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Development and Validation of Simulation-based Instructional Material on Force and Motion for Grade 9

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PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education

DEVELOPMENT AND VALIDATION OF SIMULATION-BASED INSTRUCTIONAL MATERIAL ON FORCE AND MOTION FOR GRADE 9

An Undergraduate Thesis
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In Partial Fulfillment of the Requirements
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(Science Research 2)

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APPROVAL SHEET

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ABSTRACT

Name:	Joseph Miles K. Margallo; Grace S. Pareja
Title of the Study:	Development and Validation of Simulation-Based Instructional Material on Force and Motion for Grade 9
Key Concepts:	PhET Simulations, Instructional material, Force and Motion
Degree:	Undergraduate
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Physics, whereas students find its concepts difficult, leading to misconceptions such as the idea that heavier objects fall faster (Fadaei & Mora, 2015). It is deeply rooted in the challenges the students face in understanding the concepts due to vernacular challenges (Liu & Fang, 2016). These misconceptions about its fundamental concepts may lead to further difficulty in learning physics, as most students only memorize and do not find relationships between them (Papakonstantinou & Skoumios, 2021). These problems often arise in traditional learning settings, where there is no integration of modern technology. As the world progresses, so does education, adapting and coping with technology, referred to as education 5.0. Integrating technology such as simulations in learning can improve students' conceptual understanding (Diola & Mistades, 2021). This study aims to develop and validate the interactive Simulation-Based Instructional Material (IM). To achieve this, the researchers will conduct Design and Development Research. The participants for this study will be the researchers who will design and develop the Simulation-Based IM integrated with the MATATAG Curriculum, with the guidance of physics experts for content, instructional design

and technical/usability quality and technical experts for instructional design and technical/usability quality. The data collection and analysis will focus on two phases: (1) the design and development of the simulation-based IM and (2) the validation of the said IM. As the study concludes, it is expected to provide a significant contribution to the existing body of knowledge in education and learning.

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JMKM & GSP

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ACRONYMS

EDCOM 2	The Second Congressional Commission on Education
E-Module	Electronic Module
IM	Instructional Material
MOODLE	Modular Object-Oriented Dynamic Learning Environment
PhET	Physics Education Technology
PISA	Programme for International Student Assessment
OECD	Organization for Economic Cooperation and Development

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CHAPTER 1

THE PROBLEM AND LITERATURE REVIEW

This chapter includes the background of the problem, the literature review, the research problem and hypotheses, the theoretical and conceptual framework, and the definition of terms used in the study.

Background of the Problem

One of the fields in education where the students find it difficult to understand is Physics, the branch of science that deals with the interaction of matter. It is governed by universal laws essential for fundamental concepts. Many studies focus on understanding students' grasp of concepts such as Force and Motion and Newton's Laws. Understanding these concepts allows students to have a better understanding of how the physical world works, forming a deeper understanding of the concepts that are important for understanding more complex topics in physics. Traditional teaching strategies often focus on memorizing and listening rather than fostering active engagement through collaboration and experiential learning. These traditional teaching strategies limit opportunities for developing critical thinking and problem-solving skills. This is evident in the recent report of EDCOM 2, where the primary mode of instruction is a teacher-centered approach, limiting the opportunities of the students to think critically and take an active role in the learning process. As a result, many students develop misconceptions about force and motion concepts, which makes learning difficult. This can create a cycle, where students feel frustrated and lose interest in science. This situation is particularly acute in the Philippines, where educational assessments,

like 2018 and 2022 PISA results, revealed that the Philippines ranked lowest among OECD member states in Science, Mathematics, and Reading. These findings highlight an urgent need for education reform aimed at improving the quality of education. Moreover, the integration of technology in education - referred to as education 5.0 - offers a promising solution. By using technology as a supportive tool, teachers can create a more interactive and engaging learning environment. When students are engaged, they are more likely to explore, ask questions, and take charge of their learning, which is important for mastering the subject. However, there are still some schools facing difficulties in effectively integrating technology into physics classes.

Literature Review

Understanding the principles of force and motion is important in physics, but there are a lot of students who find these concepts difficult. Teachers today manipulate simulations to enhance students' comprehension of force and motion. Recent studies highlight how these simulations can help bridge the gaps in understanding and address common misconceptions. Some of the misconceptions in force and motion can be traced to the problem in understanding science concepts where students tend to memorize the formulas and concepts instead of finding relations and connections that will help them develop a meaningful understanding of the topics. That is why it is necessary to develop skills that would help the students, such as the integration of science and engineering practices into the student's learning because without these strategies, it will limit the learners' ability to connect concepts meaningfully (Papakonstantinou & Skoumios, 2021). Recent studies highlight how simulations can help bridge the gaps in understanding and address common misconceptions.

A current study shows that students who use physics simulations improve their conceptual and procedural knowledge, with these simulations truly creating deep bonds in physics (Alabidi et al., 2023). This is similar to the use of digital hands-on tools to significantly improve students' conceptual comprehension, particularly in grasping concepts such as inertia and reaction forces to help make these abstract physics concepts more engaging and relatable (Amarille & Berry 2024). It is essential for teachers to acquire a basic understanding of physics concepts so that they can shape students' conceptual understanding. Interactive teaching strategies can lead to better engagement and understanding than traditional teaching strategies (Ibrahim et al., 2024). As some students, including college students, might have the factual knowledge of physics concepts such as Newton's Laws, their conceptual and procedural understanding was weak, indicating a requirement for better teaching strategies by the teachers emphasizing problem-solving over memorization (Cashata et al., 2022).

Another study also used simulations to see the forces acting on solid particles in transformer oil under direct current voltage, revealing important understandings into its dynamics (Meng et al., 2022). Using interactive simulations can address common misconceptions about force and motion topics. The study focused on Grade 8 students, with the use of interactive simulations, they noticed students' conceptual understanding improved, as shown by their improved scores on the Force Concept Inventory (Diola & Mistades, 2021). Computer simulations can truly improve education; using these tools will help students to learn better, particularly in the topic named Newton's Second Law of Motion (AlArabi et al., 2022). Traditional teaching methods are excellent in imparting information and concepts but

may not be as efficient in addressing misconceptions about force and motion, such as the belief that motion requires continuous force or that heavier objects fall faster, which persisted despite instruction (Fadaei & Mora, 2015). Finally, in teaching difficult concepts such as physics, it is necessary to develop engagement during the learning process, as it is crucial for understanding the concepts in a particular learning area (Bahtaji, 2023).

Understanding force and motion requires conceptual comprehension, which is important in education, particularly in the field of science, where grasping foundational concepts is essential for students to apply their learned knowledge effectively. This conceptual comprehension involves more than just memorization; it also includes the ability to connect new information to existing knowledge and apply it in real-world scenarios. In recent years, researchers have emphasized the need for innovative teaching strategies that enhance students' conceptual comprehension, particularly in physics.

In higher education, using microlearning activities can improve students' biochemistry comprehension and performance. Students were able to grasp difficult concepts more effectively by breaking down these concepts into short, focused lessons, resulting in better exam performance (Nowak et al., 2023). By identifying misconceptions and developing a learning management process using Mr. Posner's approach, students can get better scores in both performance and conceptual comprehension, provided that structured learning approaches are highly effective (Kaanklao & Suwathanpornkul, 2018). Better teaching strategies to correct misconceptions about electric circuits can truly improve students' understanding (Chang & Shieh, 2018). Another technique in teaching to improve students’

conceptual understanding is the use of mind mapping through organizing concepts and knowledge in ways that are built on prior learning, aligning with Ausubel's meaningful learning theory, and helping students to build connections with other concepts (Sefriyanti et al., 2021). Furthermore, the utilization of project-based learning also showed a significant boost in comprehension through hands-on activities that encourage critical thinking and active learning, surpassing conventional teaching methods (Boleng et al., 2024). Finally, a clever method of improving the conceptual comprehension of the students is the use of concept cartoons due to their ability to enhance active learning (Finbråten et al., 2022).

