Development and Validation of Pump-in-a-Box: An Interactive 3D Instructional Material for Pulmonary and Systemic Circulation

Mr. Emil B Broñoso[1], Ms. Sarnitte O Bequillo[2], Ms. Jecel R. Repotente[3], Ms. Bernadeth B. Saludes[4], Ms. Mary Joyce L. Tamuyao[5], Ms. Rose Anne B. Tawagon[6], Ms. Ma. Monica A. Zarate[7]

[1]Faculty of Biology Education, College of Education, Bicol State College of Applied Sciences and Technology
[2,3,4,5,6,7]Student of Science Education, College of Education, Bicol State College of Applied Sciences and Technology

Abstract
Cardiovascular diseases are rampant across the country; it is said that uneducated individuals are at risk to the said health condition. There is an urgency to provide better health education to address and reduce the number of cases having cardiovascular diseases. Education is also facing a problem on how to teach the students on this topic particularly on how pulmonary and systemic circulation works due to limited resources, particularly in pulmonary and systemic circulation. Though schools only have traditional instructional materials, mostly textbooks and other printed materials are only available.
Thus, this study aimed to develop an interactive 3D instructional material for pulmonary and systemic circulation known as Pump-in-a-Box, an intervention to aid the scarcity of learning materials for teaching pulmonary and systemic circulation intended for grade 9 students. This study uses descriptive-evaluative research design and utilizes the Learning Resources Management and Development System or (LRMDS) which is a set standard of DepEd for evaluating the features of the Pump-in-a-Box. For acceptability and suitability of the Pump-in-a-Box, the researcher adopted and modified a validated research evaluation tool. After developing the Pump-in-a-Box, survey questionnaires are given to experts to evaluate and validate the instructional material. Data for the Pump-in-a-Box suggested that it was able to pass the required criteria for the factors: content and manipulative. However, the general weighted average for factor errors was 15 points thus, it failed to meet and pass the said criteria. On the other hand, the acceptability of Pump-in-a-Box in terms of its design, durability, and functionality got a general weighted average of 4.77; the general weighted average for the level of suitability gained 4.78 points in terms of: structure of the model, delivery, ease of operation, and experience attained a high level of acceptability. The failure to meet and pass the criteria leads to revalidation of the modified model.
Upon revalidation, the model garnered a perfect score for its acceptability and suitability among the experts which received a "Very High" descriptive rating, making the enhanced Pump-in-a-Box commendable after following the several suggestions of validators. The study concludes that the interactive 3D instructional materials for pulmonary and systemic circulation is suitable to utilize in

education settings. The researcher recommends further improvement and incorporates Pump-in-a-Box in teaching pulmonary and systemic circulation for the improvement of the students' learning experience.

Keywords: Pump-in-a-Box, Three-dimensional model, Pulmonary and Systemic circulation, interactive instructional material, science education

The heart is said to be the organ of love, but in science, it is an organ that plays a crucial role in our body. It pumps the blood so it can flow to the veins, for every organism to breathe, live, and love (Onomatopoeia of the Beating Heart, 2016). It signifies the crucial aspect of our heart in our health as it is the main organ of the circulatory system (Boucher, 2024). However, over 17 million people around the globe suffer from cardiovascular diseases (World Health Organization, 2021). Lives perished, families were left behind as the heart gave up and its pumping of blood came to an end. In the Philippines, 17.8% or more than 130 thousand Filipinos died due to heart problems, making heart diseases the leading cause of death inside the country (Philippine Statistics Authority, 2022). On the other hand, heart diseases such as ischemic heart disease ranked fifth (5) in the leading cause of death in the Bicol Region (Bicol Region: Philippine Statistics Authority, 2023). It shows how valuable our heart is and being knowledgeable on the things that will lead people into having a poor circulation of blood that of course might result in heart diseases, would keep people away from things that can put them at risk. Problems have their equal solutions, but to have those, we need to find the root of those problems, especially the increasing case of heart diseases in our society.

Regardless in the society where people live or the social classes where they belong to, it has become common knowledge how life-threatening heart diseases are, but despite being known, they continuously do things that can be harmful to their own body. Initially, a person's lifestyle would come to mind as a contributing factor. A healthy lifestyle is indeed a must when a person wants to have a longer and healthy life, but there are factors that need also to be considered to view it on a broader perspective, on why a person ended up having bad health habits. There are social factors that can influence the condition of human health, and one of those is education.

