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Research Article

Development and Evaluation of Experiential Learning with Digital Simulation (ELDS) Modules in Electricity & Magnetism

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Abstract
The extreme heat index experienced in the Philippines, which forced several schools to transition to distance learning, highlights the urgent need for instructional materials suitable for remote education. This study aimed to develop and evaluate Evaluation of Experiential Learning with Digital Simulation (ELDS) modules in electricity and magnetism as potential instructional resources for General Physics 2 class. The participants included in the study involved physics experts (n = 5) and Grade 12 STEM students (n = 43) from a private school in Bulacan, Philippines. A Research and Development (R&D) approach utilizing the ADDIE framework was employed, as the study focused on designing and developing instructional materials for the physics subject. Quantitative data were collected using the ELDS Module Evaluation Checklist (ELDSMEC) and analyzed through average means, standard deviations, p-values, and the Mann-Whitney U test. The results indicated no significant difference ($p > 0.05$) between the assessments of physics experts and STEM students regarding the potential effectiveness of the ELDS modules in electricity and magnetism. This suggests that both groups recognize the developed modules as valuable tools for enhancing student learning in these critical areas of physics. The findings underscore the importance of creating adaptable and effective instructional materials that can support distance learning, particularly in response to environmental challenges such as extreme heat index.

Keywords: Digital Simulation, Distance Learning, ELDS Modules, Electricity & Magnetism, Experiential Learning, Physics

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1. INTRODUCTION

In the Philippines, during summer in 2024, the country experienced unprecedented extreme heat, with the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) reporting dangerously high heat indices across various provinces, peaking at 47 degrees Celsius in Manila and nearby cities (Morelo, 2024). In response to the escalating temperatures, which posed significant health risks such as heat exhaustion and heatstroke, the Department of Education (DepEd) mandated a transition to distance learning for many public and private schools nationwide (Marcelo, 2024). This shift aimed to protect students and staff from the adverse effects of extreme heat while ensuring educational continuity amid climate-related challenges.

The transition to alternative learning modalities in numerous schools across the Philippines has led many public institutions to adopt instructional materials, particularly learning modules, as a primary means of lesson delivery. This shift is largely driven by the recognition that a significant number of students lack the necessary resources and access to participate in online classes effectively. The use of learning modules has become a familiar approach for both educators and students, as it mirrors the strategies employed during the height of the COVID-19 pandemic when face-to-face instruction was severely restricted. This continuity in instructional methods not only facilitates the learning process for those unable to engage in

digital platforms but also underscores the resilience of the educational system in adapting to ongoing challenges.

The use of learning modules has proven to be an effective strategy for teaching physics in distance learning contexts, particularly during asynchronous classes(Moradi et al., 2018; Razi, 2024; Villanueva & Concepcion, 2023). A learning module is a structured educational resource designed to facilitate the acquisition of knowledge and skills by providing clear objectives, instructional materials, and activities that guide learners through a specific topic or subject area (Houghton 2023; Rodriguez, 2022). Several studies have underscored the advantages of this learning modules, noting that these instructional materials facilitate self-paced learning and allow students to engage with complex concepts at their own convenience. For instance, a study conducted by Reyes et al. (2022) demonstrated that students utilizing physics learning modules exhibited improved understanding and retention of key principles compared to those relying solely on traditional lecture formats. Additionally, a study revealed by Yuliono et al., (2018) revealed that the structured nature of these modules not only enhances student learning outcomes and motivation but also fosters greater engagement with the material, as learners can revisit challenging topics as needed.

Active learning has emerged as a pivotal pedagogical approach in the teaching of physics, effectively engaging students in the learning process by fostering collaboration, critical thinking, and practical application of concepts (Balta & Awedh, 2017). A number of studies indicates that when students participate actively in their education—through discussions, problem-solving activities, and collaborative projects—they not only enhance their understanding of complex physical principles but also develop essential skills that are critical for their future academic and professional endeavors (Carli & Pantano, 2023). To this day, the incorporation of hands-on laboratory experiences in physics instruction remains particularly effective, as it allows students to directly observe and manipulate physical phenomena, thereby reinforcing theoretical knowledge through practical application (Shana & Abulibdeh, 2020). This experiential learning not only deepens comprehension but also cultivates a sense of curiosity and inquiry, essential components for success in the field of physics (Agsalog, 2019).

