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Project SIGLA: Development and Evaluation of a Google Cardboard Laboratory Application in Science Using Virtual Reality for Android

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APPROVAL SHEET

This thesis entitled **"PROJECT SIGLA: DEVELOPMENT AND EVALUATION OF A GOOGLE CARDBOARD LABORATORY APPLICATION IN SCIENCE USING VIRTUAL REALITY FOR ANDROID"** prepared and submitted by **JESSICA LUZ M. BRIGOLA** in partial fulfillment of the requirements for the degree of **Master of Arts in Education with Specialization in Curriculum and Instruction**, is hereby recommended for approval and acceptance.

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DEDICATION

I dedicate my thesis to my supportive family and friends. A special feeling of gratitude to my loving parents, Arlyn and Edwin Brigola, for always believing in me. Mama and Papa, you are my source of inspiration. I also dedicate my thesis to my grandmother, Dely, thank you for always praying for me. My special someone, Ken Joseph Clemente, who has never left my side and is very supportive from the very beginning of this research. Above all, I dedicate this work to God, our Heavenly Father, who has been the source of my wisdom and strength.

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ABSTRACT

Name: JESSICA LUZ M. BRIGOLA

Title: PROJECT SIGLA: DEVELOPMENT AND EVALUATION OF GOOGLE CARDBOARD LABORATORY APPLICATION IN SCIENCE USING VIRTUAL REALITY FOR ANDROID

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Virtual reality (VR) has a great potential when integrated into education especially in the science curriculum. Scientific literacy is important in today's society. However, the lack of facilities and resources in schools may hinder the mastery of competencies and skills. The aim of this study was to develop and evaluate a Google Cardboard laboratory application in science using virtual reality for Android. The Virtual Reality Education Model (VEM) was used in designing and developing the virtual laboratory application, the researcher called this Project SIGLA. A VR lab kit called *Labn'aBox* was prepared. Experts evaluated the material and results revealed that it conforms to quality in terms of objectives, content, format and language, presentation and usability. As implementers of the curriculum, teachers' perspectives must be taken into consideration in introducing this technology in the classroom. Seven (7) senior high school science teachers participated in the implementation and evaluation phase of the study. Based on the results of the evaluation survey, participants found the material very satisfactory based on content, instructional and technical quality. Focus Group Discussion (FGD) was conducted to further analyze their responses. Concerns and barriers in using virtual reality in the classroom were raised by the participants. Participants' responses also revealed that virtual reality is highly engaging and suitable to serve as a supplementary learning material for doing laboratory activities in science. The result of this study shows a favorable response towards accepting the use of VR technology and how it can be integrated into the science curriculum.

CHAPTER 1

THE PROBLEM AND LITERATURE REVIEW

1.1 Background of the Study

Teachers are the implementers of the curriculum. They have direct connection to the students and they are the ones who give meaning to the curriculum through the use of different instructional materials. Instructional materials help to enhance the learners' imagination, helps to prevent misconceptions, and makes learning more interesting (Okobia, 2011). Teachers enhance the skills of the students so that they will be responsive to the needs of the society.

Students who possess the skills required for the 21st century will always have the edge over others. Generally, they are those who know the process of learning, logical thinking, creative thinking, decision-making, and problem-solving. Overall, they are scientifically literate individuals. Scientific literacy, as one of the aims not just of science education in the Philippines but also internationally, is one of the skills required in digital age literacy. However, problems arise if there is limited source of equipment and facilities to support learning in schools. According to the research conducted by Zimnas et al. (2009), instructions that are not integrated to information technology are no longer effective for the current generation and if educational institutions would want to achieve the core learning standard, instruction should be integrated to information technology. Digital technologies have brought a drastic change on how learners view learning and how instructors view teaching. In the New Normal, delivering education through digital technologies is seen as an alternative.

Computer and videogames are potentially the most engaging pastime in the history of mankind (Prensky, 2001). This is simply because games are fun. More than 1.2 billion people are playing games worldwide (Takashi, 2013). In the Philippines, 8 in every 10 children play online games according to a survey conducted by the Asian Institute of Journalism and Communication (Benigno, 2014). The same survey reported that Luzon has the greatest number of gamers (Benigno, 2014). In the metro, the sight of students gathering around, clamoring for games and planning for the next battle is no strange sight to the public. Teachers and instructional material developers could look into what makes computer and video games exciting and integrate it in the curriculum.

The Department of Education reported the declining trend in the achievement scores based on 2007 – 2015 results. Among the five (5) learning areas taken in the National Achievement Test (NAT), Science has been consistently receiving the lowest Mean Percentage Score (MPS) since 2011. The Philippines also consistently ranked low in the Trends in International Mathematics and Science Study (TIMSS) for 1995, 1999 and 2003. In 2018, 79 countries participated in the Program for International Student Assessment (PISA). The Philippines joined the program for the first time and received below average scores in Mathematics, Science and Reading based on the statement released by the Department of Education (Official Gazette of the Department of Education, 2019). It has been suggested that teaching strategies may be impacting the lack of interest in Science which is widespread among elementary and high school learners in the Philippines (SEI-DOST & UP NISMED, 2011). These results pose a challenge for the government and curriculum developers to make necessary efforts to address deterioration of the state of education through instructional material development that would engage the students to learn.

Based on the Enhanced Basic Education Act of 2013 (RA 10533), the K-12 Curriculum was designed to *"develop productive and responsible citizens equipped with the essential competencies, skills, and values for both life-long learning and employment"*. The effectiveness of the curriculum lies in its implementation. Educational institutions should explore innovative teaching materials and strategies that will support students to acquire the desired competencies and skills needed in the 21st century. Teachers have a crucial role in the process of implementing the curriculum. Their perspectives must be given importance when a new tool will be introduced to implement the curriculum. Teachers are experts in the practice of education and are in charge for introducing the curriculum to the learners (Alsubaie, 2016).

Virtual reality has tremendous potential to offer education and cause positive changes to the learner's behavior. The current problem in achieving learning standards in science most especially access to laboratories can be addressed through virtual reality. Although not all students pursue scientific careers, valuable knowledge and skills needed in the society can be provided by the science curriculum. In the Philippines, where education is widely regarded as an investment for a transformative society, there is still a pressing need to continuously increase and modernize the quality of instructional materials.

The aim of this research is to develop and evaluate a virtual laboratory application in science. A lot of educational games are available in the market but most of these do not respond to the learning competencies set by the Department of Education (DepEd). Project SIGLA consists of a selected laboratory activity in science for senior high school students that is based on DepEd competencies. The name of the project is coined from the Filipino descriptive word “sigla” which means “lively”. SIGLA stands for Science classroom Innovation through a Google Cardboard Laboratory Application.

1.2 Literature Review

STEM Education Movement and its Impact on Curriculum and Instruction

It is a basic right for every person to have access to high quality education (ICASE, 2013). In times of global crises, Science, Technology, Engineering and Mathematics (STEM) education must be strengthened. STEM education is seen as an important aspect of economic growth. It describes teaching and learning in such fields with the overall purpose of developing a STEM literate society (Bybee, 2013).

In 2013, the International Council of Associations for Science Education (ICASE) issued the Kuching Declaration on Science and Technology Education. The declaration calls upon researchers, policy developers, and educators involved in STEM disciplines to acknowledge that there is a need to better prepare students for their future lives as global citizens (Kennedy & Odell, 2014). STEM education basically aims to equip all students for post-secondary study and be responsive for a 21st century society. To maintain the premise that all students are expected to acquire STEM literacy, all schools and their students must participate towards the STEM vision and teachers must be supported to actively engage in professional development that will enable them to effectively deliver STEM literacy to all students (Crow et al., 2013).

To do this, teachers must be able to offer standards-based STEM programs that use innovative instructional tools. Enhanced learning and relevance can be attained through the integration of technology with the curriculum implementation process. It is therefore beneficial that STEM is delivered in an interdisciplinary style to learners while carefully taking into account the standards set in the national and/or state course guidelines (Kennedy & Odell, 2014).

The Current State of Philippine Science Education

In the Philippines, the Department of Education reported the declining achievement rates of the National Achievement Test. The test determines the quality of education attained by students in subjects Mathematics, English, Science, Filipino and Araling Panlipunan. The performance is assessed based on a Mean Percentage Score (MPS). A mean percentage score (MPS) of 75 percent is the target set by the DepEd (de Dios, 2013). As shown in Table 1.1, National Achievement Test results of high school students increased from 46.64% - 49.26% in 2008. This percentage dropped from 49.26% to 46.41% for academic year 2008-2009. It continued to drop down to 45.56% in 2009-2010. The fourth-year students obtained an MPS of 48.90% in 2012, a slight improvement compared to 47.93% in 2011. An increase in performance was also shown in 2012-2013 with an MPS of 51.41% and 53.77% for 2013-2014. The last reported data on the Philippine Statistics Authority website was in 2015 with a score of 49.48%.

Table 1.1

Mean Percentage Score (MPS) of High School Students on the National Achievement Test

School Year	Mean Percentage Score (High School Students)
2006 – 2007	46.64
2007 – 2008	49.26
2008 – 2009	46.71
2009 – 2010	45.56
2010 – 2011	47.93
2011 – 2012	48.90
2012 – 2013	51.41
2013 – 2014	53.77
2014 – 2015	49.48

Note: Data gathered from Philippine Statistics Authority. Retrieved from https://psa.gov.ph/content/annual-reports-0

No test results had been found for the school year 2015-2016. For 2017, the Mean Percentage Score (MPS) is 37.44 and for 2018, the MPS is 44.59. In a published report from the Department of Education (2019) entitled*, "Making the Pivot from Access to Quality",* the NAT results in 2017 provides the baseline data for the new National Assessment Framework, 21st Century Skills. Note that the 2017 NAT is different from the 2015 NAT and prior years which were content-based and understood in terms of mastery levels. Starting in 2017, NAT results are interpreted based on proficiency levels. However, the latest 2018 NAT results, although already available, were not incorporated for publication in the 2019 Philippine Statistical Yearbook (PSY) (Albano, 2020).

Table 1.2 shows that science scored the lowest for SY 2016-2017 and second to the lowest for SY 2017-2018 in the National Achievement Test conducted to Grade 10 students. All subjects and 21st century skills scored as low proficient.

Table 1.2

Grade 10 NAT MPS by Subject Area and by 21st Century Skills

Subject Areas	SY 2016-2017	SY 2017 – 2018
Filipino	52.59	58.02
Mathematics	37.30	34.26
English	46.01	43.48
Science	35.68	36.52
Araling Panlipunan	48.81	50.67
Overall	44.08	44.59
21st Century Skills		
Problem Solving	44.06	47.48
Information Literacy	45.11	46.54
Critical Thinking	42.71	41.96
Overall	44.08	44.59

Note: Data gathered from DepEd Report *"Making the Pivot from Access to Quality"*. Retrieved from https://magna-anima.com/advantages/research-and-development

The DepEd did not hold the NAT in SY 2018-2019. NAT was supposedly scheduled in March 2020 but was cancelled due to the COVID-19 pandemic.

Basic Education Exit Assessment (BEEA) was administered to the first two cohorts (batch 2018 and 2019) of senior high school students. Table 1.3 shows the MPS by subject areas and by 21st century skills. Science scored second to the lowest for both batches.

Table 1.3

Senior High School Students MPS by Subject Area and by 21st Century Skills

Subject Areas	SY 2017-2018	SY 2018 – 2019
Science	31.26	32.11
Philosophy	37.09	34.89
Humanities	37.05	33.60
Media and Information Literacy	47.87	44.97
Mathematics	29.60	27.91
Language and Communication	38.61	41.63
Social Studies	36.23	36.82
Overall	36.71	36.45
21st Century Skills		
Problem Solving	36.92	38.06
Information Literacy	36.91	35.86
Critical Thinking	36.15	34.94
Overall	36.66	36.29

Note: Data gathered from DepEd Report *"Making the Pivot from Access to Quality"*. Retrieved from https://magna-anima.com/advantages/research-and-development

The K-12 Program is seen by the Department of Education as the main solution to improve learning competencies of Filipino graduates and raise chances of success not just for themselves but for their family as well as stated by the former President Benigno Aquino during his speech at the launching of the K-12 Program (Official Gazette of the Republic of the Philippines, 2013). The Department of Education currently uses the K-6-

4-2 Model which is structured as kindergarten (1 year), elementary education (6 years), junior high school (four years) and senior high school (2 years). The final two years in K-12 which is senior high school is designed to give time for learners to strengthen acquired academic skills and competencies (Official Gazette of Republic of the Philippines, 2013).

Efforts have been made to improve the quality of instruction including Science disciplines at the birth of the K-12 Program. The framework published by the Department of Science and Technology – Philippines reveals conversations with excellent students in science who significantly inspired by science teachers who give them engaging tasks that boosted their scientific inquiry and problem-solving skills. This statement challenges teachers to seek opportunities that can enable them to deeply understand how learners with wide-ranging interests, abilities, and experiences can be given support and guidance. Consequently, learners will still be able to create ideas and learn science concepts. These ideas must be linked and be used in their real-life situations (SEI-DOST & UP NISMED, 2011).

For the first time, in 2018, the Philippines participated in the Programme for International Student Assessment (PISA) of the Organization for Economic Co-operation and Development (OECD). Unfortunately, the PISA results showed that Filipino students (15-year-old) had lower scores in reading, mathematics, and science compared to those in most of the countries and economies that participated (OECD, 2019). According to the official statement released by the DepEd, participation in PISA establishes a baseline for the Philippines in relation to global standards and benchmark the effectiveness of the current educational reforms in the country. The PISA results together with the local assessments and studies in the Philippines, will aid in policy formulation, planning and programming (Official Gazette of the Republic of the Philippines, 2019).

The DepEd envisions a Philippines with no learners left behind and that it takes an entire nation to educate a child. Accordingly, DepEd encourages Filipinos in advancing the quality of basic education in the Philippines through active involvement, cooperation, and collaboration.

The Teachers' Role in Curriculum Implementation

The curriculum is an instrument through which the society via the schools educates its citizens. It is planned and implemented based on what the society needs.

To acquire the desired knowledge, attitudes, abilities and skills, implementing the curriculum requires the interaction between the learner and the curriculum under the teachers' guidance. The classroom is the center of curriculum implementation and the teacher is in the middle, leading the achievement of curriculum objectives. Curriculum implementation is the process of interpreting contents of the curriculum by the teacher (Nnabuike et al., 2016). Good quality in the curriculum and learning activities can be induced through the involvement of teachers in curriculum planning. The teacher is not just the receiver, but also the modifier and the transmitter of the planned curriculum to the students.

Nnabuike (2012) pointed the following factors that could be hindering the achievement of instructional objectives:

- Lack of knowledge of the objectives
- Inability to communicate the language of the subject matter
- Application of inappropriate teaching methods
- Non utilization of instructional materials.
- Inability to manage the classroom among others

Curriculum implementation also involves the development and use of instructional materials by and for the teachers. Instructional materials are important in making the subject-matter more real. It helps to enhance the learners' imagination, helps to prevent misconceptions, and makes learning more interesting (Okobia, 2011). Teachers also select the learning materials that they use for their classes. Teachers are quick to eliminate instructional materials deemed to be erroneous, such as those that contain grammatical errors, spelling errors, incorrect information, or problems with wrong answer keys (Bugler et al., 2017).

Teachers must be kept ablaze with the current trends in curriculum and teaching methods by encouraging them to participate in various up-to-date training, seminars, and workshops (Nnaibuke, 2012). There are also other parts in the curriculum process that teachers can benefit by participating, such as planning and development phases. These enables teachers to explore further their creative and innovation skills or improvisation capabilities especially during times when materials or resources are not readily available/accessible. Many studies highlighted that better teaching comes with a teacher with high efficacy (Bautista & Boone, 2015).

Role of Information Technology to Science Education Curriculum and Instruction

"Personal electronic devices such as laptops and handheld computers, smart phones, and institution's computers and associated devices" is referred to as Information Technology or IT (Alfahad, 2012). IT advancements provide considerable opportunities aimed at improving teaching and learning in the context of 21st century education (Suduc et al., 2011).

Intel conducted a case study on Transforming Education in Rural Philippine in Davao City. As a result, the school's dropout rate went down, graduation and promotion rates went up, and average National Achievement Test scores have increased by 24 percent since the technology program was introduced (Intel Education, 2014). Schools in Makati have utilized gamified online lessons to achieve higher performance of the students. The schools claimed to improve their students' performance in the recent National Achievement Test (NAT) by up to 30 percent by making learning more fun for the students (Yee, 2016). Furthermore, observations show that technology assisted learning also minimizes distraction of children and boosts the learning curve.

Information technology has an impact on science education curriculum and instruction as well. Inclusion of activities and experiments that support the development of scientific skills is important in designing lessons for students. Since experiments can be expensive and dangerous in real settings, the use of ICT-produced simulations and interactive explorations in science education can offer an advantage (Suduc et al., 2011). Students can be engaged and have improved thinking and problem-solving skills when ICT tools are used suitably and effectively in science classrooms (Bybee et al., 2008).

The effectiveness of technology integration depends on the perspectives, objectives and roles of both teachers and students in the classroom. Integrating technology to the science curriculum could be a challenging task. In the study conducted by Waight & Abd-El-Khalick (2007), two implications of technology in science teaching and learning process were found. The first implication is that there is a need for more studies that will analyze the impact of introducing technology in the science classroom. The second implication is that there should be more research about the different aspects of a science classroom that significantly impact technology use and effectiveness.

Researchers studied the use of mobile phones in the classroom. In 2010 and 2013, two researchers analyzed the effect of using mobile devices on science curriculum and instruction and they reported that the use of mobile phones support students' engagement in science learning. Looi et al. (2010) emphasized that the presence of multiple apps on mobile phones can assist students in ways such as observing the world better, recording important details, and synthesizing their concepts while Nouri (2014) examined the use of mobile phones specifically in inquiry-based science learning. Nouri found out that mobile phones support conceptual and procedural scaffolding. When students can make connections with what they know, performance grades would be affected positively.

Virtual Reality and its Current Use in Education

Virtual reality (VR) is a technology which allows a user to interact with a computer-simulated environment, whether that environment is a simulation of the real world or an imaginary world (Mandal, 2013). VR is a term used to describe a computer-generated virtual environment. This virtual environment may be manipulated by a user in real time. There are several ways on how a virtual environment may be displayed. It can be on a head-mounted display, a computer monitor, or a large projection screen. To enable the user to observe, move around, and manipulate the virtual environment, head and hand tracking systems are employed. Commonly, VR environments are largely visual experiences which are often projected either on a computer monitor or through other screen displays. VR may also include stimulating the auditory senses through speakers or headphones. Users commonly use handheld devices such as a keyboard, a mouse, or a wired glove to interact with the virtual environment.

There are available products in the market that can be used to display a virtual environment. Among those products are high-end head mounted displays (HMDs) which enable the user to have an almost full immersion experience (e.g., Oculus Rift and HTC Vive) and low-cost head mounts such as Google Carboard which uses a cheap cardboard holder to mount smartphones and turn them into reasonable handheld device capable of virtual reality experience using any smartphone that can run Cardboard-enabled apps (Google Cardboard, 2020).

The use of VR in education is regarded as a product that evolved from the idea of computer-assisted instruction (CAI) (Pantelidis, 2009). VR may be seen as a new developing technology, but its first use can be traced back to the 1950s (Virtual Reality Society, 2017). A concept called VR Education Model (VEM) features four key elements of VR as an educational tool which includes: Experiencing, Engagement, Equitability and Everywhere (Cooper and Thong, 2019).

Virtual reality is immersive in nature. Experiencing different phenomena and locations are potentials of this technology. VR enables people to experience operating immutable objects, exploring inaccessible phenomena, or even responding physically to experience a distant location (Lee & Wong, 2014). Previous studies suggest the advantages of immersive virtual environments which enhances the attainment of situated learning and knowledge transfer, providing effective learning experiences that consider user experience at different perspectives (Dede, 2009).

The second element is engagement. Compared to watching videos and listening to music, VR is a multi-sensory experience and is more effective in sustaining engagement (Cooper, et al., 2019). Higher engagement means more time on learning tasks (Winn, et al., 2002). Engagement with technologies (such as VR) is seen as a subset of experiences identified with a range of indicators that can be regarded important for learning, i.e., attention, novelty, interest, control, feedback, and challenge (O'Brien & Toms, 2008). The novelty that comes along with VR may stimulate engagement in the typical classroom, so, teachers might need to shift their existing paradigm to the pedagogical potential of virtual technology (Cooper, et al., 2019).

The third element is equitability. Equitability refers to stakeholders' actions and environments that foster more consistency in the educational experiences of the learners

(Cooper & Thong, 2019). Stakeholders include and are not limited to students and teachers. VR is presented as a technology that changes how we view the sameness and differences among schools at different scales. Cooper (2019) gave a state-of-the-art exercise-science lab as an example. This kind of lab can be found in metropolitan areas and is limited only to students who attend elite education providers. With VR technology, a VR lab that closely replicates the state-of-the-art exercise-science lab has the potential to be accessed anywhere and provide all students with equivalent virtual learning environment (Cooper, et al., 2019). This scenario shows how VR can promote equitability because it provides consistency in the learning environments that are being accessed by students across different institutions.

Lastly, VR is everywhere. VR technologies provide exciting opportunities and potentials in relation to where, when, and how learning take place. Learning can happen without being physically present in a place and still learners experience the same environment. Students can have the freedom to explore and move easily between different virtual environments of their choice from their physical location.

Cooper et al. (2019) examined pre-service teachers' (PSTs) perceptions about the pedagogical use of VR. Previous studies have centered more on the inclusion of virtual environments into PST programs (Domingo & Bradley, 2018) but little is known about PST's perceptions of VR, specifically on its potential use as a material for teaching and learning. The study then revealed that there was a significant difference in PSTs' amount of self-efficacy to teach using VR when compared to their overall confidence in using digital technologies. Some of the issues raised by PSTs include their relatively low self-efficacy in using VR for teaching, monitoring, associated financial costs, and safely implementing the technology (Cooper et al., 2019).

Fransson et al. (2020) enumerated challenges teachers experienced with VR and AR. This includes lack of economic resources to purchase hardware and software, worries about technical issues and availability of technical support, time needed to learn the technology and the need for professional development, possible lack of focus by students who might get distracted from the learning content by the VR experience itself, organizational challenges such as suitable teaching environment, availability of sufficient devices, teachers and support, and issues related to curricula, syllabuses and expected learning outcome.

Alalwan et al. (2020) enumerated the common challenges in the use of VR and AR as the following: lack of competency, limited instructional design, lack of focused attention, lack of time, and limited environmental resources.

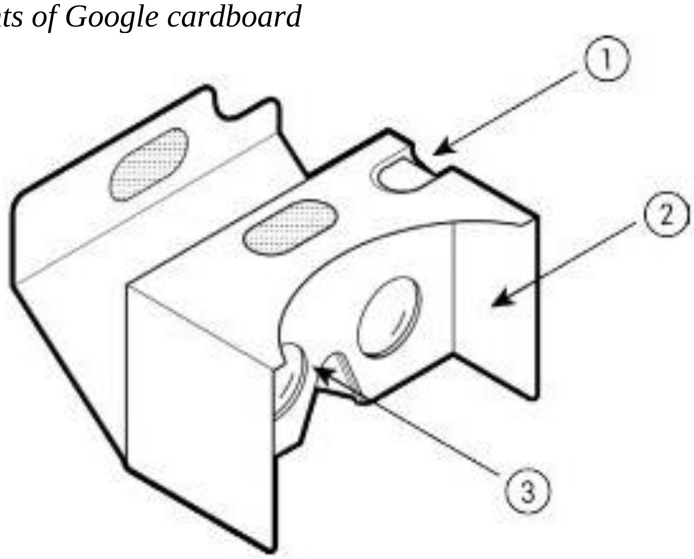
The Google Cardboard as an Instructional Tool

Technological advancements in recent years brought virtual reality closer to ordinary consumer**s** (Powell et al., 2016). Virtual reality (VR) gears are input devices, clothing and equipment worn by people who engage in virtual reality (Virtual Reality Society, 2017). The Google Cardboard is a VR gear that is used to mount a mobile phone to the head of the user using a strap or it can also be held by hand. Google Cardboard is affordable, portable and can work with most mobile phones to reach ordinary consumers (Powell, et al., 2016). It is primarily used for passive entertainment or viewing 360-

degree media and uses in education have not been explored. Figure1 shows the three (3) main components of Google Cardboard: (1) input (control button), (2) enclosure (cardboard), and (3) lenses. Google Cardboard can be bought from manufacturers, or it can also be created using the guidelines provided by the Google VR team.

Figure 1.1

Typical components of Google cardboard



Note. The typical components of Google Cardboard are (1) - input, (2) - enclosure, (3) lenses. Adapted from https://arvr.google.com/cardboard/get-cardboard/

In research by Yap (2016), grade 9 students were asked to answer a survey about their experience in using Google Cardboard for a lesson in social studies. The students provided valuable feedback on the attention and relevance factor of Google Cardboard utilization. About 96% of the students enjoyed learning about Google Cardboard and they also had a 100% level of enjoyment using the product. About 83% of the students believed that Google Cardboard is beneficial for them to remember content because of the 3D feature and about 75% believed that subjects such as English, Math, Science, and Social Studies should include the use of Google Cardboard. Interestingly, 100% of the students believed in the potential of Google Cardboard to allow them to virtually visit and explore places that cannot be readily accessed physically.

In Fokides et al. (2020), whose study focused on teaching history, found that 14–15-year-old students who used the Google Cardboard head-mounted displays (HMDs) surpassed the performance of students who used non-VR tools. It was highlighted that the combination of 3D videos, smartphones, and HMDs was more exciting and engaging.

In a college geography course, Oigara (2019) assessed students' perceptions of using Google Cardboard and smartphones as a learning tool. Students reacted in favor of Google Cardboard as an instructional material and believed it as an effective tool that offered an immersive and active learning experience. Student participants perceived Google Cardboard as a new approach for learning that can help unravel complex concepts better and enhanced their interest and focus with the course material.

