ONLINE FLIPPED CLASSROOM IN ELECTRICITY AND MAGNETISM COURSE SUPPORTED GOOGLE CLASSROOM AND TELEGRAM: A CASE STUDY

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Abstract

The online flipped classroom is a learning design gaining popularity in the current Education 4.0 era. This learning design combines the synchronous and asynchronous learning and provides opportunities for students to explore material before virtual meetings and solve problems directly during virtual meetings. This study aims to obtain an overview of the online flipped classroom implementation in physics courses. The researcher used the qualitative method in this study. Data collection was carried out through observation and documentation toward two lecturers and 25 physics education students taking electricity and magnetism courses at a university in West Java. The results showed that electricity and magnetism online learning combined asynchronous and synchronous learning through Google Classroom and Telegram in three stages: pre-class, in-class, and post-class. Studies on online learning using other learning management systems and social media to gain a more comprehensive overview of the use of learning management systems and social media in online learning are suggested.

Keywords: Flipped Classroom, Electricity and Magnetism, Google Classroom, Telegram.

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1. Introduction

Science and technology are advancing at a breakneck pace at the moment (Durib, 2014). It promotes changes and technological innovations in the industry, dubbed the industrial revolution, beginning with the 1.0 Industrial Revolution, which relied on steam engines, progressing to the 2.0 Industrial Revolution, which relied on electricity, the 3.0 Industrial Revolution, which relied on information systems, and the 4.0 Industrial Revolution, which relied on Cyber-Physical Systems (Benešová & Tupa, 2017; Darma et al., 2020; Zhou et al., 2015). Industrial Revolution 4.0 has altered the pattern of human life due to the presence of different advanced technological items such as artificial intelligence, robotics, autonomous vehicles, additive technology, and nanotechnology (Dumiretscu et al., 2019). Humans are urged to collaborate with machines or robots, manage tasks remotely, manage tasks digitally, and automate tasks (Afrianto, 2018).

In education, the Industrial Revolution 4.0 has accelerated the development of a significant initiative dubbed Education 4.0. Education 4.0 is a model of education that was born as a form of innovation in response to the Industrial Revolution 4.0.(Shahroom & Hussin, 2018). Education 4.0 is a term that alludes to the digital revolution and innovation that are beginning to take hold in education and many other disciplines. Education 4.0 has increased the customization, sophistication, smartness, portability, global reach, and virtuality of learning (Shahroom & Hussin, 2018).

There have been numerous changes in how teaching and learning are conducted, the role of teachers, and students' learning styles during the Education 4.0 era(Shahroom & Hussin, 2018). In the Education 4.0 era, learning evolved via the internet and technology in a network known as online learning. Online learning is defined as the process of developing materials for educational purposes, learning, and program management through the use of technology and internet devices. This online learning enables the transfer of knowledge gained in a classroom or lecture room to a virtual space. The use of technology in online education is critical in assisting students in comprehending the learning material (Ramadhani et al., 2019). Teachers and students may interact, communicate, and learn in an online learning environment to make knowledge more accessible while at the same time (Ayub et al., 2019).

There are two types of online learning: synchronous and asynchronous (Hrastinski, 2008). Synchronous learning occurs when students and teachers connect in real-time. In contrast, asynchronous learning occurs when students and teachers interact via the internet via an online platform or without real-time interaction (Bryson & Andres, 2020). In general, synchronous learning activities are comparable to traditional learning. However, the interactions are more focused on essential activities and are conducted synchronously (Harris et al., 2009; Hrastinski, 2008; Simonson et al., 2012). Synchronous learning enables students and teachers to communicate, collaborate, and ask live questions in several ways in real-time. Video conferencing, webcasts, interactive learning, telephone conferencing, virtual learning, and chat rooms are examples of synchronous learning activities (Er et al., 2009). Students can participate actively in asynchronous learning in their style, interact with peers, provide feedback to their friends, and reflect on personal learning goals and outcomes (Er et al., 2009; Harris et al., 2009; Simonson et al., 2012). Students benefit from asynchronous learning because it enables them to reflect, collaborate, and communicate with one another (Bonk & Zhang, 2006; Skylar, 2009). Online learning has several advantages, including its flexibility, interactive nature, and fostering self-directed learning (Leszczyński et al., 2018; Smedley, 2010; Wagner et al., 2008).

