Exploring Teachers' Challenges in Teaching Electric Motors and Generators: Basis for the Development of an Inquiry-Based E-Flipbook

Benz Lydylee G. Tanaman, Fedelis C. Bonocan

Master of Arts in Science Education, Faculty of the College Education, University of Southeastern Philippines

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INTRODUCTION

Background of the study

In the context of 21st-century education, the integration of digital technologies into science instruction is no longer optional, it is essential. Today's students are expected to master critical 21st-century skills such as problem-solving, innovation, collaboration, digital literacy, and scientific reasoning. These skills thrive in learning environments that promote active exploration and meaningful interaction with content.

Among the instructional approaches aligned with these goals, Inquiry-Based Learning (IBL) has emerged as a powerful pedagogical strategy that fosters curiosity, autonomy, and deep understanding. When combined with digital innovations like interactive e-flipbooks, IBL can transform traditional content delivery into dynamic and student-centered learning experiences. According to Khasanah et al. (2021), digital flipbooks offer an engaging format for presenting science concepts, allowing learners to visualize abstract topics through animations, videos, and interactive features that enhance conceptual understanding.

Globally, researchers and educators have increasingly adopted technology-enhanced learning tools to improve science education. Studies by Hidayatulloh (2019) and Khaerunnisa et al. (2023) demonstrated that inquiry-based flipbooks significantly enhance student engagement and science process skills, especially when applied to complex physics topics. Nedungadi et al. (2018) emphasized that digital learning platforms are particularly beneficial for visual and auditory learners, providing alternative pathways to understand content that traditional textbooks may fail to deliver. Similarly, Suryani and Ardianto (2019) pointed out that flipbooks offer sustainable, multimedia-rich resources that align with the digital literacy demands of the Fourth Industrial Revolution. These global findings confirm the value of integrating inquiry and technology in science instruction, particularly for topics that require visualization and experimentation such as the relationship between electricity and magnetism in electric motors and generators.

In the Philippines, the Department of Education (DepEd) responded to the challenges of the pandemic by providing Self-Learning Modules (SLMs) to ensure continuous learning in remote and low-resource contexts. These modules remain widely used under the K to 12 curriculum and are considered primary references in public schools (DepEd, 2022). However, despite their accessibility, SLMs have limitations. They are often static and text-heavy, offering limited support for learners who need more engaging, hands-on experiences to grasp scientific principles.

In addition, Santiago (2020) found that students struggle particularly with electromagnetism, specifically electric motors and generators, due to the abstract nature of the topic and the lack of interactive materials. Guisasola et al. (2017) likewise observed that many students fail to understand the energy transformation processes in generators and motors without contextual and inquiry-driven instruction.

These challenges are not far from our own experiences in Davao del Sur School of Fisheries (DSSF), where teachers have consistently observed that learners struggle to relate the functions of electric motors and generators to real-life applications. This difficulty is often attributed to the absence of visual materials and interactive learning tools in the current instructional setup. Based on consolidated feedback and performance records from Grade 10 science teachers at DSSF, these competencies particularly those related to electromagnetism have been identified as among the least mastered by students.

Moreover, this aligns with national trends, highlighting a pressing need for more engaging and contextually relevant instructional materials to bridge these conceptual gaps. These also suggest a need for improved teaching tools that align with both content and performance standards, as outlined in DepEd Order No. 012, s. 2020 and DepEd Order No. 158, s. 2011.

To address these challenges, this study aims to identify the least-learned competencies and common issues students encounter when using the SLMs on electric motors and generators, and to develop an inquiry-based e-flipbook as a supplementary learning tool. The flipbook is not intended to replace existing modules but to enhance learning by offering interactive, inquiry-driven tasks aligned with the curriculum. Ultimately, this research seeks to contribute to the improvement of science education in the country by designing a contextualized and engaging tool that supports both learner autonomy and academic achievement.

Statement of the Problem

This study aims to assess the performance, competencies, and challenges of Grade 10 science students in learning Electric motor and generator using the DepEd Self-Learning Module (SLM), and to develop inquiry-based e-flipbook as a supplementary learning tool to address the identified gaps and enhance student engagement and understanding.

Specifically, this research seeks to answer to the following questions:

1. What are the performance task results of Grade 10 science students on electric motor and generator using the DepEd's Self Learning Module (SLM)?
2. What is the Grade 10 science students least performed competencies electric motor and generator using the DepEd's Self Learning Module (SLM)?
3. What are the issues and challenges of Grade 10 science students in performing tasks on electric motor and generator using the DepEd's Self Learning Module (SLM)?
4. How do Grade 10 science students cope with the challenges in performing tasks on electric motor and generator using the DepEd's Self Learning Module (SLM)?
5. What are the performance tasks on Electric Motor and Generator that can be designed using inquiry-based learning approach as supplementary tool to address the challenges experience by the Grade 10 science students?

