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Research

Flipped Learning: An Innovative Model for Enhancing Education Through ChatGPT

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Abstract:

The limitations of traditional education models and the advancement of technology have revealed the need to transform the learning experience. The "Flipped Learning" approach, born out of this need, is a model where students study learning materials in advance and participate in more interactive and hands-on activities in the classroom. This research discusses how the Flipped Learning model can be combined with ChatGPT. ChatGPT is a language model developed by OpenAI, and it can interact with students thanks to its natural language processing capability. In this way, combined with the Flipped Learning model, it can provide students with a more individualized and interactive learning experience. From this viewpoint, in this research, a model called "ChatGPT Aided Flipped Learning Model (CAFLM)" has been developed, which enables ChatGPT to be used in the "Flipped Learning" learning environment. CAFLM has three main phases: 1) Preparation, 2) Outside classroom teaching, and 3) inside classroom teaching. At these phases, the tasks of the student and the teacher are explained in detail. Sample activities and use cases are provided on how ChatGPT can be integrated into the Flipped Learning model and help students. To experience the model, activities developed for mathematics and science lessons were carried out using ChatGPT. The experiences have shown that the Flipped Learning model can be combined with Chatbots such as ChatGPT to provide students with a more effective and personalized learning experience. CAFLM can enable students to be more active in the learning process and contribute to innovative approaches in education.

Keywords: Flipped learning, chatgpt, 5E learning model, chatbot

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INTRODUCTION

Flipped learning is a model that tries to improve students' learning experiences by reversing the traditional classroom structure. In this model, students watch video lectures recorded or prepared by the teacher at home and learn the course materials in advance. Class time becomes more interactive, and students work in class to consolidate their learning, understand concepts, and solve problems. In this model, teachers can track students' progress and become more involved in the student's learning process. Flipped learning positively affects students' success (Gross et al., 2015) and their learning motivation (Su & Chen, 2018).

The flipped learning model is an effective method for improving students' learning experiences. Chatbot technology has also played an important role in diversifying learning experiences recently. Chatbot technology can provide feedback and learning materials and help students track their learning progress (Vanichvasin, 2021).

ChatGPT, an artificial intelligence chatbot, can be used in a learning environment compatible with the flipped learning model. Students can ask questions on ChatGPT and get answers right away. ChatGPT can be used to present students' learning materials and can help students track their learning progress. Students can also reinforce their learning processes through assignments and quizzes offered by ChatGPT.

Combining the flipped learning model and ChatGPT can improve students' learning experiences. In this way, students can gain more learning motivation by making learning processes more interactive. This model may also allow teachers to monitor students' learning progress more effectively. This research focuses on how ChatGPT can be combined with the flipped learning model and how students' experience with this model can be improved.

Flipped Learning

Flipped learning constitutes an instructional strategy in which students are exposed to preparatory materials, such as videos, readings, or interactive content, before the traditional classroom instruction. This pedagogical approach aims to foster students' autonomy and accountability for their learning, enhance their engagement and the effectiveness of face-to-face interactions, and cultivate a more immersive and rewarding learning environment (Covill, Patel, & Gill, 2013; Hwang, Lai, & Wang, 2015). The flipped learning methodology is becoming increasingly prevalent across diverse educational institutions, encompassing primary and secondary schools, higher education institutions, and professional settings (Abd Rahman, Yunus, & Hashim, 2019). Flipped learning can be employed across various academic disciplines and educational levels. Nonetheless, further longitudinal investigations are imperative to ascertain the enduring impacts of implementing the flipped learning approach.

F-L-I-P mainly focuses on four elements. These are a flexible environment, a learning culture, an intentional context, and a professional educator (Sezen-Yüksel, 2020). A flexible environment means that the teacher can create a group work and independent working environment while teaching a topic or concept. It can adapt the learning environment with physical arrangements and provide flexibility to help students learn what and when. Learning culture refers to an environment in which the student discovers knowledge. The course is devoted to more in-depth research and enrichment activities of the subjects. The student plays an active role in the creation of knowledge. The intentional context enables the teacher to use the activities in the lesson process best. Depending on the topic, it uses deliberate content to organize student-centered, active learning strategies. The professional educator takes on a more responsible role than it appears in the flipped classroom. Responsible for managing tasks such as observing students, providing feedback, and making assessments throughout the course process.

The flipped learning model changes learning environments and combines technology and face-to-face activities (Nover & Orhan, 2018). The flipped learning model is generally defined as an approach where the course process and homework are replaced (Çakır & Yaman, 2018). Although the application of the flipped learning model differs from class to class, the basic principle is the learning process and the situation in which the student first encounters the course material. While in a traditional classroom, the student encounters the course material during the course, in this model, the first contact with the material is provided outside the classroom, online, and with the opportunities offered by technology (Murphy, Chang, & Suaray, 2016).