The flipped classroom or flipped course is a learning design that has grown in popularity in recent years in higher education (Abeysekera & Dawson, 2015; Knapp, 2018). The Flipped Classroom's primary goal is to maximize classroom efficiency by allowing teachers to provide timely feedback (O'Flaherty & Phillips, 2015; Zainuddin & Halili, 2016). The flipped classroom model argues that students learn through interactive technology, such as watching films at home and practicing active learning practices in the classroom (Bergmann & Sams, 2012; Herreid & Schiller, 2013; Roach, 2014). Thus, teachers can devote time to students who require assistance during the course, and students can collaborate to solve issues or discuss topics during class. Face-to-face class meetings in flipped classrooms can now take place remotely via various synchronous programs dubbed online flipped classrooms (Lin et al., 2019; Stöhr et al., 2020).

Electricity and magnetism is a subfield of physics concerned with various electrical, magnetic, and electromagnetic phenomena (Serway & Jewett, 2019). Electricity and magnetism are the fundamental principles underlying the technology used to operate various electronic devices, including radios, televisions, electric motors, remote sensors, computers, and high-energy particle accelerators (Chabay & Sherwood, 2006; Serway & Jewett, 2019). At the college level, electricity and magnetism concepts are covered in courses such as Basic Physics and Electricity and Magnetism. The Electricity and Magnetism course delves deeper into the ideas of electricity, magnetism, and electromagnetics through vector calculus analysis. The

Electricity and Magnetism subject is critical because it prepares students to transition from classical to modern physics. Thus, explaining how electricity and magnetism learning is implemented is critical to understand as a foundation for developing and increasing the effectiveness of physics learning, particularly in electricity and magnetism courses. This study aims to overview online learning in electricity and magnetism. More precisely, this study examined numerous aspects of online learning in electricity and magnetism, including the profile of electricity and magnetism courses, the process of online learning in electricity and magnetism, and the teaching materials utilized in electricity and magnetism online learning.

2. Method

Research Method and Participants

This research is a case study with a qualitative method. The study was carried out at a university in West Java. Twenty-four students and a lecturer participated in this study, which focused on online learning about electricity and magnetism at a university in West Java.

Data Collection and Instruments

The data collection methods included document analysis and observation. To begin, document analysis was used to ascertain learning outcomes in courses on electricity and magnetism. Then, observations were performed to ascertain how electricity and magnetism online learning is implemented in the field. Curriculum documents (syllabuses and lesson plans) and observation sheets were employed in this study.

Researchers gathered and analyzed documents, including syllabuses and lesson plans for electricity and magnetism courses. The researcher attempted to ascertain the learner's electrical and magnetic subject accomplishment by analyzing the document. After analyzing the paper, the researcher examined the implementation of electricity and magnetism online learning to ascertain how the syllabus and lesson plans were implemented in the field.

Electricity and magnetism are taught online asynchronously via Google Classroom and synchronously via Telegram. Therefore, researchers must first join groups on Google Classroom and Telegram comprised of students and lecturers engaged in an online study of electricity and magnetism before conducting observations. The researcher began observing, taking notes, and photographing various learning activities conducted by lecturers and students and the instructional materials used.

Data Analysis

Field notes and screenshots taken during observations, curriculum materials, and lesson plans from electricity and magnetism courses were used to collect data for this study. The data is processed, analyzed, and described in six stages: organization, transcription, exploration of the general sense of the data, coding, deriving themes from the data, and summarizing data based on themes. Creswell's five steps were accepted.

The researcher groups and gathers data based on the type of data, namely text, audio, and images/photos, and offers information about activities, locations, and time/duration on photographs/images and sound recordings (audio). Following data organization, the researcher transcribed the data. At this point, the researcher converts the audio-recorded interview data to text. After transcribing the data, the researcher examines the data's overall image. At this stage, the researcher carefully examines and reads all of the data twice to ascertain the data's overall meaning and then notes the data's overall meaning. After gaining a general understanding of the data, the researcher coded it. The researcher splits the data into various information segments and then assigns a code to each section. The researcher built a theme from the data once it was coded. The researcher then gathered codes that were similar or cognate and then integrated them into a theme. Finally, the researcher describes based on the themes developed from the data. There are three major themes in this study: the profile of electricity and magnetism courses, the online learning process for magnetic electricity, the teaching materials used in online learning electricity, and magnetism.

