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Development and Acceptability of Virtual Laboratory in Learning Systematics

Arnolfo Jade Ryan N. Sison, Jason M. Bautista, Janine L. Javier, Renee Juselle B. Delmonte, Rizalyn B. Cudera*

Sultan Kudarat State University, EJC Montilla, Tacurong City, Philippines
*Correspondence: E-mail: arnolfojaderyansison@sksu.edu.ph

ABSTRACT

Virtual laboratory increases learning engagement and may be illustrated through the use of technology and animation media, making it simpler for students to learn and acquire knowledge. This study aimed to develop a Virtual Laboratory In Learning Systematics (ViLIS) website utilizing the Analysis, Design, Development, and Evaluation (ADDE) that would provide users with an array of different interactive activities in various concepts covered in the subject biology in the topic systematics specifically on insects, and provide additional instructional material for teachers. This quantitative study also determined the acceptability level of the developed virtual website. The level of acceptability of the developed virtual laboratory was evaluated by science students and teachers/IT experts based on content, technical, and instructional qualities. The overall results showed that ViLIS satisfied the quality components with an interpretation of "Very High Quality". It is recommended to conduct an intervention to strengthen the feasibility and effectiveness of the created virtual laboratory.

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1. INTRODUCTION

Laboratory activities are an important pedagogical strategy for acquiring competencies in science education, making learners understand through a practical approach the theoretical topics taught in the classroom (Paredes-Labra *et al*., 2018). However, the rise of a global pandemic due to the COVID-19 outbreak caused the closure of schools worldwide (Dhawan, 2020). At the same time, it has been necessary to think about appropriate alternatives to provide training in the laboratory and to adopt digital content and formats within didactic curricula to overcome this situation (Gamage *et al*., 2020). A solution to this issue can be found in the adoption of virtual laboratories, which would allow the creation of virtual practical activities that can simulate the processes and actions that take place in physical laboratories (Ahmad, 2010). Furthermore, this alternative learning through virtual laboratories can positively affect students' science process skills, which would allow them to also develop their science knowledge (Carlone & Johnson, 2007).

In the study by Ramadhan, the use of virtual laboratories can enhance students' scientific attitudes, thinking abilities, and skills, including problem-solving, critical thinking, creativity, conceptual understanding, science process skills, lab skills, motivation, interest, perception, and learning outcomes (Tatli & Ayas, 2013).

Stated that the interactive instructional material's goal is to help students visualize abstract concepts thus interactive multimedia should be designed to make learning more engaging and may be visualized through examples such as the use of technology and animation media, making it easier for students to learn and gain knowledge (Al Balushi *et al*., 2016). Moreover, it has been used in many universities and schools around the world to keep up with the technological development we are witnessing in the digital age, which is reflected in various forms in the fields of distance learning and e-learning (Barth & Burandt, 2013).

In the Philippines, common problems in schools are the lack of essential and modern equipment in their science laboratories and a lack of facilities. As a consequence, it limits the students to performing simple laboratory activities. Since working in a science laboratory creates interactive learning that expands our knowledge of science concepts, the use of virtual laboratories enables students to see the experiment design and perform the experiment on computers, laptops, and mobile devices (Hassan *et al*., 2012).

Finally, virtual labs are one of the most important applications of e-learning. As it provides a virtual learning and teaching environment that aims to develop the practical skills of the students (Potkonjak *et al*., 2016). And since they are available through the Internet, the student can conduct many experiments without being restricted to a specific location or specific times, as is the case when using real laboratories. This is a good alternative method of assisting pupils with their ignorance of science subjects, particularly in biology class on the topic of systematics. Concerning the aforementioned studies, we formulated a study that aimed to develop a virtual laboratory in systematics, specifically on insects (Insecta) including beetle (Coleoptera), butterfly and moth (Lepidoptera), and dragonfly (Odonata), and to evaluate the created Virtual Laboratory in Learning Systematics (ViLIS) in terms of content, technical, and instructional qualities.

This study was conducted in the College of Health Sciences and the College of Teacher Education. The findings of this study can be added to the body of knowledge in basic and higher education, particularly in science education (Bhardwaj, 2016; Valderrama-Hernandez *et al*., 2020). It would also provide additional instructional materials online as a tool for teachers in delivering instruction in a flexible and effective learning environment, especially when conducting laboratory activities amidst the COVID-19 pandemic.

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Generally, this study aimed to develop a virtual laboratory activity in learning systematics for science students. Specifically, this study sought to answer the following questions:

(i) What is the level of acceptability of students and teachers/IT experts of the developed virtual laboratory website in terms of Content Quality, Technical Quality, and Instructional Quality.

(ii) What is the level of acceptability of general/mean rating scores of students and teachers/IT experts of the developed virtual laboratory website in terms of Content Quality, Technical Quality, and Instructional Quality.

The findings of this study on the development of virtual laboratory website in learning systematics will provide significant information that will benefit the following:

(i) Educational Institutions. The result of this study will help the institution provide a virtual laboratory experience to students without any constraints on time and place, as well as provide information to help improve the methods of teaching and learning strategies of teachers, resulting in an effective learning process (Redha, 2010).

(ii) Administrators. The outcome of this study will help them to stipulate a virtual laboratory for students' learning. It will also suggest adopting and practicing both laboratory settings as part of learning instruction in line with the university's mission, which is to primarily provide advanced instruction in science, technology, and education.

(iii) Teachers. The result of this study will help teachers improve their teaching styles and increase their teaching performance, provide quality education in a flexible and effective environment, particularly in conducting experiments virtually that can easily explain the theoretical concepts to gain knowledge and motivate students as well.

(iv) Students. The findings will help the students improve their learning in discovering and exploring science through a conducive learning environment on an online website. This also gives them more room to have a virtual laboratory experience that will help them practice their skills virtually.

(v) Future Researchers. The results of this study will serve as a reference for other researchers researching studies similar to this, and they can use this study as a tool for further improvement.