Figure 1. Traditional vs. Flipped Classrooms, Source: https://teaching.washington.edu/topics/engaging-students-in-learning/flipping-the-classroom/

In a traditional classroom setting, teaching often occurs as students read textbooks, work on assignments outside the classroom, and listen to lectures in class. However, in the flipped classroom model, while students learn most or all of the content outside the classroom, teaching in the classroom is carried out with group work and cooperation under the teacher's guidance (McBride, 2015). In the flipped learning model, students do the expected homework and participate in activities by accessing teaching resources outside of

school (Figure 1). The student is expected to be ready for the lesson by acquiring basic information about the subject outside the school. Class time is realized with activity and a student-oriented approach (Bergmann & Sams, 2012). The student's access to essential information outside of the classroom provides the teacher with learning opportunities to develop the student's high-level thinking skills, such as discussion, activity, and problem-solving in the classroom (Noysever & Orhan, 2018). In addition, the teacher takes the role of guiding students in the classroom. The teacher can provide immediate feedback and correct misconceptions by following students' work closely. The teacher plays an essential role in learning compared to a traditional classroom (Carter, Carter, & Foss, 2018).

Studies have pointed out that flipped learning has advantages and challenges. Akçayır and Akçayır (2018) found that student learning performance improvement is the most frequently mentioned benefit of flipped learning. However, there are also challenges related to out-of-class activities. Gündüz and Akkoyunlu (2019) indicated that students felt more responsible for their learning and experienced greater instructional flexibility. However, some people expressed dissatisfaction with the slow Internet access outside the classroom and the lack of immediate feedback while watching videos. Straw et al. (2016) emphasized that flipped learning encouraged students to take ownership of their education, learn at their own pace, and expand their knowledge and understanding. However, challenges included access to technology and the appropriateness of online resources. Fisher, LaFerriere, and Rixon (2020) found that flipped learning has positive and negative attributes and that flipped learning strategies must be conceptualized and understood as influencing or facilitating learning. Overall, the papers suggest that flipped learning can be an effective pedagogy but requires careful planning and considering potential challenges.

Studies have shown that flipped learning helps increase students' academic success. Simko et al. (2019) indicated that a flipped approach to a second-year engineering course resulted in higher marks, improved engagement, and overall student satisfaction. Låg and Sæle (2019) examined studies that compared flipped classroom teaching to traditional, lecture-based teaching. They discovered a little benefit for the flipped classroom regarding learning, pass rates, and student satisfaction. Purwaningtyas, Hidayanto, and Prabowo (2020) reviewed the success factors in flipped learning and found that applying technology and the framework used are important factors in student engagement. Bormann's (2014) literature review revealed that flipped learning has the potential to create a highly engaging educational setting, resulting in enhanced academic performance and improved readiness for the demands of 21st-century learning and professional environments. Gross et al. (2015) conducted a study in which flipped learning environment was preferred instead of the regular teaching environment. The research results showed that the flipped learning format led to a significant increase in the test scores of female and low-GPA students, improved significantly.

Flipped learning increases student success and positively affects students' desire to learn. Vliet, Winnips, and Brouwer (2015) found that flipped-class pedagogy enhanced

critical thinking, task value, and peer learning. Su and Chen (2018) indicated that flipped learning and student question generation positively impacted students' learning motivation, attitudes, and engagement. Haghegh and Nugroho (2021) found that flipped learning positively predicted students' learning motivation, attitudes, and engagement. Chung and Lee (2018) found that flipped learning improved learning motivation and attitudes. Nevertheless, Vliet et al. (2015) underscored that the impact of flipped classes was not enduring, prompting the recommendation for incorporating flipped classes repeatedly within the curriculum to ensure long-term sustainability.

During the COVID-19 pandemic from 2020 to 2022, as in-person education was suspended in schools worldwide, the use of flipped learning practices increased significantly. Even though we live in a digital age, the limited use of technology in education before the COVID-19 pandemic, along with teachers' lack of experience with online and hybrid teaching methods, left many countries unprepared for the educational challenges brought by the pandemic. Lo et al. (2021) highlighted that during the pandemic, teachers expressed concerns and desires for more detailed instructions, advanced questions, and interactive exams, emphasizing the significant need for open access flipped learning resources. Aljarvi et al. (2024) found that flipped learning during the COVID-19 pandemic contributed to students' academic success and their attitudes towards learning. López-Belmonte (2023) showed that using pedagogical methods like flipped learning during periods of health restrictions like COVID-19 created improved competencies in students. Specifically, the learning process experienced by students who followed the flipped learning course effectively benefited them in two of the three analyzed dimensions: self-regulation and decision-making. Paragoo and Sevnarayan (2024), found that pedagogy of flipping the classroom for engaged learning had a positive effect on students. Cevikbas and Kaiser (2023), in their literature review of 97 articles, stated that flipped learning is an innovative pedagogy with the potential to engage students in mathematics education through hybrid learning, combining online and in-person instruction, which is especially important during a pandemic. Their review found that flipped learning offers numerous benefits for teaching and learning mathematics.