3. Results

Profile of Electricity and Magnetism Courses

The researchers developed profiles of electrical and magnetism courses through a review of curriculum documents and lesson plans. This electricity and magnetism course profile includes semester credits, course descriptions, learning outcomes, resources, instructional techniques, and instructional media. Semester courses with a credit system are required as part of the five-semester Study Program Expertise Courses having a credit value of three. This study of electricity and magnetism is intended to supplement the lecture content on electricity and magnetism acquired by students in the Basic Physics course and to serve as a primer for lectures at a higher level.

The learning outcomes for electricity and magnetism courses include the ability to analyze concepts, apply technology, and make sound judgments to solve problems related to electricity and magnetism studies logically, critically, and methodically, as well as to provide innovative thinking with a responsible and independent attitude, high quality, and quantifiable performance. More precisely, the learning outcomes for the electricity and magnetism course are divided into four sub-learning outcomes.

1. Possess an understanding of vector algebra about the concepts of electricity and magnetism.
2. Capable of conducting a logical, analytical, and systematic analysis of the concepts of electricity and magnetism
3. Capable of logically, critically, and methodically analyzing the application of electricity and magnetism to technology using inventive and responsible thinking.
4. Capable of resolving problems by making sound judgments based on the concept of magnetism in an independent, quality, and quantifiable manner.

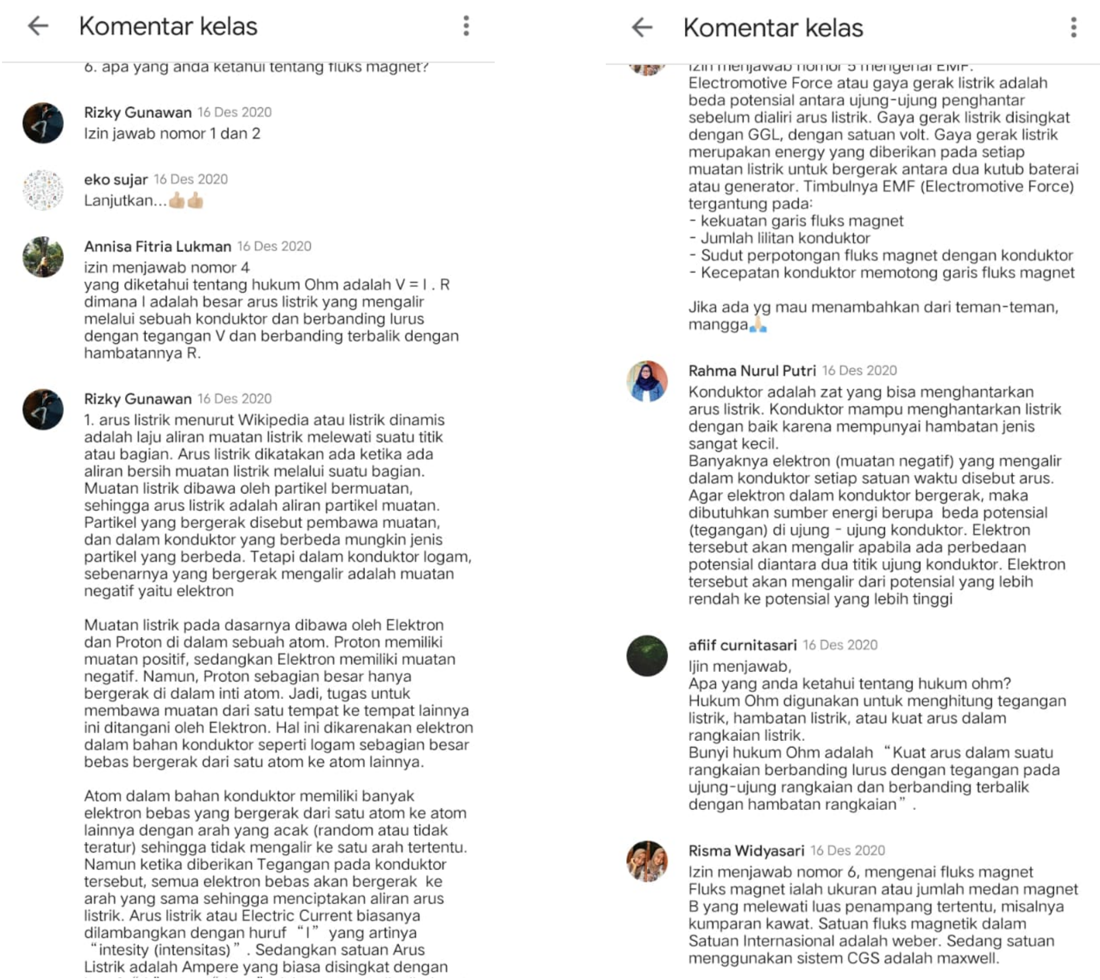
Process of Electricity and Magnetism Online Course