Objectives of the Study

This study aims to assess the performance, competencies, and challenges of Grade 10 science students in learning electric motor and generator using the DepEd Self-Learning Module (SLM), and to develop inquiry-based e-flipbook as a supplementary learning tool to address the identified gaps and enhance student engagement and understanding.

Specifically, it seeks to achieve the following objectives:

1. To determine the performance task results of Grade 10 science students on electric motor and generator using the Department of Education's Self-Learning Module (SLM).
2. To identify the least mastered competencies in electric motor and generator among Grade 10 science students using the DepEd SLM.
3. To determine the issues and challenges encountered by Grade 10 science students in performing tasks related to electric motor and generator using the DepEd SLM.

4. To describe the coping strategies employed by Grade 10 science students in addressing the challenges of learning electric motor and generator using the DepEd SLM.
5. To design inquiry-based performance tasks as a supplementary learning tool to address the identified challenges in understanding electric motor and generator among Grade 10 science students.

Significance of the Study

The results of this study will contribute significantly to the growing body of knowledge on enhancing students' academic performance in science through innovative and inquiry-based digital learning tools. Specifically, it aims to provide insights into the challenges faced by Grade 10 students in understanding Electric Motor and Generator using the DepEd Self-Learning Modules (SLMs), and how these may be addressed through the integration of an inquiry-based e-flipbook. The findings of this study will be beneficial to the following:

Students. This study is beneficial to Grade 10 students as it introduces an interactive and engaging alternative to the traditional SLM. The inquiry-based e-flipbook promotes active learning, critical thinking, and conceptual understanding, particularly in a complex topic like Electric Motor and Generator. It allows learners to explore content at their own pace, visualize scientific processes, and connect concepts to real-world scenarios—thereby improving motivation, comprehension, and performance.

Teachers. For science teachers, the study offers a supplementary instructional tool aligned with the inquiry-based approach in the K–12 curriculum. It provides an opportunity to differentiate instruction and cater to diverse learning styles using multimedia features. Furthermore, the insights gathered from this study can help teachers identify students' least performed competencies and common challenges, allowing them to make data-driven instructional adjustments and improve classroom strategies.

School Administrators. School administrators will benefit from the study by gaining insights into how digital, inquiry-based tools like e-flipbooks can support learning outcomes and enhance science instruction. The results can inform decisions on integrating low-cost, high-impact innovations into school programs and provide a model for supporting teachers in delivering more engaging and effective instruction. It also promotes the development of a more flexible and responsive learning environment aligned with 21st-century education goals.

Future Researchers. This study may serve as a valuable reference for future researchers who wish to explore the integration of inquiry-based approaches with digital tools in science education. The findings, design, and methodology of this research can provide direction for replicating or extending the study to other science topics, grade levels, or subject areas. It also opens opportunities for further investigation on the long-term effects of using e-flipbooks, their impact on learners with diverse needs, and their application in blended or fully digital classrooms.

Scope and Limitations of the Study

This study will focus on the topic of electric motors and generators and create a contextualized e-flipbook as a supplemental interactive learning material that serves as a strategy to support the learning competency on explaining the operation of a simple electric motor and generator to further enhance the students' understanding and application of the concept. Moreover, the contextualized e-flipbook will not undergo expert validation, since this study will only focus on the learning competency and will just support the DepEd's Grade 10 science curriculum on electric motors and generators. Furthermore, the topic will only focus on electric motors and generators as identified to be one of the least-mastered competencies both in the school and the division of Davao del Sur based on classroom performance tasks. In addition, this study will be conducted in only one section and the participants are the Grade 10 science students in one of the public schools in Davao del Sur and is composed of seventeen (17) males and fourteen (14) females, in which three (3) male and three (3) female students will be interviewed, and the study will be conducted during the second quarter of the school year 2025–2026.

Definition of Terms

In order to fully understand the study, the following terms were defined:

Inquiry-based Learning Approach. According to Branch and Solowan (2003), IBL, which is a student-centered approach focuses on asking questions, critical thinking, and problem solving, which enables students to develop skills needed throughout their whole lives. As such, it helps students to cope with their problems. It also helps create a learning environment that supports innovation by encouraging independent thinking, autonomy, and initiative. This study will center on creating inquiry-based e-flipbooks as a supplementary tool for teaching Grade 10 science students the concepts of electric motor and generator. Through this approach, the research aims to provide an engaging, interactive, and student-driven learning experience that addresses the limitations of the current Self-Learning Modules (SLMs) and improves students' understanding and performance in electric motor and generator during academic year 2025-2026.

Self-Learning Module. Self-Learning Modules (SLMs) are developed as independent, self-paced, and interactive instructional materials that allow students to learn on their own, especially in situations where face-to-face instruction is not feasible (Department of Education, 2020). These modules aim to ensure continuity of learning during emergencies or in geographically isolated areas. In this study, the SLM provided by the Department of Education on the topic of electric motors and generators for the second quarter of the school year 2025–2026 will be utilized by Grade 10 science students. It will serve as a basis for data collection and identifying which parts of the learning competency, specifically explaining the operation of a simple electric motor and generator that are least understood, thereby guiding the development of a supplemental e-flipbook.