Chatbots and ChatGPT

Chatbots are computer programs that interact with users using natural language. They have many applications, including education, information retrieval, business, e-commerce, and customer service. According to Suta et al. (2020), the functionality of chatbots involves a three-stage process, which includes comprehending natural language input, generating automated and appropriate responses, and constructing natural language responses that are both realistic and fluent. The industry's current bottleneck in designing artificially intelligent chatbots is a lack of natural language processing capabilities. Maher, Kayte, and Nimbhore (2020) explain that chatbots use natural language processing techniques to simulate human conversation and can be applied to business, telecommunications, banking,

health, customer call centers, and e-commerce. It can also be used as a machine conversation, virtual agent, dialogue, and information retrieval system.

ChatGPT, developed by OpenAI, is a recently popular chatbot featuring a conversational artificial intelligence interface. Renowned as one of the most advanced applications in artificial intelligence, ChatGPT has garnered significant global attention (Tlili et al., 2023). OpenAI, a research lab specializing in artificial intelligence, introduced ChatGPT, a Generative Pre-trained Transformer, in November 2022. This conversational AI interface employs natural language processing (NLP) to engage in realistic interactions, encompassing the ability to respond to follow-up questions, acknowledge its errors, challenge erroneous assumptions, and reject inappropriate requests (OpenAI, 2023). While the primary objective of ChatGPT is to emulate the human conversation, it possesses capabilities that extend well beyond that scope. It can generate various forms of creative content, such as poems, stories, or even novels, and effectively assume different roles within its capacity.

As ChatGPT continues to make its way into our lives, with a wide range of uses already emerging, we are seeing an increasing number of studies on its use in the field of education. According to Lo (2023); ChatGPT has the potential to serve as an assistant for educators, such as creating teaching materials and providing suggestions, and as a virtual teacher for students, such as answering questions and facilitating collaboration. However, when used for educational purposes, it can pose various issues, such as generating incorrect or fake information and bypassing plagiarism detectors. Therefore, it would be beneficial to consider updating assessment methods and institutional policies in schools and universities to ensure the appropriate use of ChatGPT in educational settings. Furthermore, it is essential to provide education support to teachers and students to enhance the appropriate use of ChatGPT in educational settings.

In his literature review, Sallam (2023) aimed to investigate the benefits and potential limitations of ChatGPT in health education, research, and applications. He found that in 85% of the articles he examined, ChatGPT's benefits were mentioned. These benefits include: (1) Enhanced scientific writing and research inclusivity and versatility, (2) Benefits in health research, including effective analysis of datasets, code generation, literature reviews, timesaving for focusing on experimental design, and drug discovery and development, (3) Benefits in healthcare services, including workflow organisation, cost-saving, documentation, improvement of personalised medicine and health literacy, (4) Benefits in health services education, including enhanced personalised learning and focus on critical thinking and problem-based learning.

As chatbots such as ChatGPT become more prevalent and their capabilities increase in tandem with technological advancements, the lives of individuals who integrate them into their daily routines will undoubtedly change. This will lead to a greater need for studies on how chatbot-style tools should be effectively used in daily life.

Integrating ChatGPT into Flipped Learning Model

Chatbots such as ChatGPT can be integrated into education systems to provide quick and personalized services to students and institutional employees. Okonkwo and Ade-Ibijola (2021) present a systematic review of previous studies on using Chatbots in education, highlighting the benefits and challenges of implementing Chatbot technology in education. Hiremath et al. (2018) proposed an automated system that uses neural networks, NLP, pattern matching, and data mining algorithms to enhance the performance of Chatbots in education. Clarizia et al. (2018) present a prototype of a Chatbot in the educational domain that uses natural language processing techniques and ontologies to provide answers to students. Jalil et al. (2023) evaluated how well ChatGPT answers typical problems from a well-known software testing curriculum. The studies reveal that ChatGPT can offer answers and explanations that are entirely or partially accurate. However, more research is required to assess the potential benefits and risks of chatbot use by students and instructors.

Many studies provide insights into the use of ChatGPT in different learning methods. Huang, Hew, and Gonda (2019) discuss implementing and evaluating three chatbot activities enhanced by IBM Watson in a flipped graduate course. Jalil et al. (2023) investigated how well ChatGPT performs when attempting to answer common questions from a popular software testing curriculum. Bang et al. (2023) proposed a framework for evaluating interactive LLMs such as ChatGPT using publicly available datasets and found that ChatGPT outperforms LLMs with zero-shot learning on most tasks. Finally, Mattas (2023) discusses the potential benefits and ethical considerations of conversational AI models such as ChatGPT. Overall, the papers suggest that ChatGPT can enhance flipped learning, but further research is needed to understand its potential and limitations fully.