In Ahmed & Hussain (2020), an android-based mobile application that presents a virtual zoo was developed. They collected qualitative feedback from 25 participants who had prior experience with traditional zoos and reported that participants have a positive attitude in their new experience of exploring a virtual zoo using Google Cardboard. These findings create further impression that the use of VR systems can have a significant application to education settings apart from its perceived potential to the tourism and entertainment industry.

With the above positive notes about Google Cardboard, some studies also identified limitations. Most VR-associated mobile apps available in the market are restricted to a limited amount of interaction options, thus limiting the possibilities of full immersion. For instance, menu and object selection can be refined through improving "head orientation" mechanics such that a relaxed user looks directly at an object for a specified period (Sibert & Jacob, 2000), or comfortably manipulates a switch somewhere in the head mount (Smus & Riederer, 2015).

Using the first version of Google Cardboard, researchers analyzed the responses of users by asking them to try-out three (3) different approaches to travel and navigation. The three approaches were continuous motion (no control of travel), magnetic switch (travel can be stopped and started using toggle switch), and *bluetooth* controller (direct control of forward and backward travel). It has been reported that none among the three approaches offered a suitable way for travelling and navigating within mobile VR environment. Nonetheless, they argue that continuous motion approach would be the best compromise owing to its ability to control the speed and stop. With the newest Google cardboard V2 headset with latest capacitive switch being released, it is interesting to note that future evaluation may impact the previous analyses (Powell et al., 2016).

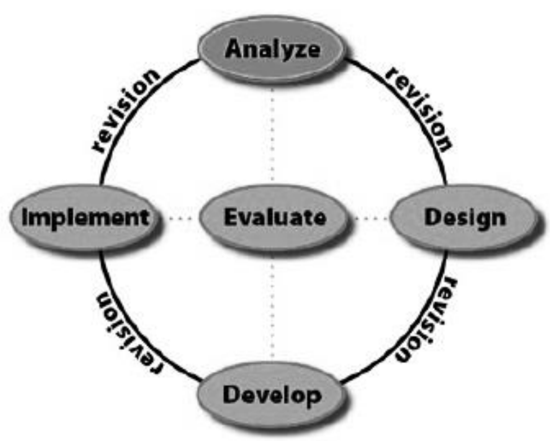
The ADDIE Model

Instructional design also referred to as Instructional Systems Development (ISD) is a systematic process that helps in making instructional materials development using a supportive environment such as art and instructional theory that can be used in online and face-to-face learning environments wherein phases are interrelated with each other (Aldoobie, 2015). Despite that more than a hundred of different ISD models exist, they can be deduced to have been generically based on the ADDIE Model (Kruse 2011). ADDIE is an instructional design model which primarily aims to improve learner performance (Almomen et al., 2016). The ADDIE model consists of five phases: analysis, design, development, implementation, and evaluation. The ADDIE Model will be more effective in solving the problems if it is utilized in this cyclical way (Arkun & Akkoyunlu, 2008). This means it is flexible enough to allow the researcher to revisit a step and refine it (Downes, 2021).

Analyzing content availability on a certain topic, considering delivery options for the training, and assessing project timelines are examples of what is done in the *analysis* phase (Downes, 2021). The *design* stage is where a blueprint is made based on the developers' conception of ideas or alternative solutions. Blueprints will be the starting point that establish the direction in developing and creating in instructional materials. Designs or blueprints can be depicted in the form of illustrations, drawings, sketches, schematics, scripts, storyboards, screenplays, or flowcharts. The *development* stage turns the blueprints into reality by developing real products in the form of an actual learning media that serve the purpose expressed in the design stage. The *implementation* stage is where the developer places the developed media into action by using it in an actual learning episode (Ramansyah et al., 2020). The *evaluation* stage is where the developer reviews the entire instructional design process in terms of its quality and effectiveness (Downes, 2021).

Figure 1.2

The Elements of ADDIE Instructional Design Model



Note. The elements of ADDIE Instructional Design Model are Analysis, Design, Develop, Implement, and Evaluate. Adapted from Soto, 2013

A study by Soto (2013) identified which instructional design (ID) models are currently used in designing virtual world instruction and why. However, studies on the application of ID models in the development of virtual learning environments are limited. It was then concluded that the ADDIE model was the most used process in designing instructions that uses virtual elements. But even though the ADDIE model is commonly regarded as a fundamental process over the years for designing instructional media, researchers have suggested that modifications can be made to respond to the needs and demands of the modern classroom such as those utilizing online and virtual learning environments (Fresen, 2007; Irlbeck et al., 2006; Kapp & O'Driscoll, 2010; Wang & Hsu, 2009). It is understood and believed that each ID project may, if not often, requires a unique approach, especially if the ID involves creating virtual learning environment.

In Hong Kong, university educators have started to venture into the emerging immersive learning environment and adapted the ADDIE Model (Hodgson et al., 2019). In Bangladesh, the ADDIE model was also used in the development of virtual reality applications for educators of children with autism. The researchers based their application development by discovering the characteristics of children with autism. Next, the storyboard was designed by the researchers and implemented to sixteen (16) educators and two (2) experts. The virtual application was aimed to help prospective educators understand the characteristics of autistic children. Likewise, it provides a safe and pleasant teaching skill practice for future in-service educators (Fudholi et al., 2020). ADDIE was also used in the development of virtual reality (VR) application for fine motor stroke rehabilitation. Results from interviews and questionnaires from patients and therapists were very promising (Iberahim et al., 2020). Development of virtual reality technology in environmental pollution media learning content for junior high school students also adapted the ADDIE Model.

Current research suggests a dearth in literature that deals on how ISD models are applied to develop instruction that uses virtual world environments. However, ADDIE was the most used model for the design of virtual world instruction and was also deemed the most appropriate (Soto, 2013). Studies have concluded the effectiveness of the ADDIE model in creating instructional materials. For instance, the model was applied in redesigning a General Chemistry course and improved success in student outcomes by significantly increasing the average course GPA and significantly lessening failure rate (Shibley et al., 2011). ADDIE model applications were also thought to be beneficial to other professions. For instance, physicians underwent professional development programs designed through ADDIE which ensures that an effective response to their learning needs are satisfied (Almomen, et. al., 2016).

Synthesis of the Review of Related Literature

The Kuching Declaration of 2013 calls upon researchers, policy developers, and educators involved in STEM disciplines to acknowledge that there is a need to better prepare students for their future lives as global citizens. Whether or not students pursue courses in science and technology, literature reveals that scientific literacy is important for the development of the nation and ensures the success of the students in the 21st century.

In the Philippines, where education is widely regarded as an investment for a transformative society, there is still a pressing need to continuously increase and modernize the quality of instructional materials. Data on previous standardized assessments have shown that high school students, specifically the first two cohorts (batches 2018 and 2019) of the senior high school program, had low proficiency in both science and 21st century skills. These results pose a challenge for the curriculum developers and teachers to make necessary efforts through instructional material development that would engage the students to learn.

Teachers give meaning to the curriculum through the use of different teaching strategies. Research revealed that most teachers nowadays integrate technology to their teaching because it has brought positive effects on students' engagement and achievement. Teachers must be provided with the opportunities to learn new technologies so that they will be confident and comfortable to use the technology in their classes. With proper training, teachers will be able to select the best strategies appropriate for their lessons and for the students. The learners are most engaged and tend to exhibit superior thinking and problem-solving skills when educational technologies and other relevant ICT tools are appropriately used to deliver effective instruction in the science classroom.

In a fast-growing world, a lot of technologies arise that could help improve teaching and learning processes. One of these is Virtual Reality where users manipulate virtual objects in real time. This will provide the opportunity to science students to access distant places and laboratories using head mounted gears that display a virtual environment. One of the cheapest and most reliable head mounted gear for VR sold in the market today is the Google Cardboard. It can be used in most types of Android phones. Data showed that most Filipinos are Android users and most students have access to a mobile device.

Studies have shown that virtual reality can be highly engaging. For that fact, VR could be used for students without access to a science-quality laboratory or learning environment. They will be given a chance to experience and perform experiments in a less expensive and safer environment. Virtual reality offers a great potential to education especially in the time of global crisis where the New Normal brings the challenge to educators on how to deliver the curriculum.

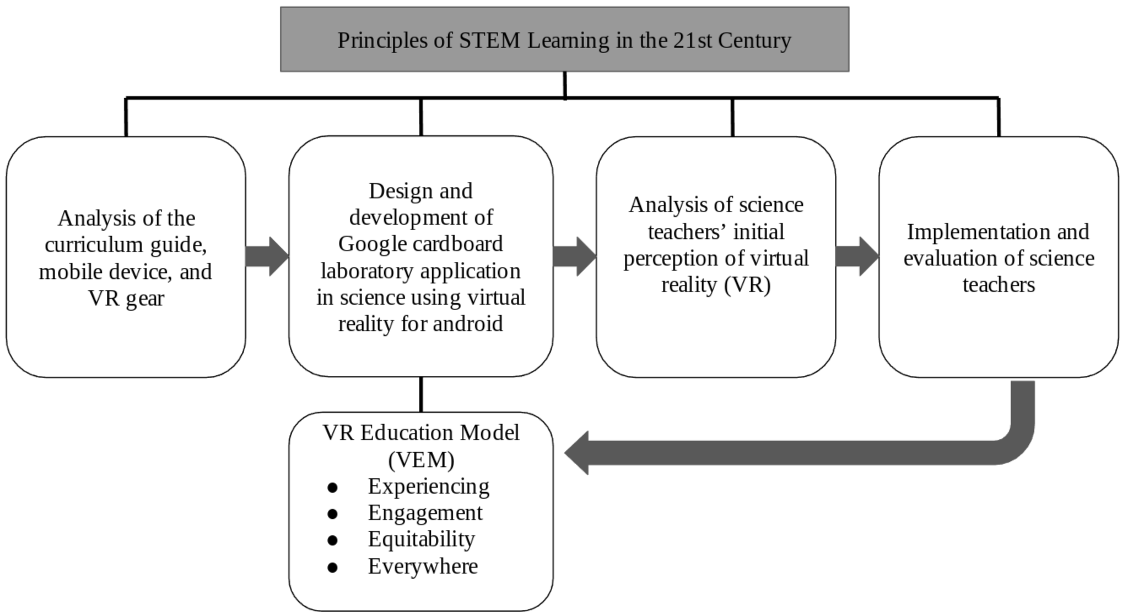
Before this technology can be incorporated in the classroom, teachers' perspective should be given focus first. VR is not a new technology in other fields but in education, it is still considered emerging. VR is known to be engaging but the pedagogical advantages of using this technology especially in the Philippines have not been well explored.

Current research suggests a dearth in literature that deals on how ISD models are applied to develop instruction that uses virtual world environments. However, ADDIE was the most used model for the design of virtual world instruction and was also deemed the most appropriate.

1.3 Conceptual Framework

Figure 1.3

Conceptual Framework



Virtual reality (VR) offers a lot of potential to learning and teaching, especially to science education curriculum and instruction. There are several countries now that advocate the advantages of increased participation and engagement in STEM education. Many countries recognize the need to prioritize STEM-related competence (Cooper, et al., 2019) as they shift their economies and labor markets towards service-oriented industries that foster high quality knowledge and skills (Powell & Snellman, 2004). This is referred to as the STEM education movement. Upgrading STEM competence is critical for a country to maintain citizens that are globally competitive, increase productivity, promote modernization and innovation, and maintain living standards (Office of the Chief Scientist, 2013).

The aim of this study was to develop and evaluate a Google cardboard laboratory application in science using virtual reality for android. The phases of the ADDIE model were followed to develop the virtual laboratory application. Namely, analysis, design, development, implementation and evaluation phase. Studies have concluded the effectiveness of using the ADDIE model in developing instructional materials (Almomen et al., 2016; Shibley et al., 2011; Soto, 2013). The elements of the VR Education Model (VEM) of Cooper and Thong (2019) were used to evaluate the application. There are four important elements of VEM. Cooper and Thong named these elements as experiencing, engagement, equitability and everywhere.

In the analysis phase, the researcher reviewed the Biology 1 curriculum guide of the Department of Education. This is the curriculum guide that is being followed by STEM programs in the public schools and most private schools in the Philippines. The type of mobile device and VR gear were selected during this phase. It is important to identify the device and VR gear to be used at this stage because it will influence the design and development of the virtual laboratory application. The Google Cardboard was chosen because of its affordability and functionality (Powell, et al., 2016). Researchers that used Google Cardboard in teaching history, social studies, and geography concluded that students had positive learning experience (Fokides et al., 2020; Oigara, 2019; Yap, 2016).

The design and development of the virtual laboratory application was done with a team of game development experts. The researcher together with a game development team conceptualized Project SIGLA. The task of transforming an actual laboratory to a virtual laboratory needs the collaboration between the researcher and the game developers. During the design and development phase, the laboratory activity was conducted in an actual science laboratory. All the materials that were used were converted into assets and the game environment was created. This is done to make the laboratory application more realistic and immersive.

Before introducing the virtual laboratory application to science teachers, they were asked to give their initial perspective on virtual reality using the Self-efficacy and Pedagogical Use Survey. It is important to take this step before introducing the technology to the teachers. It will show the teachers' acceptance and confidence to teach using VR technology since this technology has not been incorporated into the science education curriculum in the Philippines. Many studies highlighted that better teaching comes with a teacher with high efficacy (Bautista & Boone, 2015).

Science teachers were asked to try the virtual laboratory application and give their evaluation using the Evaluation Rating Sheet for Non-Print Materials and through a focus group discussion (FGD). The responses of the teachers during the FGD were analyzed by the researcher based on the VR Education Model (VEM).

This virtual laboratory application was designed based on the VEM of Cooper and Thong (2019). Teacher responses during the FGD were also analyzed based on the four elements of VEM. The first element is experiencing. Virtual reality is immersive in nature. VR enables people to experience operating immutable objects, exploring inaccessible phenomena, or even responding physically to experience a distant location (Lee & Wong, 2014). The second element is engagement. Compared to watching videos and listening to music, VR is a multi-sensory experience and is more effective in sustaining engagement (Cooper et al., 2019). The third element is equitability. VR is presented as a technology that changes how we view the sameness and differences among schools at different scales. There are public schools in the country without access to a science laboratory. By using a virtual laboratory, students will have the opportunity to access a science laboratory and see what is in it. Lastly, VR is everywhere. VR technologies provide exciting opportunities and potentials in relation to where, when, and how learning takes place. Learning can happen without being physically present in a place and still learners experience the same environment.

Virtual reality can be a tool for revolutionizing STEM learning in the 21st century. It is now used in the field of medicine to treat patients suffering from post-traumatic stress disorder (PTSD), depression, anxiety and more (Lee-Smith, 2019). VR also offers benefits to the field of engineering. Prototypes of cars are created in a virtual environment before being manufactured. A Spanish university has created a VR package for math students to virtually manipulate 3D geometric shapes and models.

Virtual reality may seem new to our country and incorporating it in our curriculum and instruction can be difficult. The involvement of all stakeholders, including individuals who are directly involved in student instruction, are seen as important factors in successful curriculum development and revision (Johnson, 2001 in

Alsubei, 2016). In this study, teachers' perspectives and evaluation on virtual reality are given focus. Teachers are seen as the implementers of the curriculum and their perspectives highly affect the transmission of a written curriculum to what students learn and what competencies are achieved.

1.4 Statement of Purpose

The main objective of this study is to develop and evaluate a virtual laboratory application in Science:

Specifically, it aims to:

1. develop a virtual laboratory application on a selected topic in Biology 1;
2. analyze the teachers' initial perception of Virtual Reality (VR) in terms of:
    A. self-efficacy; and
    B. pedagogical use; and
3. evaluate the developed virtual laboratory application through a Focus Group Discussion (FGD).

1.5 Significance of the Study

Technology has drastically reformed the landscape of education and influenced how educators direct these new educational tools to provide meaningful experiences in learning, collaboration, and gauging students as they face the future of society. The information superhighway provides a vast availability of materials that will make learning more fun and meaningful. Exploring how teachers accept new technology and evaluate virtual reality application in their classroom instruction can innovate the delivery of the curriculum. The current problem in achieving learning standards in science and access to laboratories can be addressed through VR.

To Curriculum and Instruction, the results of this research will give a new perspective on how the curriculum may be delivered through virtual reality. It will serve as a basis on how digital instructional materials can be designed and developed to address the needs of the 21st century learners. The research highlights the significance of teachers' perspective in introducing new technology in the classroom and teachers' role in the design, development, and evaluation process of new instructional materials.

To Teachers, this research will help teachers understand the importance of innovating teaching strategies and instructional materials to achieve curriculum standards. It will open their minds to the possibilities of digital instruction in a way students will learn best. This will lead to the development of teaching strategies suitable for digital learning environments. Virtual laboratory development would not be possible without the inputs of science teachers. Game development experts are skillful in creating games and virtual environments, but the contents and instruction must be developed by science teachers. May this research open new possibilities to teachers in developing innovative teaching strategies and instructional materials.

To Students, this research will serve as a bridge between them, the teacher and the instruction. It will recognize their needs as digital natives. They will learn better if they like what they are doing. Improvement of instruction leads to improvement of outcomes.

To Researchers, the Philippines is a developing country, virtual reality has not yet been fully introduced in the education sector. Research on potential use of virtual reality in education offers a lot of possibilities. Virtual reality projects encourage collaboration in the field between content experts like teachers and technical experts like game development. Both roles play important role in making effective instructional materials for STEM learning and 21st century education as a whole.

1.6 Definition of Terms

The definition of terms provides a conceptual and operational definition based on how it will be used in this research for better understanding of its readers.

ADDIE – an instructional system design (ISD) model that will be used in the development of virtual laboratory application in science; it stands for the five-phase application development program of analysis, design, development, implementation and evaluation

Analysis - the first phase of ADDIE model; the stage where the researcher formulated the objectives and content of the virtual laboratory application

Android - an operating system (OS) used in mobile devices

Android Application Package (APK)- a file that can be downloaded and installed in an android phone that will turn into an app

App - a short term for a mobile application

Assets - images from the real environment that were transformed into the virtual environment

Curriculum guide- a document which systematically outlines instructional elements such as targeted competencies, objectives, teaching and learning resources, and assessments that comprise a certain course, subject or an educational program.

Evaluate- the last phase of the ADDIE model; the stage where participants provide their feedback on the developed laboratory application

Google Cardboard - a virtual reality gear that displays a virtual laboratory; can be used as head-mounted device or hand-held gear

Labn'aBox - a virtual reality kit that contains a user's guide, Google Cardboard, lesson plan for teachers, laboratory sheet and answer keys

Laboratory Application - a software that can be downloaded and used on mobile devices

SIGLA - an acronym used for Science Classroom Innovation through a Google Cardboard Laboratory Application in Science

Virtual Environment - a simulated environment where users interact and manipulate with objects in virtual reality

Virtual Laboratory Application – an instructional tool designed and developed to improve teaching and learning experience of teachers and students

Virtual Reality – simulates a science laboratory in the classroom that uses an android phone

CHAPTER 2

METHODOLOGY

This chapter covers the materials and methods that were used in the study. Different methods of data collection were discussed and followed by justifications on the practicalities of the conduct of the methods and approaches for data collection and data analysis.

2.1 Research Design and Methods

This educational research focused on the development and evaluation of a Google Cardboard laboratory application in science using virtual reality for android. Developmental research is a systematic approach to investigate the design, development, and evaluation of instructional programs, processes and products intended to satisfy criteria of effectiveness and internal consistency (Seels & Richey, 1994 in Richey et al., 2004). In the field of instructional technology, development is the process of translating the design specifications into physical form" (Seels & Richey, 1994, p. 35) or simply the process of producing instructional materials (Richey et al., 2004). A group of experts were asked to evaluate the developed material. Science teachers were asked to try out the application and give their feedback through a focus group discussion and an evaluation questionnaire. Developmental research is of particular importance in the field of educational technology especially in aspects that involves the analysis and description of a product-development process and the evaluation of the final product from such process (Richey et al., 2004).

2.2 Research Locale

The study was conducted among senior high school science teachers in one Schools Division in the National Capital Region. A letter of informed consent was given to the Schools Division Superintendent informing her on the procedures and conduct of the research. The contents of the informed consent form (Appendix B) are consistent with the objectives of the study. The Schools Division Superintendent endorsed the researcher to the principals of the different senior high schools.

2.3 Sampling and Participants

Purposive sampling was used in selecting the participants of the study. Since the virtual laboratory application is designed for senior high school students, the researcher invited senior high school science teachers to participate through a letter addressed to the Schools Division Superintendent. The letter was approved, and the Schools Division Office selected the teachers and they were endorsed to the researcher. It is important to analyze teachers' evaluation because they are, without doubt, experts in the practice of education and are in charge for introducing the curriculum to the learners (Alsubaie, 2016).

Personal information of the participants will be kept private and confidential. The researcher assured that the material that was used by the participants did not pose any physical and mental harm to them. Participants will not receive financial or non-financial benefit from the study but they were given a load allowance that they used during the conduct of the study via Google Meet since the research was conducted during the pandemic and mass gathering restrictions were in place. The researcher will not gain any form of compensation from the participants or from the Schools Division so that research objectivity will not be compromised and conflict of interest will be avoided.

2.4 Instruments

The instruments listed below were used in the study and were designed specifically to ensure that these are free from any form of biases:

1. **VR use, self-efficacy and pedagogical use of VR Survey Questionnaire.** An 11-question survey adapted from Cooper et al., 2019 that is used to determine VR use, self-efficacy and pedagogical use of virtual reality for senior high school science teachers (Appendix C).

2. **Virtual Laboratory Application.** A virtual reality (VR) mobile app that uses Google cardboard that is designed and developed by the researcher. The contents of the material are aligned with the competencies in the curriculum guide prescribed by DepEd for senior high school students. It includes a selected laboratory activity in Biology.

3. **Focus Group Discussion (FGD) Questionnaire.** A tool that enabled teachers to evaluate the virtual laboratory application. This instrument only included open-ended questions. Arguably, questions in an open-ended format tends to extract

insights on the thoughts and feelings from a person's own words (Patton, 2002). The open-ended questions were validated by experts.

4. Evaluation Rating Sheet for Non-Print Materials. An evaluation checklist adapted and modified from Department of Education (DepEd) Guidelines and Processes for Learning Resources Management and Development System (LRMDS) Assessment and Evaluation for Localized Materials which aims to assess teachers' views on content, instructional and technical quality of the developed virtual laboratory application (Appendix L).

2.5 Procedure

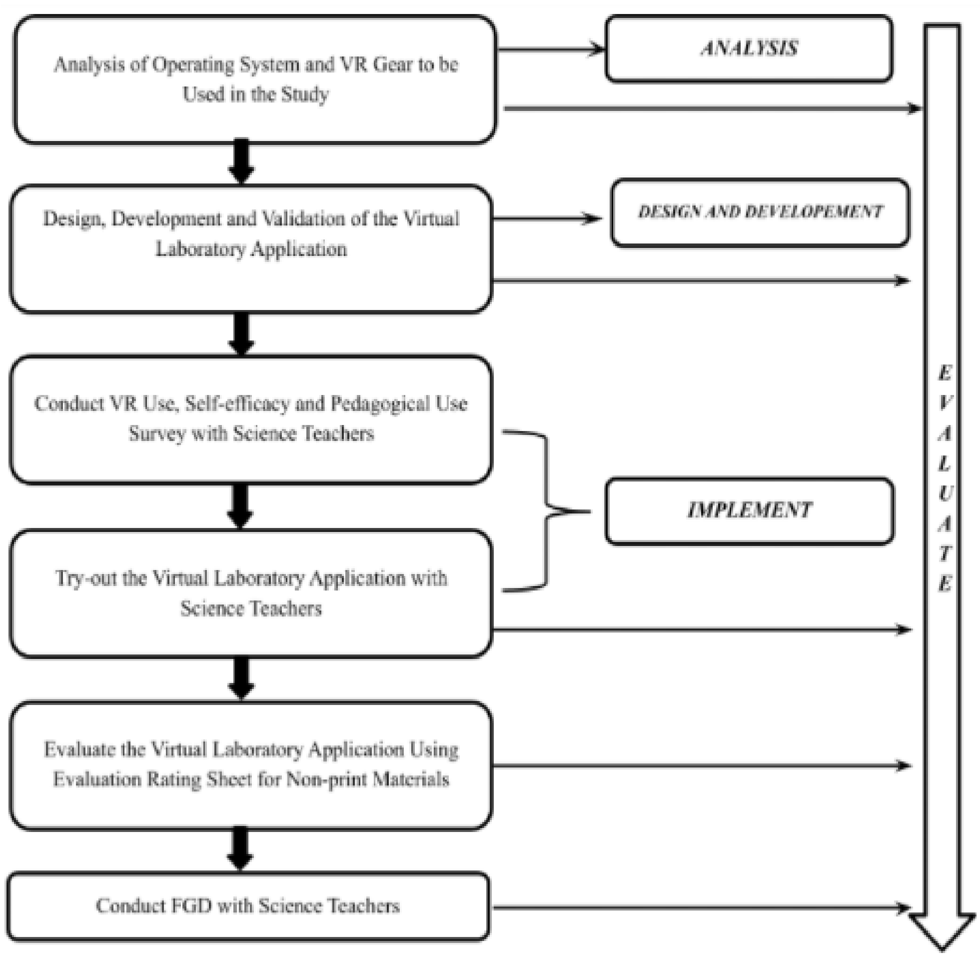
The study followed the five phases of instructional design of the ADDIE Model namely, analysis, design, development, implementation, validation and evaluation (Figure 2.1).

2.5.1 The Analysis Phase

Having clear pedagogical goals and objectives is a critical element in starting a multimedia project. Reviewing this step in every decision and phase along the project is essential to ensure success. In this phase, the researcher studied the curriculum guide of Biology 1 for senior high school students. There is no virtual reality laboratory available in the market for these competencies. The researcher gave focus on the first competency in Biology 1 and specific objectives were formulated.

Fig 2.1.

Flowchart of the Study



During the analysis phase, the type of mobile device that can run the virtual laboratory application was also identified based on cost and number of users in the country. The VR gear which will hold the mobile device and display the virtual environment was also chosen at this phase. Considerations based on the VR Education Model (VEM) of Cooper and Thong (2019) were taken in conceptualizing the application.