This study was limited to developing a virtual laboratory in systematics, specifically on insects (Insecta) including beetle (Coleoptera), butterfly and moth (Lepidoptera), and dragonfly (Odonata). The level of acceptability was evaluated in terms of content, technical, and instructional qualities by the science students from Bachelor of Science in Nursing students and Bachelor of Secondary Education major in science.

2. THEORETICAL AND CONCEPTUAL FRAMEWORK

The study is supported by different theories that would strengthen the foundation of the research including the Diffusion Innovation Theory of Everett Rogers, the Cognitive Theory of Multimedia Learning of Richard Mayer, and the Self-Determination Theory of Edward Deci and Richard Ryan. This combination of theories was considered to address the elements used in the development of virtual laboratories used in this research (Wästberg *et al*., 2019). The Diffusion Innovation Theory is a perception in technological innovations, it is measured quantitatively by the constructs namely relative advantage, compatibility, complexity, trialability, and observability.

A virtual laboratory is designed to become user-interactive content-rich material that provides an actual feel of laboratory experience (Achuthan *et al*., 2017). Richard Mayer's Cognitive Theory of multimedia learning proposed that in a virtual laboratory, the use of

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words, pictures, simulation, and motion pictures can improve students' perception of abstract science concepts (Campos *et al*., 2020). On the other hand, Self-Determination focuses on the motivational development of learners by acquiring the needs of autonomy, competence, and relatedness.

The conceptual framework for the research was structured using the Input – Process – Output, or IPO model for a quantitative study **(Figure 1)**. The model is a process viewed as a series of boxes (processing elements) connected by inputs and output (Zajko & Brada, 2018).

The Input of this study contained the Analysis, Pilot testing conducted by We using the acceptability components (content, technical, and instructional quality), and We training using wix.com in developing a virtual laboratory website. The Process of this study involved the Development of the Virtual laboratory in Learning Systematics (ViLIS). The Output of this study was the ViLIS and evaluation data of ViLIS.

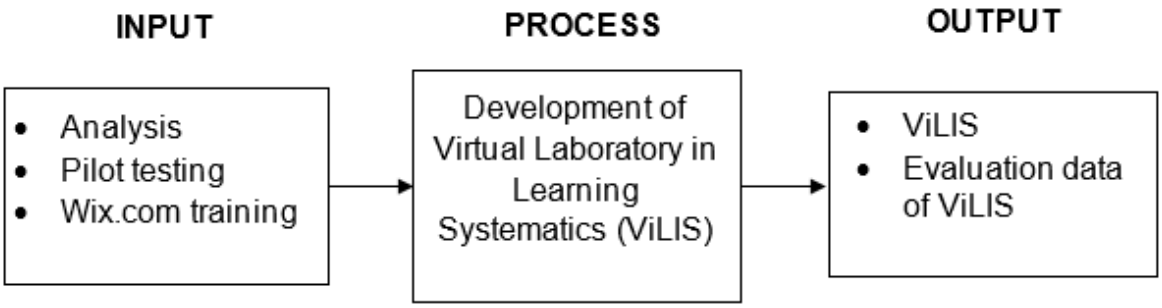

Figure 1. The IPO model of the research.

For clarity and a better understanding of the readers, the following terms are defined according to how they are used in the study.

(i) Virtual Laboratory – a computer-based activity where students interact with an experimental apparatus or other activity via a computer interface (Sarabando *et al*., 2014). It is a learning environment composed of graphics, texts, videos, and assessments developed by We as an interactive tool for learning in a biology class with a systematics topic, and it is considered as the process in this study.

(ii) Systematics – a branch of biology concerned with organism classification systems and nomenclature and studies the distinctive characteristics of species and how they are related to other species over time, which is used by researchers as learning content for the created virtual laboratory website.

(iii) Content Quality – one of the quality components adopted and modified by We to validate the quality of content of the developed virtual laboratory website (ViLiS), an instructional material in learning systematics with emphasis on insects.

(iv) Technical Quality – one of the quality components adopted and modified by We to validate the technical quality of the developed virtual laboratory website (ViLiS), including navigation, layout and design, graphics, etc.

(v) Instructional Quality – one of the quality components adopted and modified by We to validate the instructional quality of the developed virtual laboratory website (ViLiS).

(vi) Website – a set of linked web pages and commonly used tools for knowledge mobilization for research projects and labs. We used wix.com to design, create, manage, and develop the Virtual Laboratory in Learning Systematics (ViLIS).

(vii) ADDIE Model – this model is an approach that helps We to create an efficient, effective teaching design by applying the processes of the ADDE (Analyze, Design, Develop, Evaluate) stages for technology-based teaching.

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3. METHODS

This paper contains the research design and methodology that was used in the conduct of this study. It incorporates the locale and respondents of the study, sampling technique, research instrument, data-gathering procedure, and statistical tools.

3.1. Research Design

This quantitative study gathered and analyzed data about the statement of the problem using a descriptive developmental design. The descriptive developmental method is the systematic study of designing, developing, and carefully evaluating instructional programs, processes, and products that must meet internal consistency and effectiveness standards.

The development and validation of the Virtual Laboratory in Learning Systematics (ViLIS) utilized Research and Development (R&D). Studies have shown that R & D is useful in conducting studies that involve the production of teacher supplementary materials such as laboratory manuals, workbooks, modules, and other instructional materials. We used the ADDIE (Analyze, Design, Develop, Implementation, and Evaluation) model for the evaluation of the developed virtual laboratory website. However, the research was only carried out at the ADDE stage due to time constraints. The ADDIE model serves as the basis for over 100 instructional design models today. The developed virtual laboratory was assessed in terms of its acceptability **(Figure 2)**.

ADDIE model is one of the most common models used in the instructional design field as a guide to producing an effective design. This model is an approach that helped We create an efficient, effective teaching design by applying the processes of the ADDE model. In addition, this systematic process is represented in the acronym ADDIE, which stands for the important components in the process of creating the instructional design, which are Analysis, Design, Development, Implementation, and Evaluation. Each phase in the ADDIE model is related to and interacts with each other. The details on how the ADDE model was adopted for the design of the developed virtual laboratory website were illustrated in **Figure 2**.