Healthy behavior reflects a positive education and exhibiting positive correlation (Li & Powdthavee, 2015). What is taught inside the classroom is the reflection of our society and the world we live in. People who are educated tend to have a longer life as they are participative in a healthy lifestyle and those who are statistically less engaging, live which cause them to have bad habits such as smoking (Social Determinants of Health, 2024). Education is not only significant in nurturing the brain, but it also fosters positive impact in cardiovascular health. Lower cardiovascular susceptibility is observed among individuals with higher levels of education which secures better financial status, lifestyle choices, and more secure access to healthcare emphasizing the importance of integrating more health-related lessons into the school curriculum (Mersche, 2020). In this case, the need to educate the people on how vital for a person to at least be aware of what would come after as they continuously engage in a lifestyle that puts their lives in danger.

Not being able to fully understand the concept of how blood circulation works and how the heart works together with the lungs is led by the problem faced by the education system. Based on the released least mastered competencies in Science 9 of Carpentino Integrated School (2020) in Surigao Del Sur for the school year 2019-2020, explaining how circulatory and respiratory works came third in students least mastered competencies. The said school also mentioned lungs and pump models as a planned intervention.

The said planned intervention adheres to the fact that there is scarcity in instructional materials that need to be addressed. Eusebio G. Asuncion Integrated School (2022) encountered similar data, wherein explaining the mechanism on how the circulatory system transports nutrients, gases, and other molecules ranked third in the least mastered competencies. Understanding science concepts became difficult as students do not seem to find the relevance of science concepts in their everyday life, and find it difficult to understand (Prabha, 2020).

To fill the gap that hinders the learning of the students, there is a need to develop effective instructional materials that can fill the gap between students and the science concept circulatory system (Raved & Yarden, 2014). It is revealed that the scarcity of instructional materials in schools and the teachers not utilizing it effectively affects the students, and it became evident in their exam results (Bukoye, 2019). The way teachers develop and utilize instructional materials will reflect on how the students will perceive the importance of learning science concepts and how they will use it outside the four corners of their classrooms. The learners' attaining and practicing the knowledge is influenced by how the teacher teaches the science concepts and processes (Valanides et al., 2013). Bigger problems can be avoided if there is a proper education that caters to the needs of the learners, without being perpetually dependent on the images in the textbooks, or videos online that lack interaction and engagements from both teachers and the students.

Thus, this study came up with an intervention like the possible intervention primarily mentioned by the Carpentino Integrated School which is a pump model of heart and lungs. The researchers, however, decided to go for a three-dimensional model of Pulmonary and Systemic circulation that exhibits how blood circulates from heart to lungs, then back to the heart again. The 3D model will emphasize and encourage active learning as students engage with the model, learn, and at the same time reflect on their past and present experiences related to the topic, Kolb's experiential learning theory wherein students reflect from their experiences and at the same time relate and apply what they have learned to real life settings.

As Fenton (2023) said, the integration of 3D models to teaching is the new approach to K-12 Science Education. Therefore, the school and its stakeholders need to adapt to this new approach to be able to fulfill the changing needs of the students and to be able to have a quality education that they deserve. With that, the researcher is committed to developing a three-dimensional instructional material that will be useful as a tool to deliver a quality education that every student deserves

Objectives

This study aimed to develop and validate an interactive three-dimensional model of Pulmonary and Systemic Circulation to be used as an instructional material in teaching Circulatory Systems Working Together with the Respiratory System (**S9LT-la-b26**) to 9th grade students. In particular, this study aimed to evaluate the Pump-in-a-Box model in terms of its features, acceptability, and suitability as perceived by experts by accomplishing these set of objectives; (1) identify the features of Pump-in-a-box in line with the standard set by Learning Resources Management and Development System (LRMDS) of DepEd in terms of its content, errors (conceptual, factual, and grammatical/typographical), and its manipulability; (2) determine the level of acceptability of Pump-in-a-Box from the perception of Biology teachers in terms of its design, durability, and functionality and; (3) assess the suitability of Pump-in-a-Box from the Grade 9 science teachers' expertise in terms of the model's structure, delivery, ease of operation, and experience to whether the model is fit to be used as their instructional material.