At the end of this phase, the researcher together with the game development team has decided to develop the virtual laboratory application that runs on Android phones since based on data, most Filipinos are Android Users. As of the latest data available in June 2021, Android held the highest share (87.59%) of the mobile operating system market in the Philippines (Statista, 2021). Google Cardboard was chosen to display the virtual environment because it is affordable and portable (Powell et al., 2016).

2.5.2 The Design and Development Phase

In this phase, the virtual laboratory application was designed and developed with the help of experts from the field of Game Development. The virtual laboratory activity is based on the selected competency and objectives that were formulated during the analysis phase.

The researcher and the team of game developers worked closely to effectively transform an actual science laboratory to a virtual science laboratory. Intellectual properties developed by the game developers with the help of the researcher as part of the research collaboration and their corresponding copyrights and/or patents shall belong to the game developers and the researcher. Intellectual properties developed by the researcher independent of the game developers for the research and their corresponding copyrights and/or patents shall belong to the researcher.

To develop a virtual environment, an actual science laboratory was used as a model. It is a science laboratory located in one of the top universities in the country. With VR technology, a VR lab that closely replicates a state-of-the-art science laboratory has the potential to be accessed anywhere and can provide learners with equivalent virtual learning environment (Cooper et al., 2019). Important objects in the laboratory were transformed into assets. The researcher captured 360^0 images and videos of the objects in the actual lab. Then, game developers converted these images and videos into assets through computer software. A video of how the actual laboratory activity is done was recorded by the researcher and this video was used by the game developers to create the VR laboratory activity.

The developed virtual laboratory application was subjected to validation and revisions based on the comments and suggestions of the experts.

2.5.3 The Implementation Phase

Before the participants tried the virtual laboratory application, they were asked to answer the VR Use, Self-efficacy and Pedagogical Use Survey. Results on this survey were analyzed. Participants were given an orientation so they will be aware of the purpose and procedures of the study.

Due to the current situation brought about by the COVI-19 pandemic, the implementation phase was conducted virtually via Google meet. At the beginning of the research, a letter of informed consent which indicates the objectives and procedures of the research were given to the participants. All records from this study were kept confidential. The researcher did not include any information that can possibly infringe the identity of the participants in any document that might be published. All collected data were secured in a locked drawer and/or on security-enabled cloud and PC storage (whichever is applicable).

The researcher sent a virtual reality (VR) kit to the participants so they can try out the developed application. The VR kit is called Labn'aBox. Since the implementation was conducted virtually, the installer of the virtual laboratory application was also sent to the participants and each of them installed it on their android phone.

The researcher facilitated the implementation phase following the lesson plan that was validated by experts. An assistant moderator was assigned to take down notes that can be raised during the focus group discussion (FGD). The participants were able to finish two (2) tasks in the virtual laboratory activity, The Cell.

2.5.4 The Evaluation Phase

Evaluation must be done on every phase to serve as checkpoints whether the primary goal of the study is always achieved. It must be noted that this phase existed at different points of the research whenever evaluation is needed. During the analysis phase, the content of the virtual laboratory application was validated. Evaluation also happened during the design and development phases between the researcher and the game developers to check if the objectives set at the initial phase were met.

After the implementation phase, participants were asked to evaluate the virtual laboratory application using an Evaluation Rating Sheet for Non-Print Materials. A Focus Group Discussion (FGD) was conducted so participants can share their evaluation and provide a deep explanation of their responses. The researcher prepared open-ended questions to be answered by the respondents. These questions were validated by experts. An FGD protocol was followed based on Krueger, 2015. The researcher recorded the implementation phase and FGD via Google meet.

2.6 Data Analysis

The virtual laboratory activity was evaluated by experts in terms of Objectives, Content, Format and Language, Presentation and Usability. The results from this evaluation were collected and analyzed. Descriptive statistics (means, standard deviation, percent agreement) were computed and interpreted.

The data in the VR Use, Self-efficacy and Pedagogical Use Survey and the Evaluation Rating Sheet for Non-Print Materials were collected and analyzed. Descriptive statistics (means, standard deviations) were computed and interpreted.

For qualitative data, data collection, data analysis, and report writing is not presented independently and they are often interconnected and simultaneously organized in the entire process of research (Creswell, 2007). The answers of the respondents during the focus group discussion were analyzed. The researcher transcribed the session with the help of the assistant moderator. Coding the data is processed systematically by analyzing and categorizing specific statements into themes that correspond to patterns or phenomena of interest (Creswell, 2014). The data was coded, grouped into categories and thematic analysis was done by the researcher. For each question, the researcher noted the main ideas that occur in the answers and identified ideas which occur again to identify themes. A narrative was prepared by the researcher to show how the themes in the current study are similar to, or different from, related previous studies.

Results of the study will be shared to the participants and to the Schools Division of where the research was conducted. To disseminate research results quickly, new communication technologies provide researchers with additional ways to do so (National Academy of Sciences, 2009). An electronic link will be created where teachers, administrators, students and their parents can access and have the opportunity to review the scientific publication of study results. Results may also be shared during the general assembly of teachers, students and parents for the school year 2021 – 2022. The research will also be shared to other teachers during seminars to gain interest and contribution in this field of study.

2.7 Ethical Considerations

Educational research deals with human interaction which has potential ethical issues. "Each stage in the research sequence may be a potential source of ethical problems (Cohen, et.al, 2000, p.49). Achieving goodwill and co-operation is especially important where the proposed research extends over a period time (Cohen et.al., 2000, p.54). Therefore, the Schools Division Superintendent was informed about the objectives of the study and approved the procedures in the conduct of the research through a written letter with the informed consent form as an attachment. It is also important to note that the contents of the informed consent form are consistent with the objectives of the study.

Informed consent is another ethical issue which ensures the participant's awareness of his participation in the study. The participants knew the risks and benefits of his participation through the informed consent form. The researcher met this ethics requirement by conducting an orientation to the respondents at the beginning of the research. Privacy and confidentiality issues were addressed by keeping the participants' names confidential. Their personal information will not be published or used for any other purposes from this research.

Subjectivity of the researcher can influence the research process and the possibility of interpretation and representation of data. To address misinterpretation and misrepresentation of data, the most appropriate statistical analysis was employed that leads to correct analysis and decision making. As a researcher, it is important to deliver the comprehensive results that were obtained from the study without hiding any information or accentuating any idea for personal gain, her friends, and relatives financially or non-financially. In this manner, conflict of interest was avoided.

Authorship was limited to those who have significantly contributed to the conception, design execution, or interpretation of the reported study. Individuals who have made significant contributions will be listed as co-authors. Others who have participated in certain substantive aspects of the project were acknowledged or listed as contributors. In this study, authorship was limited to the researcher who has significantly contributed to the conception, design execution and interpretation of this study. The game developers who have participated in certain substantive aspects of the project were acknowledged in this research.

The development of the virtual laboratory application received a grant of fifty thousand pesos (P50,000) from the Department of Science and Technology (DOST) through Science Education Institute (SEI) as one of the Most Innovative Teaching and Learning Resources in Science during its Innobox Competition in 2017-2018.

The grant was solely used for materials to support the development of the VR laboratory application. The researcher and the game developers did not receive compensation to develop the project. The deed of undertaking (DOU) was attached to this research (Appendix S).

CHAPTER 3

RESULTS AND DISCUSSION

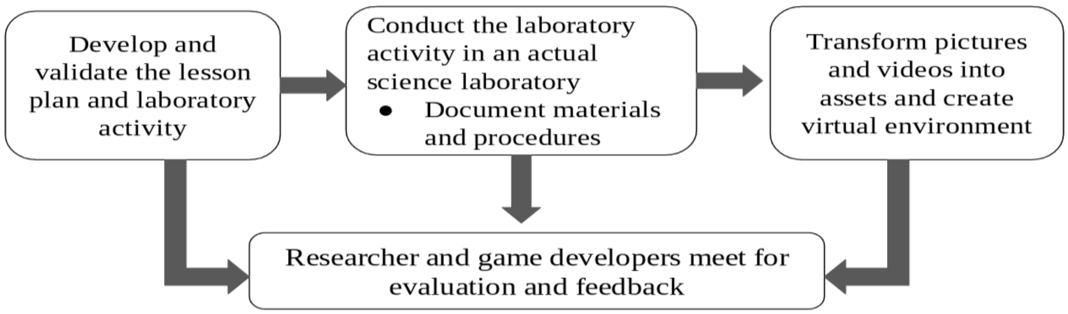
This chapter contains a detailed presentation of results and discussion with reference to the Statement of Purpose of the study. This chapter is divided into four (3) major headings based on the three (3) purposes of this study: Development of Virtual Laboratory Application in Science, Teacher's Initial Perception of Virtual Reality, and Evaluation of the Virtual Laboratory Application. All data collected in the study were openly stated together with the specific details and sources (e.g., proper referencing and citations) to warrant prospective replication of this research.

3.1 Development of Virtual Laboratory Application in Science

The main objective of this study is to develop and evaluate a virtual laboratory application in Science. The virtual laboratory application was developed by the researcher and a team of game developers. The virtual laboratory application is named Project SIGLA. SIGLA stands for Science classroom Innovation through a Google Cardboard Laboratory Application. Figure 3.1 shows the flowchart of the development process.

Figure 3.1

Flowchart of the Development of Virtual Laboratory Application



Develop and Validate the Lesson Plan and Virtual Laboratory Activity

The researcher developed a lesson plan (Appendix G) and virtual laboratory activity (Appendix H) for a selected topic in Biology 1. The laboratory activity was called The Cell. The parts of the lesson plan include Content Standards, Performance Standards, Learning Competencies, and Specific Objectives that were based from the Biology 1 Curriculum Guide of the Department of Education. It also has the following parts: Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend which are the 7Es of lesson planning. The parts of the laboratory activity sheet include Objectives, Investigation Question, Hypothesis, Materials, Procedures, Data and Observation, Analysis and Discussion, Conclusion and Reflection. The lesson plan and laboratory activity sheet were validated by three experts. Table 3.1 shows the result of Expert Validators' rating in terms of objectives.

Table 3.1

Expert Validator's Rating on Objectives of the Virtual Laboratory Activity

	Criteria	Mean	SD	Remark
Objectives				
1	The objectives are clearly stated in behavioral form.	5.00	0.00	Excellent
2	The objectives are specific, measurable and attainable.	4.67	0.58	Excellent
3	The objectives are relevant to the topic.	5.00	0.00	Excellent
4	The objectives take into account the needs of the students.	5.00	0.00	Excellent
	MEAN	**4.92**	**0.29**	**Excellent**

Judged on the mean obtained in every criterion of the checklist, all the expert validators rated the virtual laboratory activity as excellent in terms of objectives. The objectives of the virtual laboratory activity were based on the curriculum standards set by the Department of Education for the subject Biology 1.

The second criterion is content. The expert validators evaluated the content of the virtual laboratory activity as shown on Table 3.2.

Table 3.2

Expert Validator's Rating on Content of the Virtual Laboratory Activity

	Criteria	Mean	SD	Remark
Content				
1	The content of the laboratory activity is directly relevant to the defined objectives.	5.00	0.00	Excellent
2	The content of the laboratory activity is simple and easy to understand.	5.00	0.00	Excellent
3	The laboratory activity is suited for the level of the students.	5.00	0.00	Excellent
4	The laboratory activity is free from content and typographical errors.	5.00	0.00	Excellent
	MEAN	**5.00**	**0.00**	**Excellent**

The three expert validators rated the material as Excellent in terms of content. The content of the virtual laboratory activity was consistent to the objectives. The activity was developed in such a way that it would be simple and easy for senior high school students to understand.

Table 3.3. shows that format and language criterion also received an Excellent remark from the expert validators.

Table 3.3

Expert Validator's Rating on Format and Language of the Virtual Laboratory Activity

	Criteria	Mean	SD	Remark
Format and Language				
1	The format/layout is well-organized, which makes the lessons more interesting.	4.67	0.58	Excellent
2	The language used is easy to understand.	5.00	0.00	Excellent
3	The language used is clear, concise, and motivating.	5.00	0.00	Excellent
4	The instructions are concise and easy to follow.	5.00	0.00	Excellent
	MEAN	**4.92**	**0.29**	**Excellent**

Nnaibuike (2012) found out that the inability to communicate the language of the subject matter is one of the challenges why instructional materials were not met. The format and language of a learning material is important to make it engaging for the students.

The fourth criterion is presentation. Table 3.4 shows the expert validator's rating on presentation of the virtual laboratory activity.

Table 3.4

Expert Validator's Rating on Presentation of the Virtual Laboratory Activity

	Criteria	Mean	SD	Remark
Presentation				
1	The laboratory activity is presented in a logical and sequential order.	5.00	0.00	Excellent
2	The laboratory activity is presented in a unique and original form.	5.00	0.00	Excellent
3	The laboratory activity is presented clearly.	5.00	0.00	Excellent
4	The presentation of each laboratory activity is attractive and interesting to the students.	5.00	0.00	Excellent
	MEAN	**5.00**	**0.00**	**Excellent**

The three expert validators rated the material as Excellent in terms of presentation. Learning materials come in different forms, but what they all have in common is the ability to support learning. Presentation includes how attractive the material is to the users and how clearly the concepts are presented. This is why presentation is a key component to achieve the objectives of the activity.

Table 3.5

Expert Validator's Rating on Utility of the Virtual Laboratory Activity

	Criteria	Mean	SD	Remark
Utility				
1	The laboratory activity will motivate the students to study Plant and Animal Cells	5.00	0.00	Excellent
2	The laboratory activity will allow the students to use their time more efficiently.	5.00	0.00	Excellent
3	The laboratory activity will develop science process skills of students.	5.00	0.00	Excellent
4	The laboratory activity will serve as a supplementary material that can cater to the needs of the students.	5.00	0.00	Excellent
	MEAN	**5.00**	**0.00**	**Excellent**

The sixth and last criterion is utility. Utility is how beneficial the learning material is to the learners. The expert validators rated the utility of the virtual laboratory activity as excellent. Previous studies suggest the advantages of immersive virtual environments which enhances the attainment of situated learning and knowledge transfer, providing effective learning experiences that consider user experience at different perspectives (Dede, 2009).

The criteria used in evaluating the virtual laboratory activity are shown in Table 3.6. Mean, standard deviation and percent agreement were indicated with corresponding remarks.

Table 3.6

Summary of Expert Validator's Evaluation and Percent Agreement

Criteria	Mean	SD	Remark	% Agreement	Remark
Objectives	4.92	0.29	Excellent	75%	MSA
Content	5.00	0.00	Excellent	100%	PA
Format and Language	4.92	0.29	Excellent	75%	MSA
Presentation	5.00	0.00	Excellent	100%	PA
Utility	5.00	0.00	Excellent	100%	PA
Overall	**5.00**	**0.00**	**Excellent**	**100%**	**PA**

Using linear weighted analysis, they had perfect agreement on content, presentation, and utility. They had marked substantial agreement on objectives, and format and language. The following table (Table 3.7) was used to interpret percent agreement (P) of the experts.

Table 3.7

Interpretation of Percent Agreement

Range	Remark
0	No agreement (NA)
$0.0 < P \leq 20.0$	Negligible agreement (NeA)
$20.0 < P \leq 40.0$	Low agreement (LA)
$40.0 < P \leq 60.0$	Moderate agreement (MA)
$60.0 < P \leq 80.0$	Marked substantial agreement (MSA)
$80.0 < P \leq 90.0$	High agreement (HA)
$90.0 < P < 100.0$	Very high agreement (VHA)
100	Perfect agreement (PA)

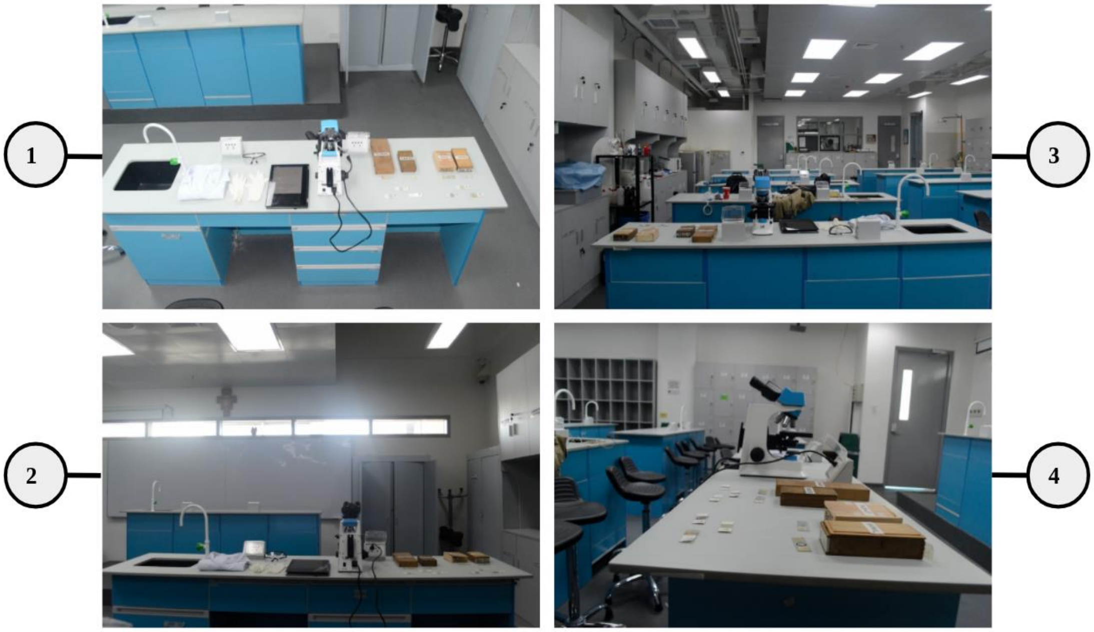
Conduct the Laboratory Activity in an Actual Science Laboratory

The laboratory activity was conducted in a Biology laboratory of a private University in Manila. Permission from the University was sought. This laboratory was chosen because of its complete facilities and one of the members of the game development team served as a faculty in this University. The laboratory and the materials for The Cell activity were prepared by the researcher.

The researcher and one member of the game development team conducted The Cell experiment in the actual science laboratory. The researcher documented every material in the laboratory by taking pictures and videos. Pictures included the 4-angle view of every material and videos of procedures using a DSLR camera.

Figure 3.2

Sample Documentation of the Actual Laboratory Experiment



Note: The actual experiment at different angles (1) Top, (2) Back, (3) Front, and (4) Side

Due to the large file size of pictures and videos from the DSLR Camera. The files were stored in a USB flash drive and were given to the game development team. It was important to note that the researcher and game development team regularly met to evaluate the progress and give feedback on the development process.

Transform Pictures and Videos Into Assets and Create the Virtual Environment

The pictures were transformed into assets. Assets are the materials that can be found and manipulated inside the virtual environment. The videos provided by the researcher were used by the game developers so that the game developers would know how to use each material and how the experiment is being conducted inside an actual laboratory. This step was done so that the users will be able to interact with the virtual environment which is a simulation of the real world (Mandal, 2013).

The game developers used a computer software in creating the application. The game developers provided an APK to the researcher. APK stands for Android Application Package which can be downloaded and installed in any android mobile phone. The researcher downloaded the APK in an android phone and it occupied 118.4 MB of storage. Once installed, the app takes up 156 MB of storage. The app is designed to run on affordable android phones in the market, using a Google Cardboard, and even without the use of internet connection.

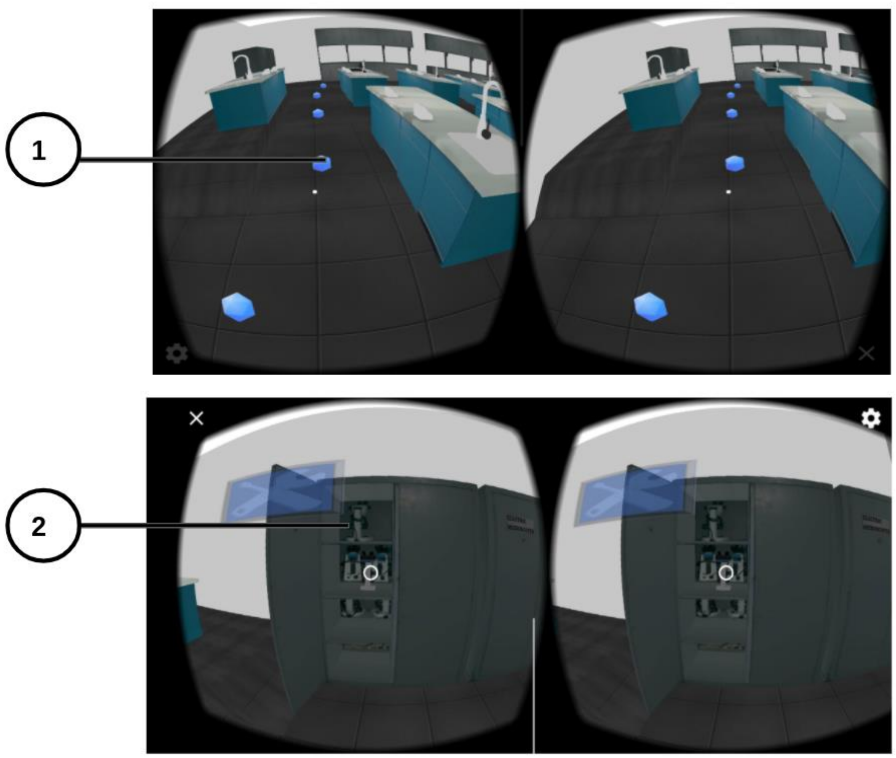
Project SIGLA was developed based on the principles of the VR Education Model. There are four important elements of VEM. These elements are Experiencing, Engagement, Equitability and Everywhere (Cooper et al., 2019).

Experiencing

Through VR, people respond physically like using arm movements to experience a distant location, operate immutable objects, and explore phenomena that are commonly inaccessible by physical means (Lee & Wong, 2014). In the developed application, participants were able to explore a science laboratory virtually through its features (Figure 3.1).

Figure 3.3

Features of the Virtual Laboratory Application



Note. (1) Polyhedrons as markers, (2) Cabinet with microscopes

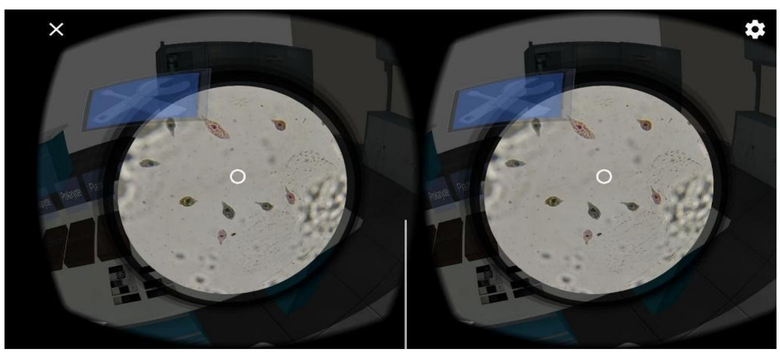
Participants moved around the virtual laboratory by following the polyhedrons on the floor. They were able to pick up a microscope from the cabinet.

Engagement

Compared to watching videos and listening to music, VR is a multi-sensory experience and is more effective in sustaining engagement (Cooper et al., 2019). This virtual laboratory is designed to immerse the user and make him or her feel that he or she is really inside a laboratory and can manipulate the things that surround him or her. Figure 3.2 shows a sample of a slide under a virtual microscope.

Figure 3.4

Euglena Under Virtual Microscope



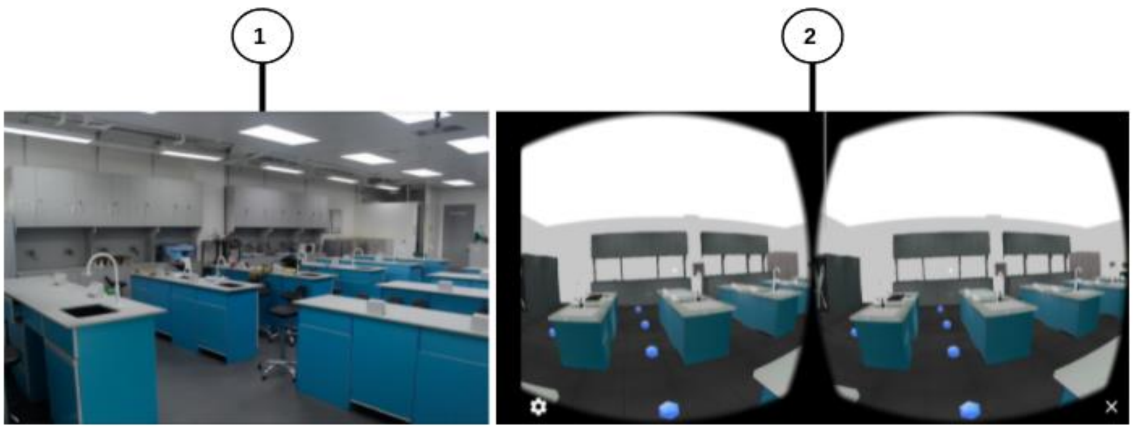
The developed virtual laboratory uses a sense of sight and touch. Sense of hearing, smell and taste which are components of reality are not incorporated in the development of the application.

Equitability

VR is presented as a technology that changes how we view the sameness and differences among schools at different socio-economic scales (Cooper & Thong, 2019). Figure 3.3 shows how the real laboratory looked and how it looked after being transformed into a virtual laboratory.