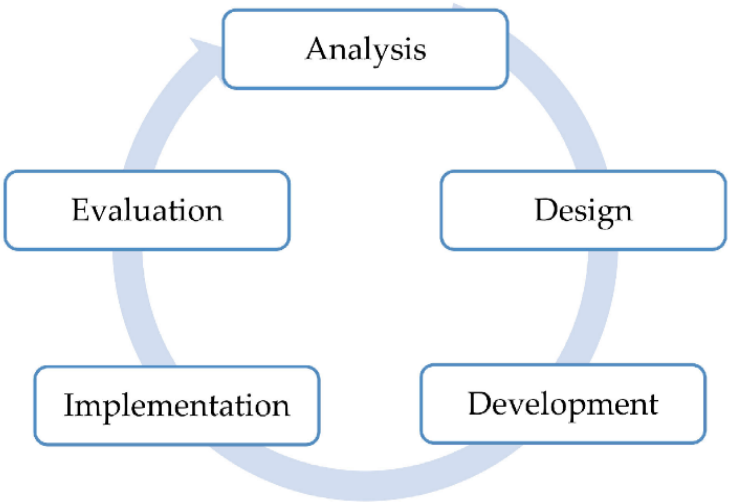

Figure 2. The ADDIE (analyze, design, develop, implement, and evaluate) model.

3.1.1. Analysis

At this stage, all the variables that need to be considered when designing the virtual laboratory website, such as the instructional goals and objectives, were established, and the learner's characteristics and the resources available were determined as follows:

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(i) We created interactive activities based on various concepts covered in the subject biology in the topic systematics, specifically on insects (Insecta) such as beetles (Coleoptera), butterflies and moths (Lepidoptera), and dragonflies (Odonata), to improve students' understanding of species concept and variation, taxonomic characters, and classification.

(ii) The characteristics of the study participants were determined, and a total of 100 BSED-Science students pilot tested the developed virtual laboratory. A sample of 145 students from the 1st year to 4th year of Bachelor of Science in Nursing and Bachelor of Secondary Education major in science students, and 5 science teachers/IT experts, performed the final evaluation of the developed Virtual Laboratory in Learning Systematics (ViLIS).

(iii) Content Analysis: The content of the created virtual laboratory website was analyzed from the syllabus of Bachelor of Science in Biology in the subject Biology with a topic Systematics (Son, 2016). The website consisted of four lessons: Species Concept and Speciation, Variation of Species, Some Basic Principles of Classification, and Taxonomic Characters, with emphasis on insects, including beetle, butterfly and moth, and dragonfly. Additionally, ViLIS placed emphasis on the data generated during the NRCP-funded project: Insect Fauna of Lake Holon, Mt. Parker Range, Tboli, South Cotabato, and Ethno-entomological Knowledge of the Tboli Ethno-linguistic Groups. This study was implemented by Sultan Kudarat State University in collaboration with the University of Mindanao and Davao Oriental State University from 2018-2022.

3.1.2. Design

Following the analysis phase, the researcher, conceptualized the outline of the material and how to integrate interactive activities and user-friendly features in the design phase. The parts of the lesson were also predetermined based on the BS-Biology syllabus. Considering the various concepts covered in the subject of biology in the topic of Systematics.

The researchers, together with their adviser, drafted the content of the data generated from the aforementioned study and various resources in the form of short videos. We have also looked for appropriate and interesting visuals and educational background music sourced from Google Images and YouTube to grab the attention of students (Zaid & Alabi, 2021).

At this level, we assessed the possible tools for the development of ViLIS. The tool includes the use of Adobe Photoshop CC and the CapCut application in laying out the cover, designing the content, creating video presentations, and using wix.com for publishing the materials online.

3.1.3. Development

The development phase included the writing of lessons, activities, and exercises and the editing of instructional videos. The development involves creating an organization of the actual learning material to be used in the supervision. The construction of the content of ViLIS was done with the use of the course syllabus as a guide. The flow of the content of the website was based on the identified parts of the researchers.

The media elements, such as the background and insect characters, were created to effectively convey the learning content to the intended users using Adobe Photoshop CC. The creation of video lessons by We was done using the CapCut application to produce quality video content and was checked by their research adviser. The video was uploaded to YouTube and embedded in the website. Highlighted the demand for engaging multimedia content like animated instructional videos in the modern age of education. This is significant for

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performing the functions of presenting complex information and capturing student interest in the learning process (Brickhouse, 2001). The developed virtual laboratory was then submitted to the evaluators, specifically the science teachers for validation and feedback as shown in **Tables 1, 2, and 3**. The quantitative ratings of the try-out group were carefully considered in the refinement of the ViLIS. The suggestions received may be used to evaluate and update the course as per expectations.

3.1.4. Evaluation

The final process in the ADDIE model is the evaluation phase. This phase was reviewed to ensure that the instructional design and content satisfied the objectives based on BS-Biology Syllabus. The developed virtual laboratory website (ViLIS) was evaluated by the students via a Google form to test the level of acceptability in terms of content, technical, and instructional qualities using a 5-point Likert rating scale. The information gathered, such as corrections and suggestions from the respondents, would be used as a guide for re-designing or improving the website. They also thought that this type of learning was interactive, comprehensive, and innovative, as shown in their comments:

"They did a great job with providing very interactive, comprehensive, and innovative learning resources." – Student A

"The website created is fun to explore and provides new knowledge in regards to the topics presented." – Student B

"The website is easy to navigate and has good teaching-learning materials that are accessible to teachers and students." – Teacher A.

3.2. Location of the Study

This study was conducted in the College of Health Sciences and College of Teacher Education of Sultan Kudarat State University (SKSU) located at EJC Montilla, Tacurong City, Sultan Kudarat, Mindanao, Philippines. (6.67°N 124.63°E) **Figure 3**. SKSU is a State University in the province of Sultan Kudarat, Mindanao, Philippines. There are seven campuses within the province of Sultan Kudarat and the center central site services (ACCESS) main campus is located in EJC Montilla, Tacurong City, Sultan Kudarat, Philippines. Formerly called Sultan Kudarat Polytechnic State College, it was elevated to university status in 2010. SKSU provides instruction in science and technology, agriculture, fisheries, and education. It also undertakes research and extension services.