E-flipbook. A digital flipbook is an electronic format of a book that simulates the experience of flipping through pages, similar to traditional printed books, but includes interactive elements like animations, audio, and videos. The integration of digital flipbooks aims to boost learners' engagement and motivation, making it easier for them to grasp scientific concepts (Asad et al., 2020). In this study, it refers to the supplementary tool to be developed on the topic Electric Motor and Generator as an alternative to the DepEd Self-Learning Module (SLM).

Electric Motor and Generator. Anything that changes electricity into motion, meaning electrical energy into mechanical energy is called an electric motor. It converts electrical energy to mechanical energy. In addition, a generator converts mechanical energy to electrical energy. It produces an electric current when a coil of wire is wrapped around an iron core and rotated near a magnet an electric generator is a device that converts mechanical energy obtained from an external source into electrical energy as the output (Boldea, 2017). In this study, the electric motor will serve as the focused content for designing inquiry-based performance tasks within the supplementary e-flipbook with particular attention to the learning competency of explaining the operation of a simple electric motor and generator. This is aligned with the content standard emphasizing the understanding of the relationship between electricity and magnetism in the context of electric motors and generators. It also supports the performance standard requiring learners to design, build, and explain the operation of a simple electric motor or generator, allowing them to apply theoretical knowledge to practical tasks which aligns with the Most Essential Learning Competencies (MELCs).

REVIEW OF LITERATURE AND THEORETICAL FRAMEWORK

This chapter covered the relevant literature and studies used to support the study's claims. This chapter also presented the conceptual framework to fully understand the study to be done and its hypothesis to define the relationship between two variables.

Inquiry-based Learning Approach

According to Wilson (2020), the integration of Inquiry-Based Learning (IBL) into science instruction significantly enhances students' inquiry skills and their ability to relate scientific concepts to real-world issues. In a similar vein, Zubaidah et al. (2018) emphasized that cultivating critical thinking improves learners' reasoning and decision-making, particularly when contextual and problem-based activities are embedded in digital learning tools.

In addition, Spronken-Smith and Walker (2010) described IBL as a student-centered and self-directed pedagogical approach. This method empowers students to take ownership of their learning, which increases motivation, supports autonomy, and strengthens their problem-solving abilities—factors essential for lifelong learning.

Moreover, Ennis (2011) and Klein (2011) highlighted that critical thinking is rooted in analyzing evidence, interpreting data, and making well-reasoned conclusions and the core competencies developed through inquiry-driven learning. These cognitive processes align with the structure of IBL, as outlined by Pedaste et al. (2015), who identified five key phases: orientation, conceptualization, investigation, conclusion, and discussion. When embedded into tools like e-flipbooks, these stages facilitate deeper, structured learning experiences.

Likewise, Lazonder and Harmsen (2016) and Keselman (2003) affirmed that IBL enables students to actively construct knowledge through meaningful problem-solving and data interpretation. Such active engagement is especially valuable when tackling complex science topics like electric motors and generators. Further reinforcing this, Bybee (2014) asserted that IBL strengthens students' cognitive abilities by promoting hands-on exploration and scientific reasoning.

Furthermore, Chinn (2007) also defined IBL as an approach that encourages learners to pose questions, investigate phenomena, and create explanations grounded in evidence—thereby developing scientific reasoning and curiosity. Lastly, Lipman (2003) provided foundational insight by arguing that inquiry is often sparked by cognitive dissonance, where learners encounter gaps or inconsistencies in their understanding. This discomfort drives them to explore, resolve, and construct new knowledge, especially when faced with authentic, real-world challenges.

Critical thinking. As Susetyarini et al. (2020) highlighted, critical thinking skills are essential for achieving academic success and ensuring lifelong learning, especially in the context of an increasingly complex and dynamic world. Building on this, Shaw (2019) emphasized that such competencies are not only vital in the classroom but are also foundational to success in professional environments. Similarly, Tan (2019) pointed out that critical thinking fosters innovation, independence, and effective problem-solving—traits that are necessary for developing self-reliant and adaptable individuals. Earlier, Glaze (2018) underscored the importance of empowering modern learners with both conceptual understanding and practical life skills to help them navigate the multifaceted demands of the 21st century.

Self-Learning Module

The Philippine Department of Education (DepEd) acknowledged the importance of SLMs during the COVID-19 pandemic by implementing the Basic Education Learning Continuity Plan (BE-LCP). This initiative, supported by DepEd Orders No. 007, 012, 013, and 014, s. 2020, aimed to maintain learning continuity through the development of standardized and contextualized SLMs across the country. These modules were aligned with the Most Essential Learning Competencies (MELCs), which aimed to reduce the cognitive load on students and simplify the curriculum (DepEd, 2020). According to Bayod and Bayod (2020), MELC-aligned SLMs played a crucial role in bridging the digital divide, especially for learners in rural and under-resourced areas with limited or no access to the internet.