Figure 3.5

Transformation of an Actual Laboratory Into a Virtual Laboratory



Note. (1) Actual Laboratory and (2) Virtual Laboratory

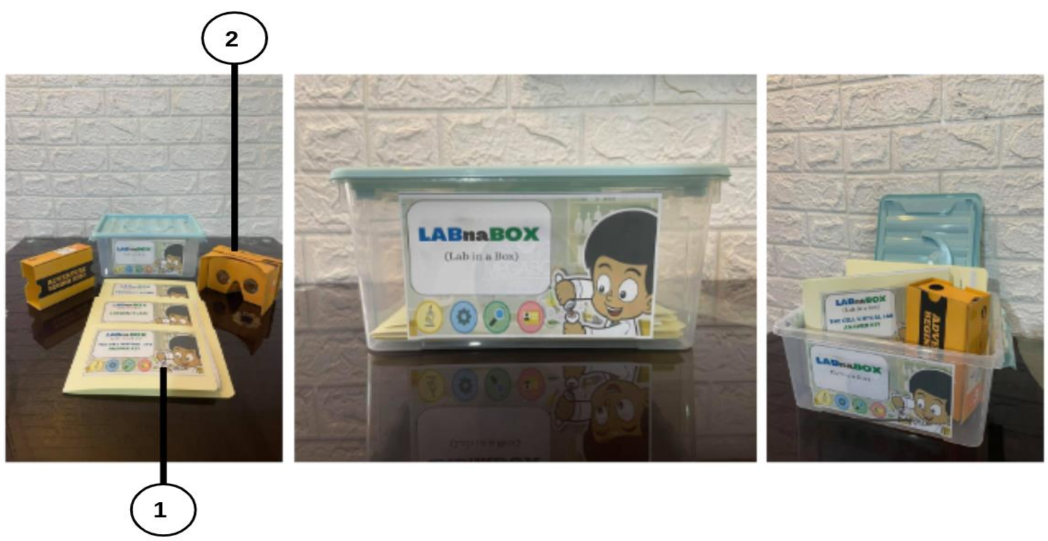
There are public schools in the country that do not have access to a science laboratory. By using this virtual laboratory, teachers and students will have the opportunity to access a science laboratory and perform scientific activities. This VR laboratory application is designed to run on affordable Android phones sold in the market today. It also does not require internet connection or mobile data.

Everywhere

Users can launch the virtual laboratory application anywhere and anytime. VR technologies offer exciting possibilities in relation to where, when and how learning take place. Learning can happen without being physically present in a place and still learners experience the same environment. Together with the virtual laboratory application, a VR Lab Kit was prepared by the researcher for the participants (Figure 3.4). This kit is called Labn'aBox (Lab in a Box).

Figure 3.6

VR Lab Kit (Labn'aBox)



Note. The contents of Labn'aBox are (1) User's Guide (Appendix F), Laboratory Sheet: The Cell and Lesson Plan (Appendix G) , Answer Key (Appendix H) and (2) a Google Cardboard.

Google Cardboard (Fig 3.5) is an example of a VR Gear. VR gears are used to display VR environments. There are several VR gears sold in the market that range from two hundred fifty (₱ 250) pesos to twenty-five thousand pesos (₱ 25,000).

Figure 3.7

Google cardboard

VR must not be expensive for education. This is why the researcher, and the game developers created the app that will use Google Cardboard which is the cheapest but still functional for teachers and students to use. A lesson plan, laboratory worksheet with answer keys that were validated by experts were included in the kit as well.

Data gathering was conducted with teacher participants from one Schools Division situated in the National Capital Region. Before the implementation phase, the participants were asked to answer a survey on their initial perception of virtual reality using the VR Use, Self-efficacy and Pedagogical Use Survey adapted from Cooper et al. (2019).

3.2 Teacher's Initial Perception of Virtual Reality

Prior to integrating technology, the factors that affect its acceptance or resistance should be examined (Alfalah, 2018). In this study, seven (7) senior high school science teachers participated. They have attended several trainings in the past at the school level, division, regional and national level. However, none of them received any training about virtual reality for education.

3.2.1 Self-efficacy

Self-efficacy refers to a self-belief by an individual in relation to the competence to attain a specific performance with confidence (Bandura, 1977, 1986, 1997). Table 3.8 shows teacher participants' confidence to use digital technologies.

Table 3.8

Teacher-participants' Confidence to Use Digital Technologies

Confidence to Use Digital Technologies	Frequency	Percentage (%)
1- very unconfident	0	0.00
2	0	0.00
3	0	0.00
4	0	0.00
5	0	0.00
6	3	42.86
7- very confident	4	57.14
Total Responses	7	100.00
Weighted Mean Response ($\bar{x}$)	6.57	

On a scale of 1 (very unconfident) to 7 (very confident), participants rated themselves 6-7 (very confident) in terms of their confidence to use digital technologies with a mean response of 6.57 (Table 3.5). Several teacher-centered studies in recent years have been focusing on teachers' self-efficacy. Remarkably, many studies highlighted that better teaching comes with a teacher with high self-efficacy (Bautista & Boone, 2015).

Compared to their responses when asked about their confidence to teach using digital technologies, teacher participants gave varied answers when they were asked to rate their confidence to teach using VR. For this question, the majority responded that they are somewhat confident as shown in Table 3.9 with a mean response of 5.00.

Table 3.9

Teacher Participants' Confidence to Teach Using VR

Confidence to teach using VR	Frequency	Percentage (%)
1- very unconfident	0	0.00
2	0	0.00
3	1	14.29
4	1	14.29
5	2	28.57
6	3	42.86
7- very confident	0	0.00
Total Responses	7	100.00
Weighted Mean Response ($\bar{x}$)	5.00	

Participants' confidence to use VR in teaching is lower compared to their previous response on using digital technologies. This result is similar to a previous data suggesting that limited exposure and insufficient familiarity on the usage and potential of VR may well be primary cause of low self-efficacy among users (Cooper, et al., 2019).

This slight decrease in confidence to teach using VR compared to teaching using non-VR technologies in general can be attributed to various reasons. In the study conducted by Fransson et al. (2020), challenges teachers experienced with VR and AR are enumerated. This includes lack of economic resources to purchase hardware and software, worries about technical issues and availability of technical support, time needed to learn the technology and the need for professional development, possible lack of focus by students who might get distracted from the learning content by the VR experience itself, organizational challenges such as suitable teaching environment, availability of sufficient devices, teachers and support, and issues related to curricula, syllabuses and expected learning outcome. These challenges and concerns are similar to the results obtained by Alalwan et al. (2020).

3.2.2 Pedagogical Use of the VR Lab

All participants showed enthusiasm to use VR for their science classes if presented with the opportunity. They also think that VR can potentially affect students' learning positively. VR is most useful in simulating experiences, exploring inaccessible locations, virtually traveling to other countries, connecting with students and people in and outside the school. Teacher participants were asked to rank these uses and responses are shown in Table 3.10.

All participants, 100% (n=7), indicated that simulating experiences was the most useful way to use VR in the classroom. A total of 57.14% (n = 4) of respondents indicated that virtually traveling to new countries was the most useful way they could use VR in their teaching pedagogy, whereas 9.38% (n = 3) classified this as the least useful way to use VR. Only 9.38% (n = 3) of participants in this section ranked connecting with students and people inside/outside school as the most useful way they could use VR in the classroom, while 50% (n = 16) categorized it as the least useful way to incorporate the platform into their teaching.

Table 3.10

Teacher-participant's Views on the Significance of VR

VR Use Significance	***1- Most Useful***	***2***	***3***	***4 - Least Useful***
Simulate experiences	7 (100%)	0	0	0
Explore inaccessible locations	0	4 (57.14%)	3 (42.86%)	0
Virtually travel to other countries	0	0	3 (42.86%)	4 (57.14%)
Connect with students and people in and outside the school	0	3 (42.86%)	1 (14.28%)	3 (42.86%)
Total Responses	7 (100%)	7 (100%)	7 (100%)	7 (100%)

The availability of resources, limitations of using VR and how to resolve those issues were the participants initial concerns in using VR technologies in the classroom. Their responses are also similar to the concerns and challenges enumerated by Cooper et al., (2019) and Fransson et al. (2020).

Implementation of the Developed Application to Science Teachers

Teacher participants were asked to try the developed virtual laboratory application. The researcher facilitated the session following the validated lesson plan and laboratory activity. An assistant moderator was tasked to take notes of participants' reactions while trying out the developed virtual laboratory application. Teachers were oriented on how to use the Google Cardboard and the virtual laboratory application. They were asked to do the virtual laboratory activity entitled “The Cell”. In this virtual laboratory activity, participants were asked to do two (2) tasks. First, they classified slides as prokaryotes or eukaryotes. Second, they classified slides as plant or animal cells. They were able to accomplish these tasks using the virtual microscope. Users can change ng magnification of the microscope through the Google Cardboard. A notification appears on the screen if the participant got the correct or incorrect answer.

Teacher participants were also encouraged to take note of their questions and talk about it during the Focus Group Discussion (FGD). After the implementation, participants were asked to evaluate the following aspects of the developed application: Content, Instructional, and Technical Quality using the evaluation tool adapted from the Department of Education - Learning Resources Management and Development System (Appendix L).

This evaluation tool asks the rater to examine the material carefully and consider the extent to which the resource meets each evaluation criterion. Teacher participants have checked the appropriate number [with 4 being Very Satisfactory (VS); 3 - Satisfactory (S); 2 - Poor; and 1 – Not Satisfactory] and evaluated the virtual laboratory application. The developed material must score at least 30 points out of a maximum 40 points to pass the criterion.

3.3.1 Content Quality of the VR Lab

As shown in Table 3.11, the teacher participants rated the content quality as very satisfactory.

Table 3.11

Teacher-participants' Evaluation on Content Quality of the Virtual Laboratory

Factor A. Content Quality	Mean	SD	Remarks
1. Content is consistent with topics/skills found in the DepEd Learning Competencies for the subject and grade/year level it was intended.	***4.00***	***0.00***	***Very Satisfactory***
2. Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives.	***4.00***	***0.00***	***Very Satisfactory***
3. Content is accurate.	***4.00***	***0.00***	***Very Satisfactory***
4. Content is up-to-date.	***4.00***	***0.00***	***Very Satisfactory***
5. Content is logically developed and organized.	***4.00***	***0.00***	***Very Satisfactory***
6. Content is free from cultural, gender, racial, or ethnic bias.	***4.00***	***0.00***	***Very Satisfactory***
7. Content stimulates and promotes critical thinking.	***4.00***	***0.00***	***Very Satisfactory***
8. Content is relevant to real-life situations.	***4.00***	***0.00***	***Very Satisfactory***
9. Language (including vocabulary) is appropriate to the target user level.	***4.00***	***0.00***	***Very Satisfactory***
10. Content promotes positive values that support formative growth.	***3.86***	***0.38***	***Very Satisfactory***
TOTAL POINTS:	***39.86***	***0.12***	

Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a check mark on the appropriate circle.

● **Passed**

This criterion also received the highest mean and total score (± 0.12). This result is consistent with the evaluation of expert validators during the development of the virtual laboratory application.

3.3.2 Instructional Quality of the VR Lab

The second criterion is instructional quality which received a very satisfactory rating from the participants with a total score of 39.43 (± 0.20). Table 3.12 shows that the participants find the developed material as appropriate for the learners and it will motivate them to learn.

Table 3.12

Teacher-participants' Evaluation on Instructional Quality of the Virtual Laboratory

Factor B. Instructional Quality	Mean	SD	Remarks
1. Purpose of the material is well defined.	***4.00***	***0.00***	***Very Satisfactory***
2. Material achieves its defined purpose.	***4.00***	***0.00***	***Very Satisfactory***
3. Learning objectives are clearly stated and measurable.	***4.00***	***0.00***	***Very Satisfactory***
4. Level of difficulty is appropriate for the intended target user.	***4.00***	***0.00***	***Very Satisfactory***
5. Graphics / colors / sounds are used for appropriate instructional reasons.	***3.71***	***0.49***	***Very Satisfactory***
6. Material is enjoyable, stimulating, challenging, and engaging.	***4.00***	***0.00***	***Very Satisfactory***
7. Material effectively stimulates creativity of target user.	***3.86***	***0.38***	***Very Satisfactory***
8. Feedback on target user's responses is effectively employed with target user's previous experience.	***4.00***	***0.00***	***Very Satisfactory***
9. Target user can control the rate and sequence of presentation and review.	***3.86***	***0.38***	***Very Satisfactory***
10. Instruction is integrated.	***4.00***	***0.00***	***Very Satisfactory***
TOTAL POINTS:	**39.43**	**0.20**	
Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a check mark on the appropriate circle.	● **Passed**		

The evaluation of the participants in terms of instructional quality is consistent with the expert validators rating on presentation, format and language, and utility. The learners are most engaged and tend to exhibit superior thinking and problem-solving skills when educational technologies and other relevant ICT tools are appropriately used to deliver effective instruction in the science classroom (Bybee et al., 2008).

Table 3.13

Teacher-participants' Evaluation on Technical Quality of the Virtual Laboratory

Technical Quality	Mean	SD	Remarks
1. There is complete synchronization of audio with the visuals, if any.	***3.71***	***0.49***	***Very Satisfactory***
2. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing.	***3.86***	***0.38***	***Very Satisfactory***
3. Visual presentations (non-text) are clear and easy to interpret.	***3.71***	***0.49***	***Very Satisfactory***
4. Visuals sustain interest and do not distract user's attention.	***3.86***	***0.38***	***Very Satisfactory***
5. Visuals provide accurate representation of the concept discussed.	***4.00***	***0.00***	***Very Satisfactory***
6. The user support materials (if any) are effective.	***3.86***	***0.38***	***Very Satisfactory***
7. The design allows the target user to navigate freely through the material.	***4.00***	***0.00***	***Very Satisfactory***
8. The material can easily and independently be used.	***3.86***	***0.38***	***Very Satisfactory***
9. The material will run using minimum system requirements.	***3.58***	***0.54***	***Very Satisfactory***
10. The program is free from technical problems.	***3.58***	***0.54***	***Very Satisfactory***
TOTAL POINTS:	**38.00**	**2.09**	

Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a check mark on the appropriate circle.

● **Passed**

3.3.3 Technical Quality of the VR Lab

The third and last criterion is technical quality. As revealed in Table 3.13, teacher participants marked most of the items as Very Satisfactory with a total score of 38.00 ($\sigma = 0.20$). The criterion which states that the material will run using minimum system requirements and that the program is free of technical problems received the lowest rating compared to all other criteria in this evaluation tool. The researcher attributed this to the participants' experience during the implementation phase where two participants needed to look for another Android phone to run the application.

Teachers are generally highly selective of the learning resources they use for their classes. Teachers are quick to eliminate instructional materials deemed to be erroneous, such as those that contain grammatical errors, spelling errors, incorrect information, or problems with wrong answer keys (Bugler et al., 2017). Overall, no conceptual, factual, grammatical, and typographical errors had been noted and the developed learning material was rated very satisfactory in all criteria.

3.3 Evaluation of Project SIGLA through a Focus Group Discussion (FGD)

After the implementation phase, participants were asked to evaluate the virtual laboratory application through a Focus Group Discussion (FGD). The researcher aims to listen to the participants' perceptions and experience in using the developed material. The questions in the FGD are aligned to the VR Use, Self-efficacy and Pedagogical Use Survey that was initially given to the participants before the implementation phase. The questions asked during the FGD were validated by experts.

An FGD protocol was followed when the session was conducted based on Krueger (2015). Please see Appendix M. Participants were welcomed, ground rules were set, and they were encouraged to share their views with one other. An assistant moderator was tasked to help the researcher in facilitating the FGD and analyzing the results. The session was recorded in Google Meet which lasted for 70 minutes. Teacher participants were assured of complete confidentiality in analyzing and reporting the data. The digitally recorded data was transcribed and were later coded by the researcher (Charmaz, 2006). The transcription was reviewed by the researcher and the assistant moderator. Similar codes were combined into categories. The researcher looked for wider themes and highlighted important messages of the participants for the purpose of making sense from the data collected (Charmaz, 2006).

Three main themes were obtained as a result of thematic analysis. These are: Initial Perception of Virtual Reality, General Evaluation and Potentials of the Virtual Laboratory Application, and Concerns and Barriers in Using Virtual Reality.

3.3.1 Initial Perception of Virtual Reality

Various kinds of technology are being integrated in the science classroom of the participants. They were asked about their initial perception of virtual reality and their responses were summarized in Table 3.14.

Table 3.14

Initial Perception of Teacher Participants on Virtual Reality

Themes and Sub-themes	Codes	Statements
1. What is the initial perception of teacher participants on virtual reality?		
1.1 Seminars and trainings attended on VR	Lack of exposure and training	*"May mga na-attendan rin po akong seminar, but more on gamified assessments and game-based learning. Nothing like VR."*
1.2 Initial Exposure to VR	For Games	*"Kasi ung perception ko po ng VR technology is more on pang-gaming lang siya hindi siya pwede i-apply sa classroom."*
		"Honestly, di po talaga siya na-utilize kasi di po na-introduce sa education. Na-introduce siya sa gaming, sa paglalaro."

They have attended several training sessions about the use of technology in teaching at the school, division, regional and national level in the past. However, none of them have attended any training about virtual reality. Participants stated that they were not able to try VR in their classes in the previous years due lack of resources and knowledge about it. Participants mentioned that it was never introduced to education and is only used in gaming as indicated by their statements below:

> *"May mga na-attendan rin po akong seminar, but more on gamified assessments and game-based learning. Nothing like VR." [I have also attended seminars but it's more on gamified assessment and game-based learning. Nothing like VR.]*

> *"Kasi ung perception ko po ng VR technology is more on pang-gaming lang siya hindi siya pwede i-apply sa classroom." [My perception about VR technology is more on gaming alone and cannot be applied in the classroom.]*

> *"Honestly, di po talaga siya na-utilize kasi di po na-introduce sa education. Na-introduce siya sa gaming, sa paglalaro." [Honestly, it was not utilized because it was not introduced to education. It was introduced in gaming, for playing.]*

These statements support the claims of Cooper et al., (2019) and the initial findings of this research that there is relatively limited exposure to the technology and insufficient familiarity with VR use or its potential to education. Although the history of virtual reality can be traced back from the 1950s when it was created for entertainment, it is still considered an emerging technology today especially for education. The flexibility of use and the reduction in the cost of VR systems have resulted in a rising interest in the Virtual Environment (VE) in education (Alfalah, 2018). Teachers must be provided with the proper professional development opportunities that will enable them to guide all their students toward acquiring STEM literacy (Crow et al., 2013).

3.3.2 General Evaluation and Potentials of the Virtual Laboratory Application

Participants were asked to share their experience after trying out the virtual laboratory application and its potential use in education. Table 3.15 shows their responses.

Table 3.15

General Evaluation and Potentials of the Virtual Laboratory Application

Themes and Sub-themes	Codes	Statements
2. What can you say about your experience in using the virtual laboratory application?		
2.1 What they liked most	Emotion	*"It's the feeling that it gives us, this is something new."*
	Novelty and Appearance	*"Actually, pagkakainstall ko pa lang ng application, nakita ko na uy ang cute. Kase ung ibang VR tech kase, di ganun kaganda 'yung appearance."*
	Content	*"Dito sa VR, with the use of VR tech, nagkakaroon ng independence ung mga bata so sila mismo 'yung nag-eexplore, sila mismo ung natututo."*
2.2 Potential Use	Advantage of Using VR	*"Kasi sa lab namin, very limited 'yung bio resources. Kulang kami sa slides, walang mga sample slides about types of cells."*

The participants were asked to share what they liked most about the virtual laboratory application. Their initial answers were about the emotion they felt while using the application:

"It's the feeling that it gives us, this is something new."

"Super na-excite." [I got very excited.]

"Parang bumalik sa pagkabata. Nakaka-miss pumasok sa laboratory." [It brings me back

to my childhood. I miss going to the laboratory.]

The novelty of VR such as this virtual laboratory application in science attracted the teachers. The participants liked what they saw and what they felt and thus, they were engaged. They also claim that there is also a possibility that students will also feel excited the moment they try-out the developed application. When students are engaged, they are more likely to spend more time on learning tasks (Winn et al., 2002).

Participants mentioned several times that the instructions are simple and easy to follow. A VR environment that is visually appealing also promotes engagement:

"Actually, pagkakainstall ko pa lang ng application, nakita ko na uy ang cute. Kase ung ibang VR tech kase, di ganun kaganda 'yung appearance." [Actually, when I installed the application, I thought it was cute. Other VR tech are not as good in terms of appearance.]

"Lupit ng pagkakagawa ng slides." [How the slides were created is awesome.]

Cooper and Thong (2019) encouraged educators to see the potential of VR not just as a gimmick because of its novelty in the classroom but also as a tool for teaching and learning. The participants stated that students will be hands-on and more engaged compared to watching videos. VR technology supports students' educational thinking and involves them actively in forming knowledge by experiencing hands-on learning. They pointed out that students will be able to develop a sense of independence because they work at their own pace, which utilizes constructivist learning theories (Chen, 2009). This supports the claim that VR provides equal opportunity of communication for learners from different backgrounds, and characteristics to play an active role in their education (Pantelidis, 2009).

Participants stated that this kind of technology suits the current generation of students. VR enables students to discover and explore their own knowledge (Alfalah, 2018). VR can immerse students in environments which allow them to represent, analyze and virtually manipulate objects (Cooper and Thong, 2020).

> *"Nakakatuwa na puwede mo buksan, puwede mo hawakan, puwede gumamit ng mga bagay dun sa lab." [It is nice that you can open it, you can hold it, you can use the things in the lab].*

"Dito sa VR, with the use of VR tech, nagkakaroon ng independence ung mga bata so sila mismo 'yung nag-eexplore, sila mismo ung natututo." [In VR, with the use of VR tech, children are given the independence so they explore on their own, they learn on their own.]

"Saktong sakto sya sa generation ng mga students na meron tayo ngayon." [It definitely suits the generation of students that we have today.]

"Because of that, 'yung teaching-learning process magiging maganda 'yung flow." [Because of that, there is a good flow of the teaching-learning process].

Participants were also able to share the potential use of the virtual laboratory application in science as an alternative to science laboratory especially for public schools that lack a science laboratory or other resources.

"Kasi sa lab namin, very limited 'yung bio resources. Kulang kami sa slides, walang mga sample slides about types of cell." [Because in our lab, bio resources are very limited. We lack slides, there are no sample slides about types of cell.]

Having said that a number of public schools lack materials in the laboratory, participants were asked if the virtual laboratory is as good as the actual laboratory. In terms of observing behavior and attitude in conducting laboratory activities, participants claimed that the actual laboratory is still better than VR. In terms of building knowledge, having the students experience the excitement of going to a laboratory, and doing laboratory activities, VR is good enough:

"Ang kagandahan para sakin nito, oo, the best talaga 'yung actual laboratory. Pero to think 'yung case natin na nasa public school, medyo mahirap ma-cater ung 60 students sa isang laboratory activity." [The good thing here is even though the actual laboratory is the best, in the case of public school, it is difficult to cater 60 students in one laboratory activity.]

"Although enjoyable din 'yung actual lab, pero this time may technology. 'Yung cellphone ko lang nagagamit ko. Un po, maganda sya." [Although the actual lab is also enjoyable, this time it uses technology. Even with just my cell phone, I can use it. It is nice.]

VR does not aim to replace reality. It supplements reality.

"It's the closest thing a public student can get to being familiar with the microscope and slides."

"Maganda siya kasi na-fafamiliar na ung student ano itsura ng slide, ano ma-eexpect niya looking through the slide." [It is good because students can become familiar with how microscope slides look like and what they could expect when looking through the slides]

VR offers exciting possibilities in relation to where, when and how learning takes place (Cooper and Thong, 2019). The participants shared the common experience that materials are not always available. Participants pointed out that with VR, experiments can be conducted while students are in their homes, classroom, or anywhere else. They can observe natural disasters and experience dangerous situations (Suduc et al., 2011).

> *"Puwede mo dalahin 'yung bata dun sa mismong event without risking life nila."*
>
> *"Ayun ang kagandahan dito, kung nasa bahay lang sila or nasa classroom sila, hindi masyado magastos kumbaga. 'Yun nga lang, mag-iinvest ka lang sa mga devices."*

The participants stated that the potential use of VR in science subjects is limitless. Participants have enumerated several topics in Earth Science, Biology and Chemistry where VR can be used.

Table 3.16 Summarizes the evaluation of the participants on the virtual laboratory application and its corresponding elements of VR based on Cooper and Thong (2019) VR Education Model (VEM).

Table 3.16

Participants' General Evaluation of VR Laboratory App in Science and its Corresponding Element based on VEM (Cooper and Thong, 2019)

General Evaluation	Elements of VEM
Brings excitement and motivation to the user	*Experiencing*
Instructions are simple and easy to follow	*Experiencing*
Visually engaging	*Engagement*
Students can manipulate objects on their own and	*Engagement*
Contributes to the development of a sense of independence	*Equitable*
Learning can take place anywhere and anytime	*Everywhere*
Less expensive compared to actual experiment	*Equitable*
Experience would not threaten students' lives	*Experiencing*

The table summarized the general evaluation of the participants after trying out the virtual laboratory application. The researcher analyzed the responses in terms of the elements of VEM. This shows that the four elements of VEM are evident on the virtual laboratory application as experienced by the participants

3.3.3 Concerns and Barriers in Using Virtual Reality

Concerns of participants on the use of VR can be classified into 3 categories: Technical, Health and Educational (Table 3.17). Despite the benefits associated with integrating VR technology in education, participants expressed concerns about its use and implementation

Table 3.17

Participant's Concerns and Barriers in Using Virtual Reality

Themes and Sub-themes	Codes	Statements
3. If you were to use VR in the classroom, are there any concerns you would have about implementing these technologies?		
3.1 Technical Issues	Hardware	*"'Yung ibang students ko kasi mam, hindi ganoon ka-advance 'yung mga phones nila."*
	Software	*"Kasi 'yung ibang VR technology, hindi siya compatible kagaya nung nangyari sa atin kanina. May mga phones na hindi siya compatible."*
3.2 Health-related concerns	Eye-related problems	*"Tinanggal ko po 'yung eyeglasses ko, mas naging clear po ung vision ko, mas naging okay po ung graphics ng application."*
	Mental Health	*"Baka pag nasobrahan naman sa VR, maisip ng bata is pag nagkamali ka, pwede mag-restart. Kumbaga, hindi nila maseparate ung virtual reality sa buhay nila"*.
3.3 Educational Issues	For Teachers	*"That's a very important factor po na ma-condition po natin ang ating mga bata when you are trying to introduce something new to our students in order for them to ma-engage po talaga sila 100%"*
	For Students	*"Para kahit papaano, maranasan ng estudyante na magkaroon ng pagpapahalaga at pag-iingat doon sa laboratory equipments or tools kahit na through VR lang ito."*

Hardware and software problems were encountered during the implementation phase. Two out of seven mobile devices failed to run the application. Participants had to find a replacement to run the application. This is considered a technical problem. Participants raised that this can also happen to the students especially if they do not have good quality phones that meet the minimum requirement to run the application.