Scope and Delimitation

The primary goal of this study was the development and validation of Pump-in-a-Box: An Interactive 3D Instructional Material for Pulmonary and Systemic Circulation. This study involves the development and validation of the Pump-in-a-Box in relation to the topic Respiratory and Circulatory Systems Working with the Other Organ Systems (S9LT-la-b26) in which the pulmonary and systemic circulation will be tackled as part of the Circulatory System in the subject matter of Grade 9 students.

The Development and Validation of Pump-in-a-Box: An Interactive 3D Instructional Material for Pulmonary and Systemic Circulation undergoes a validation process. The evaluation tool use for the validation of the 3D manipulative model are based on the Learning Resources Management and Development System (LRMDS) of the Department of Education (DepEd) under DepEd Memo No. 82 S. 2017 for instructional aides evaluation rating sheet (section 6.5) and descriptors (section 6.5.1) for charts, posters, drills/ flashcards, and manipulatives. The features of Pump-in-a-Box that was evaluated in line with the standards set by LRMDS of DepEd includes: (a) content, (b) errors (conceptual, factual, grammatical and typographical), and (c) manipulability. The acceptability level of the Pump-in-a-Box was evaluated in terms of its: (a) design, (b) durability, and (c) functionality while the level of suitability was evaluated in terms of its: (a) structure of the model, (b) delivery, (c) ease of operation, and (d) experience.

The instructional material was developed only to cover the pulmonary circulation and systemic circulation. The pulmonary circulation begins when the deoxygenated blood enters the superior and inferior vena cava and passes through to the right atrium, going to the right ventricle and pumped into the lungs and back to the heart, carrying the oxygen-rich blood. While systemic circulation begins once the oxygenated enters the left ventricle and pumped into the aorta. The researchers delimited the circulation and did not fully expound the systemic circulation but instead open a possibility for adaptation and modification of this study for the other researchers to conduct.

The respondents are limited to Grade 9 Science teachers, Biology teachers, and Science Coordinator in place of the supposed LRMDS Coordinator that was not available during data gathering procedure. The initially planned pilot testing was disregarded due to unforeseen circumstances.

Furthermore, researchers are restricted to inquire and gather data on other teachers majoring in other branches of science and/or teaching at another grade level for the consistency of the research results

CONCEPTUAL FRAMEWORK

This study focuses on the Development and Validation of Pump in Box: An Interactive Three-Dimensional Instructional Material for Teaching Pulmonary and Systemic Circulation. That is why the researchers utilize the IPO or the Input Process Output. The input provides necessary resources and information that are required in the design and development of the Pump-in-a-Box, to ensure the effectiveness of the 3D instructional material. While the Process involves the step-by-step process in the development and validation of the Pump-in-a-Box. The process includes making the hand sketch design of the model and its box, the creation of the 3D layout of the heart and lungs based on the sketch design, and the 3D printing of the heart and lungs. The last process focuses on the validation of the model. Furthermore, the output primarily analyzes the results of the Pump-in-a-Box based on the validation process, this includes data gathered during the input and process stages.