Self-Learning Modules (SLMs) are increasingly being recognized as effective instructional tools that support student-centered and independent learning. As noted by Cudillo et al. (2022), these modules offer flexibility in terms of what, when, how, and where students learn, making them particularly useful for addressing diverse learning needs. Supporting this, Kareem et al. (2022) and Sirisuthi and Chantarasombat (2021) affirmed the instructional value of SLMs but pointed out the lack of studies exploring how these tools can be enhanced through technology and inquiry-based strategies. Similarly, Sareen (2021) found that SLMs significantly improved students' process skills, while Logan et al. (2021) reported increased student engagement when using these modules.

In addition, DepEd (2019) emphasized that SLMs should incorporate various teaching strategies—such as inquiry-based, collaborative, and reflective learning—to promote deeper conceptual understanding. Complementing this, Maile and Cooper (2018) described SLMs as systematic instructional materials that help students grasp complex concepts independently. Earlier, Sequeira (2012) highlighted the value of learner autonomy, stressing that SLMs allow students to navigate content at their own pace and according to their learning preferences.

Despite these positive outcomes, much of the existing literature has concentrated on the general effectiveness of SLMs, leaving a research gap in how they can be innovated further, especially through digital tools like interactive e-flipbooks. This highlights the need for integrating inquiry-based strategies into digital science materials, particularly in complex topics such as electric motor and generator, to enhance both engagement and learning outcomes in today's educational landscape.

E-Flipbook

With the rise of digital learning tools in education, e-flipbooks have gained increasing attention as interactive and engaging instructional resources. According to Khasanah et al. (2021), a digital flipbook is an electronic textbook that simulates the experience of turning physical pages while integrating multimedia elements such as animations, images, and videos. These features enhance students' ability to visualize complex content, especially in science subjects where conceptual understanding is critical. The interactive flipping effects, combined with ease of creation, make flipbooks practical and appealing for both teachers and learners.

In addition, Riyanto et al. (2020) highlighted that using flipbooks in science education fosters deeper engagement and cultivates students' critical thinking skills—qualities central to inquiry-based learning environments. Similarly, Suryani and Ardianto (2019) emphasized that the growing adoption of digital flipbooks reflects a broader shift toward technology-driven instruction brought by the Fourth Industrial Revolution. They argued that flipbooks offer sustainable and adaptable alternatives to traditional materials while maintaining content quality and expanding functionality.

Moreover, Isnaeni and Agustina (2018) reported that flipbooks supported by online resources significantly improve student learning outcomes by creating dynamic and interactive science lessons. Likewise, Nedungadi et al. (2018) noted that the multimedia-rich nature of flipbooks—through videos, images, and sound—caters to various learning styles, particularly for visual and auditory learners, making science content more accessible and engaging.

Furthermore, Hayati et al. (2015) also observed that flipbooks promote improved motivation, creative thinking, and learning outcomes due to their integration of audio, animation, and graphics. These qualities support the goals of active, independent learning—core principles of the inquiry-based approach. Collectively, these studies demonstrate that digital flipbooks serve not only as modern teaching tools but also as effective platforms for student-centered, inquiry-driven instruction in science education.

Electric Motor and Generator

An electric motor converts electrical energy into mechanical motion through electromagnetic principles: when a current flows through a coil wrapped around an iron core, a magnetic field forms. This field interacts with surrounding magnet where opposite poles attract, like poles repel causing the coil to rotate. Conversely, an electric generator operates in reverse, converting mechanical motion into electrical energy via electromagnetic induction. With it, pinning a coil within a magnetic field induces a current, although it's crucial to note that generators don't create electricity, but rather redirect existing charges in a circuit through mechanical input. This duality, a shared structure but opposite function, can be a stumbling block for students, especially when the abstract concept of magnetic field interaction and energy conversion is involved.

Moreover, research in physics education highlights that these concepts are among the least mastered competencies in Grade 10 science. Guisasola et al. (2013) found that students at the tertiary level often struggle to differentiate between macroscopic magnetic fields and the microscopic inductive processes underlying motor and generator operation. Similarly, studies on student misconceptions identify errors such as believing that generators create electricity or that electromagnetic induction can occur in stationary magnetic field an indicative of conceptual misunderstandings related to fundamental scientific principles.

The above-mentioned related literature and studies will guide and support the forthcoming data collection, analysis, and interpretation phases of this study.

Theory base

This study will be anchored on the inquiry theory (Dewey, 1938) mentioned by Hargraves (2021), Cognitive Load Theory (Sweller, 1988), as cited by Sweller, Ayres, and Kalyuga (2011), and Social Constructivist Learning Theory (Vygotskky,1978), as cited by Palincsar (1988).

The Inquiry theory of John Dewey (1938), as cited by Hargraves (2021), is the first theory that this study is anchored with which emphasizes active student participation, real-world exploration, and independent investigation. These principles are embedded in the design of the inquiry-based e-flipbook developed in this research. By allowing students to interact with content, raise questions, and engage in self-directed discovery, the e-flipbook serves as a dynamic platform for experiential science learning, shifting the learner from a passive recipient to an active constructor of knowledge.