Another study used Kotobee, which is an interactive e-module designed to improve students' understanding. When students have the opportunity to visualize and manipulate something that is related to their topic, they can develop a better understanding of it (Baring & Berame, 2022). Similarly, Moodle is an online platform that can facilitate various educational activities; using this digital tool can improve students' understanding of wave concepts (Herayanti et al., 2018). Another digital tool that was used to enhance students' conceptual comprehension is the PhET simulations, which are proven to improve students' understanding by offering an interactive and engaging learning experience (Sakona et al., 2024). Furthermore, using technology-based digital tools such as Augmented Reality (AR) could significantly improve the comprehension of the students due to its capability to assist learners to visualize the concepts, thus significantly helping them grasp the principles, which is significantly better than traditional methods (Yoon et al., 2017).

Addressing misconceptions helps students to develop conceptual comprehension of force and motion concepts. Many young students, particularly in elementary school, misunderstood that an object in motion requires continuous force to push it, an idea from Aristotle, which is proven wrong according to science (Maryani & Atmojo, 2024). For high school, many of them seem confused about the speed with acceleration and struggle with Newton's third law. These misconceptions were identified using the Force Concept Inventory (Khoirunnisa et al., 2024). Meanwhile, the study of Kirya et al. (2022) focused on a Ugandan high school, where they also use the Force Concept Inventory, and it showed major gaps, likely because this school focuses on memorization rather than deep learning. That is why students have a hard time understanding basic concepts like inertia and action-reaction forces. Misconceptions like “no motion is equal to no force,” shown in multiple studies reviewed by Hidayati et al. (2023), also suggest better teaching strategies. This connects to the study of Kibirige and Mamashela (2022), which uses flipped classrooms and found out that it has a positive effect on understanding force concepts compared to traditional teaching strategies. Furthermore, several studies revealed that there is indeed an inconsistency with students’ conceptions about force and motion, where they inconsistently apply the concepts to various contexts (Pinar, Cabahug, Tee, Malayao, Malicoban, & Aban, 2016). This is primarily due to the misconceptions on these concepts such as the idea that motion implies force (Sari, Ramdhani, & Surtikanti, 2019 & Bani-Salameh, 2017). The cause for these misconceptions is deeply rooted and caused by factors such as incomplete understanding of the concept (Liu & Fang, 2016) and is aggravated by misunderstandings and challenges they encounter in their language and culture (Villarino, 2018).

Research Problems and Hypotheses

Understanding the principles of force and motion is important in physics, yet many students find it difficult to grasp these concepts. Teaching physics can be challenging when students struggle to visualize abstract ideas, which is why simulations were invented. Simulations help us visualize phenomena that are otherwise impossible to see, such as forces, which play a crucial role in physics. By providing such visualizations, simulations can enhance our understanding and prevent misconceptions about the topics. However, simulations alone are not enough to trigger critical or deep learning, which limits their effectiveness in the classroom. This limitation suggests the need to integrate simulations into a more structured instructional framework. Therefore, this study aims to develop and validate interactive simulation-based instructional material (IM) on force and motion for Grade 9 students.

To achieve the aim of this study, the objectives are as follows:

1. Develop interactive Simulation-Based Instructional Material (IM).
2. Validate the developed Simulation-Based IM through the expert validation.

This study tests a clear hypothesis regarding the instructional material's quality. The researchers propose that the interactive simulation-based IM meet the required standards for content validity. This is formally stated in two parts: null hypothesis (H_0) states that the material fails to meet content validity standards, while the alternative hypothesis (H_1) states that it meets or exceeds these standards. The expert validation process will determine which of these statements is correct.

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Theoretical & Conceptual Framework

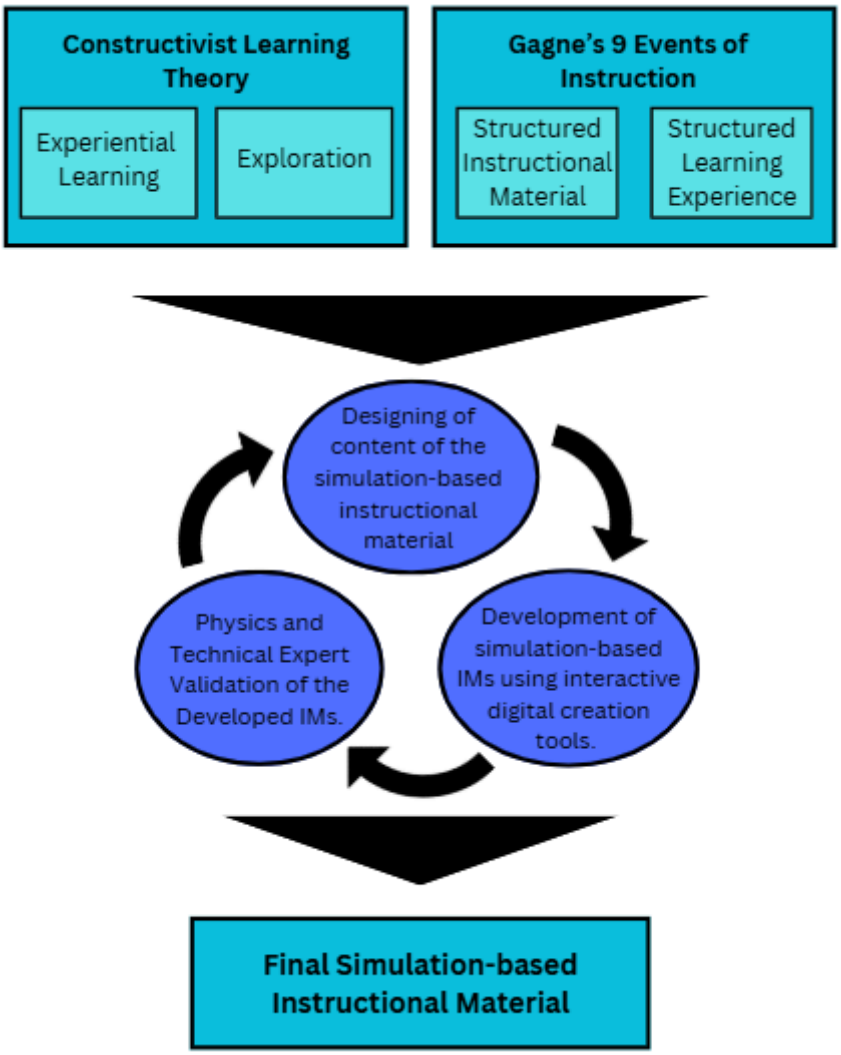

Figure 1: Theoretical Framework for Simulation-based Instructional Material (IM).

Figure 1 shows the theoretical grounding and the proposed study of Simulation-based Instructional Material (IM) on Force and Motion for Grade 9. It is necessary to develop conceptual comprehension in students to ensure that they are learning and that they can apply their learning elsewhere. To achieve this, the constructivist learning theory suggests that for

learning to occur, students need to explore the concepts and allow them to learn from experiences through hands-on activities and/or other learning experiences such as experiments. This theory suggests that students build their understanding from these experiences. With this, constructivist learning theory is necessary for learning to occur.

In order to facilitate learning and to develop the conceptual comprehension of learners, a structured learning experience is necessary. With that, the researchers applied the events of learning described by Robert Gagné: gain attention, inform learners of objectives, stimulate recall of prior learning, present the content, provide "learning guidance," elicit performance, provide feedback, assess performance, and enhance retention and transfer to the job. The simulation-based IM will be designed following these events to ensure the cohesiveness of the topics to be explored in the IM.

In this study, the researchers' goal is to design, develop and validate simulation-based IM that adheres with the curriculum and needs of education of an technologically integrated instructional material that will adhere to the Education 5.0. With the guiding theories, the achievement of the goal relies on these fundamental steps. The developed simulation-based IM will feature (1) Experiential Learning, as the students will have the opportunity to learn the physics concepts by experiencing various simulations that will help them to understand better. (2) Exploration, as students can navigate through the learning material freely, highlighting autonomy and independence, where students can explore the simulations and the whole web itself. To structure the content of the simulation-based IM and to ensure the effectiveness of instruction, the nine events of learning by Robert Gagne (1988) suggest that

for smooth learning to occur, a structured approach in delivering the lesson is needed. Beginning with gaining the attention of the students, identifying the objectives or the goals of the discussion, recalling prior knowledge, presenting stimulus, guiding learning, eliciting performance, providing feedback, assessing performance, and then generalizing the knowledge of the students. This develops competence through immediate feedback that allows students to assess themselves, featuring observable and achievable goals, and they will feel related to the lesson, where students utilize the tool that features contextualization and levels the students, reducing competition and rivalry. Lastly is learning; through assessments and immediate feedback, it will help students assess themselves whether they have learned something or they still need to continue learning. All with the goal to develop web-based IM that will assist students in learning.