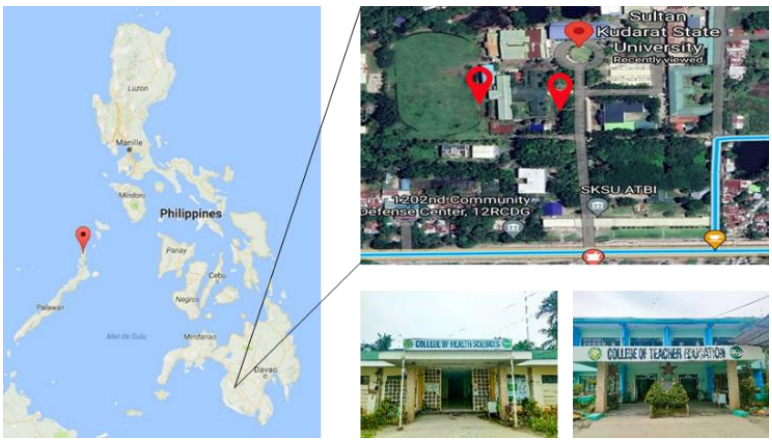

Figure 3. Map of sultan kudarat state university – ACCESS campus showing the college of health sciences and college of teacher education marked by red location tag (courtesy to google earth).

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3.3. Respondents of the Study

To determine the level of acceptability of the developed virtual laboratory website in learning systematics, a total of 145 students were randomly selected from the Bachelor of Science in Nursing and Bachelor of Secondary Education majoring in science from 1st year to 4th year who had already taken a biology class at the Sultan Kudarat State University-ACCESS campus. Hence, this study used the population of students for the academic year 2022-2023. As for teachers and IT experts, a total of five (5) were selected based on their teaching experience in biology. On the other hand, IT experts were determined based on their background in educational technology, as evidenced by their practice and training in technology and learning. Overall, the study was composed of 150 respondents.

3.4. Sampling Techniques

We used the simple random sampling technique for the evaluation of students of the developed Virtual Laboratory in Learning Systematics (ViLiS), which has a total population of 145. A simple random sample is a randomly selected subset of a population.

In this sampling method, each member of the population in this study has an exactly equal chance of being selected as a respondent who is officially enrolled in science courses at the Sultan Kudarat State University-ACCESS campus in the academic year 2022-2023. On the other hand, a total of five (5) teachers/IT experts were chosen purposively by We to evaluate the ViLIS. The selected respondents served as the source of primary data due to the nature of the research design, aims, and objectives of the study.

3.5. Data Gathering Instruments

In evaluating the created virtual laboratory, the Virtual Laboratory Development Evaluation was used. Three factors were considered in the tool, namely: (a) Content Quality (8 items); (b) Technical Quality (7 items); and (c) Instructional Quality (8 items). These were rated by the evaluators after validation using the scale and description **(Tables 1, 2, 3, and 4).**

Table 1. Evaluation sheet of the content qualities of the developed virtual laboratory in learning systematics.

Content quality	**SA** **5**	**A** **4**	**NAD** **3**	**D** **2**	**SD** **1**
1. The content is scientifically adequate and accurate.					
2. It emphasizes active learning.					
3. It is well organized.					
4. It is relevant to learning objectives.					
5. It helps students build strong ideas.					
6. It allows the development of multiple intelligences.					
7. The topics are interesting.					
8. The contents are free of ethnic, gender, and other stereotypes.					

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Table 2. Evaluation sheet of the technical qualities of the developed virtual laboratory in learning systematics.

Technical quality	SD 1	D 2	NAD 3	A 4	SA 5
1. The website is easy to navigate.					
2. The graphics are excellent.					
3. The layout and design are appropriate.					
4. The navigation for buttons is comprehensive and direct.					
5. The website runs quickly with minimum wait time.					
6. Intended users can easily and independently use the website.					
7. The website is aesthetically pleasing.					

Table 3. Evaluation sheet of the instructional qualities of the developed virtual laboratory in learning systematics.

Instructional quality	SA 1	A 2	NAD 3	D 4	SD 5
1. It provides feedback on the correctness of the student's answers.					
2. It is of high educational value.					
3. It is a good supplement to the curriculum.					
4. It addresses the needs and concerns of the students.					
5. The instructional material facilitates collaborative and interactive learning.					
6. It integrates students' previous experiences.					
7. It reflects the current trend in Systematics instruction.					
8. The graphics and colors used are appropriate for instructional objectives.					

Table 4. Rating scale with its description for the development of Virtual laboratory.

Scale	Range of mean	Description	Interpretation
5	4.21 - 5.00	Strongly Agree	Very High Quality
4	3.41 - 4.20	Agree	High Quality
3	2.61 - 3.40	Neither Agree Nor Disagree	Fair Quality
2	1.81 - 2.60	Disagree	Poor Quality
1	1.00 - 1.80	Strongly Disagree	Very Poor Quality

For the reliability test of the instrument, we conducted a final evaluation with the science students of Sultan Kudarat State University-ACCESS Campus who met the inclusion criteria of the study. The reliability result of the instrument was analyzed using Cronbach Alpha (coefficient alpha) **(Table 5)** with an average of 0.884, measuring the internal consistency of the instrument as "Good" as shown in **Table 5**.

It was also specified in the last part of the questionnaire that all data were treated confidentially and generally analyzed. No result bore one's identity for Data Privacy.

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Table 5. Cronbach alpha for the level of acceptability of the developed virtual laboratory in learning systematics (ViLIS) gathered from students.