Moreover, Cognitive Load Theory (Sweller, 1988), as cited by Sweller, Ayres, and Kalyuga (2011), provides strong theoretical support for the cognitive design of digital learning tools, which is reflected in the structure and function of the inquiry-based e-flipbook. Cognitive load theory explains how instructional materials should be structured to manage the limited capacity of working memory, especially in complex subjects like electric motor and generator. The theory differentiates between extraneous, intrinsic, and germane cognitive loads and advocates for the reduction of unnecessary information while encouraging deep cognitive processing. The e-flipbook in this study reflects these principles by breaking content into digestible chunks, using visuals to clarify abstract concepts, and embedding inquiry prompts that foster understanding.

According to Social Constructivist Learning Theory by Lev Vygotsky (1978) as cited by Palincsar (1998), learning is a socially mediated process where knowledge is constructed through interactions with others and with tools in the learning environment. Central to this theory is the concept of the Zone of Proximal Development (ZPD), which describes the range of tasks that learners can accomplish with guidance and support. Through scaffolding, learners are gradually able to perform more complex tasks independently. Furthermore, Palincsar (1998) affirms that social interaction and dialogue are central to knowledge development, even when mediated by technology. In this light, e-flipbooks are designed not only to present information but to simulate teacher guidance through structured prompts, questions, and feedback-like features. Similarly, Driscoll (2005) emphasizes that meaningful learning occurs when learners are actively engaged in constructing their own understanding, particularly when the content is situated in real-life or meaningful contexts.

The development of e-flipbooks as a supplementary interactive learning material for science concepts of Electric Motor and Generator in this study are guided by these theories: Inquiry Theory, Cognitive Load Theory, and constructivism. the Constructivist Learning were applied to enhance student engagement and conceptual understanding, especially in addressing the challenges encountered when using the DepEd Self-Learning Modules (SLMs) alone.

Conceptual Framework

This section of the study represents the conceptual framework and will serve as a guide in the conduct of the study. Figure 1 shows the schematic diagram for the conceptual framework of the study.

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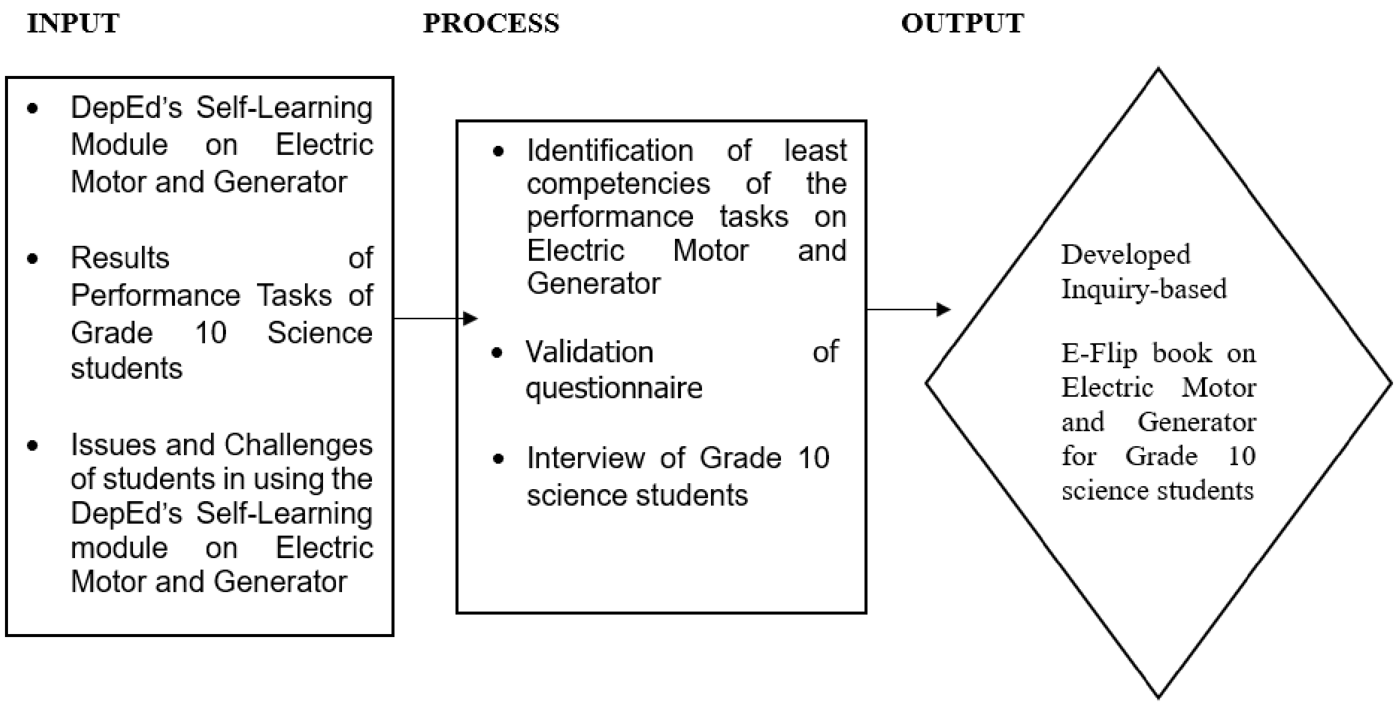