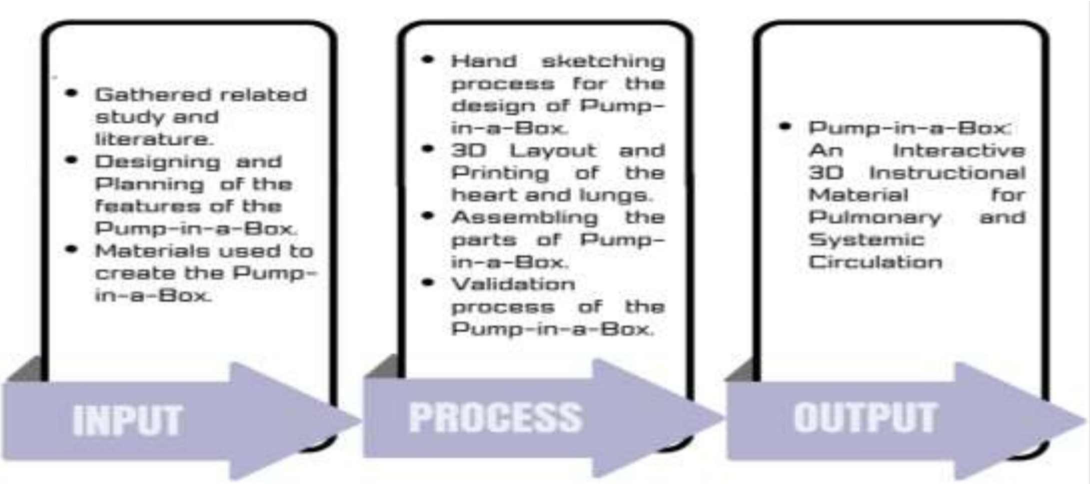


Figure 2. Conceptual Framework

METHODOLOGY

The Descriptive-evaluative research design used in the study (Manuel, 2023). It was utilized to validate the Pump in a Box in developing an Interactive 3D Instructional Material for Pulmonary and Systemic Circulation. The features, and the level of acceptability and suitability of the Pump in a Box was validated and revalidated by the experts to assess whether it is accepted and suitable to use as instructional material for teaching pulmonary and systemic circulation. In determining the level of acceptability and suitability of the Pump in the Box, the data was collected using questionnaires that were validated by experts who have expertise in biology education.

This part of the study described the step-by-step process for developing the Development and Validation of Pump in a Box: An Interactive 3D Instructional Material for Pulmonary and Systemic Circulation. The process is broken down into five following steps: (1) Hand sketch of the Pump in a Box; (2) 3D layout of the Pump in a Box; (3) Materials for the construction of the Pump in a Box; (4) Development of the Pump in a Box; and (5) Adding the several suggestions of validators for the improvement of Pump-in-a-Box.

The respondents of this study were chosen based on purposive sampling. They were selected based on their experience and expertise in the field of teaching science, knowledge in validating instructional materials. The researchers selected have five (5) science biology major teachers for the level of acceptability, the validators were chosen according to their expertise in the field of Biology. Five (5) Grade 9 science teachers for the level of suitability of the model; and three (3) science coordinators from 4 different schools in Naga City, and one school outside Naga.

The researchers utilized descriptive analysis to thoroughly evaluate the development and validation of the Pump-in-a-Box model together with its manual aid. In the interpretation process of the gathered data, the researchers utilized the 4-point and 5-point Likert scale and descriptive equivalent with corresponding numerical rating scale in examining the level of acceptability and suitability and of Pump-in-a-Box with the help of selected experts who have the expertise in the field of science education and relate how vital it is for our body to maintain a proper blood circulation, and for teachers to instill in their students' minds how crucial it is for them to relate and understand the concept of blood circulation in order for them to be mindful of their actions that can affect their health.

Educational institutions can further develop the model aligning to the changing needs of the students. By that, students can no longer be confused nor end up in misconceptions as they learn and reflect on their own, and the teachers can guide and educate their learners effectively, establishing a quality education that every student deserves.

RESULTS AND DISCUSSION

Features of Pump-in-a-Box

The features of Pump-in-a-Box: An Interactive Three-Dimensional (3D) Instructional Material for Pulmonary and Systemic Circulation were aligned to the set stantand of Learning Resources Management and Development System (LRMDS) based on the Evaluation Rating Sheet for Charts, Posters, Drills/Flashcards, and Manipulatives.

Table 1. Initial Validation of Pump-in-a-Box

Features	**Mean Average**	**Interpretation**
Content	3.73	Satisfactory
Errors	3.9	Satisfactory
Manipulability	3.61	Satisfactory
Weighted Mean	3.74	Satisfactory

The table shows the results of the Initial Validation for the features of Pump-in-a-Box. The first feature which is the content gained a mean average of 3.73. While the second feature, which is Errors received a mean average of 3.9. The last feature which is the Manipulability got a mean average score of 3.61. Overall the features of the Pump-in-a-Box for its initial validation got a weighted mean of 3.74 which indicates a satisfactory result.

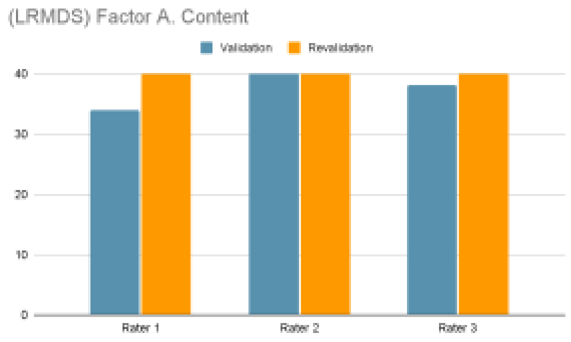
Table 2. Revalidation of Pump-in-a-Box

Features	**Mean Average**	**Interpretation**
Content	4	Very Satisfactory
Errors	4	Very Satisfactory
Manipulability	4	Very Satisfactory
Weighted Mean	4	Very Satisfactory