Chatbot technology can be an effective tool for providing feedback and learning materials to students. Vanichvasin (2021) found that using a chatbot in an educational setting led to positive learning outcomes and provided students with a better-personalized learning experience. Cunningham-Nelson et al. (2019) identified potential use cases for chatbots in education, including FAQ chatbots for answering commonly asked student questions and short response quiz chatbots for providing automated feedback based on student responses. Sandu and Gide (2019) suggested that chatbot technology can improve productivity, communication, and learning in the educational sector. Bii (2013) proposed integrating chatbot technology into the teaching-learning environment to enable students to acquire 21st-century skills in a developing country. Rudolph, Tan & Tan (2023), reveals that the greatest benefit of ChatGPT is its ability to enable students to learn by doing and experiencing. By using ChatGPT, students can evaluate different strategies and approaches about problem-solving and goal achievement through game-based learning or other student-centered pedagogies. Additionally, the students who prefer hands-on and experiential learning will use ChatGPT as a learning aid. Overall, the studies suggest that

chatbot technology has the potential to enhance the student learning experience by providing personalized feedback and learning materials.

Using 5E with Flipped Learning

The 5E learning model, developed by Rodger Bybee, is frequently used to apply the constructivist learning theory that enables students to actively use their knowledge and skills (Akkaya, 2019; Bıyıklı, 2009; Bybee, 2009). The 5E model delineates a comprehensive framework for teaching and learning, consisting of five sequential stages: Engage, Explore, Explain, Elaborate, and Evaluate. Notably, the 5E model seamlessly integrates all essential 21st-century skills, commonly called the 4Cs - create, critically think, communicate, and collaborate - and the effective use of technology (Mairc, 2020).

According to Cheng-jun (2010), the emphasis on students' self-construction is the core of the 5E teaching model. Students are the subject of the learning activities, whereas teachers are mentors and helpers. The teacher does everything to facilitate the students to inquire and acquire scientific concepts.

Many studies have revealed that the 5E learning model allows students to practice and develop competencies. The 5E model is effective in helping students practice and nurture competence in teaching natural science (Wui Nyugen & Lee, 2022). According to Bui Ngoc Phuong at al. (2021), the 5E teaching model is effective in helping students practice and nurture competence. Moreover, according to Nurdini et al. (2021), the learning environments based on the 5E learning cycle model effectively improve students' mastery of electrolyte and non-electrolyte solution material concepts and skills.

However, many studies show that the 5E learning model increases academic achievement. Gök and Tufan (2014), demonstrated that the levels of academic achievement and retention were higher in the experimental group taught with the 5E model than in the control group taught with traditional methods. Kanlı and Ünsal (2008) revealed that the experimental group students who used the 5E model were more successful than the control group students who used the traditional method. They developed a more positive view of the topic. Bakri (2021) reveals that using the 5E learning model can improve mathematical learning. Kozcu Cakir (2017) revealed that the 5E learning model affected the student's academic achievement, attitude toward science, and science process skills.

According to Bybee (2009), the phases of the 5E learning model are as follows:

1) Engagement: the instructor or a curricular assignment examines the learners' existing knowledge. It assists them in becoming involved in a new idea by using brief tasks that foster curiosity and elicit past knowledge. The activity should integrate previous and present learning experiences, disclose prior assumptions, and arrange students' thinking toward current activity learning objectives.

2) Exploration: Exploration experiences offer students a standard set of activities for identifying present concepts (i.e., misunderstandings), processes, and abilities, as well as

facilitating conceptual change. Learners may participate in lab activities that allow them to apply past knowledge to develop new ideas, investigate questions and possibilities, and design and conduct a preliminary inquiry.

3) Explanation: During the explanation phase, students focus on a particular aspect of their engagement and exploration activities. This phase allows students to demonstrate their conceptual understanding, procedural skills, or application of knowledge. Additionally, teachers can use this phase to introduce new topics, techniques, or skills. Learners are encouraged to articulate and express their understanding of the concept. A teacher's or curriculum's explanation may assist students toward better comprehension, a critical aspect of this phase.

4) Elaboration: Teachers develop students' intellectual knowledge and skills. Students gain more profound and broader knowledge, information, and appropriate abilities due to new experiences. Students put their knowledge to use by participating in extracurricular activities.

5) Evaluation: The assessment phase plays a crucial role in enabling students to evaluate their understanding and skills while also providing teachers with a means to measure student progress toward educational objectives.