In addition to the proven effectiveness of hands-on activities in physics education, the integration of technology, particularly digital simulations, has emerged as a valuable resource in physics classroom (Agyei et al., 2024). This shift has become especially pertinent during periods of distance learning, where traditional laboratory experiences are often inaccessible to students (Alsharif, 2024). Digital simulations provide an interactive platform that allows learners to engage with complex physical phenomena in a safe and controlled environment, thereby facilitating active learning even when in-person experiments are not feasible (Agyei & Agyei, 2021; Banda & Nzabahimana, 2022; Jain & Kaur, 2022). A study of Pranata (2024) indicates that these digital simulations not only enhance students' conceptual understanding but also promote critical thinking and problem-solving skills by allowing students to manipulate variables and observe outcomes in real time. As such, digital simulations have become a go-to teaching resource for physics educators striving to maintain student engagement and foster a deeper understanding of scientific principles during challenging circumstances.

The primary objective of this study is to design, develop, and evaluate a learning module that integrates both experiential learning and digital simulation within an instructional module – ELDS modules. This research specifically aims to determine whether there is a statistically significant difference in the evaluations provided by physics teachers and senior high school students regarding the effectiveness of the ELDS modules. The results of this investigation are intended to serve as a foundational instructional material that can be utilized in future educational settings, particularly in scenarios where traditional hands-on laboratory experiences may be compromised or inaccessible.

2. METHODS

2.1. Research Design

This study employed a Research and Development (R&D) approach, specifically following the ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation (see Figure 1). The ADDIE framework provided a systematic and iterative process for creating an effective learning module that integrates experiential learning and digital simulation in physics education (Mayfield, 2011). Initially, a thorough analysis was conducted to identify the specific needs of both physics teachers

and senior high school students, which informed the design phase where instructional objectives and content were established. The development stage involved creating the learning materials and digital simulations, ensuring they aligned with the identified needs. Following this, the module was implemented in a classroom setting to facilitate active learning experiences. Finally, an evaluation was conducted to assess the effectiveness of the module based on feedback from participants, allowing for necessary revisions and enhancements.

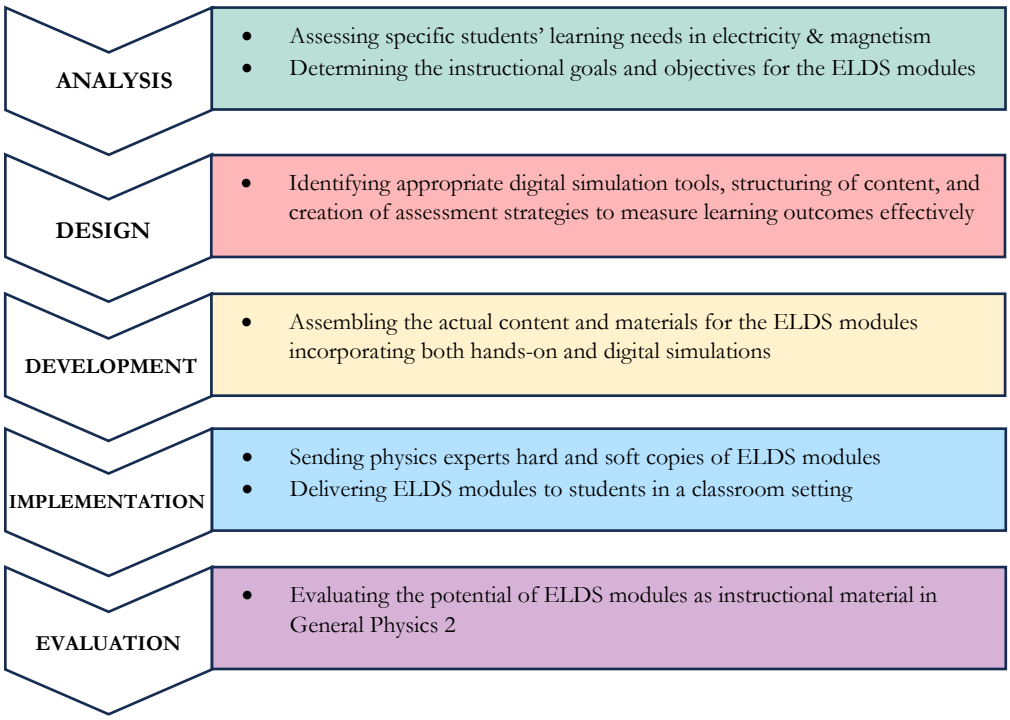

Figure 1. ADDIE Framework

2.3. Participants

This study involved the participation of five physics experts, each holding at least a master's degree in science education, who were tasked with providing their expert evaluations of the developed ELDS modules. Their insights were crucial in assessing the content validity and pedagogical effectiveness of the instructional materials. Additionally, employing a purposive sampling technique, the study engaged 43 Grade 12 STEM students from a private university in Bulacan Province, Philippines. These students evaluated the ELDS modules after utilizing them in their General Physics 1 class, offering valuable feedback on their learning experiences and the perceived impact of the modules on their understanding of physics concepts.