Figure 1. Input-Process-Output Model for the Development E-Flipbook on Electric Motor and Generator

This study will be anchored on the premise that a well-designed digital learning tool, such as an inquiry-based e-flipbook, can enhance students' understanding of complex science concepts like the Electric Motor and Generator. In addition, this adopted the Input Process Output (IPO) model. It offers structured framework that outlines the necessary resources and information, the steps involved in the process, and the resulting output. This model also aids designers in assessing and improving their design by identifying and addressing issues prior to implementation (Davis, 2019)

The input includes the existing DepEd's Self-Learning Module on Electric Motor and Generator, which serves as the baseline instructional material currently used in the Grade 10 science curriculum. In addition, the study includes the performance task results of Grade 10 Science students, to determine their level of understanding before and after using the self-learning module. Furthermore, the study consists of the common issues, challenges, encountered and coping mechanism by the students in using the current module through interviews to determine the needs of the students.

Moreover, the process includes the following steps. Beginning with the identification of the least learned competencies related to Electric Motor and Generator determined through the analysis of the students' performance results. Second, will be the development of the interview questionnaire for the Grade 10 students to further examine the students' issues, challenges, and coping mechanisms in using the DepEd's self-learning module on Electric Motor and Generator. Followed by the validation of a researcher-made questionnaire. Finally, is conducting the interview of Grade 10 science students to gather qualitative data that will support the refinement and development of the E-Flipbook. These steps will ensure that the instructional tool to be developed is grounded in actual student needs.

Furthermore, the output will be the Inquiry-Based E-Flipbook on Electric Motor and Generator tailored for Grade 10 Science students. This learning material will be designed to address the identified gaps in the DepEd's self-learning module on Electric Motor and Generator. It is expected to improve the performance tasks results of the grade 10 science students on Electric Motor and Generator. This output will aim to promote active engagement, critical thinking, and deeper conceptual understanding through inquiry-based learning strategies integrated into a digital format.

Research Hypothesis

Based on the research questions, this study hypothesized that:

H_{01}. There is no significant difference between the performance task results of the Grade 10 science students using DepEd's self-learning module on Electric Motor and Generator

METHODOLOGY

This chapter presents the research methodology that will be used in the development of the supplemental learning material on Electric Motor and Generator for Grade 10 science students. It outlines the methods that will be used, sources of data, data gathering instrument, sampling technique, the procedure of the study, and statistical treatment. The techniques to be employed are thoroughly explained in this chapter.

To uphold ethical standards, this study will strictly adhere to the principles of data privacy and confidentiality. Participation will be entirely voluntary, and respondents will be fully informed about the nature, purpose, and academic intent of the research prior to their involvement. They will be asked to provide informed consent, ensuring that they understand their rights as participants. No personally identifiable information will be collected, and all responses will be treated with the utmost confidentiality. The study will be conducted in full compliance with the Data Privacy Act of 2012 (Republic Act No. 10173), ensuring that all data is managed with integrity and respect for participants' privacy.

In addition, this study supports Sustainable Development Goal 4: Quality Education, which advocates for inclusive, equitable, and quality learning opportunities for all (United Nations, 2015). By addressing the challenges students face in using the DepEd's Self-Learning Modules (SLM's) this study aims to develop an inquiry-based e-flipbook on the topic Electric Motor and Generator to serve as a supplementary learning material for Grade 10 science students, with the goal of enhancing their conceptual understanding, engagement, and independent learning in a digital learning environment.

Research Design

This study will employ a mixed-method approach, specifically using an explanatory sequential mixed methods design wherein quantitative data will be collected and analyzed first then followed by qualitative data, this qualitative data will be used to explain the collected quantitative findings (Creswell & Plano Clark, 2018). By combining numerical patterns with in-depth participant observations, this approach aims to provide both breadth and depth of understanding. This design is suitable for this study that aims to assess the performance tasks results and identify the issues, challenges, and the coping mechanism of grade 10 science students in using self-learning modules on Electric Motor and Generator to develop a supplemental learning material on Electric Motor and Generator.

Moreover, research that focuses on collecting and evaluating numerical data is known as quantitative research. It is based on the scientific process and uses statistical analysis to find trends, test theories, and make predictions (Creswell, 2018). Quantitative methods will be used to analyze the performance results, and identify the least-learned competencies on Electric Motor and Generator of grade 10 science class.