Studies have pointed out that the 5E and flipped learning models can be combined to create effective teaching strategies. Schallert (2020) created a design heuristic based on the 5E inquiry model for flipped classroom scenarios, and it was used in an online professional development course for secondary mathematics teachers. Asiksoy (2017) found that a flipped classroom approach based on the 5E learning cycle model improved student achievement in physics. Romero (2019) conducted a poll-based study on the impact of the flipped learning model in online-based education for secondary teachers, finding that it enhanced active and autonomous learning and improved student performance. Lee (2013) suggested instructional design methods to improve flipped learning that depend on previous knowledge and emphasize a flexible learning environment, a change in how people learn, purposeful classroom material, and teachers with professional expertise. The papers suggest that combining the 5E learning model with flipped learning can lead to effective teaching and learning strategies.

Purpose of the Study

This research aims to develop a model that recommends using ChatGPT together with the 5E model in flipped learning environments. Flipped classrooms consist of outside-classroom activities as well as inside-classroom activities. In the scope of outside classroom activities, the teacher shares materials such as videos that were prepared before with the students. Students perform self-study, and they become ready for classroom activities. In the scope of inside-classroom activities, teaching is carried out under the guidance of the teacher. Students engage in routine activities that raise their academic performance.

This research developed a model that proposes using ChatGPT instead of the videos used in outside classroom parts of the flipped learning approach. In this model, the teacher prepares guiding activities that enable students to work with the support of ChatGPT instead of offline videos. The implementation of these activities is carried out according to the steps of the 5E learning model. Sample activities were prepared for some achievements related to Mathematics and Science lessons, and the application process was explained step by step.

ChatGPT Aided Flipped Learning Model (CAFLM)

This section explains the "ChatGPT Aided Flipped Learning Model (CAFLM)", developed in line with the purpose of the study and application process. The model can be applied to secondary and high school education levels. Within the scope of the research, sample application activities were prepared for mathematics and science lessons at the secondary school level. The model showing how ChatGPT is integrated into the Flipped Learning environment with the phases of the 5E learning model is shared in Figure 1. In the proposed model, the teaching process, both outside and inside the classroom, is prepared following the stages of the 5E model.