The table above shows the revalidation of Pump-in-a-Box. The Content garnered a perfect score of 4 points which is very satisfactory. The Errors also got an average of 4 points which indicates a very satisfactory result. Lastly, the Manipulability receives a mean average of 4 points which also indicates a very satisfactory result. The revalidation process results garnered a weighted mean of 4 which indicates a very satisfactory result. This signifies that the features of Pump-in-a-Box have improved its quality as an instructional material and the manual is free from errors.

Figure 3

Comparison of the result of initial and revalidation and of the Pump-in-a-Box in Factor A. Content



The graph presents the compared results of the initial validation and revalidation of Pump-in-a-Box. The results for initial and modified Pump-in-a-Box for Rater 1 from 34 to 40, Rater 2 remains 40, and Rater 3 from 38 to 40. It shows that the modified Pump-in-a-Box received a higher and perfect rating from the validators. This implies that the suggestions and recommendation of the validators improves the quality and content of Pump-in-a-Box as an instructional material for teaching pulmonary and systemic circulation. In connection with literature reviews, it is concluded that the 3D Instructional materials as mentioned in the study of Hassan U. et al., (2019) and Adalikwu S. et al., (2013), through the use of appropriate and effective instructional materials that enhances students' academic performance along with their understanding of anatomical ideas, instructional materials act as a pathway between educators and learners, allowing them to interact in a real-world setting.

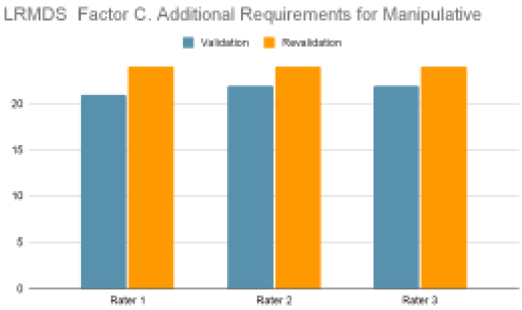
Figure 4

Comparison of the result of initial and revalidation of the Pump-in-a-Box in Factor B. Errors

The graph presents the compared results of the initial validation and revalidation of Pump-in-a-Box for Factor B: Errors. The results for initial and modified Pump-in-a-Box for Rater 1 got the same points of 16, Rater 2 from 14 to perfect score of 16 points, and Rater 3 from 15 to 16 points. The results indicate that the modified Pump-in-a-Box achieved a perfect rating from the validators. This signify, that the modified manual of the model is free from any conceptual errors, factual errors, grammatical and any obsolete information. In addition, 3D models are utilized as the representation of an actual object in a detailed manner (How Can Educators Benefit from 3D Models in Their Pedagogy?, 2024). Instructional materials are used to give a realistic approach to the main source of information rather than relying on textbooks, books, journals, and other scholarly materials (Cook, 2024.). 3D models are used to create more interactive learning and observe more than just by seeing the things inside the books.

Figure 5

Comparison of the result of initial and revalidation of the Pump-in-a-Box in Factor C. Additional Requirement for Manipulative.



The graph above shows the comparison of results for Factor C: Additional Requirement for Manipulative. The results for initial and modified Pump-in-a-Box for Rater 1 gave 21 to 24 points, Rater 2 from 22 to perfect score of 24 points, and Rater 3 from 22 to 24 points. The results signify that the modified Pump-in-a-Box achieved a perfect rating from the validators. This indicates that the modified manual and the added activities from the suggestions of validators improves the overall quality of the manual and the Pump-in-a-in-a-Box. This was supported by the study of Astuti et al., (2020) that the use of three-dimensional models as an effective instructional material for teaching scientific concepts like the human circulatory system. It also states that the hands-on experience with the 3D models are effective in improving the students' visualization and understanding of complex concepts in science education. Using three-dimensional models as an instructional material promotes active learning, whereas the experience of the students while using it contributes to their learning as they reflect on the things that they have learned.

Level Of Acceptability

The level of acceptability of Pump-in-a-Box: An Interactive Three-Dimensional (3D) Instructional Material for Pulmonary and Systemic Circulation of the experts which pertains to the Science teacher majoring in Biology, the Researcher made use of a 5-point likert scale to measure the acceptability of the model.