Definition of Terms

To ensure clarity and understanding, the following terms are defined as they are used in this study:

Conceptual comprehension - ability to understand and make sense of concepts and ideas.

Experiential learning - an active educational approach where individuals acquire knowledge and skills through direct, hands-on experiences and reflection.

Feedback - information or criticism provided regarding a person's performance, work, or understanding, intended to help improve or reinforce skills, knowledge, and behavior.

Force and Motion - relationship between push and pull (force) and the change in position or velocity of an object (motion).

Interactive - students actively involve themselves in their learning through the use of technology.

Misconceptions - an incorrect understanding or interpretation of a concept, often stemming from a lack of knowledge, experience, or the influence of preconceived notions.

Simulation - replicates real-life situations to help students practice and understand concepts in a safe way.

CHAPTER 2

METHODOLOGY

This chapter presents the research design and methodology, research site, selection criteria and participants, role of researcher, research instrumentation and methods of validation, intervention, data collection, data analysis, potential ethical issues, and risk analysis.

Research Design

The aim of this study is to develop and validate the interactive Simulation-Based Instructional Material (IM). To achieve this, the researchers adopted the Design and Develop Research approach; this approach allows the researchers to design, develop, and evaluate a product that adheres to instructional design models and frameworks. This study will undergo two key phases: (1) design and development of the simulation-based IM, and (2) validation of the said IM.

Research Site

This study will focus on the design, development, and validation of interactive Simulation-Based Instructional Material (IM). Hence, the study will primarily focus on the development of the product and the validation phase of the research which will include validation from physics experts at the Philippine Normal University - Manila and technical experts from Technological Institute of the Philippines - Quezon City.

Selection criteria and participants

The participants involved in each phase of this study are as follows:

1. **Design and Development of the Simulation-Based Instructional Material**

   In this phase, researchers will design and develop interactive simulation-based IM. The content of the instructional material will be obtained from the unpacked learning competency from the MATATAG Science 9 Curriculum for the concepts of Force and Motion.

2. **Validation of Simulation-Based Instructional Material**

   After the design and development, the materials will undergo validation. This process will require 2-3 physics experts to review the content, instructional design, and technical/usability aspects of the interactive simulation-based instructional material (IM). Additionally, the material will undergo technical validation by 2-3 experts in the field of technology to ensure the quality of its technical and usability features.

Role of researcher

The role of researchers will be to design and develop the Simulation-Based Instructional Material (IM), aligning it with the Science Grade 9 Curriculum on the topic of force and motion, making it interactive with simulations and other features that are engaging. Lastly, they will be responsible for implementing the simulation-based IM to physics and technical validators that will evaluate the said IM.

Research Instrumentation and Methods of Validation

The first phase of the data collection involves designing and developing Simulation-Based Instructional Material (IM) on the topic of force and motion, using the MATATAG Curriculum as the basis and guide for the content of the material. Finally, for the validation process of the instructional material, a validation instrument adapted by Marasigan (2019) will be utilized by both physics and technical experts.

Intervention

The intervention of this study will include the design and development of Simulation-Based Instructional Material (IM) and the validation of the content of the material, aligning it with the MATATAG Grade 9 Science Curriculum. Additionally, it will validate its instructional design and technical/usability to ensure it is user-friendly. The simulation-based IM features interactive simulations on the topic of force and motion.

Data Collection

The data collection process of the Simulation-Based Instructional Material (IM) will involve two key steps, these are:

1. **Design and Development of Simulation-Based IM**
    (a) The design and development of simulation-based IM will be undertaken by the researchers. The content of the IM will be obtained and aligned with the MATATAG Science 9 Curriculum Guide.

(b) It will be embedded in Genially, an interactive digital creation tool that will allow the researchers to craft the learning of the students structurally, aligned with instructional design models and frameworks.

2. Validation of Simulation-Based IM

Researchers will:

(a) Collaborate with physics experts in designing and developing simulation-based IM for content accuracy and curriculum alignment.

(b) The researchers, with the help of technical experts, will evaluate the technical aspect of the said IM.

(c) For validation, the researchers will collect feedback from physics and technical experts through:

(i) Structured validation (5-point Likert scale) to rate the IMs' quality, usability, engagement, and relevance, and

(ii) Open-ended interviews to gather detailed qualitative feedback and suggestions for improvement.

For ethical safeguards of this data, the researchers will prioritize ethical considerations throughout the study.

- Informed consent forms and Non-Disclosure Agreements (NDAs) will be given to 2-3 physics education and technical experts.
- All data will be kept confidential, and participants' identities will be protected.
- Researchers will comply with intellectual property rights by properly acknowledging and citing all sources, including ideas, data, and content.

Data Analysis

In the process of undertaking the first phase of the study, which is the design and development phase, there will be no data to be analyzed in this process, as it will solely focus on the design and development of Simulation-Based Instructional Material (IM) using Genially, an interactive digital creation tools, where the content will be aligned with the MATATAG Science 9 Curriculum Guide which will serve as the guide in structuring the content as well as using instructional design models and frameworks - Gagne's Nine Events of instructional, that will ensure a seamless and structured learning experience.

On the other hand, for the second phase of the research, which will involve the validation process, that will ensure that the developed simulation-based IM truly adheres to the standards of the content quality, usability, engagement, and relevance, the 5-point Likert scale validation tool by Marasigan (2019) will be utilized. To draw out the significant result and have a meaningful analysis of the validation tools, the researchers will utilize Aiken's Content Validity Index in analyzing the data.

Potential Ethical Issues

To evaluate the Simulation-Based Instructional Material (IM), the researchers will collaborate with participants during the validation phase. A Non-Disclosure Agreement (NDA) will be required to protect the materials' intellectual property. Feedback and recommendations from participants will remain confidential and will be used to enhance the educational value and effectiveness of the materials. Additionally, the researchers will

implement clear protocols for voluntary participation and the unconditional right to withdraw from the study at any time.

Risk Analysis

- The development process acknowledges potential risks and has established corresponding mitigation strategies. A primary consideration is that the instructional module may not fully align with curriculum standards. To mitigate this, the researchers will conduct a thorough cross-check of all content against the MATATAG Curriculum.
- Furthermore, technical challenges such as non-user-friendly simulations, software bugs, or slow loading times present a significant risk. These will be addressed by utilizing established simulation platforms, implementing a responsive design for cross-device compatibility, and conducting rigorous pre-deployment testing. This plan assumes that such simulations are effective for illustrating abstract concepts and that the majority of the target audience will have access to a compatible device.
- Finally, delays or reviewers' subjective comments may have an effect on the validation process. To preempt this, all necessary documentation will be prepared in advance, earlier deadlines will be set to create a buffer, and reviewers will be provided with a structured evaluation guide. This strategy is predicated on the assumption that the selected validators are subject-matter experts whose insights will be both reliable and constructive for refining the materials.

CHAPTER 3

RESULTS AND DISCUSSION

This chapter presents the curriculum unpacking of the learning competencies, the features of simulation-based IM, and the validity of the developed IM for teaching Force and Motion in Grade 9 Physics. The data were presented and discussed in response to the research questions.

Curriculum Unpacking of the Learning Competencies

Teaching Physics, particularly Force and Motion, has long been recognized as challenging due to its abstract, highly mathematical, and conceptually difficult nature. Students found difficulty visualizing forces, understanding their interactions, and connecting these principles with real-world phenomena, making instructional clarity essential. Because of these, curriculum unpacking becomes a crucial process in ensuring that teachers translate the curriculum into meaningful, accessible, and developmentally appropriate learning experiences. The unpacked competencies presented in Table 1 demonstrate how this process transforms broad content standards into clear, sequenced, and measurable learning objectives supported by simulations through the simulation-based instructional material that enhances conceptual understanding.