2.4. Research Instruments

The researchers employed the ELDS Module Evaluators' Checklist (ELDSMEC), a tool developed and validated by Marin and Marasigan (2003) as referenced by Torrefranca et al. (2017), to evaluate various instructional modules. This checklist facilitated assessments from both experts and students regarding key aspects of the modules, including their objectives, content, format and language, presentation, and usefulness (*see Appendix A*). The findings indicated a comprehensive evaluation process, with a sample of the evaluators' checklist presented in Table 1.

The acceptability of each parameter was assessed using a scale where 5 represented "strongly agree," 4 indicated "agree," 3 stood for "neither agree nor disagree," 2 meant "disagree," and 1 signified "strongly disagree." Furthermore, the mean score for each parameter was classified based on the following

criteria: highly acceptable (4.21-5.00), acceptable (3.41-4.20), moderately acceptable (2.61-3.40), least acceptable (1.81-2.60), and not acceptable (1.00-1.80).

Table 1. Sample ELDS Module Evaluators' Checklist (ELDSMEC)

Parameters	Number of Items	Item Placement	Sample Question
Objective	5	1	The objectives are clearly expressed in behavioral terms.
		3	The stated objectives are precise, quantifiable, and achievable.
Content	5	8	The topics of each lesson are thoroughly discussed.
		10	Each topic receives equal emphasis in the lesson.
Format and Languages	5	11	The format/layout is well-organized, making the lessons more engaging.
		14	The mathematical symbols used are well-defined.
Presentation	5	16	The topics are arranged in a logical and sequential order.
		19	The presentation of each lesson is appealing and engaging to the students.
Usefulness	5	21	The objectives are clearly expressed in behavioral terms.
		25	The objectives address the needs of the students.

2.4. Procedures

The data gathering procedure for this study will be divided into three distinct stages: (1) Pre-implementation, (2) Implementation, and (3) Post-implementation Stage. Each stage is designed to systematically collect and analyze relevant data to ensure a comprehensive understanding of the study's objectives and outcomes.

2.4.1. Pre-implementation Stage

During this stage, the researchers conducted a thorough analysis of the specific learning needs of students in the area of Electricity & Magnetism, a topic often regarded as one of the more challenging subjects within General Physics 2 due to its abstract concepts. The researchers conducted a formative assessment prior to the commencement of the semester in which General Physics 2 was offered. This preliminary testing provided valuable insights into students' existing knowledge and misconceptions, enabling the researchers to identify critical gaps in understanding that could hinder their learning. By identifying common difficulties faced by learners, the researchers aimed to tailor the ELDS modules to address these challenges effectively.

After analyzing the specific learning needs of the students, the researchers identified suitable digital simulation tools, structure the content effectively, and develop assessment strategies to accurately measure learning outcomes. To facilitate the hands-on activities embedded within the ELDS modules, the e-Gizmo Physics Electrical Package 2, which includes a digital multimeter (DMM) and various common electricity materials for conducting physics experiments, will be utilized. Additionally, for the digital simulation component of the ELDS modules, the researchers will incorporate Multisim.com software and PhET simulations, providing students with interactive and engaging resources to enhance their understanding of Electricity and Magnetism concepts (*see Figure 2*).

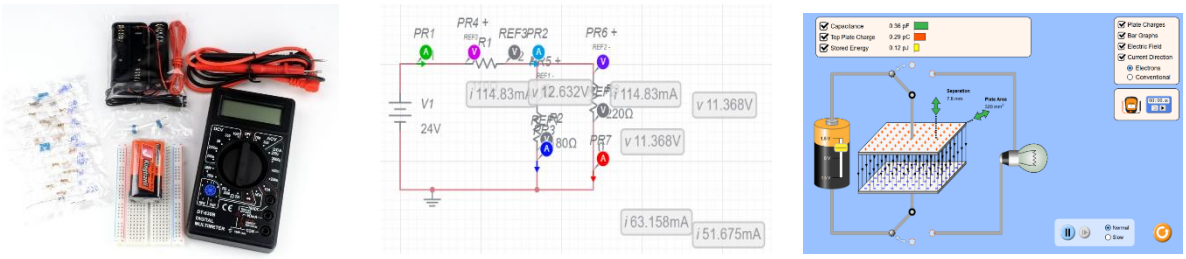

Figure 2. e-Gizmo Physics Electrical Package 2, Multisim.com Software, and PhET Simulations

Following the completion of the initial steps, the researchers proceeded to design the topics for the ELDS modules. The content of these modules is structured to enhance student understanding and

engagement, comprising four key sections: **(1)** ***Introduction***, which elucidates the theoretical concepts underlying each lesson; **(2)** ***Equipment***, detailing the materials necessary for the hands-on activities; ***(3) Procedure***, providing a comprehensive step-by-step guide for conducting both the hands-on and digital simulation activities integrated into the curriculum; and ***(4) Data Sheet***, which includes tables and guiding questions that students will utilize to record their observations and reflections throughout the activities.