"Kasi 'yung ibang VR technology hindi siya compatible. Kagaya nung nangyari sa atin kanina, may mga phones na hindi siya compatible." [Because other VR technology is not compatible. Just like what happened to us a while ago, there were phones that were not compatible."

"'Yung ibang students ko kasi mam, hindi ganoon ka-advance 'yung mga phones nila." [My other students do not have advanced phones.]

One teacher participant mentioned that if future developments on the application will be made, she wanted some materials in the virtual lab to be capable of breaking if mishandled by the user to make it more real and develop a sense of responsibility:

"Para kahit papaano, maranasan ng estudyante na magkaroon ng pagpapahalaga at pag-iingat doon sa laboratory equipment or tools kahit na through VR lang ito." [So that, students can develop a sense of responsibility in handling laboratory equipment or tools even though it is just through VR.]

Participants raised health concerns in using VR which include eye-related and mental health issues. Two participants experienced dizziness at the start while looking through the Google Cardboard. They stated that VR could cause eyestrain and dizziness. "VR Sickness," a term adopted by developers and players to describe the various afflictions caused by playing VR games (Swinhart, 2021). Based on the experience of one participant, looking through the Google Cardboard got better when she removed her eyeglasses. She recommended doing this for teachers and students who have blurred vision:

> *"Tinanggal ko po 'yung eyeglasses ko, mas naging clear po ung vision ko, mas naging okay po ung graphics ng application." [I removed my eyeglasses and my vision got clearer. Graphics of the application got better].*

Participants also raised the concern on how long the students will be exposed to VR. Google Cardboard is not designed for an hour of continuous use. Doctors recommend 10-minute breaks for every hour of usage (Holly, 2018). Product safety information of Google Cardboard states that adult supervision is needed and doctor's advice should be considered if the user had or is prone to seizures. One participant is concerned that the length of exposure can affect the mental health of the students:

> *"Baka pag nasobrahan naman sa VR, maisip ng bata is pag nagkamali ka, pwede mag-restart. Kumbaga, hindi nila maseparate ung virtual reality sa buhay nila". [Maybe if students will be exposed too much, they will think that if they committed a mistake, they can restart. They can fail to separate virtual reality from their real life.]*

Educational concerns of participants include the tedious process and time it takes that will be needed if teachers will be asked to develop their own VR activity. Giving instructions to the students might be challenging is another concern of one the participants. The same concern was raised in the study conducted by Cooper and Thong in 2019, reaffirming participants' relatively low-levels of self-efficacy to use VR in their teaching. However, most of them believed that instructions can be followed by students easily and suggested that if VR will be used in the classroom, there should be a separate session wherein students will be introduced on how it works before doing the actual laboratory activity:

> *"That's a very important factor po na ma-condition po natin ang ating mga bata when you are trying to introduce something new to our students in order for them to ma-engage po talaga sila 100%"*

Participants stated that VR suits the learners in this generation. They were asked about which age group of students they think VR is most appropriate. The participants gave different views. The VR lab application is intentionally designed for senior high school students. Most VR gears sold in the market today suggest that it will be used for ages 13 and up. However, this is due to the hardware design of the VR gear. Some participants believed that it is best for junior high school and senior high school students because they are more mature and can easily follow instructions. Some claimed that it is not for primary school students at all. One participant claimed that VR can be used for any age group. It depends on the difficulty of the lesson that the students need to learn.

Participants also emphasized several times the importance of deciding the appropriateness of the lesson to use or not to use VR is still the decision of the teacher.

Table 3.18 summarizes the concerns of the participants in using virtual reality in the classroom.

Table 3.18

Summary of Participants' Concerns in Using Virtual Reality in the Classroom

	Specific Concerns
Technical Issues	Application is not running on some Android phones
	Objects should be breakable if mishandled by the user
Health-related concerns	Eye strain and dizziness
	Length of Exposure
	Mental health
Educational issues	Tedious development process
	Time allotment on introducing the technology to the students
	Age group of students

If resources and proper training will be provided, all the participants are willing to integrate virtual reality in their classroom teaching. This is similar to the results obtained by Alfalah (2018) and Cooper and Thong (2018) which revealed that users' outlook and perception towards VR technology being applied to instructional processes exhibits a potential leaning towards the acceptance and integration of this technology into the curriculum.

CHAPTER 4

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary of the study, results and conclusion in accordance with the statement of purpose which aims to develop and evaluate a virtual laboratory application in science. Limitations have been identified based on the data analyzed in the previous chapter. It also provides recommendations that can be pursued in future research.

This chapter is divided into five (5) major headings: Summary of the Study, Summary of Results with reference to the Statement of Purpose, Limitations, Conclusion and Recommendations.

4.1 Summary of the Study

The main goal of this research is to develop and evaluate a virtual laboratory application in science. The use of digital technologies is seen as one of the solutions to deliver education in the New Normal. Virtual reality (VR) has tremendous potential to offer to education especially on the development of scientific competencies.

A VR laboratory application in science was designed and developed by the researcher with a group of game developers. The developed application is called Project SIGLA which stands for Science classroom Innovation through a Google Cardboard Laboratory Application. The name of the project is coined from the Filipino descriptive word “sigla” which means “lively”. The VR Education Model (VEM) by Cooper and

Thong (2018) with its four (4) essential elements: Experiencing, Engagement, Equitability, and Everywhere was used to design the material. The developed application presents a virtual Biology laboratory where users can move around and manipulate the objects inside using a Google Cardboard and an android phone. The content of the virtual laboratory activity was validated by three (3) experts. The developed material received recognition as one of the Most Innovative Learning Materials in Science by DOST - SEI.

It is deemed important that before introducing the technology to the students, perspective and evaluation of the teachers must be considered first. Teachers are experts in the practice of education and are in charge for the first-hand introduction of the curriculum to the learners (Alsubaie, 2016). Thus, the teacher's evaluation of the developed application was given focus by the researcher.

A request letter to the Schools Division Superintendent was written explaining the purpose and the procedures of the research (Appendix A). The participants of the study were seven (7) senior high school science teachers who signed an informed consent form that they were willing to participate (Appendix A). The researcher is interested to know the participants' initial view of virtual reality, so they were asked to answer VR Use, Self-efficacy and Pedagogical Use Survey adapted from Cooper and Thong (2018). Results were gathered and analyzed.

A VR Lab Kit (Labn'aBox) was distributed to each participant. The kit contains the following materials: User's Guide, Google Cardboard, validated lesson plan and activity sheet with answer keys.

Science teachers were guided on how to use the virtual laboratory application via Google Meet. All participants were encouraged and were able to turn on the video for observation purposes. Confidentiality of the participants was assured. An assistant moderator was assigned to take notes during the session. Participants were encouraged to take notes and raise questions and concerns during the evaluation phase.

The researcher facilitated the implementation phase following the validated lesson plan. The participants were able to perform "The Cell" virtual laboratory activity. During the implementation of the developed application to science teachers, the researcher and the assistant moderator have noted that participants found it enjoyable and easy to use. However, two (2) of the participants experienced technical difficulties and they changed mobile devices because the app failed to run on their Android phone. The participants were asked to evaluate the developed material based on Content, Instructional, Technical Quality and take note of any error they have observed. This tool is adapted from the LRMDS of the Department of Education. Results were gathered and analyzed.

A focus group discussion (FGD) was conducted to evaluate the participants' experience in using the virtual laboratory application and reaffirm their responses in the previous survey. An FGD protocol based on Krueger (2015) was followed and the assistant moderator was tasked to help the researcher in taking notes during the session. Questions in the FGD were validated by experts. The session was conducted and recorded via Google meet.

Qualitative data obtained from the FGD was analyzed. Data was transcribed, coded and thematic analysis was conducted.

4.2 Summary of Results

The results of the study were summarized according to the statement of purpose stated in Chapter 1.

1. Develop a virtual laboratory application on a selected topic in Biology 1

A virtual laboratory application in science was developed which focused on the first topic in Biology 1 which is The Cell. The VR Education Model (VEM) which consists of four elements: Experiencing, Engaging, Equitability and Everywhere was used in designing and developing the material. Three (3) expert validators evaluated the material based on Objective, Content, Presentation, Format and Language and Utility. Overall, validators have evaluated the developed material as excellent evaluation in the five (5) aspects mentioned. Using linear weighted analysis, they had perfect agreement on Content, Presentation, and Utility. They had marked substantial agreement on Objectives, and Format and Language.

2. Evaluate the teachers' initial perception of Virtual Reality (VR) in terms of:

A. Self-efficacy

Participants' confidence to teach using digital technologies was higher ($\bar{x}$= 6.57) compared to their confidence to teach using VR ($\bar{x}$= 5.00), indicating relatively low levels of participant self-efficacy to use VR in their teaching when compared to their use of other digital technologies.

B. Pedagogical Use

Results showed that all participants (n=7) are willing to use VR in the classroom if presented with the opportunity. They also think that VR will have a positive effect on students' learning. All the participants indicated that VR is most useful in simulating experiences while virtually traveling to other countries is least useful for their classes according to the majority of participants.

3. Evaluate the developed virtual laboratory application through a Focus Group Discussion (FGD)

The participants were able to perform "The Cell" virtual laboratory activity using an Android phone and Google Cardboard. The researcher and the assistant moderator have noted that participants found the materials enjoyable and easy to use although two (2) of the participants experienced technical difficulties and had to change Android phones. The developed material passed all the criteria and observed errors were noted by the participants using a survey tool. Out of a maximum score of 40 points, participants gave the content quality 39.86 points (±0.12), 39.43 points (±0.20) for instructional quality, and 38.00 points (±0.20) for technical quality. Participants were invited to join the Focus Group Discussion (FGD).

Participants’ responses in the focus group discussion revealed that lower self-efficacy on VR use in teaching compared to teaching with other technologies is due to relatively limited exposure and insufficient familiarity to VR for education.

Based on participants’ responses, the virtual laboratory application in science has a positive impact on them. They were able to share the positives and potential use of the virtual laboratory application:

- Brings excitement and motivation to the user
- Instructions are simple and easy to follow
- Visually engaging
- Students can manipulate objects on their own
- Contributes to the development of a sense of independence
- Learning can take place anywhere and anytime
- Less expensive compared to actual experiment
- Experience would not threaten students’ lives

Concerns and barriers were also noted from the participants’ responses and the researcher categorized those concerns into three (3) groups: Technical issues, Health-related concerns, and Educational issues. Technical issues include that the application is not running on some Android phones; and objects should be breakable if mishandled by the user. Participants’ health concerns are eye strain and dizziness; Length of exposure; and Mental health. Educational issues that were raised by the participants include tedious development process if they will create their own, time allotment in introducing the technology to the students and suitability for different age groups of students.

4.3 Limitations

The main purpose of the study is to develop and evaluate a virtual laboratory application in science. Certain limitations should be taken into consideration.

The developed laboratory application included only the first competency in the subject Biology 1. Participants' evaluation is solely based on their experience while performing the tasks. This study was conducted with a limited number of participants located in one Schools Division in Metro Manila. The researcher does not claim that results can be generalized to all science teachers. Results should be interpreted carefully until further data from similar groups of participants from other divisions has been obtained.

The evaluation of the developed virtual laboratory application was solely limited to science teachers. No students were included in the development and evaluation phase. Try-out phase was not included in this study due to COVID-19 pandemic restrictions.

4.4 Conclusions

The research aims to develop and evaluate a virtual laboratory application in science.

The virtual laboratory application has been evaluated as an excellent material based on experts' and teachers' assessment. The four elements of the VEM are evident in the virtual laboratory application.

Specifically, the research aims to analyze science teachers' initial perception of virtual reality. For this purpose, a VR Use, Self-efficacy and Pedagogical Use Survey was adapted. The analysis of results revealed that the participants have higher self-efficacy towards teaching with technology compared to teaching with the use of virtual reality. Further investigations reaffirms that the lower self-efficacy towards the use of virtual reality is due to lack of knowledge and training. In terms of pedagogical use, the participants indicated a positive attitude towards the potential use of VR in their teaching.

Analysis of results revealed that the main strength of the application is the content and instructional quality while the technical quality needs further development because of the issues encountered by some participants during the tryout phase. The material is free from conceptual, factual, grammatical and typographical errors. Participants evaluated the virtual laboratory application as very satisfactory in all criteria.

Focus group discussion revealed that the virtual laboratory application is engaging and easy to use based on the participant' responses. The material is visually engaging and allows users to manipulate objects which has a high potential to stimulate students' interest. Virtual reality cannot replace the actual laboratory experiments however, due to lack of resources in the public schools it is seen as a good alternative compared to watching videos. With the use of virtual reality, learning can take place anywhere and anytime. Performing activities in the virtual laboratory is safer and a less expensive option. VR is still an emerging technology in education and this is evident with the participants' concerns about technical, health and educational impacts of using the technology. If resources and proper training will be provided, all the participants are willing to integrate virtual reality in their classroom teaching. This willingness shows a potential leaning towards the acceptance and integration of this technology into the science curriculum.

4.5 Recommendations

For the further improvement of this study and to check the results' veracity, the following recommendations are made:

1. It is suggested to use another group of independent participants. For a more complete analysis, the evaluation of administrators and students could also be gathered.
2. Try-out the developed virtual laboratory application to students. Quantitative and qualitative data could be gathered to evaluate the impacts of the virtual laboratory application to students as end users.
3. It is also recommended to cover other competencies in science which are not included in the developed virtual laboratory application.

4. Multi-sensory activities could be integrated in the development of VR laboratories such as sense of hearing and smell to improve user's experience.
5. To avoid technical difficulties, minimum system requirements to run the app should also be given priority during the development process.

REFERENCES

Ahmed, T., & Hossain, M. J. (2020). VR Chiriyakhana: A Virtual Zoo Using Google Cardboard. *SN Computer Science, 1*(6). https://doi.org/10.1007/s42979-020-00363-0

Alalwan, N., Cheng, L., Al-Samarraie, H., Yousef, R., Ibrahim Alzahrani, A., & Sarsam, S. M. (2020). Challenges and Prospects of Virtual Reality and Augmented Reality Utilization among Primary School Teachers: A Developing Country Perspective. *Studies in Educational Evaluation*, *66*. https://doi.org/10.1016/j.stueduc.2020.100876

Albano, E. (2020, November 26). *Senior high students score lowest in national assessment history*. *The Manila Times.*

Aldoobie, N. (2015). ADDIE Model. *American International Journal of Contemporary Research*, (5):6.

Alfahad, F. (2012). Effectiveness of Using Information Technology in Higher Education in Saudi Arabia. *Procedia - Social and Behavioral Sciences*, (46). 1268-1278. https://doi.org/10.1016/j.sbspro.2012.05.287

Almomen, R., Kaufman, D., Alotaibi, H., Al-Rowais, N., Albeik, M., Albaatal, S. (2016). Applying the ADDIE—Analysis, Design, Development, Implementation and Evaluation Instructional Design Model to Continuing Professional Development for Primary Care Physicians in Saudi Arabia. *International Journal of Clinical Medicine*, (7), 538-546.

Alsubaie, M. A. (2016). Teacher Involvement in Curriculum Development. *Journal of Education and Practice, 7*(9).

Arkun, S., & Akkoyunlu, B. (2008). A Study on the development process of a multimedia learning environment according to the ADDIE model and students' opinions of the multimedia learning environment. *Interactive Educational Multimedia*, (17), 1-19.

Bautista, N. U., & Boone, W. J. (2015). Exploring the Impact of TeachME^{TM} Lab Virtual Classroom Teaching Simulation on Early Childhood Education Majors' Self-Efficacy Beliefs. *Journal of Science Teacher Education, 26*(3). https://doi.org/10.1007/s10972-014-9418-8

Benigno, K. (2014). *Video Games Can Be Good, Proves Scientific Study*. When in Manila. www.wheninmanila.com/video-games-can-be-good/

Bugler, D., Marple, S., Burr, E., Chen-Gaddini, M., & Finkelstein, N. (n.d.). *How Teachers Judge the Quality of Instructional Materials*. Wested.org. http://www.edreports.org

Bybee, R. W. (2013). *The Case for STEM Education: Challenges and Opportunities.* National Science Teachers Association, NSTA Press, Arlington, Virginia. https://my.nsta.org/resource/2722/the-case-for-stem-education-challenges-and-opportunities

Bybee, R. W., Powell, J. C., & Trowbridge, L. W. (2008). *Teaching secondary school science (9th ed.)*. Columbus, OH: Pearson Prentice Hall.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis.* London, UK: Sage Publications Inc.

Chen, C.J. (2009). *Theoretical Bases for Using Virtual Reality in Education (EJ1131320)*. ERIC. https://files.eric.ed.gov/fulltext/EJ1131320.pdf

Cohen,L., Manion,L., & Morrison,K. (2000). *Research Methods in Education 5th Ed.* Routledge Falmer London and New York

Cooper, G., Park, H., Nasr, Z., Thong, L. P., & Johnson, R. (2019). Using virtual reality in the classroom: preservice teachers' perceptions of its use as a teaching and learning tool. *Educational Media International*, *56*(1). https://doi.org/10.1080/09523987.2019.1583461

Cooper, G., & Thong, L. P., (2019). *Implementing virtual reality in the classroom: Envisaging possibilities in STEM education, an emerging field of enquiry.* Leiden: Brill.

Creswell, J. (2007). *Qualitative inquiry and research design: Choosing among five approaches (2nd ed., pp. 179–212).* Thousand Oaks, CA: Sage.

Creswell, J. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.).* Thousand Oaks, CA: Sage.

Crow, J.E., Kennedy, T.J., Odell, M.R.L., Ophus, J.D. & Abbitt, J.T. (2013). *Improving Urban Schools: Equity and Access in K-16 STEM Education.* Information Age Publishing.

de Dios. (2013, July 20). *The National Achievement Test in the Philippines*. https://www.philippinesbasiceducation.us/2013/07/the-national-achievement-test-in.html

Dede, Chris. (2009). *Immersive Interfaces for Engagement and Learning*. Science (New York, N.Y.). 323. 66-9. 10.1126/science.1167311.

Department of Education. (2019). *Making the Pivot from Access to Quality*. Magna Anima Teachers College. https://magna-anima.com/advantages/research-and-development

Domingo, J. R., & Bradley, E. G. (2018). Education Student Perceptions of Virtual Reality as a Learning Tool. *Journal of Educational Technology Systems*, *46*(3). https://doi.org/10.1177/0047239517736873

Downes, A. (2021). *ADDIE: 5 Steps for Effective Training & Learning Evaluation*. Watershed Insights RSS. https://www.watershedlrs.com/blog/learning-evaluation/addie-instructional-design-model/

Fokides, E., Polydorou, E., & Mazarakis, P. (2020). Using Google Cardboard Compatible HMDs and Spherical Videos for Teaching History to High School Students. *International Journal of Smart Education and Urban Society*, *11*(4). https://doi.org/10.4018/ijseus.2020100102

Fransson, G., Holmberg, J., Lindberg, O. J., & Olofsson, A. D. (2019). Digitalise and capitalise? Teachers' self-understanding in 21st-century teaching contexts. *Oxford Review of Education*, *45*(1). https://doi.org/10.1080/03054985.2018.1500357

Fresen, J. (2007). A taxonomy of factors to promote quality web-supported learning. *International Journal on E-Learning*, *6*(3), 351-362.

Fudholi, D.H., Kurniawan, R., Jalaputra, D., & Muhimmah, I. (2020). Development of Virtual Reality Applications with the ADDIE Model for Prospective Educators of Children with Autism. *Jurnal RESTI (Rekayasa Sistem dan Teknologi Informasi)*. 4. 672-681. 10.29207/resti.v4i4.2092.

Google Cardboard. (n.d.) https://arvr.google.com/cardboard/.

Hodgson, P. et al. (2019). I*mmersive Virtual Reality (IVR) in Higher Education: Development and Implementation. In: tom Dieck M., Jung T. (eds) Augmented*

Reality and Virtual Reality. Progress in IS. Springer, Cham. https://doi.org/10.1007/978-3-030-06246-0_12

Holly, R. (2018). *Is it safe for kids to use VR? Yes, but* ... Windows Central. https://www.windowscentral.com/kids-can-use-vr-be-careful.

Iberahim, M.A.I., Shamsuddin, S.N.W., Makhtar, M., Rahman, M.N.A., & Simbak, N. (2020). Development of virtual reality (VR) application for fine motor stroke rehabilitation. *International Journal of Emerging Trends in Engineering Research*, *8*(5). https://doi.org/10.30534/ijeter/2020/79852020

Intel. (2014). *Transforming Education in Rural Philippines.* https://www.intel.com/content/dam/www/public/us/en/documents/case-studies/transform-education-philippines-case-study.pdf

International Council of Associations for Science Education. (2013). *Kuching Declaration on Science and Technology Education*. http://www.icaseonline.net/ICASE%20Kuching%20Declaration_Final.pdf

Irlbeck, S., Kays, E., Jones, D., & Sims, R. (2006). The phoenix rising: Emergent models of instructional design. *Distance Education*, *27*(2), 171-185. doi:10.1080/01587910600789514

Kapp, K. M., & O'Driscoll, T. (2010). *Learning in 3D: Adding a new dimension to enterprise learning and collaboration.* Pfeiffer.

Kennedy, T. J., & Odell, M. R. L. (2014). Engaging Students In STEM Education (EJ1044508). ERIC. https://eric.ed.gov/?id=EJ1044508

Krueger, R. (2015). *Moderating Focus Groups.* https://www.youtube.com/watch?v=xjHZsEcSqwo

Lee, E.A.L., & Wong, K.W. (2014). Learning with desktop virtual reality: Low spatial ability learners are more positively affected. *Computers and Education*, *79*. https://doi.org/10.1016/j.compedu.2014.07.010

Looi, C. K., Seow, P., Zhang, B., So, H. J., Chen, W., & Wong, L. H. (2010). Leveraging mobile technology for sustainable seamless learning: A research agenda. *British Journal of Educational Technology, 41(2).*

Mandal, S. (2013). Brief Introduction of Virtual Reality & its Challenges. *International Journal of Scientific & Engineering Research*, *4*(4).

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2009). *On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition.* Washington, DC: The National Academies Press. https://doi.org/10.17226/12192.

Nnabuike, E. K. (2012). Practical Guide to Effective Teaching. *International Journal in Management and Social Science*, 3(10).

Nnabuike E.K, Aneke M.C, & Otegbulu R.I. (2016). Curriculum implementation and the teacher: Issues, Challenges and the way forward. *International Journal in Commerce, IT and Social Sciences 3(6):41-48.*

Nouri, J. (2014). Orchestrating scaffolded outdoor mobile learning activities. *Department of Computer and Systems Sciences, Stockholm University*. https://www.diva-portal.org/smash/get/diva2:745651/FULLTEXT01.pdf

O'Brien, H. L., & Toms, E. G. (2008). What is user engagement? A conceptual framework for defining user engagement with technology. *Journal of the American Society for Information Science and Technology*, *59*(6). https://doi.org/10.1002/asi.20801

Office of the Chief Scientist. (2013). *Science, technology, engineering and mathematics in the national interest: A strategic approach.* www. chiefscientist.gov.au/wp-content/uploads/STEMstrategy290713FINALweb.pdf.

Official Gazette of the Republic of the Philippines. (2019). *Statement of the Philippines' Ranking in the 2018 PISA Results*. https://www.deped.gov.ph/2019/12/04/statement-on-the-philippines-ranking-in-the-2018-pisa-results/

Official Gazette of the Republic of the Philippines. (2013, May 15). *Speech of President Aquino at the signing of the Enhanced Basic Education Act of 2013.* http://www.officialgazette.gov.ph/2013/05/15/english-speech-of-president-aquino-at-the-signing-of-the-enhanced-basic-education-act-of-2013-may-15-2013/

Oigara, J. (2019). Virtual Reality in the Classroom: Applications of Google Cardboard VR to Enhance Learning. *Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (pp. 561-566)*. https://www.learntechlib.org/primary/p/212796/.

Okobia, E.O. (2011). Availability and teachers' use of instructional materials and resources in the implementation of social studies in junior secondary schools in edo state, Nigeria. *Review of European Studies;* 3(3). doi: 10.5539/res.v3n2p90

Organization for Economic Co-operation and Development. (2019). Country Note. Program for International Student Assessment (PISA). Result from PISA 2018. https://www.oecd.org/pisa/publications/PISA2018_CN_PHL.pdf

Pantelidis, V. (2009). Reasons to Use Virtual Reality in Education and Training Courses and a Model to Determine When to Use Virtual Reality. *Themes in Science and Technology Education Special Issue*.

Patton, M. (2002). Qualitative Evaluation Checklist. https://wmich.edu/sites/default/files/attachments/u350/2018/qual-eval-patton.pdf

Philippine Statistics Authority. (n.d). *Secondary Achievement Rate*. https://psa.gov.ph/content/annual-reports-0

Powell, W. W., & Snellman, K. (2004). The knowledge economy. *Annual Review of Sociology*. https://doi.org/10.1146/annurev.soc.29.010202.100037

Powell, Wendy & Powell, Vaughan & Brown, Phillip & Cook, Marc & Uddin, Jahangir. (2016). Getting around in google cardboard – exploring navigation preferences with low-cost mobile VR. 5-8. 10.1109/WEVR.2016.7859536.

Prensky, M. (2001). *Fun, Play and Games: What Makes Games Engaging. Digital Game-Based Learning.* http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Game-Based%20Learning-Ch5.pdf

Ramansyah, W., Aini, N., Arkadiantika, I., & Nur Satiantoro, A. F. R. (2020). Development of virtual reality technology in environmental pollution media learning content for junior high school students. *Journal of Physics: Conference Series*, *1511*(1). https://doi.org/10.1088/1742-6596/1511/1/012026

Richey, R. C., Klein, J. D., & Nelson, W. A. (2004). *Developmental research: Studies of instructional design and development. Handbook of Research for Educational Communications and Technology*. Lawrence Erlbaum Associates Publishers.

Seels, B. B., & Richey, R. C. (1994). *Instructional technology: The definition and domains of the field.* Washington, DC: Association for Educational Communications and Technology.