Cronbach's alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.7$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

3.6. Data Gathering Procedures

In conducting the study, a permission to conduct letter was sent to the Office of the Dean of the College of Health Sciences and the College of Teacher Education. Following approval, the 1st year to 4th year students of Bachelor of Science in Nursing and Bachelor of Secondary Education major in Science of Sultan Kudarat State University-ACCESS Campus were notified. On the other hand, teachers/IT experts were selected by We purposively. Then, the date of the conduct was arranged. We sent the link to the virtual lab to the respondents for exploration of the website. After the exploration was completed, we administered an online evaluation of the developed virtual laboratory in learning systematics in terms of content, technical, and instructional quality through a Google Form to its respondents to gather the data needed. During the conduct of the study, the respondents' anonymity and their responses were secured under Republic Act No. 10173, also known as the Data Privacy Act of 2012, which protects the fundamental human right of privacy, and communication while ensuring the free flow of information to promote innovation and growth. The data generated from their evaluation was also treated with full confidentiality. The website exploration started on December 15-22, 2022. We tallied the results for analysis and interpretation of the responses. Statistical analysis was employed, and the mean, overall mean, and standard deviation were determined and interpreted using the 5-point Likert Scale with the assistance of a statistician for valid and reliable results.

3.7. Statistical Analysis

The mean, overall mean, and standard deviation were the statistical tools used in evaluating the developed virtual laboratory in systematics in terms of content, technical, and instructional qualities **(Figure 4).**

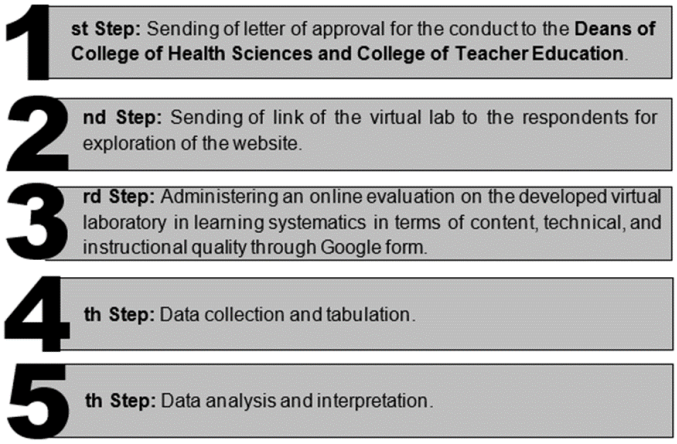

Figure 4. The flow of data gathering procedure. SKSU.2021.

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4. RESULTS AND DISCUSSION

This section presents the data gathered, the results of the statistical analysis, the findings, and the discussion of the study. This will also provide answers to the study's specific research problem. This study seeks to determine the level of acceptability of the developed virtual laboratory website in learning systematics in terms of Content, Technical, and Instructional Qualities.

4.1. Description of the ViLIS

The virtual laboratory included instructional videos, activities, and guide questions and was built on a cloud-based web development platform (wix.com), an easy-to-use tool that allows users to quickly create an online presence through drag-and-drop interaction and hassle-free coding (Ali, 2020).

The virtual laboratory website can be accessed using the given link: https://virtuallaboninsect.wixsite.com/vilis that contains a menu: the home page, the systematics, and the about, as shown in **Figure 5**. The home page featured the title "Virtual Laboratory in Learning Systematics," a description of the virtual laboratory, featured videos of researchers, and a get started button that led to the website's systematics page, as shown in **Figure 5** (a). The Systematics includes various pages such as Lessons 1, 2, 3, and 4, as shown in **Figure 5** (b). Each lesson is composed of an instructional video, objectives, an activity, guide questions, and references, as shown in **Figures 6, 7, 8, and 9**. The About page contained the ViLIS teams' profiles and information about the virtual laboratory, as shown in **Figure 5** (c).

Figure 5. The menu of the virtual laboratory in learning systematics (ViLIS) composed (a) homepage, (b) systematics, and (c) about.

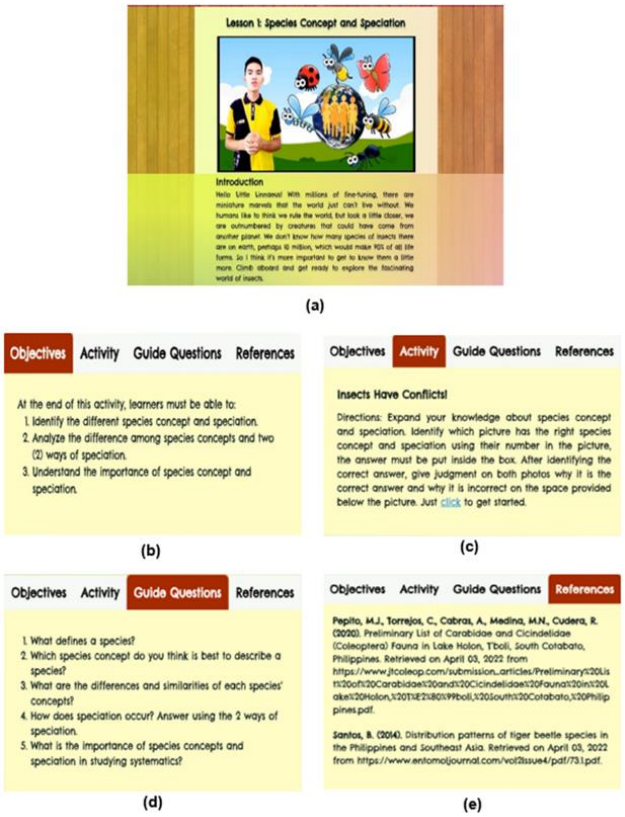

Figure 6. Lesson 1 composed of an (a) instructional video, (b) objectives, (c) activity, (d) guide questions, and (e) references.