According to researchers' observations and interviews, the online learning activities for electricity and magnetism combine asynchronous and synchronous learning. Asynchronous learning occurs through a learning management system, specifically Google Classroom, and synchronous learning occurs through Telegram. Lecture activities include briefings from lecturers on the lecture procedure to be followed, group discussions, virtual experiments, and direct questions and responses from individual students. Figures 1, 2, and 3 illustrate several student learning activities.

(a)

(b)

Figure 1. Directions from lecturer via Google Classroom



(a) (b)

Figure 2. Groups discussion through Google Classroom

Figure 3. Direct individual questions and answers via Telegram

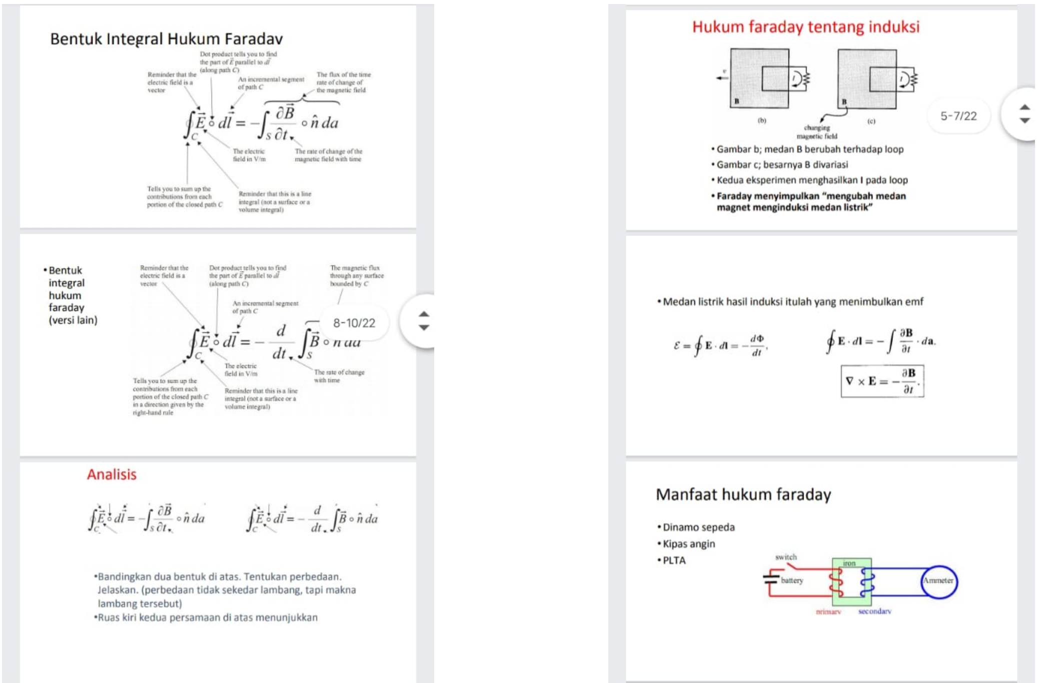
Table 1. Online Learning Stages of Electricity and Magnetism

Stages	**Learning Activities**	
	Lecturer Activities	**Students Activities**
Pre-Class	The lecturer conveyed the learning objectives at the twelfth meeting in Google Classroom, namely, to analyze the relationship between Magnetic Fields and Inductive Electric Fields and their impact logically, critically, and systematically and their application by providing innovative thinking.	Students learn the learning objectives at the twelfth meeting in Google Classroom.
	The lecturer provides direction regarding the learning activities to be carried out and divides students into several groups.	Students read learning directions in Google Classroom.
	The lecturer sends teaching materials in PPT Slides and exercises in Google Forms about Magnetic Fields and Induced Electric Fields in Google Classroom.	Students download teaching materials about Magnetic Fields and Inductive Electric Fields.
	The lecturer direct students to study material and do assignments about Magnetic Fields and Inductive Electric Fields	Students study materials and do exercises about Magnetic Fields and Inductive Electric Fields.