SEI-DOST & UP NISMED. (2011). Framework for Philippine Science Teacher Education. www.sei.dost.gov.ph/images/downloads/publ/sei_sciteach.pdf

Shibley, B. I., Amaral, K. E., Shank, J. D., Shibley, L. R., Shibley, I., Amaral, K. E., Shank, J. D., & Shibley, L. R. (2011). Designing a blended course: Using ADDIE to guide instructional design. *Journal of College Science Teaching*, *40*(6).

Sibert, L., & Jacob, R. (2000). Evaluation of Eye Gaze Interaction. *SIGCHI Conference on Human Factors in Computing Systems.* https://doi.org/10.1145/332040.332445

Smus, B., & Riederer, C. (2015). Magnetic input for mobile virtual reality. *2015 - Proceedings of the 2015 ACM International Symposium on Wearable Computers*. https://doi.org/10.1145/2802083.2808395

Soto, V. (2013). Which Instructional Design Models are Educators Using to Design Virtual World Instruction?. *MERLOT Journal of Online Learning and Teaching*, (9):3, 364-372.

Statista. (2021). *Market share of mobile operating systems in the Philippines from September 2020 to June 2021*. https://www.statista.com/statistics/931129/philippines-mobile-os-share/

Suduc, A., Bizoi, M., Gorghiu, G., Gorghiu, L. (2011). Information and communication technologies in science. *Procedia - Social and Behavioral Sciences*, (15). 1076-1080. https://doi.org/10.1016/j.sbspro.2011.03.241

Swinhart, D. (2021). Virtual reality has real problems. Here's how game developers seek to delete them. *The Washington Post.* https://www.washingtonpost.com/video-games/2021/01/21/virtual-reality-2021/

Takashi, D. (2013). *More than 1.2 billion people are playing games.* VentureBeat. http://venturebeat.com/2013/11/25/more-than-1-2-billion-people-are-playing-games/

Virtual Reality Society. (2017). *History Of Virtual Reality*. https://www.vrs.org.uk/virtual-reality/history.html.

Waight, N., & Abd-El-Khalick, F. (2007). The impact of technology on the enactment of "inquiry" in a technology enthusiast's sixth grade science classroom. *Journal of Research in Science Teaching*, *44*(1), 154–182. https://doi.org/10.1002/tea.20158

Wang, S., & Hsu, H. (2009). Using the ADDIE model to design Second Life activities for online learners. *TechTrends, 53*(6), 76-81. doi:10.1007/s11528-009-0347-x

Winn, W., Windschitl, M., Fruland, R., & Lee, Y. (2002). When Does Immersion in a Virtual Environment Helps Students Construct Understanding? *ICLS 2002. http://www.hitl.washington.edu/people/tfurness/courses/inde543/READINGS-03/WINN/winnpaper1.pdf*

Yap, M. C. (2016). *Google Cardboard for a K-12 Social Studies Module.* Scholar Space. https://scholarspace.manoa.hawaii.edu/bitstream/10125/40604/LTEC-690-Yap-Scholarspace.05.04.16.pdf

Yee, J. (2016). Makati schools thank 'gamified' online lessons for higher test scores. *Inquirer.Net.* http://newsinfo.inquirer.net/785627/makati-schools-thank-gamified-online-lessons-for-higher-test-scores

Zimnas, A., Kleftouris,D., & Valkanos, N. (2009). IDEL - A simple Instructional Design Tool for E-Learning. *World Academy of Science, Engineering and Technology International Journal of Information and Communication Engineering*, (3)1. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.193.1407&rep=rep1&type=pdf

Appendix A. Letter of Permission to the Superintendent

April 22, 2021

DR. EVANGELINE P. LADINES, CESO V
Schools Division Superintendent
Parañaque City

Thru: **MS. EVANGELINE C. DABUIT**
Senior Education Program Specialist
Planning and Research

Dear Madam,

Greetings of peace and good grace!

The undersigned would like to seek permission from your good office to conduct research among **Senior High School Science Teachers**. This is in connection with the research entitled, **"Project SIGLA: Development and Evaluation of a Google Cardboard Laboratory Application in Science using Virtual Reality for Android"**. The said study is a prerequisite towards the completion of the degree Master of Arts in Education with Specialization in Curriculum and Instruction at the Philippine Normal University, Taft Avenue, Manila.

One (1) Science Teacher from each Senior High School in the Division will be asked to answer a survey which consisted of eleven (11) questions to assess their perceptions about Virtual Reality (VR), inclusive of their beliefs about its capacity to be used as a teaching and learning tool. The teachers will also be asked to uset a developed virtual laboratory application and provide their evaluation. They will be asked to participate in a 60 to 90-minute Focus Group Discussion that will be conducted via Google Meet. It is assured that the teachers will be given proper orientation about the procedures in the conduct of the research. Results of this study will be shared to the teachers and to the Schools Division Office of Parañaque City.

Attached herein is the consent and survey form that will be given to the teachers. I am hoping for your favorable response regarding this matter. Thank you very much and may God bless you a thousand-fold.

Respectfully yours,

JESSICA LUZ M. BRIGOLA
Researcher

Noted by:

DR. VON ANTHONY TORIO
Adviser

Approved by:

DR. EVANGELINE P. LADINES, CESO V
Schools Division Superintendent

Appendix B. Informed Consent Form

Informed Consent Form

Research Title: "Project SIGLA: Development and Evaluation of a Google Cardboard Laboratory Application in Science Using Virtual Reality for Android"

Researcher: JESSICA LUZ M. BRIGOLA
Graduate Student
Philippine Normal University

Respondents: Senior High School Science Teachers

Time / Duration: 60 – 90 minutes

Subject: Science

Detailed Description:
1. You will be asked to answer a questionnaire adapted from Cooper (2019) which consisted of eleven (11) questions to assess your perceptions on Virtual Reality, inclusive of your beliefs about its capacity to be used as a teaching and learning tool.
2. You will also be asked to use a virtual laboratory application.
3. You will be asked to participate in a Focus Group Discussion (FGD) to share your experiences and evaluation of the virtual laboratory application. This will be conducted in Google Meet. You will receive a complimentary load allowance as a respondent.
4. You will also evaluate the Content, Instructional and Technical Quality of the virtual laboratory application using a tool.
5. It is assured that you will be properly oriented about the procedures in the conduct of the research.
6. Participants' anonymity is treated with utmost confidentiality by the researcher. The researcher will not include any information that will make it possible to identify you in any report that might be published.
7. An electronic link will be created to share the outcomes of the study. Results may also be shared during the general assemblies after the research was fully conducted.

--**REPLY SLIP**--

Please put a check mark (/) on the blank that corresponds to your response to this invitation.

______I am willing to be one of the participants in the research study conducted by Ms. Jessica Luz M. Brigola

______I am not willing to be one of the participants in the research study conducted by Ms. Jessica Luz M. Brigola

____
Signature over Printed Name of Teacher

Appendix C. VR Use, Self-efficacy and Pedagogical Use Survey

VR USE, SELF-EFFICACY AND PEDAGOGICAL USE SURVEY
(Adapted from Cooper, et. al., 2019)

PLEASE READ THESE INSTRUCTIONS FIRST:

Thank you for your participation. In this study, we are interested in your perceptions of virtual reality (VR) technologies. Within the scope of this study, VR has been defined as the technologies that use virtual reality headsets to generate the realistic images, sounds and other sensations that replicate a real environment. VR also simulates a user's physical presence in this environment (e.g., Google Cardboard, HTC Vive/ Oculus rift). It is important to point out that there are no right or wrong answers; I'm interested in your perceptions about VR and your views about its capacity to be used as a teaching and learning tool.

Section 1: Some general information about you

Q1: Name (Optional): ____

Q2. Do you identify as: (Please tick relevant box)
□ Male
□ Female
□ Other (if other, please specify here: ____________________)

Q3. How many years are you in the teaching profession?
□ 1-3 years
□ 4-6 years
□ 7-9 years
□ More than 9 years

Q4. What science subjects do you teach? ____

Section 2: Self-efficacy

Q5. On a scale of 1 (very unconfident) to 7 (very confident), overall, how would you rate your confidence to use digital technologies?	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Q6. On a scale of 1 (very unconfident) to 7 (very confident), overall, how would you rate your confidence to teach using VR?	1	2	3	4	5	6	7

Q7. Have you ever used VR technology?
- □ No
- □ Yes (If yes, please describe briefly below)

Section 3: Perceptions of VR as a learning and teaching tool inclusive of its potential positives, efficacy and concerns or barriers

Q8. Would you be willing to use VR in your classroom if presented with the opportunity?
- □ Yes
- □ No

Q9. Do you think the use of VR would overall have a positive effect on students' learning?
- □ No
- □ Yes (If yes, please describe briefly below)

Q10. Have a look at the possible experiences below, if you were to use VR in the classroom, please rank what you think it would be most useful (1 being most useful) to least useful (4 being least useful).

____ Simulate experiences
____ Explore inaccessible locations (e.g., space)
____ Virtually travel to other countries
____ Connect with students and people inside/outside the school

Q11. If you were to use VR in the classroom, are there any concerns you would have about implementing these technologies? If so, please describe here:

Appendix D. Permission Letter to Use Validation Tool

April 8, 2021

DR. VIRGIL D. DUAD
Faculty Member
Faculty of Science Technology and Mathematics

Dear Dr. Duad,

Greetings of peace and good grace!

I am Jessica Luz M. Brigola, graduate student at the Philippine Normal University, Taft Avenue, Manila. I am doing research as a prerequisite towards the completion of the degree Master of Arts in Education with Specialization in Curriculum and Instruction. I would like to seek your permission to allow me to use the **Evaluator's Checklist** from your research, **Development of a Strategic Intervention Material (SIM) for Grade 10 Science: Chemical Equations and Reactions.** My thesis adviser,
Dr. Von Anthony Torio, recommended this tool and I find it very useful in validating the instruments in my study. My research is entitled **"Project SIGLA: Development and Evaluation of a Google Cardboard Laboratory Application in Science using Virtual Reality for Android"**.

Attached herein is the Evaluator's Checklist that I would like to adapt and the modifications I made to suit my research. I am hoping for your favorable response regarding this matter. Thank you very much and may God bless you a thousand-fold.

Respectfully yours,

JESSICA LUZ M. BRIGOLA
Researcher

Appendix E. Validation Tool

Evaluator's Checklist
(Adapted and Modified from Duad, V.D., 2016)

Evaluator: ______________________________________
Educational Attainment: ______________________________________
Position: ______________________________________
Institution: ______________________________________

Instruction: Listed below are criteria for evaluating the VR Use, Self-efficacy and Pedagogical Use Survey. This survey will be used to assess teachers' perceptions about VR and their views about its capacity to be used as a teaching and learning tool. Please rate each item by ticking (/) the corresponding equivalent on the four-point scale.

Outstanding	4
Highly Satisfactory	3
Satisfactory	2
Needs Improvement	1

I. Format and Design

	4	3	2	1
1. The checklist is clear and readable				
2. The layout is attractive and uniform				
3. The fonts used are comprehensible and appropriate				
4. The spacing on the pages contributes to the ease of reading and responding				

II. Language and Style

	4	3	2	1
1. The language and style are appropriate				
2. The language used is consistent				
3. The checklist is free from grammatical errors				
4. The sentences are properly constructed and				

punctuated				
5. The language used in the checklist are simple and easy to understand				

III. Content

	4	3	2	1
1. The facets are factual and objective				
2. The facets are free from ideological, sexual, and racial bias				
3. The facets reflect actual teaching situations				
4. The choices for each facet are independent and do not overlap.				
5. The facets are sound, convenient, useful and proper for VR Use, Self-efficacy and Pedagogical Use survey				

____

Name and Signature of Validator

LABnaBox

(Lab in a Box)
USER'S GUIDE

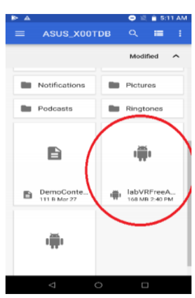
The following guide is prepared to assist you in using the virtual laboratory application. The kit you received is called LABnaBox (Lab in a Box). Please check if you received all the contents completely before starting:

INCLUSIONS

- 1 Android Phone*

**Optional. Teachers may use their own Android mobile device.*

- 1 Blank Laboratory Sheet (Student's Copy): THE CELL



- 1 Virtual Laboratory APK *(Android Application Package)*

- 1 Answer Key (Teacher's Copy: THE CELL

- 1 Google Cardboard

- 1 Lesson Plan: THE CELL

INSTRUCTIONS

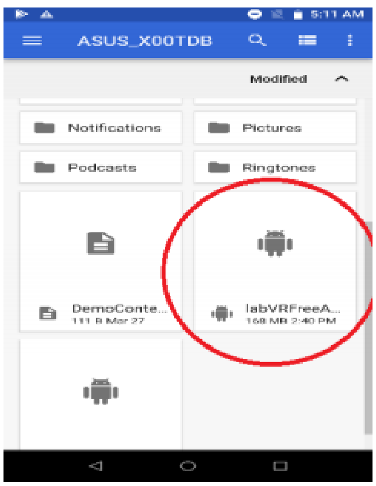
STEP 1: Download the APK from Google Drive.

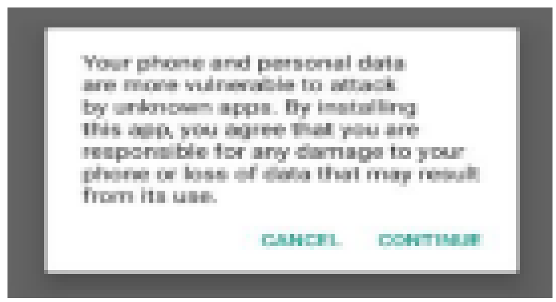
- Open this link using your Android phone:

  ____

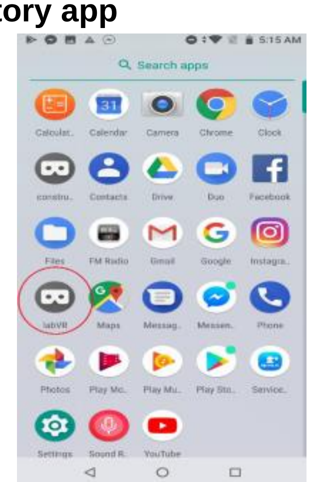
STEP 2: Install the APK on your Android mobile device.

- Press the APK to install. If there is a previous version installed simply click "continue"





STEP 3. Run the VR laboratory app

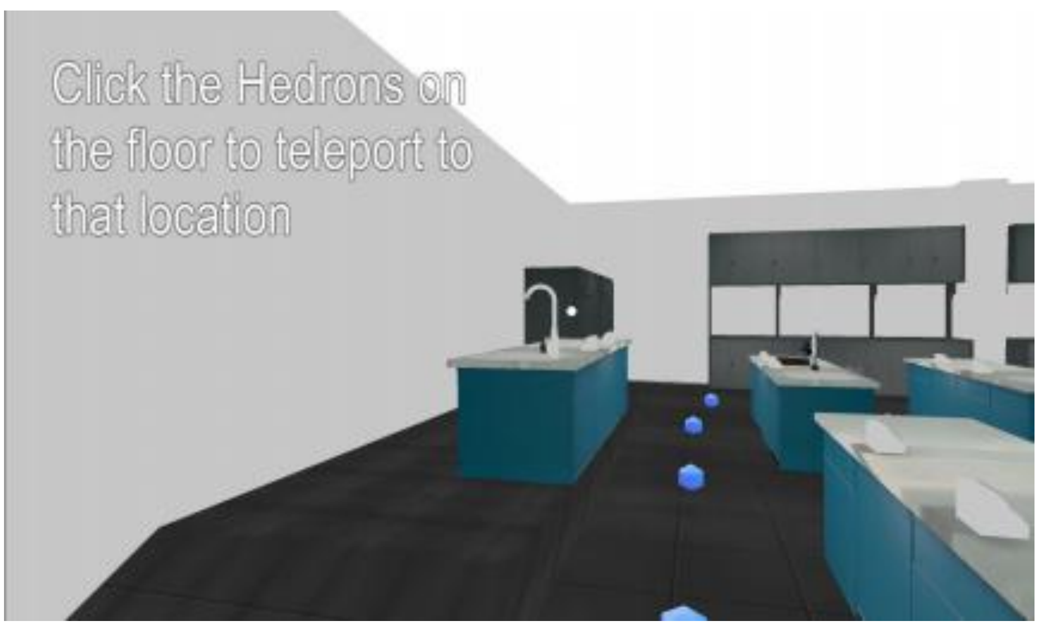


STEP 4. Insert the mobile device to the Google Cardboard.

- Attach one side using the velcro strip to keep the mobile phone in place.

STEP 5. Manipulate the virtual lab

- Move your head to rotate the in game camera
- Once you Enter the room click on the blue hexagon objects using the button located at the upper right part of the vr cardboard to teleport around the laboratory.
- Follow the instructions on the laboratory worksheet: The Cell to begin the activity



Appendix G. The Cell: Laboratory Sheet and Lesson Plan

NAME : ______________________________ **SCORE**: ________________
SECTION : ______________________________ **DATE** : ________________

Virtual Lab Activity Sheet

The CELL

INTRODUCTION

The **cell** is the basic unit of life. It is the smallest structure that is capable of performing all life's functions. **Robert Hooke** in 1665 coined the term "cells" as he observed individual compartments from a slice of cork using a primitive light microscope. In 1839, **Matthias Schleiden** and **Theodore Schwann** proposed the cell theory. These two remarkable biologists said that (1) cells are the smallest unit of all living things; (2) all cells arise from preexisting cells through cell divisions; and that (3) some organisms are unicellular and others are multicellular. All life's processes occur in a single cell of unicellular organisms. Multicellular organisms have aggregates of specialized cells that work together and perform different functions. Whether unicellular or multicellular, all organisms contain important structures that enable them to support life.

OBJECTIVES

At the end of this virtual laboratory activity, 85% of the students should be able to:

- Examine slides under the virtual microscope;
- Describe the differences between prokaryotic and eukaryotic cells; and
- Distinguish plant cells from animal cells.

INVESTIGATION QUESTION

1. How do prokaryotic and eukaryotic cells differ under the microscope?
2. Which structures are visible in plant and animal cells under the microscope?

HYPOTHESES

1. ____
____
2. ____
____

MATERIALS

LAB n'a BOX (VR Kit) - VR Lab App, Android Phone, Cardboard

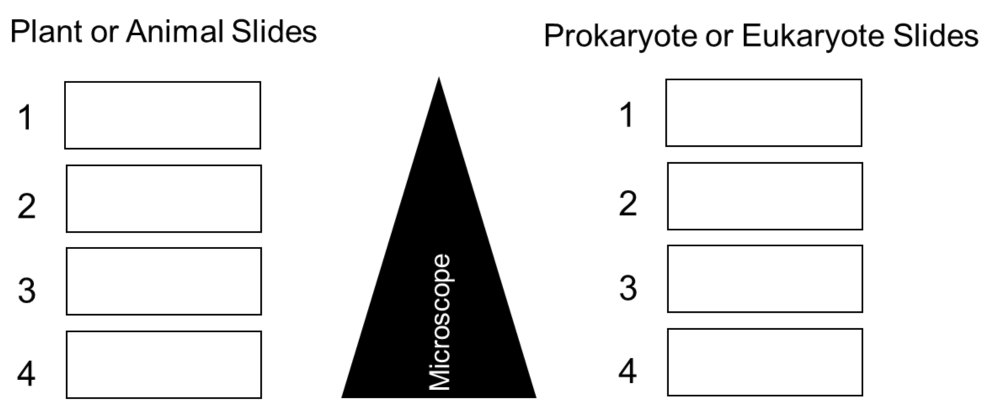
PROCEDURES

A. Prokaryotic or Eukaryotic Cell

1. Unbox the VR Kit and turn on the mobile phone.
2. Launch the ***VR Lab*** app and mount the mobile phone properly in the cardboard.
3. In the app, look for polyhedrons on the floor, hover the white cursor through these and click on the cardboard clicker to transfer from one polyhedron to another. Continue this until you reach the table with the microscope.
4. In the table, you will see the PROKARYOTE-EUKARYOTE set of slides on the RIGHT SIDE of the microscope. Click one microslide to pick it up and click on the microscope to view it.
5. Examine the specimen. You have the option to change lens for a higher magnification.
6. Refer to the DATA AND OBSERVATION section of this worksheet to classify the microslide in focus.
7. Click "Exit" and repeat steps 4 to 6 to finish viewing all the given slides.

B. Plant or Animal Cell

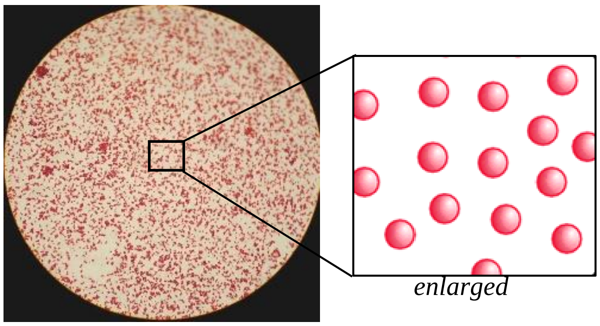
Repeat procedure 4 to 7. But this time, use the PLANT-ANIMAL set of slides on the LEFT side of the microscope.



Viewing order for classifying microslides in the VR App

DATA AND OBSERVATION

A. Classifying PROKARYOTIC OR EUKARYOTIC CELL



Sample **prokaryote** at 500x magnification

Sample **eukaryote** at 500x magnification

1 2 3 4

Do cells in this slide contain nucleus? ____________

Do cells appear to be relatively smaller or larger? ____________

Are the cells prokaryotic or eukaryotic? ____________

1 **2** 3 4

Do cells in this slide contain nucleus? ____________

Do cells appear to be relatively smaller or larger? ____________

Are the cells prokaryotic or eukaryotic? ____________

1 2 **3** 4

Do cells in this slide contain nucleus? ____________

Do cells appear to be relatively smaller or larger? ____________

Are the cells prokaryotic or eukaryotic? ____________

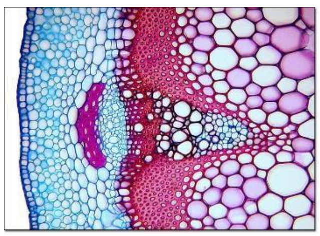
1
2
3
4

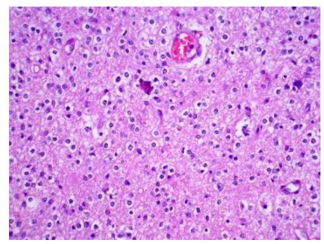
Do cells in this slide contain nucleus? ______________

Do cells appear to be relatively smaller or larger? ______________

Are the cells prokaryotic or eukaryotic? _____________

B. Classifying PLANT OR ANIMAL CELL





Sample **plant** tissue with cells having thick cell wall Sample **animal** tissue with cells having no cell walls

1
2
3
4

Do cells in this slide contain thick, rigid-looking cell walls? ______________

Do cells generally appear to be irregularly-shaped? ______________

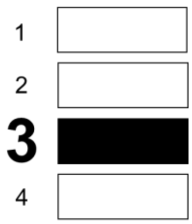
Are the cells of plant or animal? _____________

1
2
3
4

Do cells in this slide contain thick, rigid-looking cell walls? ______________

Do cells generally appear to be irregularly-shaped? ______________

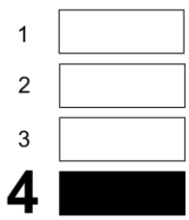
Are the cells of plant or animal? ______________



Do cells in this slide contain thick, rigid-looking cell walls? ______________

Do cells generally appear to be irregularly-shaped? ______________

Are the cells of plant or animal? ______________



Do cells in this slide contain thick, rigid-looking cell walls? ______________

Do cells generally appear to be irregularly-shaped? ______________

Are the cells of plant or animal? ______________

ANALYSIS AND DISCUSSION

1. What cell structures are present in eukaryotic cells and not in prokaryotic cells?
   ____
   ____
2. What structures help you classify plant cells from animal cells?
   ____
   ____
3. Based on your observations, what cell structures are common to all cells?
   ____
   ____

CONCLUSION

____

____

____

____

REFLECTION

Give a reflection on your today's experience of using the virtual laboratory

From 1 to 5 stars how will you rate your experience in using the virtual laboratory?

