wherein respiration initially occurs.	external naris
Transparent portion on the anterior part of the frog's eyes which serves as protection against injury while keeping it moist.	nictitating membrane
Frog's flat circular eardrums posterior to the frog's eyes.	tympanic membrane
A protuberance near the median dorsal line.	sacral hump
Frog's shorter hind limb on the upper hip part to the knee.	thigh
Frog's longer hind limb on the lower ankle part to the knee.	shank
Frog's five digits	digits of toes
Frog's four digits	digits of fingers

The general body cavity of a frog is known as coelom or peritoneal cavity. The organs that comprises the frog's coelom is known as the viscera which is enclosed by a membrane called peritoneum. The viscera are mainly composed of organs for digestion as well as other organs which serve main functions on other organ systems of the frog.



FROG VISCERA

I. Organs for Digestion

Organ	Function (Frog)	Function (Human)
1. esophagus	A 3 cm straight tube inferior to the frog's pharynx which is the passageway of bolus that extends posteriorly towards the stomach.	A long straight 25 cm tube located at the inferior part of the larynx and posterior part of the trachea, midway between the coricoid cartilage and 6th cervical vertebra wherein peristalsis occurs which promotes the passage of bolus towards the stomach.
2. stomach	A bean-shaped organ on the right part of the abdomen which consists of a cardiac end, pylorus, greater curvature, lesser curvature, rugae, and mesogastrium. This organ is where the chemical digestion of food particle take place through digestive enzymes such as proteases, lipase, and maltase.	A mango-shaped muscular region inferior to the diaphragm which turns bolus into chyme through gastric secretions which is made-up mainly of water, pepsin, and hydrochloric acid. It has four regions namely cardiac, fundic, corpus, and pyloric.
3. small intestine	A long coiled tube composed of duodenum and ileum where most of the chemical digestion and absorption of nutrients takes place.	A 2.7 to 4.5 m long coiled tube which is composed of duodenum, ileum, and jejunum where chemical digestion and absorption of nutrients takes place.
4. mesentery	A web-like structure that attaches to the small intestine to keep it in place.	A web-like structure that attaches to the small intestine. A mesentery-like mesocolon also attaches to the large intestine to keep it in place.
5. pancreas	A beige colored spongy organ medial to the stomach and duodenum along the hepatoduodenal omentum and gastroduodenal omentum that secretes pancreatic juice that contains digestive enzymes. This organ also secretes insulin.	A 13 to 15cm long spongy organ posterior to the stomach's greater curvature which secretes pancreatic juice towards the duodenum of the small intestine. This organ also secretes the glucagon, insulin, and gastrin hormones.

6. liver	A 3-lobed brown organ which is inferior to the sternum on the frog's chest area which secretes bile.	A 3 lbs. brown gland which secretes bile. This is made-up of 2 lobes- the larger right and the smaller left which is divided by a falciform ligament.
7. gallbladder	A green colored organ medial to the median lobe and right lobe of the liver which stores bile.	A 10 cm pear-shaped organ inferior to the liver which stores bile.
8. large intestine	A long tube which consists of mesorectum, cloaca, and cloacal aperture which enables the passageway of waste materials that would be excreted from the frog's body.	A 5 ft. long tube which consists of the cecum, appendix, and colon which leads to the rectum and anal canal. This tube serves as the passageway of undigested food substances which would be excreted from the body through defacation.
9. anus	The end hole of the frog's digestive system where waste materials such as fecal matter and urine as well as reproductive cells would exit.	The end hole of the human digestive system where fecal matter or undigested food substances exits.

II. Organs for other Organ Systems

Organ	Function (Frog)	Function (Human)
1. heart	A 3- chambered organ in the pericardial cavity consisting of R and L atria and a thick-walled ventricle which pumps blood towards the different parts of the frog's body.	A 4-chambered organ of the circulatory system consisting of R and L atrium and R and L ventricle which pumps blood through the systemic circuit and the pulmonary circuit.
2. lung	A 2-lobed, thin walled, spongy, egg-shaped organ anterior to the abdominal cavity which serves for the exchange of gases within the frog's body.	A 2 lobed conical organ of the respiratory system located superior to the diaphragm which serves for the exchange of gases within the human body.