Stages	Learning Activities	
	Lecturer Activities	**Students Activities**
In-Class	The lecturer sends LKM and Phet Simulation about virtual experiments on Magnetic Fields and Inductive Electric Fields.	Students download worksheets and Phet Simulation about virtual experiments on Magnetic Fields and Induced Electric Fields.
	The lecturer gives directions to conduct virtual experiments using Phet Simulation.	Students listen to the directions from the lecturer and then experiment.
	The lecturer wrote some questions for discussion related to Magnetic Fields and Induced Electric Fields in Google Classroom.	Students study questions related to Magnetic Fields and Inductive Electric Fields.
	The lecturer directs students to discuss in the discussion room provided in Google Classroom.	Students discuss questions related to Magnetic Fields and Inductive Electric Fields.
	The lecturer provides opportunities for students to ask questions directly related to the material of Magnetic Fields and Induced Electric Fields on Telegram.	Students to ask questions directly related to Magnetic Fields and Inductive Electric Fields on Telegram.
	The lecturer answered student questions via chat and voice notes on Telegram.	Students listen to the lecturer's answers.
Post-Class	The lecture sends questionnaires and assignments related to Magnetic Fields and Inductive Electric Fields learning materials.	Students download questionnaires and assignment questions related to the Magnetic Field and Inductive Electric Field lecture.
	The lecture directs students to fill out questionnaires and assignments related to magnetic fields and induced electric fields.	Students fill out and work on Magnetic Fields and Inductive Electric Fields lecture assignments.

Teaching Materials in Electricity and Magnetism Online Learning

Based on observation conducted by the researcher, it is known that the teaching materials used in online learning of electricity and magnetism are material in PPT Slides, worksheets in PDF format, Phet Simulations, and exercises in Google Form. All of them are posted in Google Classroom. The material presented in the teaching materials are essential points, such as the definition of concepts, laws, equations, applications or benefits of electricity and magnetism, and examples of problems. The material is generally presented in text, images, and formulas in PPT Slides. Knowledge in this material will be strengthened with worksheets to prove several concepts, principles, or laws in magnetic electricity. Worksheets generally contain a virtual experiment guide using Phet Simulation and an experimental result sheet. Furthermore, several problems as exercises were given to train students' understanding of electric-magnetic material. Examples of teaching materials used in magnetic electricity lectures are presented in Figures 4.



(a) (b)

Figure 4. Teaching material

4. Discussion

Major Findings

The major findings of the research indicate that the online course for electricity and magnetism effectively integrates asynchronous and synchronous learning modalities.

Asynchronous learning is facilitated by Google Classroom, and synchronous interactions occur through Telegram, enhancing student engagement through various interactive activities, such as virtual experiments and group discussions. The study outlines several key findings:

a. Integration of Asynchronous and Synchronous Learning: The process of conducting an online course on Electricity and Magnetism involves a combination of asynchronous and synchronous learning activities. Asynchronous learning takes place through a learning management system like Google Classroom, while synchronous learning occurs via platforms like Telegram. The use of learning management systems and communication platforms for collaborative and interactive learning is supported by studies on consumer behavior in educational contexts (Dąbrowska, 2011) and the impact of perceived security, often a concern in online learning, on e-loyalty which can translate to student engagement online (Chen et al., 2015). The lecturer initiates pre-class activities by conveying learning objectives, providing directions, sharing teaching materials, and assigning tasks related to Magnetic Fields and Inductive Electric Fields. Students engage by reading directions, downloading materials, studying, and completing exercises. The course effectively integrates asynchronous learning through Google Classroom, where students access lecture materials and assignments, and synchronous learning through Telegram, where real-time interactions occur. This blend allows for flexibility and continuous engagement. Research has shown that Google Classroom offers usability, accessibility, and benefits for both educators and students (Oladele et al., 2021; Susanto et al., 2021; Cahya & Ashoumi, 2022). Studies have highlighted the importance of considering students' readiness for using Google Classroom to ensure effective online learning (Annurwanda & Winata, 2021; Idoghor & Oluwayimika, 2022).
b. Student Engagement and Understanding: The flipped classroom model, by shifting lecture consumption online and utilizing class time for interactive activities, has enhanced student engagement. Students actively participate in discussions, virtual experiments, and problem-solving sessions, which improves their understanding of complex concepts in Electricity and Magnetism. The use of Google Classroom during the COVID-19 pandemic has been instrumental in maintaining the continuity of education (Periani & D, 2022; Syahfitri & Herlina, 2022; Ruqia et al., 2021). It has facilitated communication, interaction, and the learning process, enabling students to engage effectively in online classes (Susilo & Rohman, 2021; Ruqia et al., 2021). The platform has been particularly useful for various subjects, including Mathematics, English, and Science (Zakaria, 2023; Chiablaem, 2021; Muchtar et al., 2021). Additionally, the application of Google Classroom has been found to