☆☆☆☆☆

<table>
<tr><td rowspan="3">GRADE 12

DAILY LESSON LOG</td><td>Teacher</td><td>MS. JESSICA LUZ M. BRIGOLA</td><td>Grade Level</td><td>12</td></tr>
<tr><td rowspan="2">Semester</td><td rowspan="2">1ST SEMESTER

(LABORATORY SESSION 2)</td><td>Learning Area</td><td>BIOLOGY 1</td></tr>
<tr><td>Quarter</td><td>1ST QUARTER</td></tr>
</table>

<table>
<tr><th colspan="3">LESSON OUTLINE</th></tr>
<tr><td></td><td></td><td>TIME (MINUTES)</td></tr>
<tr><td>Introduction/ Tutorial</td><td>Unbox the Virtual Laboratory Kit;
Give a tutorial on how to navigate the developed application</td><td>15</td></tr>
<tr><td>Motivation</td><td>Challenge. Recall lab safety measures using the developed application.</td><td>10</td></tr>
<tr><td>Instruction / Practice</td><td>Examination of different slides under the virtual microscope</td><td rowspan="2">30</td></tr>
<tr><td>Enrichment</td><td>Allow the students to answer the given worksheet as they examine the slides</td></tr>
<tr><td>Evaluation</td><td>Assessment of learners' knowledge;
Assignment of homework for next activity</td><td>5</td></tr>
<tr><td></td><td></td><td>60</td></tr>
<tr><td colspan="3">I. Learning Targets/ Specific Objectives</td></tr>
<tr><td>A. Content Standards</td><td colspan="2">The learners demonstrate an understanding of Prokaryotic vs Eukaryotic Cells and Cell Types (Plant and Animal Cells).</td></tr>
<tr><td>B. Performance Standards</td><td colspan="2">The learners shall be able to examine slides under the microscope and classify given specimen as Prokaryotic/ Eukaryotic and Plant/Animal Cells.</td></tr>
<tr><td>C. Learning Competencies (L.C. Code)</td><td colspan="2">The learners distinguish prokaryotic and eukaryotic cells according to
their distinguishing features and classify different cell types (plant/animal tissues) and specify the function(s) of each. (STEM_BIO11/12-Ia-c-3 and STEM_BIO11/12-Ia-c-4)</td></tr>
<tr><td>D. Specific (Daily) Objective/s</td><td colspan="2">At the end of this session, students will be able to:
• Examine slides under the virtual microscope;
• Describe the differences between prokaryotic and eukaryotic cells; and
• Distinguish plant cells from animal cells.</td></tr>
</table>

II. Learning Content	THE CELL

III. Learning Resources	
A. References	• Campbell NA, Urry LA, Cain, ML, Wasserman, SA, Minorsky PV, Reece JB. 2018. Biology: A Global Approach. Global edition. Pearson Education; • Prokaryotic and Eukaryotic Cells. Retrieved from https://www.ck12.org/biology/prokaryotic-and-eukaryotic-cells/lesson/Prokaryotic-and-Eukaryotic-Cells-BIO/; • Plant vs Animal Cells. https://www.khanacademy.org/science/high-school-biology/hs-cells/hs-plant-vs-animal-cells/a/hs-plant-vs-animal-cells-review
B. Materials	• LAB n'a BOX ▪ Android Phone ▪ Google Cardboard ▪ The Cell Activity Sheet ▪ PowerPoint Presentation on The Cell Activity

IV. PROCEDURE		
A. Reviewing previous lesson or presenting the new lesson	***Elicit:*** *(The activities in this section will evoke or draw out prior concepts or prior experiences from the students)*	Tell the students that today they are going to perform their first laboratory activity using a virtual lab. Ask the students to recall what a science lab looks like. ***Guide Questions:*** *1. Have you ever been to a science laboratory before?* *2. How will you describe a science lab?*
B. Establishing a purpose for the lesson	***Engage:*** *(The activities in this section will stimulate their thinking and help them access and connect prior knowledge as a*	The students have to be oriented first on how the virtual lab works. Each group will be given 1 set of materials that can be found on **"LAB n'a BOX"**. Ask one member from each group to get the materials. Give a tutorial on how to use the contents of the **"LAB n'a BOX"** and guide the students as they do the following:

	jumpstart to the present lesson)	✓ Looking for the Lab VR App on the mobile phone ✓ Unboxing the Google cardboard ✓ Placing the phone on the Google Carboard ✓ Going around the virtual lab
C. Presenting examples/ instances of the new lesson		**Team Challenge.** Ask the students to look for 10 safety measures that can be found in the virtual laboratory. The first 3 groups that will finish at the fastest time will win the game. After the activity, remind the students that those safety measures must be remembered to avoid danger and keep the laboratory clean and safe at all times.
D. Discussing new concepts & practicing new skills #1	***Explore:*** *(In this section, students will be given time to think, plan, investigate, and organize collected information; or the performance of the planned/prepared activities from the students' manual with data gathering with Guide Questions)*	**TASK 1: Classify given slides as prokaryotic or eukaryotic cells based on distinguishing features.** In this activity, students have to use the developed application to examine prokaryotic and eukaryotic cells under the virtual microscope. They have to classify the given slides based on distinguishing features. Give the students time to examine slides. Go around to monitor their progress.
E. Discussing new concepts & practicing new skills #2		**TASK 2: Classify given slides as plant or animal cells based on distinguishing features** In this activity, students have to use the developed application to examine plant and animal cells under the virtual microscope. They have to classify the given slides based on distinguishing features. Give the students time to examine slides. Go around to monitor their progress.
F. Developing mastery	***Explain:*** *(In this section, students will be involved in an analysis of their exploration. Their understanding is clarified and modified because of reflective activities).*	Ask the students to answer the questions in their activity sheet. Allow them to discuss with their groupmates based on the results of their observations using the virtual microscope. *See attached worksheet for the Guide Questions*

<table>
<tr>
<td>G. Finding practical applications of concepts and skills in daily living</td>
<td rowspan="2">Elaborate:
(This section will give students the opportunity to expand and solidify/concretize their understanding of the concept and/or apply it to a real-world situation)</td>
<td>After the activity, ask the following questions:
1. Why do we need to study cells?
2. Why is it important for us to know more about cells?</td>
</tr>
<tr>
<td>H. Making generalizations and abstraction</td>
<td>Ask the following questions:
1. How do you distinguish a prokaryotic cell from a eukaryotic cell?
2. What are the distinguishing features of a plant cell and an animal cell?</td>
</tr>
<tr>
<td>I. Evaluating Learning</td>
<td>Evaluation:
(This section will provide opportunities for concept check test items and answer key which are aligned to the learning objectives – content and performance standards.)</td>
<td>Rubrics for rating the performance:
<table>
<tr><td rowspan="2">Criteria</td><td colspan="3">Points</td></tr>
<tr><td>3</td><td>2</td><td>1</td></tr>
<tr><td>Teamwork and Cooperation</td><td></td><td></td><td></td></tr>
<tr><td>Ability to follow instructions</td><td></td><td></td><td></td></tr>
<tr><td>Ability to handle materials with care</td><td></td><td></td><td></td></tr>
<tr><td>Accomplished Task 1</td><td></td><td></td><td></td></tr>
<tr><td>Accomplished Task 2</td><td></td><td></td><td></td></tr>
<tr><td>TOTAL</td><td colspan="3"></td></tr>
<tr><td colspan="4">Remarks:</td></tr>
</table>
</td>
</tr>
<tr>
<td>J. Additional activities for application and remediation</td>
<td>Extend:
(This section gives situation that explains the topic in a new context, or integrate it to another discipline/societal concern)</td>
<td>Assignment:
Title: Cell Parts Analogy
Task: Compare a cell to the school. Come up with an analogy for a cell and its parts through an illustration.
Example: Cell Membrane – Gate of the School</td>
</tr>
</table>

V. REMARKS

VI. REFLECTION

Appendix H. Answer Key

NAME : ______________________________ **SCORE** : ________________
SECTION : ______________________________ **DATE** : ________________

Virtual Lab Activity Sheet

The CELL

INTRODUCTION

The **cell** is the basic unit of life. It is the smallest structure that is capable of performing all life's functions. **Robert Hooke** in 1665 coined the term "cells" as he observed individual compartments from a slice of cork using a primitive light microscope. In 1839, **Matthias Schleiden** and **Theodore Schwann** proposed the cell theory. These two remarkable biologists said that (1) cells are the smallest unit of all living things; (2) all cells arise from preexisting cells through cell divisions; and that (3) some organisms are unicellular and others are multicellular. All life's processes occur in a single cell of unicellular organisms. Multicellular organisms have aggregates of specialized cells that work together and perform different functions. Whether unicellular or multicellular, all organisms contain important structures that enable them to support life.

OBJECTIVES

At the end of this virtual laboratory activity, 85% of the students should be able to:

- Examine slides under the virtual microscope;
- Describe the differences between prokaryotic and eukaryotic cells; and
- Distinguish plant cells from animal cells.

INVESTIGATION QUESTION

1. How do prokaryotic and eukaryotic cells differ under the microscope?
2. Which structures are visible in plant and animal cells under the microscope?

HYPOTHESES

1. Under the microscope, prokaryotic and eukaryotic cells differ in terms of size and the organelles found inside
2. Under the microscope, plant cells have a thicker outer covering while animal cells don't have thicker outer covering

MATERIALS

LAB n'a BOX (VR Kit) - VR Lab App, Android Phone, Cardboard

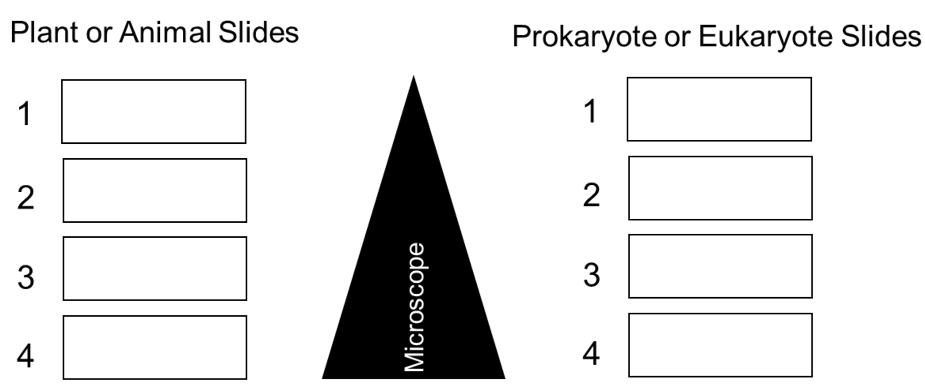
PROCEDURES

A. Prokaryotic or Eukaryotic Cell

1. Unbox the VR Kit and turn on the mobile phone.
2. Launch the ***VR Lab*** app and mount the mobile phone properly in the cardboard.
3. In the app, look for polyhedrons on the floor, hover the white cursor through these and click on the cardboard clicker to transfer from one polyhedron to another. Continue this until you reach the table with the microscope.
4. In the table, you will see the PROKARYOTE-EUKARYOTE set of slides on the RIGHT SIDE of the microscope. Click one microslide to pick it up and click on the microscope to view it.
5. Examine the specimen. You have the option to change lens for a higher magnification.
6. Refer to the DATA AND OBSERVATION section of this worksheet to classify the microslide in focus.
7. Click "Exit" and repeat steps 4 to 6 to finish viewing all the given slides.

B. Plant or Animal Cell

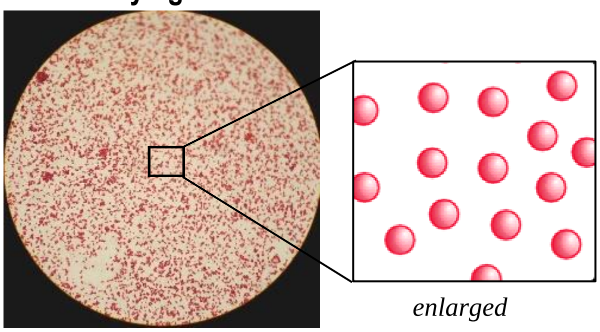
Repeat procedure 4 to 7. But this time, use the PLANT-ANIMAL set of slides on the LEFT side of the microscope.



Viewing order for classifying microslides in the VR App

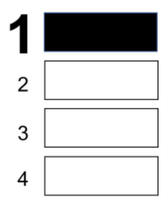
DATA AND OBSERVATION

A. Classifying PROKARYOTIC OR EUKARYOTIC CELL



Sample **prokaryote** at 500x magnification

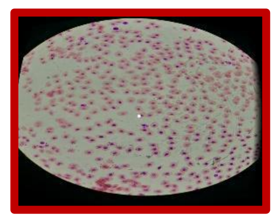
Sample **eukaryote** at 500x magnification

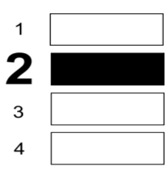


Do cells in this slide contain nucleus? YES

Do cells appear to be relatively smaller or larger? LARGER

Are the cells prokaryotic or eukaryotic? EUKARYOTIC

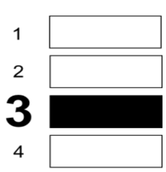




Do cells in this slide contain nucleus? YES

Do cells appear to be relatively smaller or larger? LARGER

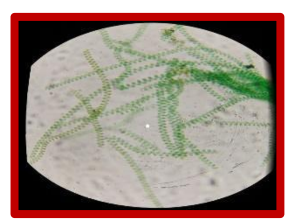
Are the cells prokaryotic or eukaryotic? EUKARYOTIC



Do cells in this slide contain nucleus? NO

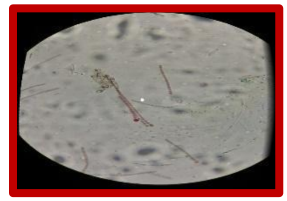
Do cells appear to be relatively smaller or larger? SMALLER

Are the cells prokaryotic or eukaryotic? PROKARYOTIC

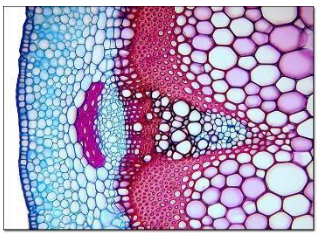


1
2
3
4

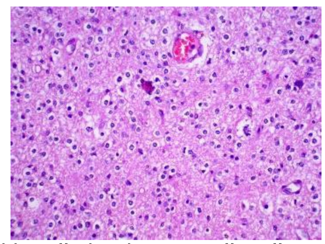
Do cells in this slide contain nucleus? NO
Do cells appear to be relatively smaller or larger? SMALLER
Are the cells prokaryotic or eukaryotic? PROKARYOTIC



B. Classifying PLANT OR ANIMAL CELL



Sample **plant** tissue with cells having thick cell walls



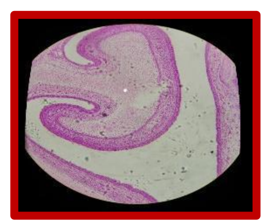
Sample **animal** tissue with cells having no cell walls

1
2
3
4

Do cells in this slide contain thick, rigid-looking cell walls? YES
Do cells generally appear to be irregularly-shaped? NO
Are the cells of plant or animal? PLANT

1
2
3
4

Do cells in this slide contain thick, rigid-looking cell walls? NO
Do cells generally appear to be irregularly-shaped? YES
Are the cells of plant or animal? ANIMAL



1
2
3
4

Do cells in this slide contain thick, rigid-looking cell walls? YES
Do cells generally appear to be irregularly-shaped? NO
Are the cells of plant or animal? PLANT

1

2

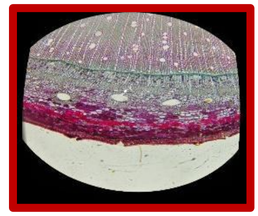
3

4

Do cells in this slide contain thick, rigid-looking cell walls? YES

Do cells generally appear to be irregularly-shaped? NO

Are the cells of plant or animal? PLANT



ANALYSIS AND DISCUSSION

1. What cell structures are present in eukaryotic cells and not in prokaryotic cells?
   Eukaryotic cells contain nucleus and other membrane-bound organelles
2. What structures help you classify plant cells from animal cells?
   The presence of cell walls and chloroplasts indicate that the cell is a plant and not an animal
3. Based on your observations, what cell structures are common to all cells?
   Based on my observation, the common features of all cells are an outer covering or the cell membrane and the cytoplasm

CONCLUSION

____

____

____

REFLECTION

Give a reflection on your today's experience of using the virtual laboratory

____

____

From 1 to 5 stars how will you rate your experience in using the virtual laboratory?

Appendix I. The Cell: Validation Tool

Content Validation of The Cell Virtual Laboratory Sheet

(Adapted and Modified from Torrefranca, 2017)

Name: ______________________________
Position: ______________________________
No. of Years in Teaching: ______________________________
Educational Attainment: ______________________________
School Graduated: ______________________________

Rubrics on Content Validation of The Cell Virtual Laboratory Sheet

Points / Descriptive Rating	
5 – Excellent	The item is very evident on the developed material
4 – Very Good	The item is evident on the developed material
3 – Good	The item is evident but needed minimal revision (Please suggest needed revision / write the necessary question)
2 – Fair	The item is evident but needed major revision (Please suggest needed revision / write the necessary question)
1 – Poor	The item is not evident (Please suggest needed revision / write the necessary question)

Aspects	Items	5	4	3	2	1	Remarks
1. Objectives	1. The objectives are clearly stated in behavioral form.						
	2. The objectives are specific, measurable and attainable.						
	3. The objectives are relevant to the topic.						
	4. The objectives take into account the needs of the students.						
2. Content	1. The content of the laboratory activity is directly relevant to the defined objectives.						
	2. The content of the laboratory activity is simple and easy to understand.						
	3. The laboratory activity is suited for the level of the students.						

	4. The laboratory activity is free from content and typographical errors.						
3. Formant and Language	1. The format/layout is well-organized, which makes the lessons more interesting.						
	2. The language used is easy to understand.						
	3. The language used is clear, concise and motivating.						
	4. The instructions are concise and easy to follow.						
4. Presentation	1. The laboratory activity is presented in a logical and sequential order.						
	2. The laboratory activity is presented in a unique and original form.						
	3. The laboratory activity is presented clearly.						
	4. The presentation of each laboratory activity is attractive and interesting to the students.						
5. Utility	1. The laboratory activity will motivate the students to study Plant and Animal Cells						
	2. The laboratory activity will allow the students to use their time more efficiently.						
	3. The laboratory activity will develop science process skills of students.						
	4. The laboratory activity will serve as a supplementary material that can cater to the needs of the students.						

____
Name and Signature of Validator
Date: ________________________

Appendix J. Letter to Validators

PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education
College of Graduate Studies and Teacher Education Research
104 Taft Ave, Ermita, Manila

April 9, 2021

Dear Sir:

I am a graduate student of Philippine Normal University currently conducting a research entitled "**Project SIGLA: Development and Evaluation of a Google Cardboard Laboratory Application in Science Using Virtual Reality for Android**". The said study is a prerequisite towards the completion of the degree Master of Arts in Education with Specialization in Curriculum and Instruction at the Philippine Normal University, Taft Avenue, Manila.

In connection with this, I am requesting you to be one of my **Expert Validators** to assess the instruments that I will be using in my study. I will be collecting validation input online via Google Forms. Attached herein are my instruments and the validation tools, converted into Google Forms:

Instruments	Validation Tools (Google Forms)
• VR Use, Self-efficacy and Pedagogical Use Survey	Validation Tool 1
• FGD Questionnaire (aligned with VR Use, Self-efficacy and Pedagogical Use Survey)	Validation Tool 2
• Virtual Lab Activity Sheet	Validation Tool 3

Thank you very much.

Very truly yours,

JESSICA LUZ M. BRIGOLA
Researcher

Appendix K. Validators' Profile

Validators' Profile

Validator	Position	Years in Teaching	Highest Education Attainment	Area of Specialization	School Graduated
A	Adjunct Professor, Southside Virginia Community College	8	MSc (with 18 units PhD)	Biology	De La Salle University - Manila
B	PhD Student, University of Canterbury, Christchurch, New Zealand	6	Master's Degree (on going PhD)	Biology	University of Santo Tomas
C	College Instructor 3	4	Ph.D. in Science Education - Major in Biology	Science Education	De La Salle University - Manila

Appendix L. Evaluation Rating Sheet for Non-Print Materials

Evaluation Rating Sheet for Non-Print Materials

(Adapted and Modified from Department of Education (DepEd) Guidelines and Processes for LRMDS Assessment and Evaluation for Localized Materials)

Instruction: *Examine the material carefully and for each evaluation criterion consider the extent to which the resource meets the criteria. Check the appropriate number [with 4 being Very Satisfactory (VS); 3 - Satisfactory (S); 2 - Poor; and 1 – Not Satisfactory]. For a rating below 4, write your comments/justifications on each evaluation criterion. If an evaluation criterion is Not Applicable (NA), the material is rated 3 on said criterion.*

Factor A. Content Quality	VS 4	S / NA 3	P 2	NS 1
1. Content is consistent with topics/skills found in the DepED Learning Competencies for the subject and grade/year level it was intended.				
2. Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives.				
3. Content is accurate.				
4. Content is up-to-date.				
5. Content is logically developed and organized.				
6. Content is free from cultural, gender, racial, or ethnic bias.				
7. Content stimulates and promotes critical thinking.				
8. Content is relevant to real-life situations.				
9. Language (including vocabulary) is appropriate to the target user level.				
10. Content promotes positive values that support formative growth.				
TOTAL POINTS:				
Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a check mark on the appropriate circle.	○ Passed ○ Failed			
Comments/ Suggestions:				

Factor B. Instructional Quality	VS 4	S / NA 3	P 2	NS 1
1. Purpose of the material is well defined.				
2. Material achieves its defined purpose.				
3. Learning objectives are clearly stated and measurable.				
4. Level of difficulty is appropriate for the intended target user.				
5. Graphics / colors / sounds are used for appropriate instructional reasons.				
6. Material is enjoyable, stimulating, challenging, and engaging.				
7. Material effectively stimulates creativity of target user.				
8. Feedback on target user's responses is effectively employed with target user's previous experience.				
9. Target user can control the rate and sequence of presentation and review.				
10. Instruction is integrated.				
TOTAL POINTS:				
Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a check mark on the appropriate circle.	○ Passed ○ Failed			
Comments / Suggestions:				

Factor C. Technical Quality	VS 4	S / NA 3	P 2	NS 1
1. There is complete synchronization of audio with the visuals, if any.				
2. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing.				
3. Visual presentations (non-text) are clear and easy to interpret.				
4. Visuals sustain interest and do not distract user's attention.				
5. Visuals provide accurate representation of the concept discussed.				
6. The user support materials (if any) are effective.				

7. The design allows the target user to navigate freely through the material.				
8. The material can easily and independently be used.				
9. The material will run using minimum system requirements.				
10. The program is free from technical problems.				
TOTAL POINTS:				
Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a check mark on the appropriate circle.	○ Passed ○ Failed			
Comments / Suggestions:				

Factor D. Other Findings *(Note down observations about the information contained in the material, where the following errors are found)*	*Not present 4*	*Present but very minor 3*	*Present & requires redevelopment 2*	*Do not evaluate further 1*
1. Conceptual errors.				
2. Factual errors				
3. Grammatical and / or typographical errors.				
4. Other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.).				
TOTAL POINTS:				
Note: Resource must score at least 16 points out of a maximum 16 points to pass this criterion. Please put a check mark on the appropriate box	○ Passed ○ Failed			
Comments / Suggestions:				

(Please put a check mark (✓) in the appropriate box.)

Recommendation

☐ I recommend this material for possible use in schools provided that the corrections / revisions included in this report are made.

☐ I do not recommend this material for possible use in schools.

Evaluator: ______________________________

Signature(s): _________________________
(Please print your full name)
Designation: ______________________________

Date: ______________________________

Appendix M. FGD Protocol

FGD Protocol

I. Welcome

"Good morning and welcome to the session. My name is Jessica Luz M. Brigola. I am a graduate student from Philippine Normal University, taking up a Master of Arts in Education with Specialization in Curriculum and Instruction."

II. Background

"We are pleased to have you today for our focus group. Today, we are going to talk about your attitudes, feelings, experiences and reaction after you have tried the virtual laboratory application. The aim of this focus group is for you to evaluate the pedagogical use of the developed application."

" The VR Laboratory application is developed for senior high school students. You are selected because you are one of the senior high school science teachers in the division and you have experience using the virtual laboratory application."

"My assistant moderator is _______________. She is also a science teacher from ____________________. She will be taking notes and helping me with the recording of this session. We record our session so we do not miss any of your answers and comments".

III. Ground Rules

"May I request you to turn off your mobile devices or put it on silent mode during our session. If you need to respond to a very important call, you may take it and come back as soon as possible."

"There are no wrong answers to the questions. Feel free to answer and comment even if what you have to say is different from another person's view. You must listen respectfully while others share their view. I encourage you to talk to each other and respond to each other with all respect."

"We are on a first name basis. We are not going to use any names on any document that might be published. Be assured of complete confidentiality."

"We are recording the session and please speak to one person at a time."

"My job is to guide the conversation and keep us on time and finish at the end of 90 minutes. Along the way, I may interrupt or push us a little faster so we can finish on time."

IV. Opening Question (Q1)

"Well, let's begin. Let's find out some more about each other by going around the table. Tell us your name, where and what subjects do you teach and have you attended any training about technology integration in teaching?"

V. Questions

Q2: Let's get started with the questions in our focus group. Anybody can answer. Tell me this: What types of technology do you often use in your classroom?

Q3: Have you ever used Virtual Technology before in your classroom? Please explain your answer.

Q4. What can you say about your experience in using the virtual laboratory application?

Q5. In terms of content, do you find the virtual laboratory useful in doing microscopy? What other topics do you have in mind that can be integrated into VR?

Q6. Can you give something that is enjoyable and stimulating in the virtual lab?

Q7. Will you say that the virtual laboratory is as good as the actual laboratory? Please explain your answer.

Q8. In what age of learners do you recommend the use of virtual reality?

Q9. Do you think the use of VR would overall have a positive effect on students' learning? Please explain.

Q10. If you were to use VR in the classroom, are there any concerns you would have about implementing these technologies?

Q11. Would you be willing to use VR in your classroom if presented with the opportunity? Please explain.

VI. Conclusion

"For the final question, we are going to go around the table. What is the most important thing that has been said, it could be said by you or other members of the group?"

VII. Summary

"We are going to ask _______________ who has been taking notes if she has any questions."

"_______________, if you don't have any questions, can you give us a brief summary or key points that we got."

"Is there anything we missed?"

"That concludes our focus group discussion. Thank you very much for your time."

Appendix N. Raw Data - Validation Results

(VR Use, Self-efficacy and Pedagogical Use Survey)

SUMMARY OF VALIDATION FOR
VR USE, SELF-EFFICACY AND PEDAGOGICAL USE SURVEY

Instruction: Listed below are criteria for evaluating the VR Use, Self-efficacy and Pedagogical Use Survey. This survey will be used to assess teachers' perceptions about VR and their views about its capacity to be used as a teaching and learning tool. Please rate each item by ticking (/) the corresponding equivalent on the four-point scale.