3. kidney	A small bean shaped organ dorsal to the peritoneum and coelom consisting of approximately 2000 nephrons which filters blood in order to eliminate soluble waste materials such as urea, excess water and mineral salt.	A 150 g bean-shaped organ having upper right and lower left lobe of the Urinary system located posterior to the abdominal wall. This organ contains nephrons- a renal corpuscle and a renal tubule which filters the plasma of the blood and converts the excess waste into urine.
4. spleen	A dark brown sphere shaped organ attached to the frog's mesentery which ruptures old blood cells.	A 160 g organ of the lymphatic system posterolateral to the stomach, inferior to the diaphragm and on the left of the hypochondriac area. This organ produces blood cells, stabilizes the volume of blood, and is the site of phagocytosis. This is also the place wherein erythrocytes rupture.
5. corpora adiposa (Fat Body)	Dark yellow finger like structures connected to the anterior of the frog's reproductive organ which stores fat.	Humans have fats or adipose tissues on specific body parts which serve as a main energy reservoir.
6. urinary bladder	A thin-walled organ which is attached midventral to the cloaca that stores urine prior to excretion.	A circular organ of the urinary system located on the posterior of pubic symphysis and inferior part of the peritoneum which stores urine prior to excretion.
7. testes (Male) **8. Ovary (Female)**	A male reproductive organ that is connected to the kidneys where frog sperm is produced. *The female counterpart of the testes is the ovary which produces egg cells of the frog.	A male reproductive organ which produces sperm cell as well as sex hormones such as testosterone and inhibin. *The female counterpart of the testes is the ovary which produces female egg cells as well as hormones such as estradiol, progesterone and inhibin.

9. vertebral column (spine)	The area where the frog's brain and spinal cord are enclosed.	A 71 cm long structure of the skeletal system which supports the skull of the head and the trunk and encloses the spinal cord as well as promote movement.

After learning the concepts of frog anatomy and physiology, here are some points to ponder:

- **Frogs are amphibians.**
- **Frogs are mainly composed of the axial and appendicular region.**
- **There are different external parts of the frogs which makes it distinct from other chordates such as the nictitating membrane, tympanic membrane, and the sacral hump.**
- **The number of the digits of the frog's finger is 4 making it different from the number of the digits of the frog's toes which is 5.**
- **There are some sort differences between the organs on the internal part of the frog as compared to humans. Frogs have 3-chambered heart and 3-lobed liver while humans have 4-chambered heart and 2-lobed liver. Frog's small intestine consists of duodenum and ileum only while humans have duodenum, ileum, and jejunum. The only resemblance is that most of these organs functions the same like that of the pancreas which secretes pancreatic juice, liver which secretes bile and reproductive organs which produces reproductive cells.**

Appendix 15. *AR/VR Frog Module with Instructions*

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TALAPANG

A MODULAR GUIDE ON AR/VR FROG DISSECTION

Instructions for AR (Augmented Reality Software)

1. Click the AR software on your cellular phone when given the cue.
2. Place the camera of your phone on top of the 2018 paper.
3. Wait for the frog to appear.
4. Use the module to guide you while studying the external anatomy of the frog through AR.
5. Exit the AR software once you are finished.

Instructions for VR (Virtual Reality Software)

1. Click the Talapang VR software on your cellular phone when given the cue.
2. Place the cellular phone on the VR glasses.
3. Place the OTG and mouse' USB on your cellular phone's port.
4. Turn on the mouse.
5. Put the VR glasses on your head but make sure you position your eyes on the VR screen.
6. Move your head so that the dot in the middle of the screen that you see will be pointed on the START button.
7. Wait for the dot to become circle before you click your mouse on the START button.
8. On the screen, you can view already the picture of the frog as well as the TOOLS, PROGRESS, INSTRUCTION, and MENU buttons respectively.
9. Place the dot on the TOOLS button and click it using your mouse when the circle appears.
10. If you see the SCALPEL, click SIMULATE, then click NEXT.
11. If you see the SCISSORS button, click SIMULATE, then click NEXT.
12. If you see the FORCEPS button, click SIMULATE, then click NEXT.
13. Click ANATOMY.
14. You can see the frog's anatomical parts on your right side. Please take note of the organs and where it is located.
15. Then, click ORGAN DETAILS.
16. Move your face to the left so that you can see the organ details.
17. Click each organ and take note of the functions of it. You may use your module as your guide for accomplishing the entire process.
18. Click the TOOLS again.
19. Click EXPAND to further view the frog parts.
20. Once you are finished learning the internal parts of the frog, click MENU.
21. Then, click EXIT.
22. You may now remove your VR glasses and place it on your table.
23. Remove your phone from the VR glasses and exit the Talapang App.
24. Remove all the accessory materials (OTG and mouse USB) that you place on your phone and place it on the table container where you got it.
25. Wait for further instructions.