Table 3. Initial Validation of Pump-in-a-Box in the Level of Acceptability in terms of Factor A (Design), Factor B (Durability), and Factor C (Functionality)

Acceptability	Mean Average	Interpretation
Design	4.84	Highly Acceptable
Durability	4.80	Highly Acceptable
Functionality	4.72	Highly Acceptable
Weighted Mean	4. 78	Highly Acceptable

In table 3, it presented the results of the initial validation for the level of acceptability of the Pump-in-a-Box across its three factors including the Design, Durability, and Functionality. The first factor which is all about the Design got a total mean average of 4.84, while the second got 4.80 for the durability factor. Moreover, Functionality receives a mean average score of 4.72. All of the mean average of the three factors are equivalent to Highly Acceptable. Gaining a combined average score of 4.78 for the initial validation in the level of Acceptability.

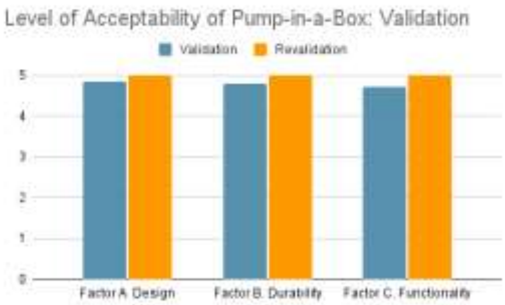
Table 4. Revalidation of Pump-in-a-Box in the Level of Acceptability in terms of Factor A (Design), Factor B (Durability), and Factor C (Functionality)

Acceptability	Mean Average	Interpretation
Design	5.00	Highly Acceptable
Durability	5.00	Highly Acceptable
Functionality	5.00	Highly Acceptable
Weighted Mean	5.00	Highly Acceptable

In the revalidation, the average scores of the three factors improved to 5.00, reflecting enhancements in detail, observation clarity, and retention support. These improvements affirm that the Pump-in-a-Box model is not only highly acceptable across all dimensions but also a robust, interactive, and pedagogically sound tool for teaching Pulmonary and Systemic Circulation.

Figure 6

Comparison of Validation and Revalidation results of Pump-in-a-Box in Factor A (Design) , Factor B (Durability), and Factor C (Functionality)



The presented graph above shows the compared results of the initial validation and revalidation process of the Pump-in-a-Box in the Level of Acceptability in terms of Factor A (Design), Factor B (Durability), and Factor C (Functionality).

In Factor A which focuses on the design of the model, the initial validation attained a high level of acceptability with a general weighted mean of 4.84 which is equivalent to Highly Acceptable. While in the revalidation process of the modified Pump-in-a-Box model the results garnered an average score of 5.00 which is highly acceptable highlighting the characteristics of the model to be an 3D instructional material in teaching Pulmonary and Systemic Circulation can contribute in nurturing the different learning

styles as it allows both the students and teachers to interact and engage in handling the 3D model to assist the instructions about the context of the intended concept.
Applying relevant science working models like the Pump in Box are useful in the representations of scientific ideas and provide a hands-on approach to learning complex topics that is supported in the study of Hmelo-Silver & Azevedo (2006).The visual features of the Pump in a Box can encourage learners to get involved in the learning process as it enables both students and teachers to interact and observe together with the presence of the model to provide a more realistic approach to the main source of information or the real things themselves rather than relying on other scholarly materials as stated by Cook(2024).
The results for Factor B which is all about the durability of the Pump-in-a-Box model that pertains to the used materials and protective features that keeps the model withstand the repeated use and other factors that will prevent damage to the model. The initial validation of Pump-in-a-Box got a mean rating of 4.80, while in the revalidation of Pump-in-a-Box the Factor A got a mean rating of 5.00 which is Highly Acceptable.
This result indicates that the materials and protective features employed in the model's construction are carefully considered by the researchers in constructing the Pump-in-a-Box to ensure its durability and ability to withstand repeated use making it a good learning instructional model. In the work of Arcagok, S., & Ozbasi, D. (2020) it emphasizes how crucial it is to evaluate the durability and practicality of instructional materials to ensure that it can perform its intended function in a given period of time. Similarly, Hollander et al. (2017) explains that the durability of the product depends on its ability to last longer compared to other products that are made with the same purpose until it wears out or breaks down.
On the other hand, Factor C which discusses the Functionality of the model the results in initial validation gained an average mean of The initial validation result was 4.72, while in the revalidation final result obtained 5.00 which can be also expressed as highly acceptable.
The overall result highlights that the Pump-in-a-Box model has strong visual representation and has the potential to be utilized as an educational tool in teaching Pulmonary and Systemic circulation which is strongly shown in the high revalidation score of the model. As supported by the findings of Teplá et al. (2019), and Astuti et al. (2020), these studies highlight how 3D models can positively impact the student's performance particularly in visualizing and understanding complex anatomical systems like the pulmonary and systemic circulation.