Outstanding	4
Highly Satisfactory	3
Satisfactory	2
Needs Improvement	1

I. Format and Design

	Validators			Mean	SD
	A	B	C		
1. The checklist is clear and readable	4	4	4	**4.00 (Outstanding)**	**0.00**
2. The layout is attractive and uniform	3	3	4	**3.33 (Highly Satisfactory)**	**0.58**
3. The fonts used are comprehensible and appropriate	4	4	4	**4.00 (Outstanding)**	**0.00**
4. The spacing on the pages contributes to the ease of reading and responding	3	4	4	**3.67 (Outstanding)**	**0.58**

II. Language and Style

	Validators			Mean	SD
	A	B	C		
1. The language and style are appropriate	4	4	4	**4.00 (Outstanding)**	**0.00**
2. The language used is consistent	4	4	4	**4.00 (Outstanding)**	**0.00**
3. The checklist is free from grammatical errors	4	4	4	**4.00 (Outstanding)**	**0.00**
4. The sentences are properly constructed and punctuated	4	4	4	**4.00 (Outstanding)**	**0.00**
5. The language used in the checklist are simple and easy to understand	4	4	4	**4.00 (Outstanding)**	**0.00**

III. Content

	Validators			Mean	SD
	A	B	C		
1. The facets are factual and objective	4	4	4	**4.00 (Outstanding)**	**0.00**
2. The facets are free from ideological, sexual, and racial bias	4	4	4	**4.00 (Outstanding)**	**0.00**
3. The facets reflect actual teaching situations	4	4	4	**4.00 (Outstanding)**	**0.00**
4. The choices for each facet are independent and do not overlap.	4	4	4	**4.00 (Outstanding)**	**0.00**
5. The facets are sound, convenient, useful and proper for VR Use, Self-efficacy and Pedagogical Use survey	4	4	4	**4.00 (Outstanding)**	**0.00**

Comments and Suggestions:

- The choices must at least be indented from the main question

Appendix O. Raw Data - Validation Results (FGD Questionnaire)

SUMMARY OF VALIDATION FOR FGD QUESTIONNAIRE

Instruction: Listed below are criteria for evaluating the FGD Questionnaire. The tool consists of 10 open-ended questions that were based on the VR Use, Self-efficacy and Pedagogical Use Survey adapted from Cooper et. al. (2019). The FGD Questionnaire will be used to further assess teachers' perceptions about VR and their views about its capacity to be used as a teaching and learning tool. Please rate each item by ticking (/) the corresponding equivalent on the four-point scale.

Outstanding	4
Highly Satisfactory	3
Satisfactory	2
Needs Improvement	1

I. Language and Style

	Validators			Mean	SD
	A	B	C		
1. The language and style are appropriate	4	4	4	**4.00 (Outstanding)**	**0.00**
2. The language used is consistent	4	4	4	**4.00 (Outstanding)**	**0.00**
3. The checklist is free from grammatical errors	4	4	4	**4.00 (Outstanding)**	**0.00**
4. The sentences are properly constructed and punctuated	4	4	4	**4.00 (Outstanding)**	**0.00**
5. The language used in the checklist are simple and easy to understand	4	4	4	**4.00 (Outstanding)**	**0.00**

II. Content

	Validators			Mean	SD
	A	**B**	**C**		
1. The facets are factual and objective	4	4	4	**4.00 (Outstanding)**	**0.00**
2. The facets are free from ideological, sexual, and racial bias	4	4	4	**4.00 (Outstanding)**	**0.00**
3. The facets reflect actual teaching situations	4	4	4	**4.00 (Outstanding)**	**0.00**
4. The choices for each facet are independent and do not overlap.	4	4	4	**4.00 (Outstanding)**	**0.00**
5. The facets are sound, convenient, useful and proper for VR Use, Self-efficacy and Pedagogical Use survey	4	4	4	**4.00 (Outstanding)**	**0.00**

Comments and Suggestions:

- May I suggest to add this question, "Have you attended any training/seminar about technology integration in teaching?" This will help as your springboard prior asking them about VR.

Appendix P. Raw Data - Validation Result (The Cell)

Content Validation of The Cell Virtual Laboratory Sheet

(Adapted and Modified from Torrefranca, 2017)

Rubrics on Content Validation of The Cell Virtual Laboratory Sheet

Points / Descriptive Rating

5 – Excellent	The item is very evident on the developed material
4 – Very Good	The item is evident on the developed material
3 – Good	The item is evident but needed minimal revision (Please suggest needed revision / write the necessary question)
2 – Fair	The item is evident but needed major revision (Please suggest needed revision / write the necessary question)
1 – Poor	The item is not evident (Please suggest needed revision / write the necessary question)

Aspects	Items	Validators			Mean	SD	% Agreement	Remarks
		A	B	C				
1. Objectives	1. The objectives are clearly stated in behavioral form.	5	5	5	**5.00 (Excellent)**	**0.00**	0	• Include "measures of success" for the objectives (example, Describe the differences between

								prokaryotic and eukaryotic cells by ________) tell how how would you know that the students were able to understand and grasp the skills from this objective. • Provide a clause to make it measurable: At the end of this virtual laboratory activity, 85% of students should be able to...
	2. The objectives are specific, measurable and attainable.	5	5	4	**4.67 (Excellent)**	**0.58**	1	
	3. The objectives are relevant to the topic.	5	5	5	**5.00 (Excellent)**	**0.00**	0	
	4. The objectives take into account the needs of the students.	5	5	5	**5.00 (Excellent)**	**0.00**	0	
2. Content	1. The content of the laboratory activity is directly relevant to the defined objectives.	5	5	5	**5.00 (Excellent)**	**0.00**	0	
	2. The content of the laboratory activity is	5	5	5	**5.00 (Excellent)**	**0.00**	0	

	simple and easy to understand.							
	3. The laboratory activity is suited for the level of the students.	5	5	5	**5.00 (Excellent)**	**0.00**	0	Will the students be able to zoom in and out the cell structure? some distinguishing features must be properly observed to determine the type of cell.
	4. The laboratory activity is free from content and typographical errors.	5	5	5	**5.00 (Excellent)**	**0.00**	0	
3. Formant and Language	1. The format/layout is well-organized, which makes the lessons more interesting.	5	5	4	**4.67 (Excellent)**	**0.58**		Properly written Retype the text in the text box under introduction section. Resize the illustration in the procedure part B. Maximize the space. Change the illustration in the Data or observation section (Part A) that is labeled as "enlarged". It does not appear as microbe. Please find a better illustration.

								Enlarge the illustrations in the Data and Observation (Part B) from 1 to 4 and provide the total magnification below the pictures. "Total Magnification = 400x"
	2. The language used is easy to understand.	5	5	5	**5.00 (Excellent)**	**0.00**		
	3. The language used is clear, concise and motivating.	5	5	5	**5.00 (Excellent)**	**0.00**		
	4. The instructions are concise and easy to follow.	5	5	5	**5.00 (Excellent)**	**0.00**		
4. Presentation	1. The laboratory activity is presented in a logical and sequential order.	5	5	5	**5.00 (Excellent)**	**0.00**		Seemless transition from the pro and eukaryotic cells to the animal and plant cell
	2. The laboratory activity is presented in a unique and original form.	5	5	5	**5.00 (Excellent)**	**0.00**		
	3. The laboratory activity is presented clearly.	5	5	5	**5.00 (Excellent)**	**0.00**		

	4. The presentation of each laboratory activity is attractive and interesting to the students.	5	5	5	**5.00 (Excellent)**	**0.00**		
5. Utility	1. The laboratory activity will motivate the students to study Plant and Animal Cells	5	5	5	**5.00 (Excellent)**	**0.00**		
	2. The laboratory activity will allow the students to use their time more efficiently.	5	5	5	**5.00 (Excellent)**	**0.00**		
	3. The laboratory activity will develop science process skills of students.	5	5	5	**5.00 (Excellent)**	**0.00**		Digital way of teaching students about cells.
	4. The laboratory activity will serve as a supplementary material that can cater to the needs of the students.	5	5	5	**5.00 (Excellent)**	**0.00**		

Appendix Q. Raw Data - Results of VR Use, Self-efficacy and Pedagogical Use Survey

VR USE, SELF-EFFICACY AND PEDAGOGICAL USE SURVEY
(Adapted from Cooper, et. al., 2019)

RAW DATA

Section 1: Some general information about the participants

	Frequency	Percentage (%)
Male	3	42.86
Female	4	57.14
Total Responses	7	100%

Q3. How many years are you in the teaching profession?

Number of Years in Teaching	Frequency	Percentage (%)
1-3 years	3	42.86
4-6 years	1	14.29
7-9 years	0	0.00
More than 9 years	3	42.86
Total Responses	7	100.00

Q4. What science subjects do you teach? ____

Subjects Taught	Frequency	Percentage (%)
Biology	1	14.29
Physical Science	1	14.29
Earth and Life Science; Physical Science	1	14.29
Biology and Earth and Life Science	1	14.29
Biology and Chemistry	2	28.57
Biology, Earth and Life Science and Physical Science	1	14.29
Total Responses	7	100.00

Section 2: Self-efficacy

Q5. On a scale of 1 (very unconfident) to 7 (very confident), overall, how would you rate your confidence to use digital technologies?

Confidence to Use Digital Technologies	Frequency	Percentage (%)
1- very unconfident	0	0.00
2	0	0.00
3	0	0.00
4	0	0.00
5	0	0.00
6	3	42.86
7- vert confident	4	57.14
Total Responses	7	100.00

Q6. On a scale of 1 (very unconfident) to 7 (very confident), overall, how would you rate your confidence to teach using VR?

Confidence to teach using VR	Frequency	Percentage (%)
1- very unconfident	0	0.00
2	0	0.00
3	1	14.29
4	1	14.29
5	2	28.57
6	3	42.86
7- vert confident	0	0.00
Total Responses	7	100.00

Q7. Have you ever used VR technology?

VR Use Experience	Frequency	Percentage (%)
Yes	4	57.14
No	3	42.86
Total Responses	7	100.00

If your answer is YES to the previous question, please describe your experience in using VR technology

- I was so amazed on how it could make the images from the book look like a real one--something that is moving and able to make sounds.
- I tried VR Box before for a short period of time.
- It imitates the actual set-up. Good for schools that lack equipment.
- Mostly for gaming

Section 3: Perceptions of VR as a learning and teaching tool inclusive of its potential positives, efficacy and concerns or barriers

Q8. Would you be willing to use VR in your classroom if presented with the opportunity?

Willingness to use VR in the classroom	**Frequency**	**Percentage (%)**
Yes	7	100.00
No	0	0.00
Total Responses	7	100.00

Q9. Do you think the use of VR would overall have a positive effect on students' learning?

VR would overall have a positive effect on students' learning	**Frequency**	**Percentage (%)**
Yes	7	100.00
No	0	0.00
Total Responses	7	100.00

If your answer is YES to the previous question, please explain the positive effect of VR on students' learning:

- Since it is technology-based and it is a new experience for them, students will be more interested and motivated to learn.
- Using the VR technology could help students have a deep understanding of the lesson. Thru this, there is a maximum engagement/participation of students. It also gives them a more accurate information about the lesson.
- It will help in learning process by serving as an alternative instructional material especially that lacks a teacher or school.
- The closest thing the students can get to laboratory apparatuses and equipment.
- Since students will not be able to go to school and experience actual laboratory experiments, VR will be a good alternative to achieve similar objectives that we want.
- They can have simulated experience of different places at the comfort of their classrooms
- Students will be more motivated to learn

Q10. Have a look at the possible experiences below, if you were to use VR in the classroom, please rank what you think it would be most useful (1 being most useful) to least useful (4 being least useful).

VR Use Significance	***1- Most Useful***	***2***	***3***	***4 - Least Useful***
Simulate experiences	7 (100%)			
Explore inaccessible locations		4 (57.14%)	3 (42.86%)	
Virtually travel to other countries			3 (42.86%)	4 (57.14%)
Connect with students and people in and outside the school		3 (42.86%)	1 (14.28%)	3 (42.86%)
Total Responses	7 (100%)	7 (100%)	7 (100%)	7 (100%)

Q11. If you were to use VR in the classroom, are there any concerns you would have about implementing these technologies? If so, please describe here:

- I want to know the limits of this learning technology and how to resolve those issues.
- Perhaps it would be the technological tool / VR materials to be used and the readiness of my students in using VR
- I think the do's and don'ts while using it, the time needed to spent on wearing or using this, and the eye condition or problem of the user, in case. Thank you very much! ^^
- The ratio of the equipment to students.
- No concerns for now.
- availability of resources
- Availability of materials

Appendix R. Raw Data - Results of Evaluation Rating Sheet for Non-Print Materials

Evaluation Rating Sheet for Non-Print Materials

(Adapted and Modified from Department of Education (DepEd) Guidelines and Processes for LRMDS Assessment and Evaluation for Localized Materials)

Instruction: *Examine the material carefully and for each evaluation criterion consider the extent to which the resource meets the criteria. Check the appropriate number [with 4 being Very Satisfactory (VS); 3 - Satisfactory (S); 2 -Poor; and 1 – Not Satisfactory]. For a rating below 4, write your comments/justifications on each evaluation criterion. If an evaluation criterion is Not Applicable (NA), the material is rated 3 on said criterion.*

Factor A. Content Quality	Participants							Mean	SD
	A	**B**	**C**	**D**	**E**	**F**	**G**		
1. Content is consistent with topics/skills found in the DepEd Learning Competencies for the subject and grade/year level it was intended.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
2. Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
3. Content is accurate.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
4. Content is up-to-date.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
5. Content is logically developed and organized.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
6. Content is free from cultural, gender, racial, or ethnic bias.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***

7. Content stimulates and promotes critical thinking.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
8. Content is relevant to real-life situations.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
9. Language (including vocabulary) is appropriate to the target user level.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
10. Content promotes positive values that support formative growth.	4	3	4	4	4	4	4	***3.86 (VS)***	***0.38***
TOTAL POINTS:	***40***	***39***	***40***	***40***	***40***	***40***	***40***	***39.86***	***0.38***
Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a check mark on the appropriate circle.	● ~~**Passed**~~ ● Failed								
Comments/ Suggestions: I had a great time learning new things! Thank you!									

Factor B. Instructional Quality	Participants							Mean	SD
	A	**B**	**C**	**D**	**E**	**F**	**G**		
1. Purpose of the material is well defined.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
2. Material achieves its defined purpose.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
3. Learning objectives are clearly stated and measurable.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
4. Level of difficulty is appropriate for the intended target user.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***

5. Graphics / colors / sounds are used for appropriate instructional reasons.	4	3	3	4	4	4	4	***3.71 (VS)***	***0.49***
6. Material is enjoyable, stimulating, challenging, and engaging.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
7. Material effectively stimulates creativity of target user.	4	4	3	4	4	4	4	***3.86 (VS)***	***0.38***
8. Feedback on target user's responses is effectively employed with target user's previous experience.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
9. Target user can control the rate and sequence of presentation and review.	4	3	4	4	4	4	4	***3.86 (VS)***	***0.38***
10. Instruction is integrated.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
TOTAL POINTS:	**40**	**38**	**38**	**40**	**40**	**40**	**40**	**39.43 (VS)**	**0.98**
Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a check mark on the appropriate circle.	● ~~Passed~~ ● Failed								
Comments / Suggestions:									

Factor C. Technical Quality	Participants							Mean	SD
	A	**B**	**C**	**D**	**E**	**F**	**G**		
1. There is complete synchronization of audio with the visuals, if any.	4	3	4	4	4	3	4	***3.71 (VS)***	***0.49***
2. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing.	4	3	4	4	4	4	4	***3.86 (VS)***	***0.38***
3. Visual presentations (non-text) are clear and easy to interpret.	4	3	3	4	4	4	4	***3.71 (VS)***	***0.49***
4. Visuals sustain interest and do not distract user's attention.	4	3	4	4	4	4	4	***3.86 (VS)***	***0.38***
5. Visuals provide accurate representation of the concept discussed.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
6. The user support materials (if any) are effective.	4	3	4	4	4	4	4	***3.86 (VS)***	***0.38***
7. The design allows the target user to navigate freely through the material.	4	4	4	4	4	4	4	***4.00 (VS)***	***0.00***
8. The material can easily and independently be used.	4	4	4	4	4	3	4	***3.86 (VS)***	***0.38***
9. The material will run using minimum system requirements.	4	4	3	3	4	4	3	***3.58 (VS)***	***0.54***
10. The program is free from technical problems.	4	3	4	4	4	3	3	***3.58 (VS)***	***0.54***
TOTAL POINTS:	**40**	**34**	**38**	**39**	**40**	**37**	**38**	**38.00**	**2.09**
Note: Resource must score at least 30 points out of a maximum 40 points to pass this criterion. Please put a check mark on the appropriate circle.	● ~~Passed~~ ● Failed								

Comments / Suggestions: The VR Lab application ran smoothly on my OPPO reno 3 phone as compared to my NOVA 2i, where I experienced difficulty starting the app.

Factor D. Other Findings *(Note down observations about the information contained in the material, where the following errors are found. 4 - Not Present; 3 - Present but very minor; 2- Present and requires redevelopment; 1 - Do not evaluate further)*	Participants							Mean	SD
	A	**B**	**C**	**D**	**E**	**F**	**G**		
1. Conceptual errors.	4	4	4	4	4	4	4	***4.00 (Not Present)***	***0.00***
2. Factual errors	4	4	4	4	4	4	4	***4.00 (Not Present)***	***0.00***
3. Grammatical and / or typographical errors.	4	4	4	4	4	4	4	***4.00 (Not Present)***	***0.00***
4. Other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.).	4	4	4	4	4	4	4	***4.00 (Not Present)***	***0.00***
TOTAL POINTS:	**16**	**16**	**16**	**16**	**16**	**16**	**16**	***16.00***	***0.00***
Note: Resource must score at least 16 points out of a maximum 16 points to	● ~~Passed~~								

pass this criterion. Please put a check mark on the appropriate box	● Failed		
Comments / Suggestions:			

Participant	**Recommendation**
A	I recommend this material for possible use in schools provided that the corrections / revisions included in this report are made.
B	I recommend this material for possible use in schools provided that the corrections / revisions included in this report are made.
C	I recommend this material for possible use in schools provided that the corrections / revisions included in this report are made.
D	I recommend this material for possible use in schools provided that the corrections / revisions included in this report are made.
E	I recommend this material for possible use in schools provided that the corrections / revisions included in this report are made.
F	I recommend this material for possible use in schools provided that the corrections / revisions included in this report are made.
G	I recommend this material for possible use in schools provided that the corrections / revisions included in this report are made.

Appendix S. Deed of Undertaking

DEED OF UNDERTAKING

Between SCIENCE EDUCATION INSTUTUTE (SEI) with office address at Levels 1&2 Philippine Science Heritage Building, DOST Compound, General Santos Avenue, Bicutan, Taguig City and represented herein by its Director, JOSETTE T. BIYO;

And JESSICA LUZ M. BRIGOLA and KEN JOSEPH E. CLEMENTE of legal age, Filipino, and the Project Leaders of the proposal entitled *Project SIGLA: Science classroom Innovation through a Gamified Laboratory Application* at Parañaque National High School (Main)-Senior High School and University of Santo Tomas-Senior High School with address Kay Talise St., Dr. Arcadio Santos Ave., San Dionisio, Parañaque City and España Blvd., Sampaloc, Manila herein referred to as the Project Leaders.

BACKGROUND

1. The Department of Science and Technology (DOST) through the Science Education Institute (SEI) in collaboration with the Department of Education, announced the InnoBox: Search for the Most Innovative teaching and Learning Resources in Science starting September 2017 to December 2018.

2. The Search aims to improve the quality of teaching and learning of science in the public and private elementary and secondary schools nationwide.

3. Specifically, the Search aims to encourage teachers to be innovative/creative/practical in teaching science concepts to improve students' performance in the subject.

4. The Search is open to all public and private schools nationwide. It has the following categories:
   4.1 Grades 3-6
   4.2 Grades 7-10
   4.3 Grades 11-12

5. The Search required the submission of project proposal detailing the innovative teaching and learning material in science, with budget and Gantt Chart.

6. Submitted proposals were evaluated based on the following criteria:
   6.1 Innovativeness/Indigeneity/Originality
   6.2 Alignment with the Curriculum
   6.3 Significance of the Innovation
   6.4 Potential Value to Teaching and Learning

7. Three qualifiers for each category will be given a grant of Php 50,000.00 each to be spent according to the approved budget for the preparation and implementation of the proposed innovative teaching and learning resource.

8. The following criteria will be the basis for evaluating the implementation of the innovative teaching and learning material:
   8.1 Innovativeness/Potential of the teaching and learning resource to bring out

8.3 Versatility (Applicability of use in other fields of science)
8.4 Cost-effectiveness (Adaptability/Replicability/Usability/Practicality)

OPERATIVE PROVISIONS

1. **Interpretation**

1.1 In this Deed, unless contrary intention appears:

Approved Line-Item Budget (LIB) means the budget of the proposed innovation approved by the SEI Director.

Deed of Undertaking means this instrument including any schedules and annexes that stipulates the conduct of the abovementioned proposal to completion.

Financial Report (FR) means the report showing the expenses incurred per item entered in the approved LIB and the balance of said items audited by the Resident Auditor of the school/district. The audited FR must be submitted to SEI right after the completion of the project together with the Technical Report.

Force Majeure Event means a natural and unavoidable catastrophe that interrupts the natural course of events.

Implementer means the science/mathematics teachers who would actually conduct the innovative practices.

Gantt Chart means the schedule of activities submitted with the proposal.

Project Leader means the person who exercises overall supervision and control of the proposed innovation.

Project Team means the individual or group which may be composed of the Project Leader, members and/or School Head who actually conduct the innovative practices.

Proposal means the study submitted to the Search and incorporated into this Deed with title appearing on the first page.

School Head means the person who exercises overall supervision and control of the school.

Search means the project to which the proposals are submitted.

Search Secretariat means the Technical Group at SEI in-charge of planning, coordination and implementation of the project.

SEI Grant means the amount of Php 50,000.00 from the SEI given to the proponents of the qualifying proposals to implement said proposal. The grant is considered liquidated when the COA-audited Financial Report and Technical Report has already been submitted to SEI.

Teaching and Learning Resource means material/s that teachers use to deliver lessons that can support student learning and helps improve students' performance in science

Technical Report (TR) means the final report which the Project Team will write all pertinent information regarding the conduct of the innovations and the effect, if any, on the students' performance in science.

1.2 The Schedule (and annexes and documents incorporated by reference, if any) form part of this Deed. In the event of any conflict or inconsistency between any part of:

(a) the terms and conditions contained in the clauses of the Deed;
(b) the Schedule;
(c) the annexes, if any;
(d) documents incorporated by reference, if any

then the material mentioned in any one of the paragraphs (a) to (d) of this sub-clause 1.2 has precedence over material mentioned in subsequent paragraph, to the extent of any conflict or inconsistency.

2. Undertaking

The Project Team undertakes to:

2.1 Plan teaching/learning and other preparatory activities based on the expected outcomes/results and evidence of assessment;

2.2 Purchase supplies, materials and other goods that are necessary in the implementation of the proposed project as stipulated in the approved line-item-budget (LIB), subject to the usual government and auditing procedures;

2.3 Identify the class, student and teacher participants of the proposed innovations;

2.4 Provide the necessary assistance during the conduct of monitoring and evaluation activities by the Board of Evaluators;

2.5 Conduct the planned implementation of the innovative teaching and learning material in accordance with the submitted proposal and within the search period;

2.6 Submit liquidation and accomplishment reports of the proposed project.

3. Terms of This Deed

3.1 This Deed commences on the date of its signing and expires on December 2018.

4. Reporting

4.1 The Project Leader must submit to the Search Secretariat the following:

4.1.2 COA-Verified financial report must be submitted to Search Secretariat a month after the completion of the Search or in the absence of an auditor from COA, all supporting documents regarding purchases made from the financial grant be submitted to SEI. These documents include approved (by the School Head) Purchase Requests, official receipts, and Invoice Receipt for Property (IRP).

5. Force Majeure

5.1 If the Project Leader is unable to perform or is delayed in performing an obligation under this Deed which inability or delay is caused by or which arises or results from a Force Majeure Event, that obligation is suspended but only so far and for so long as it is affected by the Force Majeure Event.

5.2 The Project Leader must take all necessary actions to avoid, remove or limit the effects Force Majeure Event on its performance of the suspended obligation as soon as reasonably possible.

6. Notification of Force Majeure Event

6.1 If the Project Leader is unable to perform or is delayed from performing the innovations (or any part of the innovations) by reason of or arising from a Force Majeure Event, Project Leader must notify the Search Secretariat as soon as practicable of the Project Leader's inability to perform or of the delay in performing the innovations (or any part of the innovations) including:

6.6.1 Details of the Force Majeure Event;

6.6.2 The day on which the Force Majeure Event commenced to have an effect on the Project Leader's performance of the innovations (or any part of the innovations); and

6.6.3 Actions, if any, the Project Leader proposes to take to recommence the performance of the innovations (or any part of the innovations).

7. Remedies

7.1 The SEI acknowledged that the Project Leader has entered into this Deed on a voluntary basis. Any right that the SEI has under this Deed is limited to specific performance of this Deed by the proponents. Nothing in this Deed gives SEI any right to seek compensation from the proponents for damages or loss, whether on the SEI's own behalf or on behalf of another party.

8. Entire Agreement

8.1 This Deed constitutes the entire agreement of the parties about its subject matter and supersedes all previous agreements, understandings and negotiations on that subject matter.

JESSICA LUZ M. BRIGOLA

Professional Teacher

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Dedicated professional teacher with over 8 years of experience in helping students discover and reach their full potential. Graduated from Philippine Normal University with the degree Bachelor of Science in Biology for Teachers. Possesses the talent to bring classroom to life with real-world examples and innovative technology. Encouraging educator who offers various ways of positive reinforcement and meaningful learning environment.

Teaching Experience

- **Science Teacher,** Hunter Huss High School, Gastonia, North Carolina, USA, January 2021 - Present
- **Science Teacher**, Parañaque National High School – Main, Senior High School, June 2016 – December 2020
- **Science Teacher**, Parañaque National High School – La Huerta Annex, June 2014 – Present
- **Science Teacher**, Ann Arbor Montessori, Grade 3 and 4, June 2013 – March 2014

Education

Philippine Normal University – Manila, 2014 – 2022

- Master of Arts in Education Major in Curriculum and Instruction

Philippine Normal University – Manila, April 2013

- Bachelor of Science in Biology for Teachers, GPA: 89.90

Arellano University – Jose Abad Santos Campus, Pasay City, 2009

- Secondary, graduated Salutatorian

Baclaran Elementary School Central – Parañaque City, 2005

- Primary, graduated with honors

Awards and Recognition

- **National Finalist – Most Outstanding Innovative Teaching Material in Science .** DOST Innobox Competition. December, 2018
- **Outstanding Teacher in Science.** Senior High School Level. October 5, 2018
- **Top Teacher .** Quipper Video. August 25, 2017, 1st Quarter. November 24, 2017, 2nd Quarter

Membership:

- **Vice President - Biology Teachers Association of the Philippines – PNU Chapter**
  Member since 2015