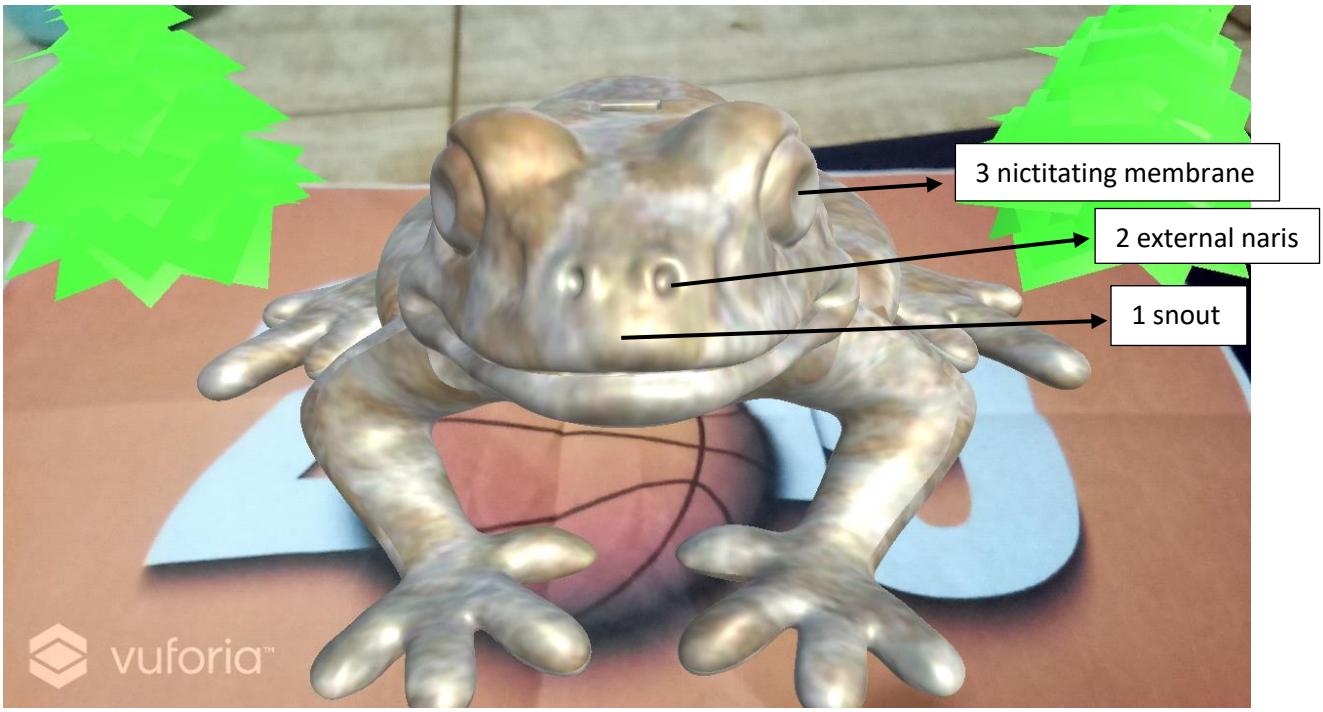

2019

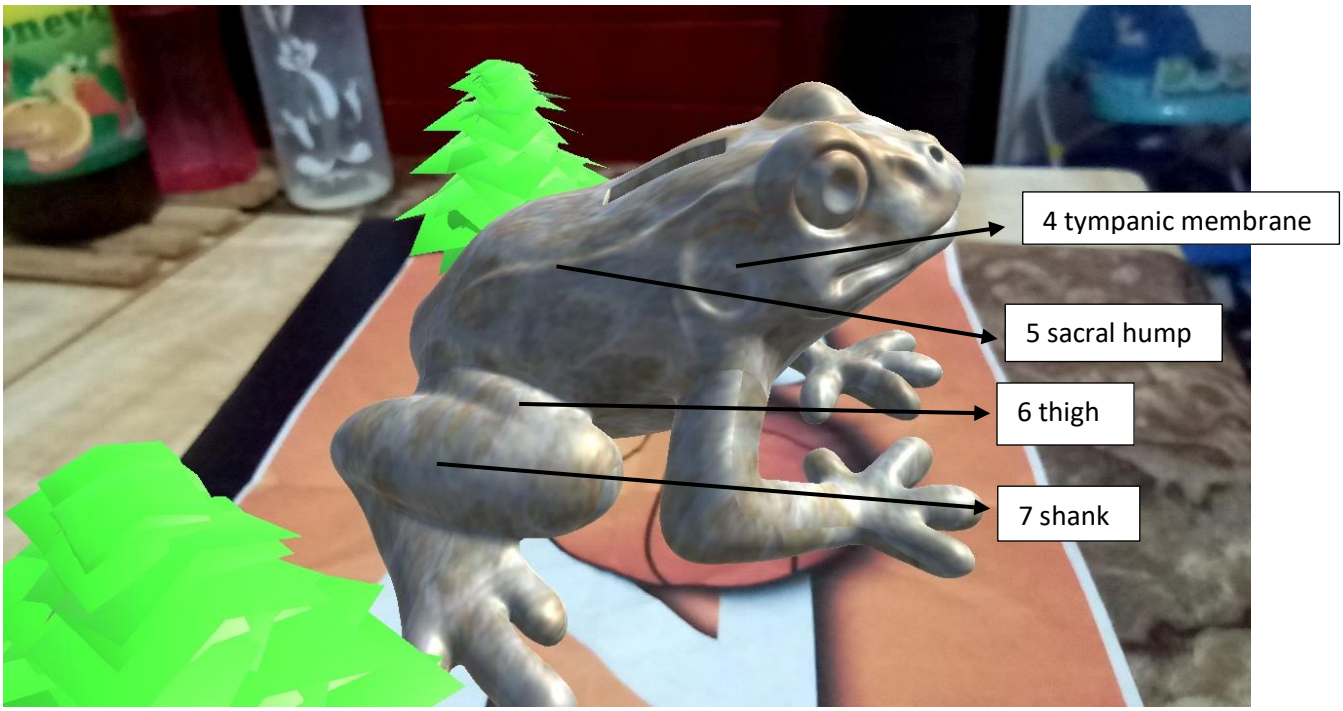
What is a frog?

A frog is an oviparous amphibian which spends a part of its life on terrestrial and aquatic environment. Frogs exhibits external fertilization which reproduces by amplexus. Fertilized frog eggs undergo cleavage until it turns into a tadpole and metamorphose into an adult frog. Frogs are important part of the ecosystem because they play a key role in controlling pest populations that may cause human illnesses. This species also aids in the cycling of nutrients among terrestrial and aquatic environment.

Open the AR (augmented reality) frog application. Place the camera on top of the paper with ball so that the AR frog will appear. Look closely at the AR frog… what have you noticed?

Frogs are smaller than human beings. Naturally, they have moist, slippery skin which is due to the fluid secretion of its mucous glands. There are frogs which have poison glands which emits thick alkaloidal secretions that protect it from predators. Some frogs have dermal chromatophores which give its distinctive green color.





#	Answer (Anatomical Part)	Function
1	snout	The tip of frog's head.
2	external naris	This consists of 2 small valvular openings located on the snout of the frog wherein respiration initially occurs.
3	nictitating membrane	Transparent portion on the anterior part of the frog's eyes which serves as protection against injury while keeping it moist.
4	tympanic membrane	Frog's flat circular eardrums posterior to the frog's eyes.
5	sacral hump	A protuberance near the median dorsal line.
6	thigh	Frog's shorter hind limb on the upper hip part to the knee.
7	shank	Frog's longer hind limb on the lower ankle part to the knee.
8	digits of toes	Frog's five digits
9	digits of fingers	Frog's four digits

Open the Talapang virtual reality frog software.