Table 1: *Curriculum Unpacking of Force and Motion Concepts Integrated with Simulations.*

Grade Level: 9	Topic: Force and Motion

Learning Competency	Unpacked Learning Objectives
● Identify inertia as the tendency for an object to stay at rest or in motion unless acted on by an unbalanced net force;	1. Identify inertia as an object's tendency to stay at rest or in motion. 2. Use a simulation to see how inertia affects motion. 3. Analyze real-life examples of inertia and their safety implications
● demonstrate in practical situations and describe that acceleration is a change in speed and/or direction as the result of a net force;	1. Describe acceleration as a change in speed or direction from a net force. 2. Use a simulation to show how acceleration influences motion. 3. Reflect on the impact of acceleration in daily life.
● investigate the relationship among force, acceleration, and mass;	1. Explain the relationship between force, acceleration, and mass. 2. Use a simulation to test how mass and force affect acceleration. 3. Share how this relationship influences real-life choices.

• explain that when any two objects interact, there are equal but opposite forces exerted between them, which is evident in many practical situations and applications;	1. Describe equal and opposite forces. 2. Use a simulation to show how objects exert these forces. 3. Discuss the relevance of this principle in everyday life.
• observe and identify action-reaction pairs in everyday situations such as stepping off a boat, or a book on a table, and draw force diagrams to explain how the pairs affect the motion of objects;	1. Identify action-reaction pairs in daily situations. 2. Use a simulation to explore their effects on motion. 3. Reflect on how these pairs help understand motion in life.

The practices reflected in Table 1 align with the literatures that emphasize the crucial role of curriculum unpacking. Gallego et al. (2024) showed that teachers often commit errors, such as double-barreled objectives, overlapping behaviors, and highly complex learning objectives when unpacking learning competencies. Oppositely, the unpacked objectives for the Grade 9 Force and Motion lessons show improved precision and clarity. Broad and complex learning competency is broken down into three specific objectives: cognitive or conceptual, simulation-based application as psychomotor, and reflective or real-life analysis

for the affective domain. This demonstrates the specificity of the objectives and avoids the common errors identified in the previous study.

Similarly, Monton and Ducot (2025) highlighted that effective unpacking requires a holistic preparation process that blends formal training, collaborative learning, accessible resources, and continuous professional development. The integration of simulations in each unpacked objective reflects its core principle. Simulations serve as technological scaffolds that help bridge the gap between abstract Newtonian concepts and concrete representations of motion, force interactions, inertia, and action-reaction pairs. The structure of the unpacked objectives, moving from understanding to simulated exploration and finally to reflection that shows real-life relations, indicates well-supported instructional design that aligns with the teachers' experiences of receiving varied technical assistance.

Furthermore, Cahayag's (2020) study on unpacking practices highlighted that while teachers often follow a linear unpacking process that adheres to curriculum standards, they may still encounter misinterpretations, particularly regarding developmental appropriateness and alignment between standards and instructional tasks. The Force and Motion unpacking presented here demonstrates strong alignment between the intended curriculum and the instructional activities. For example, the competency on inertia is broken down into identifying the concept, exploring it through simulations, and connecting it to real-life safety implications. This not only shows its curricular implications but also enhances its contextualization by enabling the students to see how physics concepts manifest in real life, such as sports and transportation. The same appears to be the competencies on acceleration,

Newton's Second Law, and action-reaction pairs, indicating a balanced approach that is both curriculum-aligned and learner-responsive.

Moreover, the unpacked competencies show features that are the consistent integration of affective and real-life components. These encourage students to interpret their simulation experiences, connect physics principles to daily life, and articulate the relevance of Force and Motion concepts. This reflects the adaptive approach recommended by Cahayag (2020), who advocated for integrating creativity, localization, and varied strategies to respond to diverse learners.

Interactive Instructional Material (IM)

The integration of technology, such as virtual simulations and web-based features in the development of instructional material is an advancement in innovating the education landscape in the country, specifically in teaching the concepts of Force and Motion where misconceptions are still prevalent. By structuring the learning material, it ensures effective instruction and conceptual understanding. The data gathered from this theme focused on the features, structures, and simulations embedded in the interactive simulation-based instructional material (IM).

Table 2: *Simulation-based Instructional Material Features.*

Components	Descriptions

Interactive Simulations	The IM utilizes digital simulations to visualize abstract physics concepts. For Inertia, students use a simulation to observe how objects stay at rest or move. For Acceleration, simulations allow students to test how varying mass and force affect motion. For Interaction, simulations demonstrate how objects exert equal and opposite forces.
Story Board	The developed simulation-based instructional material also features an interactive storyline that gains the attention of the students to encourage them to interact with the learning material.
Real-life Contextualization	Concepts are anchored in relatable, daily scenarios to activate prior knowledge. Examples include observing a cup of iced coffee on a table, spiking a volleyball, pushing a "balikbayan box", walking past scraps in a park, and stepping off a boat onto a dock.
Formative Interactivities	The material includes embedded checkpoints requiring active user input. These include selecting force diagrams that show

	balanced forces, identifying which objects have more mass (e.g., Golf ball vs. Pingpong ball), and predicting motion outcomes (e.g., "Farther, Middle, Shorter").
Immediate Feedback Mechanism	The system provides instant feedback to student inputs. It distinguishes between "Correct!" and "Wrong!" answers and immediately follows up with feedback, such as explaining why a cup stays still due to balanced forces or correcting misconceptions about strength vs. inertia.
Visualization and Diagrams	The IM uses force diagrams to represent invisible vectors. This includes visualizing the force of gravity pressing down and normal force pushing up, as well as visualizing centripetal force in circular motion and action-reaction pairs.
Scaffolded Conceptual Progression	The content is structured to build complexity incrementally. It begins with qualitative observations, moves to quantitative relationships, and concludes with complex system analysis and real-life applications.

The simulation-based features of the IM allow students to visualize abstract physics concepts, such as inertia, acceleration, and interaction forces. This aligns with Muskhir, Zakaria, and Luthfi (2024), who found that web-based simulations enhance students' learning outcomes by providing interactive learning experiences. By allowing learners to manipulate different components such as mass and force, the IMs facilitates exploration, experimentation, and immediate observation of outcomes, supporting constructivist learning theory (Sardar, 2023). With that, students are not passive recipients of information; rather, they explore, test, and revise their understanding in a guided, scaffolded environment.

The integration of storyboards and real-life contexts further strengthens the relevance of physics concepts. Connecting abstract concepts to familiar experiences such as pushing a "balikbayan box", activates prior knowledge and promotes meaningful learning. This approach aligns with constructivist frameworks, highlighting that learners build understanding through social and experiential interactions (Sardar, 2023). Moreover, the IM's formative interactivities and immediate feedback mechanisms reinforce learning by engaging students in continuous assessment and reflection, aligned with Gagne et al. 's (2005) emphasis on the importance of defining performance objectives, providing learner guidance, and designing instruction around the nine events of learning.

Finally, visualization tools in the form of simulation, support the understanding of abstract and invisible phenomena, making complex concepts such as action-reaction pair more understandable. The IM's scaffolded progression, systematic design principles highlighted by Muskhir et al. (2024) and the structured instructional sequencing discussed by

Gagne et al. (2005). Through gradually increasing complexity, the material supports student's cognitive development and promotes higher-order thinking, aligned with the objectives of constructivist and learner-centered pedagogies (Sardar, 2023).

Content, Instructional Material, and Technical and Usability Design Validity

The study produced an interactive Simulation-Based Instructional Material (IM) on Force and Motion for Grade 9, developed using Genially and enriched with embedded Phet simulations. The Simulation-Based IM is structured with the learning objectives, a pre-quiz, lesson content, interactive simulations, and a post-quiz, all arranged in a logical, interactive sequence. With the curriculum unpacking of the Grade 9 Matatag Curriculum and applying the Gagne's Nine Events of Instruction, the material was organized so that learners first activate their prior knowledge with the pre-quiz, then explore the concepts with the simulations, and access their learning through post-quiz. This design intentionally supports a constructivist learning approach, allowing students to engage with simulations by adjusting variables like force, mass, and motion, and visually observe outcomes, thereby gaining deeper and more intuitive understanding of Force and Motion concepts.