Furthermore, the first phase will focus on quantitative data collection and analysis, which involves gathering numerical data to quantify variables and measure outcomes systematically (Creswell, 2014). In this study, the quantitative phase involves analyzing the performance task results of Grade 10 science students using the DepEd Self-Learning Module (SLM) and administering a validated questionnaire to identify issues, challenges and coping mechanism using it.

On the other hand, qualitative research is a method that seeks to understand phenomena from the point of view of those experiencing it, focusing on meaning, experiences, and views rather than numerical data. It allows the researchers to analyze behaviors through rich and descriptive information gathered through interviews or observations (Silverman. 2016). In this study, qualitative research will be used to investigate the issues and challenges faced by Grade 10 science students while using DepEd's Self-Learning Module on Electric Motor and Generator. Qualitative data will be collected through interviews and analyzed thematically to uncover patterns that can be used to inform the development of a supplemental learning material called E-flipbooks.

Sources of Data

The participants of the study will be the Grade 10 science students from one section in one of the secondary public schools in Davao del Sur composed of seventeen (17) males and fourteen (14) females. The primary sources of data will be the pre-test and post-test scores of the students based on the DepEd's self-learning module on Electric Motor and Generator as well as the interviews during the second quarter of the school year 2025-2026. For the quantitative thirty-one (31) which consists seventeen (17) males and fourteen (14) females will take part in the performance tasks using the DepEd's Self-Learning Module. Meanwhile, for the qualitative data, a purposive sample of three (3) males and three (3) females will be selected to participate for the interview to provide deeper insights. Three students will be selected from those who will get low scores, moderate, and high scores.

Data Gathering Instruments

To collect comprehensive and reliable data, this study will utilize a variety of research instruments aligned with the Department of Education's curriculum standards. The DepEd Self-Learning Module (SLM) on Electric Motor and Generator will serve as the baseline material to assess students' existing performance and identify the least mastered competencies under the current instructional approach. Student outputs and tasks will be evaluated using a performance task rubric adapted from DepEd Order No. 158, s. 2011, which outlines criteria such as process skills, product quality, time management, and safety. This ensures that performance assessments are valid and consistent with national policy.

The instruments that will be used for data gathering for this study will be discussed in this section. The data gathering instruments will be DepEd's self-learning module on Electric Motor and Generator and the researcher-made interview questionnaire.

To begin with, this study will use the self-learning module on Electric Motor and Generator provided by the Department of Education as an official module used by all of the grade 10 science students in public secondary schools authored by Valenzuela, F., (2020). The self-learning module is composed of a 15-item pre-test, followed by quick lessons on mirrors, then activities 1, 2, and 3 to enhance the students' understanding on how the electric motor and generators be assembled and another quick description about electric motor and generator. The self-learning module also consists of three (3) assessments, all has 5 items. The self-learning module concludes with a summary and a 15-item post-test, furthermore, additional activities are given at the end for more enhancement of the learning. For activity 1, students will get 15 points, in activity 2, 15 points, in activity 3, another 10 points. Thus, a total of 40 points for all of the activities. However, since there is no lesson plan provided, for the purpose of this study, a researcher-made lesson plan will be created, together with the Table of Specifications, and rubrics will be created for the questions in the selected activities that required criteria.

In addition, to gather in-depth qualitative data on the experiences of grade 10 science students in learning Electric Motor and Generator using DepEd's self-learning module, a semi-structured interview will be employed. The interview will aim to explore the students' perceived issues and challenges, and coping strategies they used while studying the self-learning module independently. The interview questions will be composed of open-ended questions aligned with the statements of problem. The questions will be grouped into two main categories: 1) issues and challenges encountered by the students while using the self-learning module composed of six (6) items, and 2) strategies students used to cope with these challenges composed of four (4) items, a total of fifteen (10) core questions. The first category focuses on the difficulties in understanding concepts, clarity of content, adequacy of visuals, activity completion, and external barriers. The second category focuses on how students cope with the issues and challenges, including help-seeking behavior, use of supplementary resources, and personal learning strategies. The semi-structured format will allow flexibility for follow-up questions to gain richer responses from the participants. In addition, the interview questionnaire will undergo expert validation to ensure the questions are clear, relevant, and appropriate for Grade 10 science students. This interview questionnaire will be used in the refinement of E-Flipbooks. Moreover, the interview that will be conducted will ensure that ethical considerations will be observed such as informed consent.

The table below presents interpretation of the performance tasks results of grade 10 science students in electric motor and generator using SLM and e-flipbook.

Table 1. Interpretation of the Performance Tasks Results of Grade 10 Science Students in Electric Motor and Generator

Mean Score	Verbal Description	Interpretation
35-40	Very High	The performance task results of Grade 10 students in Electric Motor and Generator are outstanding.
31-35	High	The performance task results of Grade 10 students in Electric Motor and Generator are very satisfactory.
26- 30	Average	The performance task results of Grade 10 students in Electric Motor and Generator are satisfactory.
21-25	Low	The performance task results of Grade 10 students in Electric Motor and Generator are satisfactory.
0-20	Very Low	The performance task results of Grade 10 students in Electric Motor and Generator are very poor.