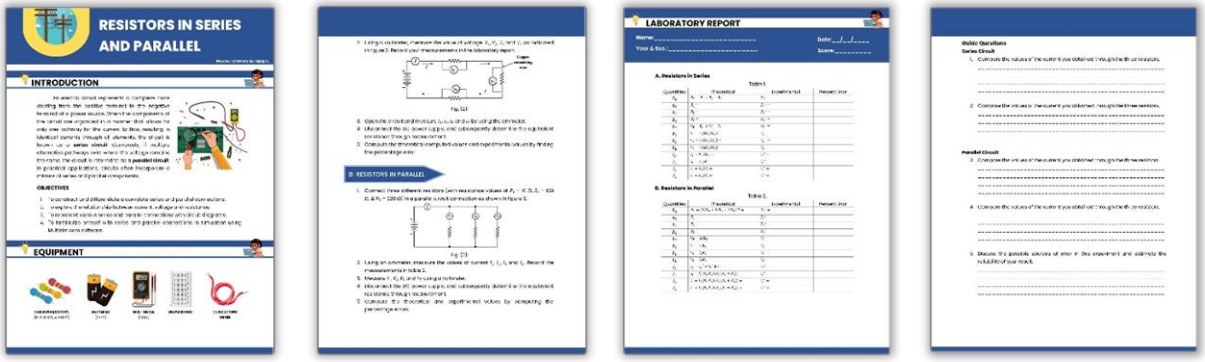

Figure 3. Elements of ELDS modules

2.4.2. Implementation Stage

The developed ELDS modules were delivered to physics experts for their candid evaluation, ensuring the content's quality and relevance. A total of five modules were created by the researchers, as presented in Table 2. Following this expert review, the modules were implemented as instructional materials for Grade 12 STEM students over an eight-week period during their General Physics 2 class hours. Upon completing the eight-week implementation of the ELDS modules, the students were invited to evaluate the developed materials to provide feedback on their effectiveness and usability. This evaluation process aimed to gather insights into the students' experiences with the modules, including their engagement with the content, the clarity of instructions, and the overall impact on their understanding of Electricity and Magnetism

Table 2. Implementation Procedures of ELDS Modules

Week	Number of Hours	ELDS Modules
1	1.5	VOM Familiarization
2-4	4.5	Series and Parallel Circuits in Resistors and Capacitors
5	1.5	Ohm's Law and Maximum Power Transfer
6	1.5	EMF and Internal Resistance
7-8	3.0	Kirchhoff's Rules

2.4.3. Post-implementation Stage

Following the eight-week implementation of the ELDS modules, the researchers conducted a thorough analysis of the data collected from both physics experts and students. This analysis aimed to assess the evaluations provided by the participants, focusing on various aspects such as content clarity, engagement, and overall effectiveness of the modules in facilitating learning. By systematically reviewing this feedback, the researchers were able to determine whether the researchers-developed ELDS modules received an excellent or good evaluation from the participants. This assessment not only highlights the success of the modules but also provides valuable insights for potential refinements in future iterations.

2.5. Data Analysis

The researchers employed a comprehensive statistical treatment utilizing IBM SPSS Statistics 22 software to analyze the data collected from participants. The analysis included several key statistical methods: (1) *Mean*, which provided an average score to summarize the data; (2) *Standard Deviation*, which measured the variability or dispersion of the data points from the mean; and (4) *Mann-Whitney U test*, a non-

parametric test employed to evaluate differences between independent samples. This combination of statistical techniques allowed for a robust analysis of the evaluation data, facilitating a nuanced understanding of both expert and student feedback regarding the ELDS modules. The use of these methods ensured that the researchers could accurately interpret the effectiveness of the modules and make informed decisions for future enhancements based on empirical evidence.

3. RESULTS

3.1. Physics Experts' Evaluation on ELDS Modules

The ELDS modules underwent an initial evaluation by a panel of five physics experts, who were provided with the ELDS Modules Evaluation Checklist (ELDSMEC) as a criterion for assessing the developed materials. This checklist enabled the experts to systematically evaluate various aspects of the modules, including content quality, instructional design, and alignment with learning objectives. The results of their evaluation, as presented in Table 3, indicated that the ELDS modules achieved an impressive overall score of 4.72 out of 5, which is verbally interpreted as "highly acceptable." The mean score was supported by a standard deviation of 0.45. This suggests that the evaluations are clustered closely around the mean. Also, this implies that the responses from the physics experts are fairly consistent, with most ratings being similar and not widely dispersed.