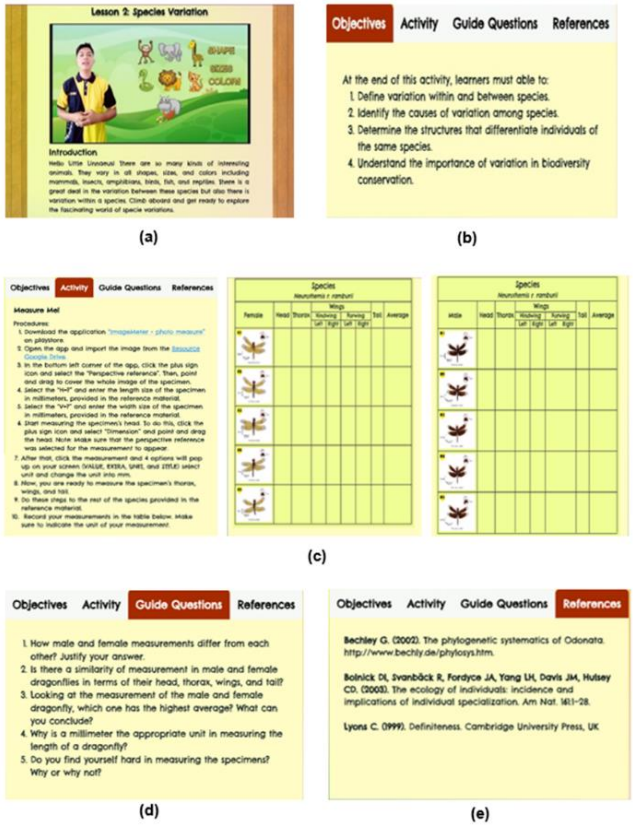

Figure 7. Lesson 2 composed of an (a) instructional video, (b) objectives, (c) activity, (d) guide questions, and (e) references.

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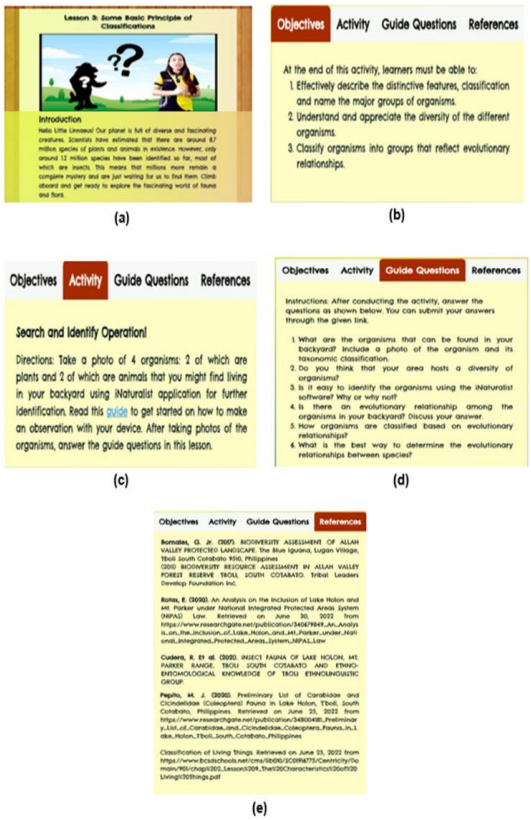

Figure 8. Lesson 3 composed of an (a) instructional video, (b) objectives, (c) activity, (d) guide questions, and (e) references.

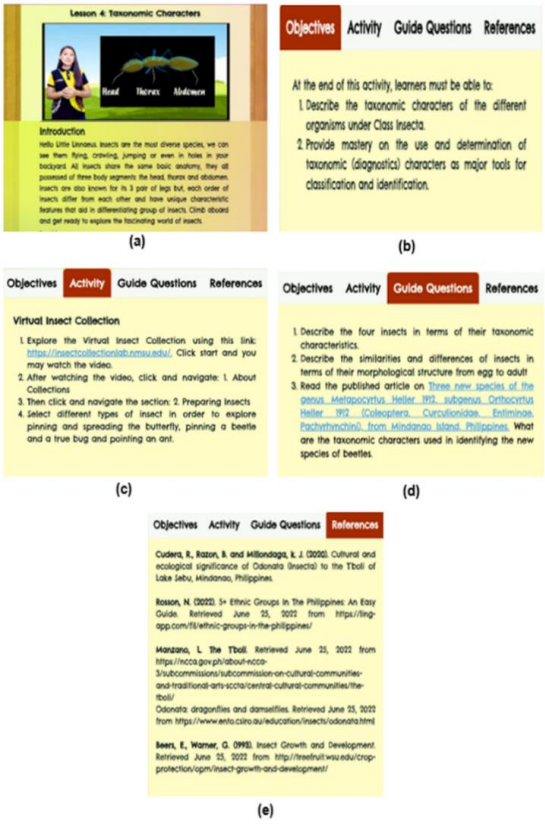

Figure 9. Lesson 4 composed of an (a) instructional video, (b) objectives, (c) activity, (d) guide questions, and (e) references.

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4.2. Students' Evaluation of ViLIS

This section presents the evaluation of students of the developed virtual laboratory in terms of Content, Technical, and Instructional Qualities.

Table 6 shows the level of acceptability of the developed virtual laboratory website in terms of content quality, technical quality, and instructional quality as gathered from students. Based on the results, the content quality obtained the highest mean of 4.59 and was perceived as "Very High Quality" with a standard deviation of 0.40, followed by the technical quality which obtained a mean of 4.50 and was perceived as "Very High Quality" with a standard deviation of 0.43, and finally, the instructional quality obtained the lowest mean of 4.47 and was perceived as "Very High Quality" with a standard deviation of 0.45.

Table 6. Level of acceptability of the developed virtual laboratory website in learning systematics gathered from the students.

Acceptability Components	Mean	SD
Content Quality	4.59	0.40
Technical Quality	4.50	0.43
Instructional Quality	4.47	0.45
Overall Mean	4.52	0.43

In general, the study revealed that the developed virtual laboratory website in learning systematics, in terms of content quality, technical quality, and instructional quality, obtained an overall mean of 4.52 and was interpreted as "Very High Quality". This implies that the students were satisfied with the developed virtual laboratory website in terms of quality of content, technicality, and instruction. Which found that virtual laboratories should be geared to support the learning performance and comprehension of concepts; they should be organized, interesting to learners, manipulative, contain clear instruction, and be aligned to learning objectives.