Suitability of the Perception of the Pump-in-a-Box: An interactive 3D Instructional Material for Pulmonary and Systemic Circulation

This segment evaluates the level of suitability of the Pump-in-a-Box among experts. Here, the Researcher found five (5) experts to validate the model's suitability in terms of structure, delivery, ease of operation, and experience. To know the level of suitability of the Pump-in-a-Box, the researcher use a five-point likert scale, which was used as a response method where the five (5) experts in the field of Science Education, specifically in Grade 9, answered or responded to the statement concerning the suitability of the Pump-in-a-Box in teaching Pulmonary and Systemic Circulation. This five-point likert scale was adopted and modified from the study of Schlegel LE, Ho M. Boyd K, Pugliese RS, Shine KM. D*evelopment of a Survey Tool: Understanding the Patient Experience With Personalized 3D Models in Surgical Patient Education (2020).*

Table 5. Initial Validation of Pump-in-a-Box in the Level of Suitability in terms of Factor A (Structure of the Model), Factor B (Delivery), Factor C (Ease of Operation), and Factor D (Experience)

Suitability	Mean Average	Interpretation
Structure of the Model	4.88	Very High (VH)
Delivery	4.68	Very High (VH)
Ease of Operation	4.84	Very High (VH)
Experience	4.68	Very High (VH)
Weighted Mean	4. 77	Very High (VH)

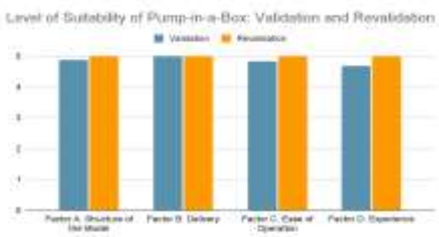
The data presented above shows the initial validation of Pump-in-a-Box in Level of Suitability. The four (4) factors; (1) Structure of the Model, (2) Delivery, (3) Ease of Operation, (4) Experience which received a “Very High” description among the validators, making the Pump-in-a-Box suitable to utilize as an instructional material in teaching pulmonary and systemic circulation.

Table 6. Revalidation of Pump-in-a-Box in the Level of Suitability in terms of Factor A (Structure of the Model), Factor B (Delivery), Factor C (Ease of Operation), and Factor D (Experience)

Suitability	Mean Average	Interpretation
Structure of the Model	5.00	Very High (VH)
Delivery	5.00	Very High (VH)
Ease of Operation	5.00	Very High (VH)
Experience	5.00	Very High (VH)
Weighted Mean	5.00	Very High (VH)

The four (4) factors of level of suitability for revalidation of Pump-in-a-Box garnered a perfect score of 5.00 rating which received a “Very High” description. The data indicates that the Pump-in-a-Box is highly suitable for both learners and educators to utilize in education settings.

Figure 7 ***The comparison of initial and revalidation results of Pump-in-a-Box.***



The figure above shows the comparison of the rating of the initial validation and Revalidation of the Pump-in-a-Box model for Pulmonary and Systemic Circulation. The Factor A: Structure of the Model obtained a weighted mean of 4.88 upon the initial validation.

However, during the revalidation of the Pump-in-a-Box the model garnered 5.00 in each descriptor, resulting in a general weighted mean of 5.00. This result signifies that the overall physical structure of Pump-in-a-Box is suitable instructional material to be used and incorporated in teaching the Pulmonary and Systemic Circulation in Grade 9 students. In the study of How Can Educators Benefit from 3D Models in Their Pedagogy? (2024), it underscores the benefits of 3D models in representing actual objects in a detailed and similar way for better visual representation.