Among the parameters assessed using the ELDS Modules Evaluation Checklist (ELDSMEC), the presentation of the ELDS modules received the highest rating from the physics evaluators, achieving an impressive score of 4.88 out of 5.00, accompanied by a standard deviation of 0.27. This indicates a strong consensus among the evaluators regarding the clarity and effectiveness of the module's presentation. Conversely, the parameter with the lowest score was the objectives of the ELDS modules, which garnered a score of 4.60 out of 5.00 with a standard deviation of 0.57. While this score still reflects a favorable evaluation, it suggests that there may be opportunities for further refinement in articulating the learning objectives to enhance their clarity and alignment with the overall instructional goals.

Despite the overall positive evaluation of the ELDS modules, several experts offered constructive comments and suggestions aimed at further refining the developed materials. For instance, regarding the objectives, Evaluator 2 suggested that: *"While the learning goals were generally clear, they could benefit from more specificity to enhance alignment with the intended outcomes of each module"*. This evaluator suggested that incorporating measurable objectives would not only clarify expectations for students but also facilitate more effective assessment of learning outcomes. Additionally, Evaluator 3 proposed that: *"Objectives should be composed of affective elements that address students' emotional and attitudinal development."* This suggestion highlights the importance of considering the emotional aspects of learning in the formulation of educational objectives. By incorporating affective elements, the objectives can better support holistic student development and foster a more engaging learning environment.

The comments and suggestions provided by the physics experts are invaluable and should be carefully considered in the next cycle of developing ELDS modules for teaching Electricity and Magnetism. Their insights not only highlight specific areas for improvement but also reflect a deeper understanding of the pedagogical needs associated with these complex topics. By integrating their feedback into future iterations, the researchers can enhance the effectiveness and relevance of the modules, ensuring that they better meet the learning objectives and address the diverse needs of students.

Table 3. Physics Experts' Evaluation on ELDS Modules

Parameters	Mean	Std. Dev.	Verbal Interpretation
A. Objectives			
1. The objectives are clearly expressed in behavioral terms.	4.60	0.55	Highly acceptable
2. The objectives are thoroughly planned, formulated, and structured.	4.80	0.45	Highly acceptable
3. The stated objectives are precise, quantifiable, and achievable.	4.20	0.84	Acceptable
4. The objectives are pertinent to the topics of each lesson in the modules.	4.80	0.45	Highly acceptable
5. The objectives consider the needs of the students.	4.60	0.55	Highly acceptable

Parameters	Mean	Std. Dev.	Verbal Interpretation
B. Content			
6. The content of each lesson is directly aligned with the defined objectives.	4.60	0.89	Highly acceptable
7. The content of each lesson is straightforward and easy to comprehend.	4.40	0.89	Highly acceptable
8. The topics of each lesson are thoroughly discussed.	4.60	0.55	Highly acceptable
9. The topics are supported by illustrative examples, and the practice tasks are suited to the students' level.	4.80	0.44	Highly acceptable
10. Each topic receives equal emphasis in the lesson.	4.80	0.44	Highly acceptable
C. Format and Languages			
11. The format/layout is well-organized, making the lessons more engaging.	4.60	0.89	Highly acceptable
12. The language used is simple to understand.	4.80	0.45	Highly acceptable
13. The language used is clear, concise, and motivational.	4.60	0.55	Highly acceptable
14. The mathematical symbols used are well-defined.	4.60	0.55	Highly acceptable
15. The instructions in the instructional modules are concise and straightforward to follow.	4.80	0.45	Highly acceptable
D. Presentation			
16. The topics are arranged in a logical and sequential order.	4.80	0.45	Highly acceptable
17. The lessons of the modules are presented in a distinctive and innovative form.	5.00	0.00	Highly acceptable
18. The learning activities are presented with clarity.	4.80	0.45	Highly acceptable
19. The presentation of each lesson is appealing and engaging to the students.	5.00	0.00	Highly acceptable
20. Sufficient examples are provided for each topic.	4.80	0.45	Highly acceptable
E. Usefulness			
21. The objectives are clearly expressed in behavioral terms.	5.00	0.00	Highly acceptable
22. The objectives are thoroughly planned, formulated, and structured.	4.80	0.45	Highly acceptable
23. The stated objectives are precise, quantifiable, and achievable.	4.80	0.45	Highly acceptable
24. The objectives are aligned with the topics of each lesson in the modules.	4.60	0.55	Highly acceptable
25. The objectives address the needs of the students.	4.80	0.45	Highly acceptable
Overall	**4.72**	**0.49**	**Highly acceptable**