positively impact student motivation and learning activity (Manurung et al., 2021).

c. Use of Diverse Teaching Materials: The course employs various teaching materials, including PowerPoint slides, PDF worksheets, Phet Simulations, and Google Forms exercises. These materials cater to different learning preferences and help in reinforcing the learning objectives effectively. The course employs various teaching materials, including PowerPoint slides, PDF worksheets, Phet Simulations, and Google Forms exercises. These materials cater to different learning preferences and help in reinforcing the learning objectives effectively. Several studies have investigated various aspects of online courses in this domain. Sadaghiani (2011) explored the use of multimedia learning modules in a hybrid-online course for electricity and magnetism, demonstrating the effectiveness of such modules.

Comparison with Previous Findings

These findings are consistent with previous research stating that online learning can be conducted synchronously and asynchronously (Hrastinski, 2008; Bryson & Andres, 2020). Additionally, the use of the flipped classroom model has also been widely applied in online learning (Lin et al., 2019; Stöhr et al., 2020). When compared to other research, there are some similarities and differences. For example, a study by Saputra et al. (2021) also found that online physics learning uses the Google Classroom platform and combines synchronous and asynchronous learning. However, they did not specifically discuss the Electricity and Magnetism course. Another study by Gunawan et al. (2020) revealed that the use of virtual simulations such as Phet Simulation is effective in improving students' conceptual understanding of electricity and magnetism material. This is in line with the findings of the above research that utilizes Phet Simulation in virtual experiments. Nevertheless, this research provides a more comprehensive overview of the profile and online learning process of the Electricity and Magnetism course, as well as the teaching materials used. These findings can serve as a reference for the development of online learning for similar courses in the future.

Novelty

The novelty of this research lies in the integration of using Google Classroom as an LMS and Telegram as a direct communication medium in online learning for electricity and magnetism with a flipped classroom design. The novel use of Telegram for synchronous communication is a significant contribution of this study. It highlights how instant messaging apps can be effectively used in educational settings to enhance real-time interaction and feedback.

Furthermore, this study also provides a detailed overview of the course profile, learning process, and teaching materials in the context of the electricity and magnetism course. The study provides insights into the application of the flipped classroom model in the specific context of Indonesian higher education, contributing to the body of knowledge on educational practices in Southeast Asia.

5. Conclusion

The study highlights the implementation of the online flipped classroom model, facilitated by Google Classroom and Telegram, in improving student engagement and understanding in an Electricity and Magnetism course. The combination of synchronous and asynchronous learning platforms provides a versatile and interactive environment that meets various learning needs. However, the research's generalizability is limited as it is based on a single case study, which may not be applicable to other educational contexts or subjects. Additionally, the reliance on self-reported data from students could introduce bias in evaluating learning outcomes and engagement. In terms of implications, the successful integration of Telegram with Google Classroom suggests that more educators could benefit from using diverse technology platforms to enhance learning experiences. Educational institutions might also consider incorporating or expanding flipped classroom models in their curriculum designs to better learning outcomes. The findings offer practical insights for lecturers and educational institutions on crafting effective online learning environments, particularly in science-related courses such as electricity and magnetism.

The contributions of this research include providing a practical framework for the implementation of flipped classrooms in higher education and demonstrating the effective use of communication technology in these settings. It also aids in the development of an online learning model that integrates Learning Management Systems (LMS) and direct communication media within a flipped classroom design. The recommendations for future research include investigating the implementation of flipped classrooms across various disciplines and more diverse educational settings to validate and broaden these findings. Longitudinal studies are also suggested to evaluate the long-term impacts of flipped classrooms on student learning and retention.

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