Furthermore, the details of how the researcher utilized the color-coding in distinguishing the oxygenated blood from the deoxygenated blood can possibly overcome the misconceptions about how the oxygen-rich and oxygen-poor blood works in the human circulatory system which identified in the study of Alkhzwaldeh (2007) .

In Factor B (Delivery), the overall weighted mean got an average score of 4.68 in
the initial validation process of Pump-in-a-Box. However, in the revalidation process of Pump-in-a-Box the Factor B got a general weighted mean of 5.00 which is very high. This implies that the Pump-in-a-Box Model provides positive user experience, practical utility, and age appropriateness for the intended audience. In support of these findings, in the study of "How Can Educators Benefit from 3D Models in Their Pedagogy?" (2024), which highlights the relevance of 3D models to create accurate representations of realistic objects and how it can be advantages in the field of science education.

In Factor C (Ease of Operation), in the previous data presented the Ease of Operation or the Factor C got an average score of 4.84 which is very high. While in the revalidation of the Pump-in-a-box, the Ease of operation general weighted mean has improved which is 5.00, it means that the model is useful in teaching the topic of Pulmonary and Systemic Circulation. The aim of the three-dimensional heart model is for the students to acquire an understanding about the blood circulation in the heart (Anjur, 2015). In a way, students who have first-hand experience will develop their ability to recognize the relationship between visual and spatial to the object itself (Caduceus International Publishing, 2023).

Furthermore, in Factor D (Experience), the initial validation got an average score of 4.68, while in the revalidation of the Pump-in-a-Box got an average score of 5.00 which is Very High. It signifies that the model is fun and easy to use, the model can achieve the intended learning goals and it will improve the teaching experience of the students by incorporating the model in the teaching process. In support of these findings, teachers used various techniques and tools to adapt to the changing needs of the students and one of those is three-dimensional models as their teaching tool. Science working models are useful representations of scientific ideas that provide students with a hands-on approach to learning complex topics (Hmelo-Silver & Azevedo, 2006). It became a tool of globalization that positively influences the teaching and learning process as it conveys knowledge and a drive force to change (Roble,2021).

CONCLUSIONS

Overall, the researcher came up with the conclusion that the features of Pump-in-a-Box such as the manual information, and the instructional and technical design of the model is sufficient to encourage the school to use the model as an instructional material that can help not only the science teachers in the delivery of their discussion but also contributes to the students learning and experiences. The researcher also got a high level of acceptability with the Pump-in-a-Box from the biology major teachers' perspectives. The result signifies that this study meets all the criteria and would most likely have an impact on education, specifically to the teaching and learning process.

The suitability of the Pump-in-a-Box was highly valued by the Grade 9 Science teachers that validated the model in which the researcher can conclude that the model has met all the criteria and is ideal to use as an instructional material in teaching and learning Science 9. Also, the researcher concluded that both Pump-in-a-Box and its manual is valid to use as an aid and learning material for teachers and students in the field of science education.

With the positive results that the Pump-in-a-Box has gotten, together with the skills and capability of the science teachers, it can surely be beneficial in fostering the utmost importance of blood circulation to people in the students' young minds. It might somehow impact the way they will live and the lifestyle that they will choose, reflecting on what they have been taught and what they have experienced while learning the pulmonary and systemic circulation in their 9th Grade.

RECOMMENDATIONS

The researchers recommend that Pump-in-a-Box should be used in Science Education as a learning material and intervention for the topic of Circulatory Systems Working Together with the Respiratory System (S9LT-la-b26). It is also recommended to be subjected to innovation and modification by the validators, specifically installing lights to enhance the visualization of the organs involved, both lungs can be open to fully exhibit the flow of the liquids, and using more lighter but durable material so that it can be pushed by one student or be carried by at least 2 people when being transported from classroom to classroom.

Furthermore, it is highly recommended for the Pump-in-a-Box to be implemented, aiming for the perspective of the students in order to have substantial data that will solidify the purpose of the Pump-in-a-Box as an instructional material for teaching Pulmonary and Systemic circulation.Being said, it is high time to invest in a 3D model as an instructional material especially in learning biology, moreover anatomy, in order to effectively educate the students not only about the parts of the circulatory system and its functions but also how the process works as the blood flows. Students can now easily visualize and relate how vital it is for our body to maintain a proper blood circulation, and for teachers to instill in their students' mind how crucial it is for them to relate and understand the concept of blood circulation in order for them to be mindful of their actions that can affect their health.

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