The general body cavity of a frog is known as coelom or peritoneal cavity. The organs that comprises the frog's coelom is known as the viscera which is enclosed by a membrane called peritoneum. The viscera are mainly composed of organs for digestion as well as other organs which serve main functions on other organ systems of the frog.

Click the organ and its corresponding function.

Organs for Digestion

Organ	Function (Frog)	Function (Human)
• **esophagus**	A 3 cm straight tube inferior to the frog's pharynx which is the passageway of bolus that extends posteriorly towards the stomach.	A long straight 25 cm tube located at the inferior part of the larynx and posterior part of the trachea, midway between the coricoid cartilage and 6th cervical vertebra wherein peristalsis occurs which promotes the passage of bolus towards the stomach.
• **stomach**	A bean-shaped organ on the right part of the abdomen which consists of a cardiac end, pylorus, greater curvature, lesser curvature, rugae, and mesogastrium. This organ is where the chemical digestion of food particle take place through digestive enzymes such as proteases, lipase, and maltase.	A mango-shaped muscular region inferior to the diaphragm which turns bolus into chyme through gastric secretions which is made-up mainly of water, pepsin, and hydrochloric acid. It has four regions namely cardiac, fundic, corpus, and pyloric.
• **small intestine**	A long coiled tube composed of duodenum and ileum where most of the chemical digestion and absorption of nutrients takes place.	A 2.7 to 4.5 m long coiled tube which is composed of duodenum, ileum, and jejunum where chemical digestion and absorption of nutrients takes place.
• **mesentery**	A web-like structure that attaches to the small intestine to keep it in place.	A web-like structure that attaches to the small intestine. A mesentery-like mesocolon also attaches to the large intestine to keep it in place.

• **pancreas**	A beige colored spongy organ medial to the stomach and duodenum along the hepatoduodenal omentum and gastroduodenal omentum that secretes pancreatic juice that contains digestive enzymes. This organ also secretes insulin.	A 13 to 15cm long spongy organ posterior to the stomach's greater curvature which secretes pancreatic juice towards the duodenum of the small intestine. This organ also secretes the glucagon, insulin, and gastrin hormones.
• **liver**	A 3-lobed brown organ which is inferior to the sternum on the frog's chest area which secretes bile.	A 3 lbs. brown gland which secretes bile. This is made-up of 2 lobes- the larger right and the smaller left which is divided by a falciform ligament.
• **gallbladder**	A green colored organ medial to the median lobe and right lobe of the liver which stores bile.	A 10 cm pear-shaped organ inferior to the liver which stores bile.
• **large intestine**	A long tube which consists of mesorectum, cloaca, and cloacal aperture which enables the passageway of waste materials that would be excreted from the frog's body.	A 5 ft. long tube which consists of the cecum, appendix, and colon which leads to the rectum and anal canal. This tube serves as the passageway of undigested food substances which would be excreted from the body through defacation.
• **anus**	The end hole of the frog's digestive system where waste materials such as fecal matter and urine as well as reproductive cells would exit.	The end hole of the human digestive system where fecal matter or undigested food substances exits.

Organs for other Organ Systems

Organ	Function (Frog)	Function (Human)
• **heart**	A 3- chambered organ in the pericardial cavity consisting of R and L atria and a thick-walled ventricle which pumps blood towards the different parts of the frog's body.	A 4-chambered organ of the circulatory system consisting of R and L atrium and R and L ventricle which pumps blood through the systemic circuit and the pulmonary circuit.