Table 4. STEM Students' Evaluation on ELDS Modules

Parameters	Mean	Std. Dev.	Verbal Interpretation
A. Objectives			
1. The objectives are clearly expressed in behavioral terms.	4.58	0.59	Highly acceptable
2. The objectives are thoroughly planned, formulated, and structured.	4.77	0.48	Highly acceptable
3. The stated objectives are precise, quantifiable, and achievable.	4.77	0.48	Highly acceptable
4. The objectives are pertinent to the topics of each lesson in the modules.	4.51	0.59	Highly acceptable
5. The objectives consider the needs of the students.	4.60	0.54	Highly acceptable
B. Content			
6. The content of each lesson is directly aligned with the defined objectives.	4.67	0.57	Highly acceptable
7. The content of each lesson is straightforward and easy to comprehend.	4.67	0.52	Highly acceptable
8. The topics of each lesson are thoroughly discussed.	4.42	0.66	Highly acceptable
9. The topics are supported by illustrative examples, and the practice tasks are suited to the students' level.	4.60	0.62	Highly acceptable
10. Each topic receives equal emphasis in the lesson.	4.65	0.53	Highly acceptable
C. Format and Languages			
11. The format/layout is well-organized, making the lessons more engaging.	4.47	0.59	Highly acceptable
12. The language used is simple to understand.	4.67	0.47	Highly acceptable

Parameters	Mean	Std. Dev.	Verbal Interpretation
13. The language used is clear, concise, and motivational.	4.65	0.61	Highly acceptable
14. The mathematical symbols used are well-defined.	4.53	0.59	Highly acceptable
15. The instructions in the instructional modules are concise and straightforward to follow.	4.58	0.66	Highly acceptable
D. Presentation			
16. The topics are arranged in a logical and sequential order.	4.60	0.58	Highly acceptable
17. The lessons of the modules are presented in a distinctive and innovative form.	4.77	0.48	Highly acceptable
18. The learning activities are presented with clarity.	4.74	0.44	Highly acceptable
19. The presentation of each lesson is appealing and engaging to the students.	4.58	0.50	Highly acceptable
20. Sufficient examples are provided for each topic.	4.56	0.55	Highly acceptable
E. Usefulness			
21. The objectives are clearly expressed in behavioral terms.	4.65	0.48	Highly acceptable
22. The objectives are thoroughly planned, formulated, and structured.	4.67	0.47	Highly acceptable
23. The stated objectives are precise, quantifiable, and achievable.	4.65	0.48	Highly acceptable
24. The objectives are aligned with the topics of each lesson in the modules.	4.65	0.53	Highly acceptable
25. The objectives address the needs of the students.	4.65	0.53	Highly acceptable
Overall	**4.63**	**0.54**	**Highly acceptable**

3.2. STEM Students' Evaluation on ELDS Modules

After an eight-week implementation of the developed ELDS modules in their General Physics 2 class, students conducted a comprehensive evaluation of the learning materials. The assessment yielded an impressive overall score of 4.63 out of 5.00, indicating a high level of satisfaction and perceived effectiveness among the participants. Additionally, the standard deviation of 0.54 suggests a relatively consistent positive response across the student cohort, reflecting a strong consensus regarding the modules' utility in enhancing their understanding of complex physics concepts.

Among the parameters assessed in the checklist, the usefulness of the ELDS modules emerged as the most highly rated aspect, achieving a mean score of 4.66, which is interpreted as highly accepted by the students, accompanied by a standard deviation of 0.50. Conversely, the format and language of the ELDS modules received the lowest score of 4.58, with a standard deviation of 0.53. Despite being the lowest-rated parameter, this score still falls within the range of high acceptability, indicating that students generally found the format and language to be satisfactory.

Some students provided positive feedback regarding the ELDS modules, highlighting their effectiveness in facilitating learning. For instance, Student 23 remarked, *"The modules are very easy to follow, the format of the modules makes it easy to follow,"* indicating that the structure and clarity of the content significantly contributed to their understanding. Additionally, Student 6 expressed appreciation for the inclusion of hands-on and virtual simulations in the lab, stating, *"I like that there are hands-on and virtual simulation integrated on the modules, it is easier to check the correct answer"* which underscores the value of interactive elements in enhancing practical learning experiences. Lastly, Student 17 noted, *"The procedure can be easily followed if you try to understand and comprehend it,"* suggesting that while the modules require engagement, they are accessible and comprehensible when students invest effort in their learning. These comments collectively affirm the positive reception of the ELDS modules among students.