4.3. Teachers/IT Experts' Evaluation of ViLIS

This section presents the evaluation of teachers/IT experts of the developed virtual laboratory in terms of Content, Technical, and Instructional Qualities **(Table 7). Table 7** shows the mean responses from selected teachers and IT (Information Technology) experts on the content quality, technical quality, and instructional quality of the developed Virtual Laboratory in Learning Systematics (ViLIS). Overall, the teachers and IT experts were pleased with the developed virtual laboratory.

The content quality obtained the highest mean of 4.63. As a result, the findings revealed that expert content evaluations were interpreted as "Very High Quality." In terms of instructional quality, they were evaluated to be "Very High Quality" by the expert respondent, as evidenced by a mean of 4.55. The technical quality obtained the lowest mean of 4.37 and was interpreted to be "Very High Quality". Indicative of the results, the expert respondents were very satisfied with the quality of content, technicality, and instruction of the developed virtual laboratory website in learning systematics provided by the overall mean of 4.52 and perceived it to be of "Very High Quality".

This result is conforming to the findings who found that developing virtual laboratories in educational institutions is necessary to develop new educational platforms for assisting instructors. The virtual laboratory should meet the standards that allow learners to navigate various types of content, such as videos, scientific images, instructions, and activities.

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Table 7. Level of acceptability of the developed irtual laboratory website in learning systematics gathered from teachers and IT (information technology) experts.

Acceptability Components	Mean
Content Quality	4.63
Technical Quality	4.37
Instructional Quality	4.55
Overall Mean	4.52

4.4. Students and Teachers/IT Experts' Evaluation of ViLIS

This section presents the summary of the evaluation of students and teachers/IT experts of the developed virtual laboratory in terms of Content, Technical, and Instructional Qualities. **Table 8** shows the level of acceptability of the general/mean rating scores of students and teachers/IT (Information Technology) experts of the developed virtual laboratory website in learning systematics in terms of content quality, technical quality, and instructional quality.

Based on the analyzed results, both students and teachers/IT experts rated the content quality as "Very High Quality" with the highest mean of 4.61. This implies that students and teachers/IT experts were satisfied with the quality of content, as shown in several indicators including "Content is scientifically accurate, emphasizes active learning and well organized"; "Content is relevant to learning objectives"; "Content allowed the development of multiple intelligences"; and "Contents are free of ethnic, gender, and other stereotypes".

The instructional quality obtained a mean of 4.51 and was interpreted as "Very High Quality". This indicates that evaluators were satisfied with the quality of instruction provided in the proper selection of elements to promote engagement and activate their prior knowledge concerning the content.

Table 8. Level of acceptability of general/mean rating scores of students and teachers/IT (information technology) experts of the developed virtual laboratory website in learning systematics (ViLIS).

Acceptability Components	General/Mean Rating Scores
Content Quality	4.61
Technical Quality	4.44
Instructional Quality	4.51
Overall Mean	4.52

The technical quality obtained the lowest mean of 4.44 and was interpreted as "Very High Quality". These were attributed to minor issues in font styles. However, these were eventually addressed with the improvement of the website. Thus, the result states that students and teachers/IT experts were satisfied with the content quality, technical quality, and instructional quality of the developed virtual laboratory website in learning systematics, as shown in the overall mean of 4.52, which was interpreted as "Very High Quality".

This result is supported by that virtual laboratories should be developed by considering the purpose, context to be used, and media that are necessary for the development- simulation, laboratory, activities, demonstration, and so on. The design should be the simplest possible, with technology that can still meet the demands of the user. In addition, the success of developed virtual laboratories in science education depends primarily on how they could be incorporated into curricula.

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5. CONCLUSION

This paper presents the summary of the findings, recommendations, and conclusions drawn from the analyzed data. Some recommendations are presented that can be utilized by future researchers. This study aimed to develop a virtual laboratory website that contained learning videos and activities with an emphasis on insects for learning systematics. The identified respondents of the study were the science students of Sultan Kudarat State University-ACCESS campus, specifically Bachelor of Science Education in Nursing and Bachelor of Secondary Education major in science from 1st year to 4th year, and teachers/IT experts. Overall, the study was composed of 145 BSED Science majors and Nursing students that were selected using a simple random sampling technique and 5 teachers/IT experts that were selected using a purposive sampling technique. An evaluation sheet was used to determine the level of acceptability of the developed Virtual Laboratory in Learning Systematics (ViLIS) in terms of content quality, technical quality, and instructional quality.

The virtual laboratory website offers users a variety of interactive activities related to various concepts covered in the subject biology in the topic systematics, specifically on insects (Insecta), including beetles (Coleoptera), butterflies and moths (Lepidoptera), and dragonflies (Odonata). These laboratory activities are online, which could be a great resource for teachers as additional instructional material for delivering instruction and creating a more dynamic and productive learning environment for students.

To determine the level of acceptability of the developed virtual laboratory website in learning systematics, the mean was used. The developed ViLiS was evaluated by science students and received an acceptability level of 4.59 (SD = 0.49) in content quality, 4.50 (SD = 0.43) in technical quality, and 4.47 (SD = 0.43) in instructional quality, with an overall mean of 4.52 (SD = 0.43) and an interpretation of "Very High Quality" for all components. As for the teachers/IT experts, the developed ViLIS obtained an acceptability level of 4.63 in content quality, 4.37 in technical quality, and 4.55 in instructional quality with an overall mean of 4.52, all of which have been interpreted as “Very High Quality”.

Furthermore, the level of acceptability of the general/mean rating scores of students and teachers/IT experts on the developed virtual laboratory website obtained 4.61 in content quality, 4.44 in technical quality, and 4.51 in instructional quality with an overall mean of 4.52; all have been interpreted as “Very High Quality”.