• **lung**	A 2-lobed, thin walled, spongy, egg-shaped organ anterior to the abdominal cavity which serves for the exchange of gases within the frog's body.	A 2 lobed conical organ of the respiratory system located superior to the diaphragm which serves for the exchange of gases within the human body.
• **kidney**	A small bean shaped organ dorsal to the peritoneum and coelom consisting of approximately 2000 nephrons which filters blood in order to eliminate soluble waste materials such as urea, excess water and mineral salt.	A 150 g bean-shaped organ having upper right and lower left lobe of the Urinary system located posterior to the abdominal wall. This organ contains nephrons- a renal corpuscle and a renal tubule which filters the plasma of the blood and converts the excess waste into urine.
• **spleen**	A dark brown sphere shaped organ attached to the frog's mesentery which ruptures old blood cells.	A 160 g organ of the lymphatic system posterolateral to the stomach, inferior to the diaphragm and on the left of the hypochondriac area. This organ produces blood cells, stabilizes the volume of blood, and is the site of phagocytosis. This is also the place wherein erythrocytes rupture.
• **corpora adiposa** • **(Fat Body)**	Dark yellow finger like structures connected to the anterior of the frog's reproductive organ which stores fat.	Humans have fats or adipose tissues on specific body parts which serve as a main energy reservoir.
• **urinary bladder**	A thin-walled organ which is attached midventral to the cloaca that stores urine prior to excretion.	A circular organ of the urinary system located on the posterior of pubic symphysis and inferior part of the peritoneum which stores urine prior to excretion.
• **testes (Male)**	A male reproductive organ that is connected to the kidneys where frog sperm is produced.	A male reproductive organ which produces sperm cell as well as sex hormones such as testosterone and inhibin.

• **Ovary (Female)**	*The female counterpart of the testes is the ovary which produces egg cells of the frog.	*The female counterpart of the testes is the ovary which produces female egg cells as well as hormones such as estradiol, progesterone and inhibin.
• **vertebral column (spine)**	The area where the frog's brain and spinal cord are enclosed.	A 71 cm long structure of the skeletal system which supports the skull of the head and the trunk and encloses the spinal cord as well as promote movement.

After learning the concepts of frog anatomy and physiology, here are some points to ponder:

- **Frogs are amphibians.**
- **Frogs are mainly composed of the axial and appendicular region.**
- **There are different external parts of the frogs which makes it distinct from other chordates such as the nictitating membrane, tympanic membrane, and the sacral hump.**
- **The number of the digits of the frog's finger is 4 making it different from the number of the digits of the frog's toes which is 5.**
- **There are some sort differences between the organs on the internal part of the frog as compared to humans. Frogs have 3-chambered heart and 3-lobed liver while humans have 4-chambered heart and 2-lobed liver. Frog's small intestine consists of duodenum and ileum only while humans have duodenum, ileum, and jejunum. The only resemblance is that most of these organs functions the same like that of the pancreas which secretes pancreatic juice, liver which secretes bile and reproductive organs which produces reproductive cells.**

visual • aural • read/write • kinesthetic

VARK®

a guide to learning preferences

How Do I Learn Best?

You may view the VARK questionnaire using the QR code below. You just need to follow some sets of instructions then you can already answer the VARK questionnaire.

Step 1: Turn on your data/ internet connection

Step 2: Open Play store

Step 3: Search for QR & Barcode Scanner

Step 4: Download the Application

Step 5: Open the Application

Step 6: Scan the QR code

Step 7: Click the Link

Step 8: Answer the VARK questionnaire

Step 9: Write your VARK results below

- -

VARK results:

Name: ____

Visual: __________

Aural: ___________

Read/ Write : ____

Kinesthetic: _____

Your Learning Preference : ______________________


Talapang

Appendix 16. *Waiver for Minor Students (Below 18 years old)*

Philippine Normal University
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Manila, Philippines

Waiver

Dear Sir/Madam:

I am Prof. Maria Fatima Parro, a SHS teacher of the University of the East- Manila who is currently conducting my research study which is the development of an AR/VR frog dissection software in teaching STEM Biology as an alternative tool for traditional frog dissection. This particular software may be utilized on a classroom setting if proven effective as a teaching tool. In connection to this, may I request you to fill-up this waiver since your son/ daughter is part of the data gathering process. This is to ensure that all parents and/or legal guardians of the minor participants are properly informed with regards to this matter. Hoping for your kind consideration. Thank you so much.

Respectfully yours,

Ms. Maria Fatima Parro
(UE SHS Faculty)

My son/ daughter's name is _____
(Your son/daughter's name)

who belongs to _____ and is residing from
(Grade and section of your son/daughter)

_____.
(Address)

He/she is a grade 12 Senior High School student who is _____ years old. I am giving a consent to my son/ daughter to participate in the data gathering procedure which will be held in the FD building of the University of the East Manila Campus. I am aware that my son/ daughter who is considered a minor will be utilizing the AR/VR Software and I will not held the researcher liable for some untoward incidences that might occur during the process. I am also giving my full trust to the researcher for the safety of my son/ daughter during the duration of the said research study.