Although the majority of comments regarding the ELDS modules were positive, several students also provided constructive feedback aimed at improving the materials. For example, Student 13 suggested that: *"The modules could benefit from additional visual aids to enhance understanding of complex concepts,"* indicating a desire for more diagrams and illustrations to complement the text. Student 3 suggested that*: "A need for more interactive elements within the modules, such as quizzes or discussion prompts, to encourage deeper engagement with the content"*. Additionally, Student 37 noted that: "*While the language used was generally clear, simplifying certain technical terms could make the modules more accessible to all learners"*. These suggestions reflect a commitment to continuous

improvement and highlight areas where the ELDS modules can be further refined to better meet student needs and enhance overall learning outcomes.

3.3. Comparison of Physics Experts and STEM Students' Evaluation on ELDS Modules

According to the results of the test for significant differences (Mann-Whitney U test) between the evaluations of physics experts and STEM students regarding the potential use of ELDS modules in electricity and magnetism, the analysis revealed a p-value of greater than 0.05 ($p>0.05$). This finding indicates that the null hypothesis should be accepted, suggesting a statistically significant difference between the evaluations of the two independent groups. Specifically, both physics experts and STEM students concurred on the effectiveness of the developed ELDS modules as a viable instructional tool for topics in electricity and magnetism.

Table 5. Test of Significant Difference of Physics Experts & STEM Students Evaluation

Mean Score		Mann-Whitney U test	Decision on null hypothesis	Remarks
Physics Experts	STEM Students			
4.72	4.63	0.51	Accept	There is no significant difference between Physics expert' evaluation and STEM students' evaluation

As illustrated in Figure 4, there is a notable consensus between the two groups regarding their evaluations of the potential effectiveness of the ELDS modules. The analysis reveals minimal discrepancies in their assessments across various dimensions, including objectives, content, format and language, presentation, and overall usefulness. This close alignment suggests that both groups share a common understanding of the modules' strengths and applicability in enhancing educational outcomes. Such agreement reinforces the validity of the ELDS modules as a promising resource for teaching complex concepts in physics, indicating that they are well-received by diverse audiences within the educational landscape.

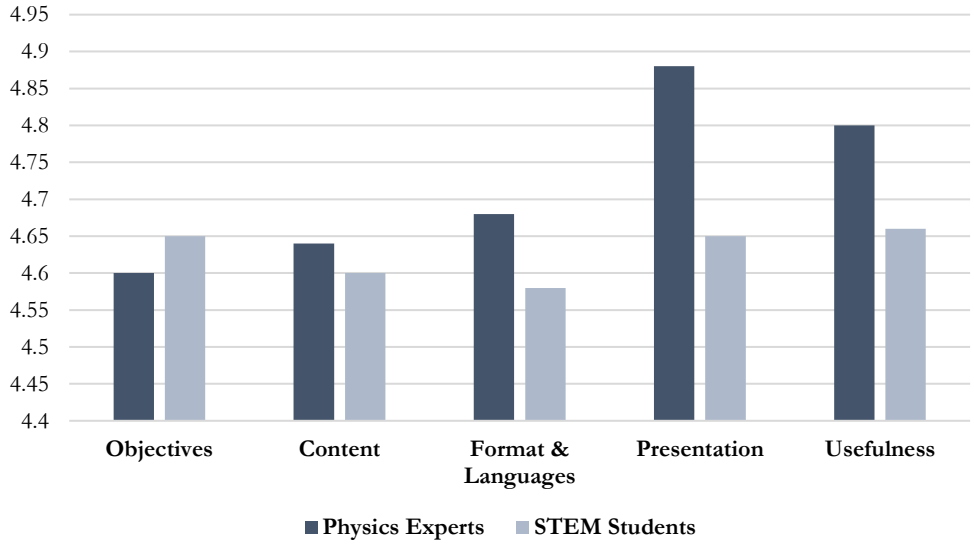

Figure 4. Participants' Evaluation on ELDS Modules

Therefore, these results indicate a significant consensus among the overall assessments of both physics experts and STEM students regarding the potential effectiveness of the developed ELDS modules as instructional tool for General Physics 2 subject, particularly in the domains of electricity and magnetism. This finding underscores the perceived value of these ELDS modules in enhancing student engagement and comprehension in complex scientific concepts. The alignment in perspectives between seasoned professionals and emerging scholars suggests that the ELDS modules could serve as a bridge to foster

deeper understanding and application of physics principles, thereby enriching the educational experience in this critical area of study.

4. DISCUSSION

Based on the results obtained from this study, it was determined that both physics experts and STEM students reached a consensus on the potential effectiveness of Experiential Learning with Digital Simulation (ELDS) modules as instructional materials in the event of a transition to distance learning. The findings indicate a strong alignment between the perspectives of seasoned educators and learners, suggesting that ELDS modules not only facilitate engagement but also enhance comprehension of complex concepts in Electricity and Magnetism. This study successfully achieved its aim of developing innovative instructional materials tailored for distance learning environments, thereby addressing the critical need for effective pedagogical strategies in the face of evolving educational modalities.