After development, the Simulation-Based IM was subjected to expert validation: 3 physics experts evaluated content, instructional design, and technical/usability quality. While 3 technical experts validated instructional design and technical/usability quality.

Table 3: *Summary of Interpretation for Content, Instructional Design, and Technical/Usability Quality Validated by Physics Experts.*

Interpretation	Number of Items
Strong Validity	7
Acceptable, may need Minor Revision	1
Needs Removal or Revision	4

Results from physics experts (Table 3), showed that the content was mostly accurate and aligned with the curriculum, as seen in high ratings for CQ1 and CQ4 (Aiken's V = 0.92). However, they gave lower ratings for CQ2 (Aiken's V = 0.58) and CQ3 (Aiken's V = 0.63), which means the coverage of key concepts needs improvement and some explanations should be clearer. For Instructional design, IDQ2 was rated well (Aiken's V = 0.83), but IDQ1 and IDQ3 got lower ratings (Aiken's V = 0.67), suggesting that some activities and feedback may not fully support the learning goals. Technical/usability aspects such as navigation, layout, and device compatibility were rated high (Aiken's V = 0.83 - 0.92), though minor delays were noted under TUQ4 (Aiken's V = 0.75). Some key concepts need enhancement to improve learning outcomes. Instructional activities and feedback should be adjusted to better support learning goals, and minor technical delays should be addressed. Revalidations are recommended to confirm improvements.

Table 4: *Summary of Interpretation for Instructional Design and Technical/Usability Quality Validated by Technical Experts.*

Interpretation	Number of Items
Strong Validity	10
Acceptable, may need Minor Revision	0
Needs Removal or Revision	0

On the other hand, results from technical experts (Table 4) showed very strong ratings across almost all items. All instructional design items IDQ1 to IDQ5 received high ratings (Aiken's V = 1), indicating full agreement that the Simulation-Based Instructional Material is easy to use, engaging, and well-structured. The technical/usability items also received mostly ratings of 1, except for items TUQ2 (Aiken's V = 0.83) and TUQ4 (Aiken's V = 0.92), which still indicated strong validity. The high ratings suggest that the material is user-friendly and effectively designed. Minor adjustments to items TUQ2 and TUQ4 could further enhance technical performance and usability.

CHAPTER 4

CONCLUSION, IMPLICATIONS, AND RECOMMENDATION

This chapter presents a summary of the findings derived from the study, theoretical implications, practical applications, and future research directions.

Summary of Findings

The study designed, developed, and validated an interactive Simulation-Based Instructional Material (IM) on Force and Motion for Grade 9, integrating Genially features and PHET simulations. The IM was designed following the Grade 9 MATATAG Curriculum and Gagné's Nine Events of Instruction, resulting in a structured sequence that includes learning objectives, a pre-quiz, lesson content, interactive simulations, and a post-quiz. This design supports a constructivist approach by allowing students to manipulate variables such as force, mass, and motion, enabling deeper conceptual understanding.

Expert validation results showed that the simulation-based IM showed strong quality overall. Physics experts rated most content items as valid, particularly in accuracy and curriculum alignment, but identified areas needing improvement, such as broader concept coverage and clearer explanations. Some instructional design elements and feedback mechanisms also required refinement. Technical and usability features received high ratings, with only minor navigation delays noted.

Technical experts rated all instructional design aspects with perfect validity scores, confirming that the material is engaging, easy to use, and well-structured. Technical/usability items were also strongly validated, aside from two items that suggested small improvements in performance. Overall, the findings indicate that the Simulation-Based IM is effective, user-friendly, and instructionally sound, requiring only minor revisions for optimization.

Theoretical Implications

The development and validation of the simulation-based instructional material (IM) for Grade 9 Force and Motion provides important theoretical implications to both the body of knowledge and in the field of education, particularly in teaching science, especially physics education through instructional design. The developed simulation-based instructional material reinforces constructivist learning theory by demonstrating learners' achievement of deeper understanding through actively manipulating variables, observing outcomes, and connecting abstract physics concepts to real-life contexts, following the exploratory and experiential aspect of learning. The IM's interactive simulations exhibit constructivist principles by supporting exploration, experimentation, and knowledge construction in a scaffolded environment (Sardar, 2023).

Ensuring that the simulation-based instructional material adheres and follows instructional design standards, the developed IMs adhered and supports the integration of Gagné's nine events of instruction in digital learning environments, highlighting how structured instructional design, formative feedback, and structured learning experience ensures an effective instruction of concepts Gagne et al. (2005). The utilization of

instructional design frameworks such as Gagne's Nine Events of Instructions ensured that they enhanced conceptual understanding of concepts that are complex such as inertia, acceleration, and action-reaction pairs.

Finally, the findings highlighted the importance of visualizing concepts through simulations and integrating technology and interactivity in enhancing conceptual understanding and making nonobservable processes understandable, providing empirical support for the use of simulation-based simulations in improving learner engagement and comprehension (Muskhir, Zakaria, & Luthfi, 2024). The study theoretically validates that simulation-based materials can assist learning in learning abstract physics concepts and utilize learners' prior knowledge to foster meaningful, learner-centered educational experiences.

Practical Applications

The validated interactive Simulation-Based Instructional Material (IM) can serve as a supplementary tool for Grade 9 teachers who are teaching science, specifically in the context of force and motion. The interactive feature and the simulation itself can help simplify difficult concepts and make the lesson more engaging as students see how things work in the said context. Science teachers can use this as their instructional material, as well as for students who do advance study for their new lesson, and it can also serve as their reviewer. Because the developed simulation-based IM is user-friendly.

Schools may also use this simulation-based IM as a model for designing instructional materials, especially for those subjects integrating digital simulations. The high usability from Technical Experts indicates that the instructional design of this simulation-based IM can be used or replicated for other topics. The said material also supports blended learning, as its compatibility with different devices, such as phones, allows students to access it anytime and anywhere. Overall, the simulation-based IM is a practical resource that can improve instruction once content improvements are made.

Future Research Directions

Since the study mainly focused on designing, developing, and validating the interactive simulation-based IM, future studies may test its effectiveness in improving students' learning outcome. They can assess how the simulation-based IM affects students' conceptual comprehension, engagement, and retention when it is implemented in the actual classroom settings. This study would help show the effectiveness of the validated simulation-based IM when it is used in actual classrooms.

Future researchers may also explore the simulation-based IM by including additional simulations, real-life applications, or making it more interactive, such as adding audio narration, videos, and other features that can enhance students' learning outcomes. They can also compare this simulation-based IM with other existing teaching tools to determine which tools are most helpful for students' learning. Furthermore, gathering both teacher and student feedback during the implementation of the simulation-based IM can provide valuable insights

for further refinement of the material. These directions can help strengthen the simulation-based IM and broaden its use in the field of science education.

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APPENDIX A

TIMELINE

Objectives	Target Activities	Target Accomplishments	Schedule
Develop interactive web-based instructional material (IM) with simulations.	• Define the learning competencies based on Science 9 Matatag Curriculum • Layout the features in Genially • Create the contents of instructional material for Grade 9 Force and Motion • Incorporate Simulations to the instructional material	The interactive web-based instructional material (IM) with simulations for Grade 9 Force and Motion was aligned and developed during weeks 1-6 and was subject to validation.	1-6 weeks
Validate the developed web-based instructional material (IM) with simulations through the expert validation.	• Recruit physics experts • Conduct expert review • Collect the expert's feedback and suggestions	The interactive web-based instructional material (IM) with simulations for Grade 9 Force and Motion was reviewed and validated by physics experts, completed within 6-10 weeks.	6-10 weeks
Finalization of Research	• Analyzing the collected data • Writing Recommendations • Finalizing the chapters	The finalized copy of the study was completed in 10-12 weeks.	10-12 weeks

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APPENDIX B

LINE-ITEM BUDGET

Table 5. Maintenance and Other Operating Expenses.

Travel Expenses	₱ 1,000.00
Supplies	₱ 2,000.00
TOTAL	**₱ 3,000.00**

Table 6. Supplies and Materials.

2 reams of Bond Paper (₱ 250 each)	₱ 500.00
Printer Ink (3 sets)	₱ 2,500.00
TOTAL	**₱ 3,000.00**

Table 7. Tokens.