The findings of this study revealed that the developed virtual laboratory website for learning systematics was perceived to be “Very High Quality”. Thus, the evaluators considered the ViLIS to have met the intended standards and satisfied the quality components, including content quality, technical quality, and instructional quality. Therefore, the virtual laboratory website could be used in teaching to enhance the learning of students in science, specifically in teaching systematics. Based on the findings and conclusions given by this study, we derived the following recommendations, which are hereby presented:

(i) As future educators, we can use the developed virtual laboratory website as a learning material to improve the knowledge of students in learning systematics. Since the evaluation of students is important, their responses became the basis for the refinement of the materials. More interactive activities may be added/modified to enrich or improve student learning in systematics.

(ii) In line with the result of the acceptability of the developed virtual laboratory website in learning systematics, we are highly recommending and encouraging educators to incorporate the developed virtual laboratory website as a teaching resource in teaching systematics to science students.

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(iii) The school administrator may conduct training for teachers in developing their skills in using technology in developing virtual laboratory websites to enhance the knowledge of their learners and consider how they can help every student accomplish the goals of the course (Aschbacher *et al*., 2010).
(iv) It is recommended that a separate budget be approved for additional training sessions to develop high-quality virtual laboratories.
(v) The teachers may plan appropriate teaching strategies to deliver the subject-content knowledge.
(vi) Future researchers may conduct the ADDIE model implementation phase to ensure the website's continuous improvement and to conduct an intervention to strengthen the feasibility and effectiveness of the created virtual laboratory.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

7. REFERENCES

Achuthan, K., Francis, S. P., and Diwakar, S. (2017). Augmented reflective learning and knowledge retention perceived among students in classrooms involving virtual laboratories. *Education and Information Technologies, 22*(6), 2825-2855.

Ahmad, A. (2010). The effect of using a virtual lab on the physics concepts achievement, acquisition of higher-order thinking skills and motivation toward science learning among students of the third preparatory class. *Scientific Journal of Education, 13*(6), 1-46.

Al Balushi, A., Al-Musawi, A., Ambusaidi, A. and Al Hajri, F. (2016). The effectiveness of interacting with scientific animations in chemistry using mobile devices on grade 12 students' spatial ability and scientific reasoning skills. *Journal of Science Education Technology, 26*, 70-81.

Ali, W. (2020). Online and remote learning in higher education institutes: A necessity in light of covid-19 pandemic. *Higher Education Studies, 10*(3), 16-25.

Aschbacher, P., Li, E., and Roth, E. (2010). Is science me? high school students' identities, participation, and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching, 47*(5), 565–582.

Barth, M., and Burandt, S. (2013). Adding the "e-" to learning for sustainable development: Challenges and innovation. *Sustainability, 5*, 2609–2622.

Bhardwaj, A. (2016). Importance of education in human life: A holistic approach. *International Journal of Science and Consciousness, 2*(2), 23–28.

Brickhouse, N. W. (2001). Embodying science: A feminist perspective on learning. *Journal of Research in Science Teaching, 38*(3), 282–295.

Campos, N., Nogal, M., Caliz, C., and Juan, A. A. (2020). Simulation-based education involving online and on-campus models in different European universities. *International Journal of Educational Technology in Higher Education, 17*, 1–15.

DOI:
p- ISSN: 2828-4887 e- ISSN: 2828-4860

Carlone, H., and Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*(8), 1187–1218.

Dhawan, S. (2020). Online learning: A Panacea in the time of covid-19 crisis. *Journal of Educational Technology Systems, 49*(1), 5-22.

Gamage, K. A. A., Wijesuriya, D. I., Ekanayake, S. Y., Rennie, A. E. W., Lambert, C. G., and Gunawardhana, N. (2020). Online delivery of teaching and laboratory practices: Continuity of university programmes during covid-19 pandemic. *Education Sciences., 10*(10), 1-9.

Hassan, H. Martinez-Rubio, J. M. Perles, A. Capella, J. V. Dominguez, C., and Albaladejo, J. (2012). Smartphone-based industrial informatics projects and laboratories. *IEEE Transactions on Industrial Informatics, 9*(1), 557–566.

Paredes-Labra, J., Siri, I.M., and Oliveira, A. (2018). Preparing public pedagogies with ict: The case of pesticides and popular education in brazil. *Sustainability, 10*(10), 3377.

Potkonjak, V., Gardner, M., Callaghan, V., Mattila, P., Guetl, C., Petrović, V. M., and Jovanović, K. (2016). Virtual laboratories for education in science, technology, and engineering: A review. *Computers and Education, 95*, 309-327.

Redha, H. (2010). Effective use of virtual lab for enquiry and demonstration in teaching chemistry on the development of scientific thinking. *Journal of Science Education, 13*(6), 61-106.

Sarabando, C., Cravino, J. P., and Soares, A. A. (2014). Contribution of a computer simulation to students' learning of the physics concepts of weight and mass. *Procedia Technology, 13*, 112–121.

Son, J. Y. (2016). Comparing physical, virtual, and hybrid flipped labs for general education biology. *Online Learning, 20*(3), 228–243.

Tatli, Z., and Ayas, A. (2013). Effect of a virtual chemistry laboratory on students' achievement. *Educational Technology and Society, 16*(1), 159-170.

Valderrama-Hernández, R., Sánchez-Carracedo, F., Alcántara Rubio, L., and Limón-Domínguez, D. (2020). Methodology to analyze the effectiveness of ESD in a higher degree in education: A case study. *Sustainability, 12*(1), 1-27.

Wästberg, B. S., Eriksson, T., Karlsson, G., Sunnerstam, M., Axelsson, M., and Billger, M. (2019). Design considerations for virtual laboratories: A comparative study of two virtual laboratories for learning about gas solubility and colour appearance. *Education and Information Technologies, 24*, 2059–2080.

Zaid, Y. A., and Alabi, A. O. (2021). Sustaining open educational resources (OER) initiatives in Nigerian universities. *Open Learning: The Journal of Open, Distance and E-Learning, 36*(2), 181–197.

Zajko, K., and Bradaˇc, H. B. (2018). Social franchising model as a scaling strategy for ICT reuse: A case study of an international franchise. *Sustainability, 10*(9), 1-28.

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