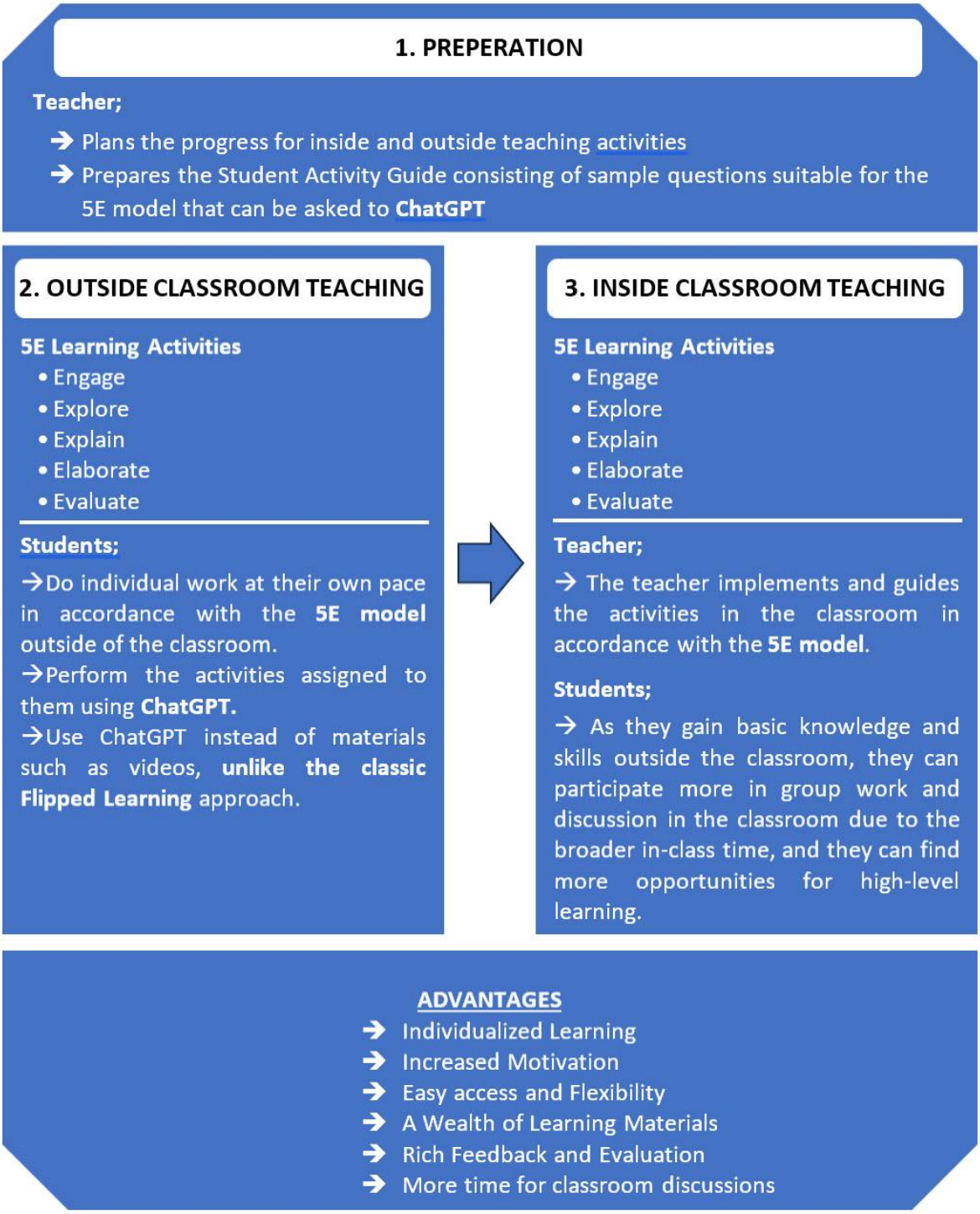

Figure 2. ChatGPT Aided Flipped Learning Model (CAFLM)

Preperation Stage

At this stage, the teacher plans the teaching process and prepares out-of-class teaching activities, considering the achievements of the course. Sample questions are prepared so students can ask ChatGPT to make them curious about the knowledge and skills related to the lesson's target. The questions should be appropriate for students to explore their

knowledge and skills and explain the concepts they have learned. In addition, the prepared questions should be such as to enable the students to associate what they have learned with daily life and to deepen their knowledge and skills. Appropriate instructions are given so that students can evaluate what they have learned. The questions in the prepared student activity guide should be flexible. Students should be encouraged to learn the subject from ChatGPT with different questions besides these questions in the student activity guide.

At this stage of traditional flipped learning environments, the teacher provides preparation materials (video, article, sound recording, etc.) to enable students to study before the lesson. 5E model activities are presented in the proposed model, and ChatGPT is used as preparation material. In this way, students can easily access content richer than the videos and materials the teacher can prepare. For example, student activity guides are prepared and shared for mathematics and science lessons in the next step.

Outside Classroom Teaching

At this stage, students do individual work outside the classroom and perform the activities assigned to them using ChatGPT. Supporting the outside classroom teaching phase of Flipped Learning with ChatGPT will provide students with the following benefits:

Individualized learning: An AI model like ChatGPT can offer students an individualized learning experience. Students can work independently and access learning materials according to their needs. ChatGPT can answer students' questions, explain, and recommend customized learning resources.

Increased motivation: ChatGPT can potentially increase student motivation to learn. ChatGPT can also attract and retain students' attention by providing an interactive learning environment. The responses of ChatGPT to students make the learning process more interactive and engage students.

Easy access and flexibility: ChatGPT during the outside classroom teaching phase allows students to access learning materials quickly and flexibly. Students can access ChatGPT anytime and anywhere. This allows students to devote more time to learning and to manage their learning processes more flexibly.

A wealth of learning materials: ChatGPT can offer students various learning materials. Materials in different formats, such as texts, videos, sound recordings, and simulations, can be presented to students. This allows students to select materials based on their learning styles and preferences, allowing them to learn more effectively.

Rich Feedback and Evaluation: ChatGPT can give students better feedback and evaluation. Students can follow their development process by asking questions and getting answers on ChatGPT. Students can also identify their weak points and evaluate their progress continuously with the help of ChatGPT's suggestions and guidance.

During the outside classroom teaching phase, the student is expected to have completed the activity the teacher gave using ChatGPT.

Inside Classroom Teaching

At this stage, in-class teaching continues according to the learning steps of the 5E model. In addition, it would be more appropriate to create discussion environments and focus on group work at this stage. Students can participate in different activities to deepen their out-of-classroom learning. In the classroom, the teacher may lead discussions, group projects, problem-solving activities, or projects with students. Students are expected to participate in classroom activities actively using the knowledge they have gained from the student activity guides prepared by the teacher. During this phase, the teacher identifies the students' weaknesses and strengths, monitors their progress, and provides feedback. Feedback can be given to students individually or in groups. Various assessment methods can be used to determine the learning level of the students.

With this model, students can be supported more efficiently to develop their high-level thinking skills in the classroom because they will acquire basic knowledge and skills in an out-of-class learning environment. In addition, teachers can devote more time to high-level activities such as application, analysis, and synthesis.