5 Tokens for Random Students (₱ 75 each)	₱ 375.00
6 Tokens for Validators *(3 physics experts and 3 technical experts)*	₱ 1,500.00
TOTAL	**₱ 1,875.00**

APPENDIX C

EXPECTED OUTCOMES AND IMPACT

Publication

- This study is expected to provide a significant contribution to the existing body of knowledge in education and learning, where it is certified and peer reviewed–published in different journals.

Product

- The study is expected to serve as reference for both learners and educators to use and develop simulation-based instructional material (IM).

Policy

- The study is expected to serve as a guide for educators and the government in developing policies in integrating technology in their teaching practices and the curriculum.

People Service

- To provide an access to students the digital learning materials that will assist them in learning the science concepts of force and motion.

Partnership

- The student is expected to serve as an initiative to develop more digital learning materials with known digital web developers, as well as the government to integrate technology in education.

Patent

- The study is expected to serve as a reference for assessing the learning of the student in particular to the science concept of force and motion. This study is to be protected with the existing rules and regulation of the land from any form of copying the original works of the authors.

Social Impact

- This study is expected to help in reducing inequalities in education and provide an equal access to learning materials, providing a quality education that is for all.

Economic Impact

- The study is expected to reduce the amount of cost that teachers, schools, and universities use in printing learning materials that they use in teaching and assessing learning, significantly alleviating the financial challenges that teachers experience.

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APPENDIX D

PERMISSION TO USE THE VALIDATION FORM

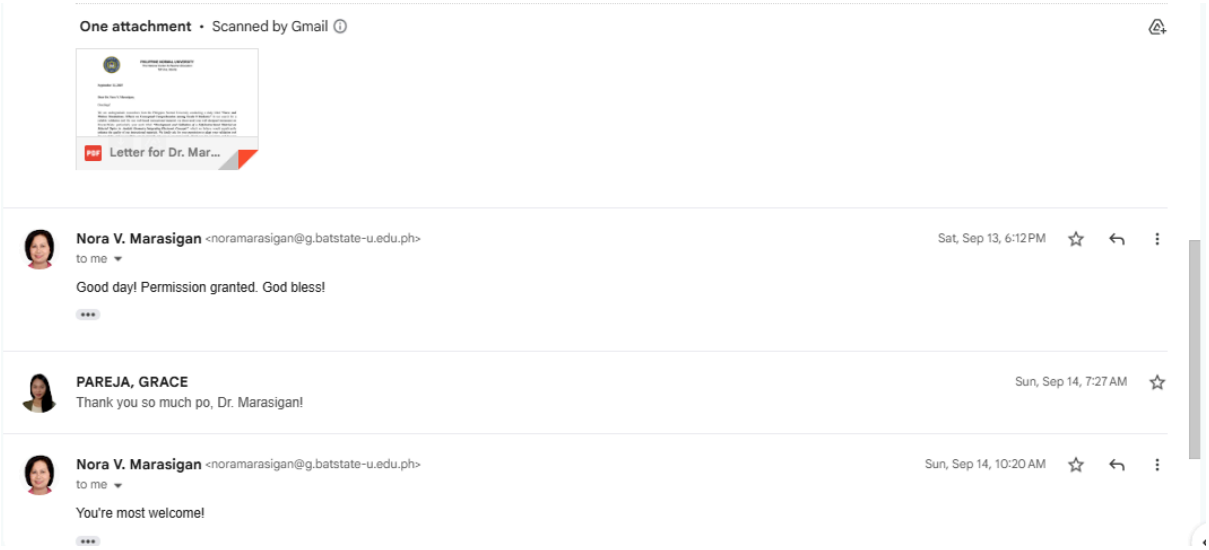

Figure 2: Permission to Use the Validation Form

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APPENDIX E

LETTER FOR PHYSICS EXPERTS

Good day!

We are 4th-year students from Philippine Normal University - Manila, taking Bachelor in Science Education with a specialization in Physics. We are writing to respectfully invite you to participate as an expert validator for our research study, entitled **"DEVELOPMENT AND VALIDATION OF SIMULATION-BASED INSTRUCTIONAL MATERIAL ON FORCE AND MOTION FOR GRADE 9"** Your esteemed expertise in Physics Education would be invaluable to this study, which aims to enhance modern teaching methods and improve science education outcomes.

Your participation would involve reviewing content, instructional design, and technical/usability quality of interactive simulation-based instructional material.

We would be grateful for your professional assessment on their content accuracy, validity, clarity, and appropriateness for Grade 9 students via validation forms we will provide. We anticipate that reviewing the material will take approximately one hour of your time.

Please be assured that your feedback will be treated with the strictest confidentiality and will be used solely for the purpose of refining these educational materials and research instruments. Your participation is entirely voluntary, and you may withdraw at any time without consequence.

If you are willing to assist, we would greatly appreciate it if you could reply to this email. Upon your agreement, we will promptly provide all materials and further details.

Thank you for considering this request.

Sincerely,

Joseph Miles K. Margallo
Student, Philippine Normal University – Manila
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APPENDIX F

LETTER FOR TECHNICAL EXPERTS

Good day!

We are 4th-year students from Philippine Normal University - Manila, taking Bachelor in Science Education with a specialization in Physics. We are writing to respectfully invite you to participate as an expert validator for our research study, entitled **"DEVELOPMENT AND VALIDATION OF SIMULATION-BASED INSTRUCTIONAL MATERIAL ON FORCE AND MOTION FOR GRADE 9"** Your esteemed expertise in Technology would be invaluable to this study, which aims to enhance modern teaching methods and improve science education outcomes.

Your participation would involve reviewing instructional design and technical/usability quality of interactive simulation-based instructional material.

We would be grateful for your professional assessment on their usability, validity, and effectiveness for Grade 9 students via validation forms we will provide. We anticipate that reviewing the material will take approximately one hour of your time.

Please be assured that your feedback will be treated with the strictest confidentiality and will be used solely for the purpose of refining these educational materials and research instruments. Your participation is entirely voluntary, and you may withdraw at any time without consequence.

If you are willing to assist, we would greatly appreciate it if you could reply to this email. Upon your agreement, we will promptly provide all materials and further details.

Thank you for considering this request.

Sincerely,

Joseph Miles K. Margallo
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The National Center for Teacher Education

APPENDIX G

NON-DISCLOSURE AGREEMENT

CONFIDENTIALITY AND NON-DISCLOSURE AGREEMENT

This Agreement is entered into by and between:

The Philippine Normal University (PNU), the national center for teacher education founded by virtue of Act No. 74 of the Philippine Commission enacted on January 21, 1901 and strengthened under Republic Act No. 9647 to become the National Center for Teacher Education, with principal office address at 104 Taft Ave, Ermita, Manila, 1000 Metro Manila, represented herein by its duly authorized representative, hereinafter referred to as the "**DISCLOSING PARTY**,"

And

_____, Filipino, of legal age, ☐single / ☐married , and a
[Full Name of Expert Validator]

resident of _____, hereinafter referred to as
[Address]

the "**RECEIVING PARTY.**"

WHEREAS, the DISCLOSING PARTY, through its research team, is conducting a study entitled:

"Force and Motion Simulations: Effects on Conceptual Comprehension among Grade 8 Students";

PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education

WHEREAS, the DISCLOSING PARTY has developed interactive web-based instructional materials (IMs) with simulations on force and motion, together with adapted assessment tools (e.g., Force Concept Inventory, interview sheets);

WHEREAS, the RECEIVING PARTY has been requested to participate in the **validation and review of the developed instructional materials** and related research instruments, which require access to materials considered confidential;

WHEREAS, the DISCLOSING PARTY desires to protect said materials from unauthorized use, reproduction, or disclosure;

NOW, THEREFORE, for and in consideration of the foregoing premises, the parties hereby agree as follows:

1. SCOPE OF CONFIDENTIAL INFORMATION. —

1.1. The developed instructional material (IM) with simulations on force and motion;

1.2 Adapted versions of the Force Concept Inventory (FCI) and related test items;

1.3 Validation instruments (rubrics, evaluation sheets, survey forms);

1.4 Any draft, digital copy, or documentation related to the study.

2. USE OF CONFIDENTIAL INFORMATION. —- The CONFIDENTIAL INFORMATION shall only be used for the following purposes:

2.1. For the validation and review of the developed interactive web-based instructional materials (IMs) with simulations on force and motion, in order to ensure scientific accuracy, curricular alignment, instructional effectiveness, user-friendliness.