_____ _____

(Signature over printed name of Parent/Guardian) *(Signature over printed name of Student)*

Appendix 17. *Authenticity Result*

Philippine Normal University
The National Center for Teacher Education
PUBLICATION OFFICE
Taft Avenue, Manila 1000, Philippines

PUBLICATION OFFICE

AUTHENTICITY RESULT

Date of Release:	March 27, 2020
Result Code:	2020-0702
Submission ID:	1282487823
Title of Output:	An AR/ VR Frog Dissection Software in Teaching STEM Biology
Author (s):	Maria Fatima L. Parro

Authenticity Report:

Similarity Report: 12%

- *Interpretation*: A similarity of 12% means that 12% of the entire paper is similar to sources in Turnitin's (authenticity software) online repository. The colored bibliographical references denote the sources of similarity to previously published work which maybe from internet sources (11%), publications (6%), and student papers (11%) for the remaining similarity percentage.

- *Highlighted text in the Manuscript:*

  - Red marks and highlights are set of texts directly or exactly copied from online sources.
  - Other color marks and highlights are set of text exactly copied from other sources (student papers and publications).

Marie Paz E. Morales, Ph.D.
Director

PNU-MN-2016-PUB-QM-001
Revision No.: 01

Effective Date: August 10, 2017

Appendix 18. *Certificate of English Grammar Editing*

i.blanco
FREELANCE EDITOR

June 01, 2020

CERTIFICATE
OF ENGLISH GRAMMAR EDITING

To whom this may concern:

This is to certify that the research/thesis/paper with the provisional titles:

TALAPANG: AN AR/VR FROG DISSECTION SOFTWARE IN TEACHING STEM BIOLOGY

which is a graduate school thesis presented to **The College of the Graduate Studies and Teacher Education Research** at **Philippine Normal University, The National Center for Teacher Education** located at **Taft Avenue, Manila** and is authored by: **MARIA FATIMA LINAWAN PARRO**; in partial fulfilment of the requirements for the degree of **MASTER OF ARTS IN SCIENCE EDUCATION Major in Biology** has been edited for language consistency and grammar coherence and has been found thorough and acceptable with respect to grammar and composition.

Neither the content nor the author's intentions were altered in any way during the editing process.

Mr. Ireneo B. Sabado Jr., LPT, M.A. Ed.
Proof-reader

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MARIA FATIMA PARRO

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mflparro364@gmail.com

Husband: Ryan Bataican Glore
Son: Ryan Parro Glore Jr.

Father: Lino Milla Parro
Mother: Socorro Villeno Linawan
Birthday: October 13, 1990
Age: 31
Height: 153 cm
Weight: 110 lbs
Nationality: Filipino

CAREER OBJECTIVE

To secure a position in a reputed organization where I can show my professional and leadership skills in order to contribute towards the organization's growth and to ensure my growth as well.

PROFESSIONAL PROFILE

I am a biologist and a licensed professional teacher who is passionate, hardworking, diligent, dedicated, and industrious in terms of work. I have high motivation, detailed orientation, and self-management skills. I am also willing to cooperate with a team and I am able to share responsibilities and rewards with my colleagues.

EDUCATION

POSTGRADUATE:

Philippine Normal University
Master of Arts in Science Education major in Biology
June, 2015- present

Philippine Normal University
Certificate of Teaching Program
June, 2013- October, 2014

Myongji University
Energy Engineering and Biotechnology
September, 2012- December, 2012

TERTIARY LEVEL:

Pamantasan ng Lungsod ng Maynila
Bachelor of Science in Biology
June, 2008- March, 2012
Consistent Dean's Lister, PLM scholar

SECONDARY LEVEL:

Colegio San Agustin, Makati
June, 2004- March, 2008

PRIMARY LEVEL:

Colegio San Agustin, Makati
June, 1999- March, 2004

Little Thinkers Educational Center
June, 1994- March, 1999

WORK EXPERIENCE

SHS Teacher| University of the East, Manila
May 21, 2017- present
The Teaching Profession
- ✓ Adviser of THE 12 1P
- ✓ Taught Earth and Life Science, Chemistry, General Biology, Physical Science, and Research subjects