Sample Student Activity Guides for Mathematics and Science Lessons

The subject of "Algebraic Expressions and Identities" was chosen in the Mathematics lesson. Within the scope of this subject, a sample student activity guide has been prepared suitable for the acquisition of "Understands and writes simple algebraic expressions in different formats". Moreover, the "Electrical Loads and Electrification" subject was chosen for the Science lesson. Within the scope of this subject, an example of a sample student activity guide has been prepared suitable for the acquisition of "Classifies objects in terms of their electrical loads". The questions of these sample student activity guides are shared in Tables X and Y.

The first phase of the model is the preparation stage. An activity has been prepared for this stage to enable students to perform individual studies. This activity was developed following the steps of the 5E learning model. Below are the sample student activity guides that enable students to do individual work outside the classroom before the math and science lesson with the teacher in the classroom.

Table 1

The Questions Used in Sample Student Activity Guide for Mathematics Lesson

Lesson: 8th Grade Mathematics **Subject:** Algebraic Expressions and Identities **Learning Outcome:** Understands and writes simple algebraic expressions in different forms.
1) Engage Have you ever heard of the concept of algebra introduced by Al-Khwarizmi, a Muslim Turkish scholar? Do you know in which areas and how we use algebra, which can be used as a communication language, in daily life? Can you research ChatGPT by asking questions such as the following? If there are other concepts that you do not understand, you can ask ChatGPT to explain them as well. - In which areas is algebra used in daily life? - How can algebra be used as a language of communication?
2) Explore Imagine talking to your friend about how much water you can fill in a cylindrical plastic bottle at home. What kind of expression would you use to generalize about the amount of water, the volume, that similarly shaped plastic bottles of different sizes can hold and tell your friend about it? So how can the volume of a cylinder be expressed algebraically? Try to discover it by asking ChatGPT. For this, you can ask the following sample questions. - How can I express the volume of a cylindrical plastic bottle algebraically? - Can I express this algebraic expression another way? - Can you teach algebra through a game? - Can you teach me the subject of algebra through the game?
3) Explain When we look at algebraic expressions, we can see that some letters, characters, or symbols represent unknown values and numerical values. This difference is expressed in an algebraic expression by different concepts. Let's try to learn these concepts by asking questions to ChatGPT listed below. - Which different parts are there in an algebraic expression? - Could you explain and provide an example of what the terms variable, constant, and coefficient mean in algebraic expressions? - Can you teach me algebra by playing a game? - How can we simplify complex algebraic expressions?
4) Elaboration When we examine the equations in algebraic expressions, we see that equality is achieved for some values of the variables. These values are referred to as the equation's solution set. Sometimes we see equality provided for each value that the variable can take. These algebraic equations are also known as identities. At this point, consider these algebraic expression features, deepen your work, reach generalizations, and integrate what you learn into your knowledge. You can do this by asking ChatGPT similar questions and evaluating theoutputs. - How to write identities for algebraic expressions? - How can you explain the identity -a^2-b^2 = (a-b) (a+b) to me? - Can you visualize this algebraic expression? - How can I develop a model to understand the same algebraic expression by cutting papers to appropriate sizes? - What is the difference between the square of the difference of two terms (a-b) ^2 and the difference of squares (a^2-b^2) in algebraic expressions? Can you explain with examples?
5) Evaluation Ask ChatGPT to ask you different types of questions about algebraic expressions. After you answer it yourself, ask ChatGPT to say the answers and compare them with your answers.

-Can you write three questions about algebra? -105^2-5^2 = ? Can you show me how to solve the question using the "difference of two squares identity"? -Can you ask practice questions similar to these?

Table 2

The Questions Used in Sample Student Activity Guide for Science Lesson

Lesson: 8th Grade Science **Subject:** Electrical Loads and Electrification **Learning Outcome:** Classifies objects in terms of their electrical loads.
1) Engage Sometimes when we approach objects around us to touch them, we hear a crackling sound and feel a tingling sensation in our fingertips. Even if the object we touch is not an electrical device, we say, "We got shocked". How do these objects shock us, despite not being electrically powered? You can ask ChatGPT questions similar to the following to investigate. If there are any terms you don't understand, you can also ask ChatGPT to explain them." - What causes non-electrical objects to shock us? - Could you please explain electrical load and electrostatic briefly? - Could you please explain positive and negative loads briefly? - Could you please explain briefly how an electrostatic charge is formed? - Could you please explain briefly how electrification occurs?
2) Explore At this point, you are expected to discover what electrification is and the types of electrification. Regarding this, you can try to explore the subject by asking questions to ChatGPT, such as the following: - What are electrification types? - Can you recommend a simple electrification experiment for me? - Can you suggest a simple experiment with electrifying by touch and electrifying by effect? - Can you teach me electrification by friction through a game?
3) Explain At this point, you need to review the subject by learning about how positive and negative loads affect electrification, what are the differences between the types of electrification, make comparisons and reach concepts. For this purpose, you can obtain information about the subject by asking the following questions to ChatGPT: - What are the similarities and differences between electrification by friction, touch, and impact? - How is the electrification affected if the positive and negative charges on the objects are equal?
4) Elaboration At this point, it is expected that you have a thorough understanding of the subject's specifics and the ability to apply what you have learned to other spheres of your life. You can use ChatGPT to inquire about the following things: - What are the factors affecting the electrification event? Can you explain briefly? - Which electrification method lasts longer? - What are the applications of electrification in technology and natural events? - How is electrification related to atmospheric behaviors and natural events? Can you explain briefly?
5) Evaluation At this point, you can ask ChatGPT to ask questions to evaluate the information you have learned. While doing this, you can ask ChatGPT to ask you multiple-choice and open-ended