3. LIMITATION OF DISCLOSURE. —-

3.1. CONFIDENTIAL INFORMATION shall not be removed without prior authorization from the Principal Investigator from the locations designated where these information are kept such as cabinets and storage drives of computers and digital equipment;

3.2. Disclosure of CONFIDENTIAL INFORMATION shall be made only to authorized team members; and,

3.3. Exercise DUE DILIGENCE in keeping and protecting CONFIDENTIAL INFORMATION to prevent theft or disclosure to unauthorized persons and entities.

4. EXCLUDED INFORMATION. —This Agreement imposes no obligation on any CONFIDENTIAL INFORMATION that:

4.1. is or becomes a matter of public knowledge through no fault of the RECEIVING PARTY;

4.2. is publicly disclosed without a duty of confidentiality to a third party by, or with the authorization of the DIS-CLOSING PARTY.

5. DISPUTE RESOLUTION. —

5.1. Should there be a misunderstanding or breach in the terms and conditions of this Agreement or in its implementation, the PARTIES shall first exert their best efforts to mutually discuss and resolve their concerns in good faith upon such terms as may be mutually agreed upon by the PARTIES;

5.2. Should the PARTIES fail to reach an amicable settlement of their dispute, the same shall be submitted to arbi-tration, in accordance with Republic Act No. 9285 or the Alternative Dispute Resolution Law of 2004 and its amendments or revisions including other rules, regulations and issuances related to arbitration.

5.3. Implementation of the arbitration award shall be through the court having jurisdiction located in the City of Manila.

6. MISCELLANEOUS PROVISIONS. —

6.1. Failure or delay of a party to require performance by the non-complying party of any provision hereof shall not constitute a waiver and shall not affect the right of the party to enforce the same;

6.2. All rights or remedies available to the PARTIES under this Agreement or by law are separate and cumulative. No right or remedy whether or not exercised, shall exclude any other right or remedy;

6.3. Any waiver, permit, consent, or approval of any kind or character by the PARTIES in connection with this Agreement shall be specified in writing and shall be effective only to the extent that such writing sets forth.

6.4. No such waiver shall be construed as a modification of any provisions of this Agreement or as a waiver of any part or future default or breach thereof, except as expressly stated in such waiver.

6.5. This Agreement embodies the entire agreement of the PARTIES hereto in respect to the transactions stipulated herewith and the subject matter hereof. The PARTIES shall not be bound by, or be liable for, any statement, representation, promise, inducement, or understanding of any kind or nature relating to the said transactions and subject matter which is not set forth or provided for in this Agreement. The PARTIES may, by mutual agreement and in writing, enter into stipulations amending, clarifying, modifying, deleting, or changing any of the terms, conditions or covenants, or any portion of this Agreement, in which case such written stipulations, du-ly signed by the PARTIES, shall form part of this Agreement.

6.6. In the event that any portion of this Agreement is rendered invalid, the remaining portion shall remain subsisting and enforceable.

6.7. All notices, requests, claims, demands and other communications between the PARTIES shall be in writing and given to the PARTIES in the addresses stated in this Agreement or where the PARTY may have transferred. No-tices and communications shall be delivered to the PARTIES through all legal means available.

8. CONSIDERATION. - Payment to the RECEIVING PARTY based on contract for services rendered includes and mandates compliance with this Agreement.

9. EFFECTIVITY. — This Agreement shall be effective from the date signed by all of the PARTIES.

IN WITNESS WHEREOF, the parties have hereunto affixed their signatures this _____ day of _____ 2025 at Manila, Philippines.

DISCLOSING PARTY

Philippine Normal University

Noted by: _____Dr. Marie Paz E. Morales_____

Research Adviser

Research Team:

Joseph Miles Margallo

Student, Philippine Normal University - Manila

margallo.jmk@stud.pnu.edu.ph | (+639) 63-285-6364

IV-23 Bachelor in Science Education with Specialization in Physics

PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education

Grace S. Pareja

Student, Philippine Normal University - Manila

pareja.gs@stud.pnu.edu.ph | (+639) 51-116-3691

IV-23 Bachelor in Science Education with Specialization in Physics

RECEIVING PARTY

Expert Validator

By: _____

(Signature over printed name)

Witnesses:

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APPENDIX H

VALIDATION FORM FOR PHYSICS EXPERTS

Validation tool for Developed Interactive Web-Based Instructional Material (IMs) using 5-point Likert-scale of Marasigan (2019) and Torrefranca (2017) in Force and Motion for Grade 9

Validator name: _____
Date: _____

To the validator: Please indicate your level of agreement with the following statements by checking (✓) the most appropriate box. Provide comments/suggestions in the space provided. Your detailed feedback is invaluable to improve this material.

Rating Scale:

1 - Excellent 2 - Good 3 - Fair 4 - Poor 5 - Very Poor

CRITERIA	1	2	3	4	5	Comments/Suggestions
I. CONTENT QUALITY						
Concepts are correct and free from errors.						
Content covers key concepts of Force and Motion sufficiently for Grade 9						
Concepts are explained clearly and understandably.						
Information is up-to-date and relevant to the curriculum.						
II. INSTRUCTIONAL DESIGN QUALITY						
The IMs effectively meet their stated learning goals.						
Interactivities are engaging and likely to motivate students.						

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Embedded quizzes/activities provide meaningful feedback.						
III. TECHNICAL AND USABILITY QUALITY						
The interface is easy to navigate.						
All interactive elements (simulations, buttons, quizzes) work effectively.						
The layout, graphics, and multimedia are appealing and well-suited.						
Materials run smoothly without significant delays.						
The material appears to be compatible with different devices/browsers.						

IV. OVERALL IMPRESSION AND FINAL RECOMMENDATIONS

1. What are the strengths of these instructional materials?

2. What are the most critical areas that need improvement?

3. Overall, I would rate the readiness of these materials for use in a Grade 9 classroom:

☐ Excellent (Ready to use)
☐ Good (Requires minor revisions)
☐ Fair (Requires moderate revisions)
☐ Poor (Requires major revisions)
☐ Very Poor (Not usable)

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4. Additional comments or suggestions:

Validator's name and signature: _____
Date: _____

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APPENDIX I

VALIDATION FORM FOR TECHNICAL EXPERTS

Validation tool for Developed Interactive Web-Based Instructional Material (IMs) using 5-point Likert-scale of Marasigan (2019) and Torrefranca (2017) in Force and Motion for Grade 9

Validator name: _____
Date: _____

To the validator: Please indicate your level of agreement with the following statements by checking (✓) the most appropriate box. Provide comments/suggestions in the space provided. Your detailed feedback is invaluable to improve this material.

Rating Scale:

1 - Excellent 2 - Good 3 - Fair 4 - Poor 5 - Very Poor

CRITERIA	1	2	3	4	5	Comments/Suggestions
I. INSTRUCTIONAL DESIGN QUALITY						
The IMs effectively meet their stated learning goals.						
Interactivities are engaging and likely to motivate students.						
Embedded quizzes/activities provide meaningful feedback.						
Students have control (self-paced learning, revisit content).						
Text is readable, concise, and well-structured.						
II. TECHNICAL AND USABILITY QUALITY						
The interface is easy to navigate.						

All interactive elements (simulations, buttons, quizzes) work effectively.						
The layout, graphics, and multimedia are appealing and well-suited.						
Materials run smoothly without significant delays.						
The material appears to be compatible with different devices/browsers.						