Elementary Teacher| St. Scholastica's College, Manila
May 21, 2015- March 30, 2017
The Teaching Profession
- ✓ Adviser of Grade 2- St. Irmine
- ✓ Taught Mathematics in Grades 1 and 2

Elementary & JHS Teacher| Grace Montessori School of Novaliches
May 23,2014- March 30, 2015
The Teaching Profession
✓ Adviser of Grade 5- Garnet
✓ Taught Science in grades 7,4,2,and 1
✓ Taught Mathematics and Filipino in grade 5

Human Resources Assistant | Wizer Industries, Inc.
January 21, 2013–December 30, 2013

Recruitment
✓ Responsible for the initial screening of applicants for any position
✓ Assists HR manager in hiring new employees
✓ Ensures immediate deployment of staffs
✓ Review the employee plantilla

Evaluation
✓ Monitor employee performance through evaluation

Employee Relations
✓ Ensures that proper disciplinary actions will be given to staffs who committed violations

Record Keeping
✓ Ensures that documents of newly hires staffs will be filed properly
✓ Facilitates documentation of employee records
✓ Makes business letter, memo, and the like
✓ Communicate and relay information to different departments

SKILLS

✓ Can converse well in English and Filipino
✓ Writes clearly and concisely
✓ Openly expresses ideas
✓ Confidently speaks in public
✓ Has high motivational skills
✓ Fast learner and capable of working under minimum supervision
✓ Can work independently with experiences in completing task on time
✓ Analytic and critical thinker
✓ Practically efficient and decisive for the best move
✓ Knows how to use MS Office, Open office, Ubuntu, and other computer applications

- ✓ Has a knowledge on how to use laboratory equipment
- ✓ Intern/ On-the-Job Trainee at the Bureau of Soils and Water Management

SEMINARS ATTENDED

Writeshop for Publication on International Journals
(December 8,9,10, 2017, Sta. Cruz, Manila)

"Probiotics: Your Healthy Option"
(November 11, 2017, Yakult Philippines, Ermita, Manila)

Mid-Year INSETT Seminar Workshop
(October 27, 2017, UE Manila)

Multimedia Seminar
(October 10, 2017, UE Manila)

Training on Applied Statistical Data Analysis for Beginners Using SPSS
(October 14-15, 2017, Sta. Cruz, Manila)

Elsevier's Author Workshop
(September 11, 2017, UP Diliman)

Performance Based, Classroom Management & Purpose Driven Life
(June 8, 2017, UE Manila)

ESLS In-House Faculty Development Workshop and Annual Year- opener Seminar Workshop
(June 7, 2017, IRC Rm. UE Manila)

Principles of Teaching and 21st Century Education and Learning Centered Pedagogy
(June 6, 2017, UE Manila)

MAP 111 Bar Model Method for Primary Mathematics
(October 15, 2016, AIM, Legaspi Village, Makati City)

2016 MTAP-DepEd-NCR Mathematics Workshop: Making K-12 Succeed
(October 1, 2016-October 2, 2016, Marikina)

Teaching and Learning Mathematics through Origami
(April 14, 2015, University of the Philippines, Diliman)

"Excellence in the Workplace: Becoming the Best that you can ever be"
(September 14, 2013, SMX Convention Center)

"15th International Biotechnology Symposium and Exhibition 2012: Innovative Biotechnology for a Green World and Beyond"
(September 16, 2012- September 21, 2012, EXCO Daegu, South Korea)

"Emerging Trends in the Philippines (Forensic Medicine and Forensic Science): A Vision for the Future"
(November 18, 2011, PLM- GusalingBagatsing AVR)

"Genetically Modified Organisms (GMO): Its Current Trends and Future Directions in the Philippines"
(September 23, 2011, PLM- Gusaling Atienza)

"Christian Life Series"
(August 4, 2009 - September 8, 2009, Th, UP-PGH Lecture Room)

UNDERGRADUATE THESIS

"Bioremediation Potential of *Bacillus licheniformis* and *Trichoderma harzianum* on Water Samples from Pasig River with Notes on Other Microbes Found in Non-autoclaved Samples"

ELIGIBILITY

Licensure Examinations for Teachers
March 29, 2015

Career Civil Service Exam Passer – Professional
October 13, 2013, CSE- PPT

I certify that all the things written above are true with the best of my ability.

Maria Fatima Parro