There are several studies that revealed that combining both hands-on experiment and digital simulation experiment can support students learning in science better than implementing only one of these (Brinson, 2015; Rutten et al., 2012; Sypsas & Kalles, 2018). The current study revealed that the developed ELDS modules possess significant potential as instructional materials for the General Physics 2 class, particularly in the context of electricity and magnetism topics. This finding aligns with the results of the study conducted by Flegr et al. (2023) and Gumilar et. al (2019), which demonstrated the effectiveness of integrating hands-on activities with digital simulations within physics modules. Their research highlighted how such a combination enhances student conceptual understanding, reinforcing the notion that interactive and multimodal approaches can significantly improve learning outcomes in complex subject areas.

However, there have been studies revealing a negative effect of combining hands-on and virtual simulation in a single session for learning physics. The research conducted by Manunure et al. (2019) indicated that while the combination approach decreased the proportion of students' misconceptions regarding electric circuits, it was more effective than traditional laboratory environments alone. Atanas (2018) further reported that the effectiveness of this combined method is contingent upon the abstract nature of the physics topics being taught, suggesting that certain concepts may not benefit equally from both modalities. Additionally, Sullivan et al. (2017) highlighted that the advantages of integrating hands-on and virtual simulations on students' learning and engagement in physics remain inconclusive, raising questions about the overall efficacy of such combined instructional strategies.

The incongruencies observed in the positive and negative outcomes of combining hands-on experiments with virtual simulation in a single topic underscore the necessity for well-designed instructional materials that integrate both approaches. This calls for a systematic exploration of ELDS modules, which could potentially harmonize the strengths of each method. It is recommended that future research focus on evaluating the effectiveness of these ELDS modules in enhancing students' conceptual understanding, attitude, and motivation in physics. By investigating how these integrated materials can facilitate deeper learning experiences, educators may better address the diverse needs of students and improve overall educational outcomes in the field of physics.

The implications of this study are significant for both educational practice and curriculum design in STEM fields. By demonstrating that ELDS modules can effectively bridge the gap between theoretical knowledge and practical application, this research highlights the potential for such digital tools to enhance student engagement and understanding in a remote learning context. Furthermore, the positive feedback from both physics experts and STEM students underscores the importance of integrating interactive simulations into instructional materials, suggesting that educators should prioritize the adoption of innovative teaching strategies that leverage technology. This study not only contributes to the existing body of knowledge on pedagogical approaches in physics education but also provides a framework for future research aimed at optimizing distance learning experiences in science disciplines.

5. CONCLUSION AND RECOMMENDATION

The primary objective of this study is to develop and evaluate ELDS modules focused on specific topics within electricity and magnetism. The findings of this study suggest that these researchers-made

ELDS modules hold promise as effective instructional materials in the field of physics, particularly for enhancing understanding of complex concepts related to electricity and magnetism. To further assess their effectiveness, it is recommended that future research implements these modules in educational settings while measuring their impact on students' conceptual understanding and motivation in learning physics. Such investigations will provide valuable insights into the potential of ELDS modules to improve educational outcomes and foster greater engagement among students in this critical area of study.

Despite the positive results of this study, it is recommended that future research on Experiential Learning with Digital Simulation (ELDS) modules be conducted with a larger sample size and a more diverse participant group to enhance the generalizability of the findings. Expanding the demographic and educational backgrounds of participants could provide deeper insights into how different learners interact with and benefit from these instructional materials. Additionally, employing a qualitative or mixed-methods approach in subsequent studies would allow researchers to capture the nuanced perceptions and experiences of participants, thereby enriching the understanding of the effectiveness and impact of ELDS modules. Such an approach could reveal valuable information about user engagement, motivation, and the specific challenges faced in learning complex concepts in Electricity and Magnetism, ultimately leading to more refined and effective educational strategies.

The researcher suggests that school administrators and stakeholders consider implementing a hybrid approach that combines practical experiments with virtual simulation modules in the event of an immediate transition to distance learning. This integrated strategy not only leverages the strengths of hands-on learning experiences but also capitalizes on the flexibility and accessibility offered by digital simulations. By testing the effectiveness of this hybrid model, educational institutions can better support student engagement and comprehension in complex subjects such as Electricity and Magnetism, particularly during unforeseen disruptions. Such an approach could provide valuable insights into how blended learning environments can enhance educational outcomes, ultimately fostering a more resilient and adaptable framework for teaching in the face of future challenges.

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