III. OVERALL IMPRESSION AND FINAL RECOMMENDATIONS

1. What are the strengths of these instructional materials?

2. What are the most critical areas that need improvement?

3. Overall, I would rate the readiness of these materials for use in a Grade 9 classroom:

☐ Excellent (Ready to use)
☐ Good (Requires minor revisions)
☐ Fair (Requires moderate revisions)
☐ Poor (Requires major revisions)
☐ Very Poor (Not usable)

4. Additional comments or suggestions:

Validator's name and signature: _____
Date: _____

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APPENDIX J

VALIDATION CODES AND DATA

Table 8: *Items developed for Content, Instructional Design, and Technical/Usability Quality of Physics Experts.*

Section	Item Code	Items
CONTENT QUALITY	CQ1	Concepts are correct and free from errors.
	CQ2	Content covers key concepts of Force and Motion sufficiently for Grade 9.
	CQ3	Concepts are explained clearly and understandably.
	CQ4	Information is up-to-date and relevant to the curriculum.
INSTRUCTIONAL DESIGN QUALITY	IDQ1	The IMs effectively meet their stated learning goals.
	IDQ2	Interactivities are engaging and likely to motivate students.
	IDQ3	Embedded quizzes/activities provide meaningful feedback.
	TUQ1	The interface is easy to navigate.
	TUQ2	All interactive elements (simulations,

TECHNICAL AND USABILITY QUALITY		buttons, quizzes) work effectively.
	TUQ3	The layout, graphics, and multimedia are appealing and well-suited.
	TUQ4	Materials run smoothly without significant delays.
	TUQ5	The material appears to be compatible with different devices/browsers.

Table 9: *Items developed for Instructional Design and Technical/Usability Quality of Technical Experts.*

Section	**Item Code**	**Items**
INSTRUCTIONAL DESIGN QUALITY	IDQ1	The IMs effectively meet their stated learning goals.
	IDQ2	Interactivities are engaging and likely to motivate students.
	IDQ3	Embedded quizzes/activities provide meaningful feedback.
	IDQ4	Students have control (self-paced learning, revisit content).
	IDQ5	Text is readable, concise, and

		well-structured.
TECHNICAL AND USABILITY QUALITY	TUQ1	The interface is easy to navigate.
	TUQ2	All interactive elements (simulations, buttons, quizzes) work effectively.
	TUQ3	The layout, graphics, and multimedia are appealing and well-suited.
	TUQ4	Materials run smoothly without significant delays.
	TUQ5	The material appears to be compatible with different devices/browsers.

Table 10: *Aiken's V Coefficients for Content, Instructional Design, and Technical/Usability Quality Validated by Physics Experts.*

ITEM / CODE	R1	R2	R3		S1	S2	S3	ΣS	n(c-1)	V
CQ1	5	5	4		4	4	3	11	12	0.92
CQ2	3	4	3		2	3	2	7	12	0.58
CQ3	5	3	3		4	2	2	8	12	0.67
CQ4	5	5	4		4	4	3	11	12	0.92

IDQ1	5	3	3		4	2	2	8	12	0.67
IDQ2	5	5	3		4	4	2	10	12	0.83
IDQ3	5	3	3		4	2	2	8	12	0.67
TUQ1	5	5	4		4	4	3	11	12	0.92
TUQ2	5	4	4		4	3	3	10	12	0.83
TUQ3	5	5	4		4	4	3	11	12	0.92
TUQ4	4	4	4		3	3	3	9	12	0.75
TUQ5	5	4	4		4	3	3	10	12	0.83

Table 11: *Aiken's V Coefficients for Instructional Design and Technical/Usability Quality Validated by Technical Experts.*

ITEM / CODE	**R1**	**R2**	**R3**		**S1**	**S2**	**S3**	**ΣS**	**n(c-1)**	**V**
IDQ1	5	5	5		4	4	4	12	12	1
IDQ2	5	5	5		4	4	4	12	12	1
IDQ3	5	5	5		4	4	4	12	12	1
IDQ4	4	5	5		3	4	4	11	12	0.92

IDQ5	5	5	5		4	4	4	12	12	1
TUQ1	5	5	5		4	4	4	12	12	1
TUQ2	4	5	4		3	4	3	10	12	0.83
TUQ3	5	5	5		4	4	4	12	12	1
TUQ4	5	4	5		4	3	4	11	12	0.92
TUQ5	5	5	5		4	4	4	12	12	1

Table 12: *Interpretations of Aiken's V Coefficients for Content, Instructional Design, and Technical/Usability Quality Validated by Physics Experts.*

ITEM / CODE	**R1**	**R2**	**R3**		**S1**	**S2**	**S3**	**ΣS**	**Aiken's V**	**Interpretation**
CQ1	5	5	4		4	4	3	11	0.92	Strong validity
CQ2	3	4	3		2	3	2	7	0.58	Needs revision or removal
CQ3	5	3	3		4	2	2	8	0.67	Needs revision or removal
CQ4	5	5	4		4	4	3	11	0.92	Strong validity
IDQ1	5	3	3		4	2	2	8	0.67	Needs revision or removal

IDQ2	5	5	3		4	4	2	10	0.83	Strong validity
IDQ3	5	3	3		4	2	2	8	0.67	Needs revision or removal
TUQ1	5	5	4		4	4	3	11	0.92	Strong validity
TUQ2	5	4	4		4	3	3	10	0.83	Strong validity
TUQ3	5	5	4		4	4	3	11	0.92	Strong validity
TUQ4	4	4	4		3	3	3	9	0.75	Acceptable, may need minor revision
TUQ5	5	4	4		4	3	3	10	0.83	Strong validity

Table 13: *Interpretations of Aiken's V Coefficients for Instructional Design and Technical/Usability Quality Validated by Technical Experts.*

ITEM / CODE	**R1**	**R2**	**R3**		**S1**	**S2**	**S3**	**ΣS**	**Aiken's V**	**Interpretation**
IDQ1	5	5	5		4	4	4	12	1	Strong validity
IDQ2	5	5	5		4	4	4	12	1	Strong validity
IDQ3	5	5	5		4	4	4	12	1	Strong validity
IDQ4	4	5	5		3	4	4	11	0.92	Strong validity

IDQ5	5	5	5		4	4	4	12	1	Strong validity
TUQ1	5	5	5		4	4	4	12	1	Strong validity
TUQ2	4	5	4		3	4	3	10	0.83	Strong validity
TUQ3	5	5	5		4	4	4	12	1	Strong validity
TUQ4	5	4	5		4	3	4	11	0.92	Strong validity
TUQ5	5	5	5		4	4	4	12	1	Strong validity

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CURRICULUM VITAE

Name	Joseph Miles K. Margallo
Date of Birth	April 20, 2004
Place of Birth	Dasmariñas City, Cavite
Sex	Male
Contact no.	09632856364
Email	margallo.jmk@stud.pnu.edu.ph

Educational Background

Elementary (Grade 1 - Grade 3)

- Langkaan Learning Center (2010 - 2013)

Elementary (Grade 4 - Grade 6)

- Saint Joseph Academy of Dasmariñas Inc. (2013 - 2016)

Junior High School (Grade 7 - 10)

- Saint Joseph Academy of Dasmariñas Inc. (2016 - 2020)

Senior High School - STEM (Grade 11 - 12)

- Saint Joseph Academy of Dasmariñas Inc. (2020 - 2022)

College (First - Fourth year)

- Philippine Normal University - Manila (2022 - present)

Achievements

Academic Excellence Award Grade 12 (2021 - 2022)
Academic Excellence Award Grade 11 (2020 - 2021)

Experience

Vice President - Internal - PNU Society for the Advancement of Physics Education (A.Y 2024 - 2025)
Faculty and Institute Representative - PNU University Student Council (A.Y 2025 - 2026)

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CURRICULUM VITAE

Name Grace S. Pareja

Date of Birth November 23, 2003

Place of Birth Antipolo City, Rizal

Sex Female

Contact no. 09511163691

Email pareja.gs@stud.pnu.edu.ph

Educational Background

Elementary (Kinder - Grade 6)

- Mayamot Elementary School (2009 - 2016)

Junior High School (Grade 7 - 10)

- Mayamot National High School (2016 - 2020)

Senior High School - HUMSS (Grade 11 - 12)

- Our Lady of Fatima University - Antipolo (2020 - 2022)

College (First - Fourth year)

- Philippine Normal University - Manila (2022 - present)

Achievements

With High Honor (2022)
Academic Excellence Award Grade 12 (2021 - 2022)
Academic Excellence Award Grade 11 (2020 - 2021)
With Honor (2020)

Experience

Organization Auditor - PNU Society for the Advancement of Physics Education (A.Y 2024 - 2025)
Organization Auditor - PNU Society for the advancement of Physics Education (A.Y 2025-2026)