Sampling Technique

Quantitative data for the study will be gathered using a total population sampling technique. Total population sampling will be appropriate due to the small class size and the specific relevance the research's objectives to the group according to Etikan et. al., 2016. In this study, the whole class in one section of Grade 10 science students, consisting of seventeen (17) males and thirteen (15) females, a total of thirty-one (31) students from one of the public secondary schools in Davao del Sur will be the selected respondents. All of the students in this section will be included in the administration of the performance tasks of the self-learning module on Electric Motor and Generator.

Meanwhile, for the qualitative phase of the study, criterion-based purposive sampling will be employed. This non-probability sampling technique involves selecting participants who meet specific, pre-established criteria relevant to the research objectives. In this study, participants will be chosen based on their direct experience with the DepEd Self-Learning Module (SLM) on Electric Motor and Generator Grade 10 Science students. This method ensures that the selected individuals can provide rich, relevant, and in-depth insights into the issues and challenges explored in the study (Palinkas et al., 2015). In this study, six (6) students will be selected as participants, three (3) of them will be males and three (3) will be females. These students will be selected based on the following criteria: (1) they completed the DepEd's self-learning module on Electric Motor and Generator, (2) they encountered issues and challenges while using the module. These students will undergo a semi-structured interviews designed to explore the issues and challenges they faced using DepEd's Self Learning Module.

Data Gathering Procedure

The following procedure will be followed in gathering the needed data.

1. Asking Permission to Conduct the Study. The researcher will ask an endorsement from the dean of college of education. Then, ask permission to the office of the Schools' Division Superintendent to conduct study in the division of Davao del Sur.

2. Development of Interview Questionnaire. A semi-structured interview questionnaire will be developed, guided by the study's objectives and focused on learners' issues, challenges using DepEd's Self-Learning Module (SLM) on Electric Motor and Generator.

3. Validity and Reliability Test of the Questionnaire. The interview questionnaire will be approved by three experts in the field of science including the Master Teachers.

4. Conduct of the Study. The performance tasks in the Self Learning Module on Electric Motor and Generator developed by the Department of Education will be administered to thirty-one (31) Grade 10 science students from one section. Before the conduct of study, the participants will be informed that the study's objectives and will be assured that their responses will be confidential and assured that their grades will not be impacted by their participation. They will also receive the needed consents and assents.
5. Retrieval of Data. The performance tasks outputs stated in the self-learning module on Electric Motor and Generator will be collected and the results will be gathered with strict confidentiality.
6. Conduct of Interview. The semi-structured interview using the validated interview questionnaire will be conducted to the six (6) selected students according to the criteria given to gather information on the issues and challenges they have encountered when using the self-learning module on Electric Motor and Generator and the lesson itself. Before the administration of the open-ended survey questionnaires, the participants will be informed that the study's objectives and will be assured that their responses will be confidential.
7. Analysis and Interpretation of Data. The results of the performance tasks result of the grade 10 science students on DepEd's self-learning module in Electric Motor and Generator, with the identified least-learned competencies, and the issues and challenges they encountered while using it will be tabulated for statistical analysis and thematic analysis and the data that will be gathered and will be interpreted.
8. Development of E-Flipbook. Based on the results of the performance tasks, with the least-learned competencies, and interviews on specific challenges faced by students, the content of the E-flipbook will be designed to target the most difficult concepts related to Electric Motor and Generator. In addition, the E-flipbook will incorporate inquiry-based learning activities, visual aids, step-by-step explanations, and interactive elements to support deeper understanding. The final version will be reviewed by experts to ensure alignment with science learning competencies and quality standards.

Statistical Treatment.

The following are the statistical tools that will used in this study:

Mean. The mean, also known as the average, is one of the most widely used measures of central tendency, particularly effective for continuous numerical data. It provides a single value that reflects the central point of a dataset. To determine the mean, the sum of all data values is divided by the number of data points (Field, 2018). In this study, mean will be utilized to determine how well students performed using the SLM and after using the e-flipbook. Specifically, it will be used in performance task scores of Grade10 students.

Paired T-test. This statistical tool, also known as the dependent sample t-test, will be used in this study to determine whether there is a significant difference between the scores between two sets of related scores (from the same group of students) is statistically significant. In this study, the test determines if there is a meaningful improvement in the students' understanding of electric motor and generator concepts after using the developed e-flipbook as a supplementary tool to the DepEd Self-Learning Module (SLM).

Thematic Analysis. Thematic Analysis (TA) offers a clear and organized method for analyzing qualitative data by creating codes and identifying themes. These codes form the foundation for themes, which are broader patterns shaped by a central concept or idea. Thematic analysis aims for a thorough and credible analysis by incorporating quality checks, such as a two-phase review where themes are compared with both the coded segments and the full dataset (Braun & Clarke, 2006, 2012, 2013). In this study, it will be utilized to interpret students' personal experiences, challenges, and coping mechanisms with the SLM.

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