questions about different sub-dimensions/sections of the subject. After answering the questions in your own way, you can also ask ChatGPT to give the answers to these questions and compare your own answers with the answers given by ChatGPT.
- Can you write five multiple-choice questions about the topics discussed in this session?
- What are the answers to these questions?
- Could you write three open-ended questions about the topics discussed in this session?
- What are the answers to these questions?

The activities developed during the preparation phase are shared with the students. Students perform individual studies outside the classroom in line with the instructions in the student activity guide. At this point, students are expected to control their learning processes and create their own notes and questions about the subject. Students are encouraged to come to class with their notes and questions about the subject.

The final phase of the CAFLM model is inside classroom instruction. At this phase, the teacher teaches following the steps of the 5E model. In this direction, the questions that the students take notes on during the out-of-class process at the entrance stage are discussed under the guidance of the teacher. In this process, the active participation of students is ensured by holding large and small group discussions. In the exploration phase, the teacher continues to guide. Provides instant feedback to students during the implementation of classroom activities. At this point, informal evaluations are included. Since students come to class prepared, the exploration activities carried out in the classroom are expected to be higher level. In the explanation activities, students explain the concepts and theories they have discovered. They discuss using the knowledge and skills they have acquired because of individual studies. In the deepening phase, the teacher encourages students to apply what they have learned in different situations. Tasks with different situations are given following the level of the students. Students are expected to use what they have learned in new situations. In the evaluation activities, the teacher evaluates the student's learning process. Students are allowed to self-assess. It may be appropriate to use formative assessment techniques.

CONCLUSION AND RECOMMENDATIONS

This research aims to develop a model that recommends using ChatGPT together with the 5E model in flipped learning environments. This model aims to increase the quality of the out-of-class teaching phase of flipped learning and encourage students to do individual research. In this context, ChatGPT was chosen as the chatbot, and how to use it in the flipped learning model was explained step by step with sample applications. The developed ChatGPT Aided Flipped Learning Model (CAFLM) consists of 3 basic steps: 1) Preparation Stage, 2) Outside Classroom Teaching, and 3) Inside Classroom Teaching. In the scope of preparation stage activities, outside classroom teaching instructions (student activity guide) are developed to guide students and shared with them. At the outside classroom teaching

step, students do individual studies using ChatGPT. At this stage, students interact with ChatGPT in line with the instructions suggested in the activities instead of the digital materials used in the classical flipped learning model. Using ChatGPT, students will have more opportunities for individualized learning, higher motivation, easy access and flexibility, richness in learning materials, and effective feedback and assessment. In the classroom teaching step, which is the last step of the model, the teaching service is expected to continue under the guidance of the teacher. Since students are expected to come to the classroom prepared, it is expected that the teaching process for the classroom will be at a higher level. Students can have a more prosperous learning environment by doing group work in the classroom and participating in the discussion environment. Since teachers will not have to transfer basic knowledge and skills in the classroom, they will have more time for a more qualified education.

In this research, sample activities developed for mathematics and science lessons within the scope of CAFLM were carried out using ChatGPT. The answers given by ChatGPT are shared in the images below (Figure 3). When the obtained outputs are examined, it is striking that the answers given by ChatGPT at the engage phase are at a level that can attract the student's attention and increase their desire and curiosity to learn. In the explore phase, it can be said that the answers given by ChatGPT are at a level that supports the students' in-depth learning of the subject. Interaction with ChatGPT at this stage can help students develop their ideas, knowledge, and understanding. It has been understood that ChatGPT has the potential to include richer explanations compared to materials such as video used in the classical flipped learning approach. In the explanation phase, ChatGPT's answers to the questions are at a level that can enable students to understand the concepts. When appropriate questions are asked, ChatGPT has been observed to clarify points that are not understood and provide adequate answers. In the elaborate phase, the questions asked, and the answers given by ChatGPT are at a level that can enable students to deepen their learning and gain different perspectives. In the last phase, the evaluation phase, it has been observed that ChatGPT can ask questions that examine the achievements of the course.

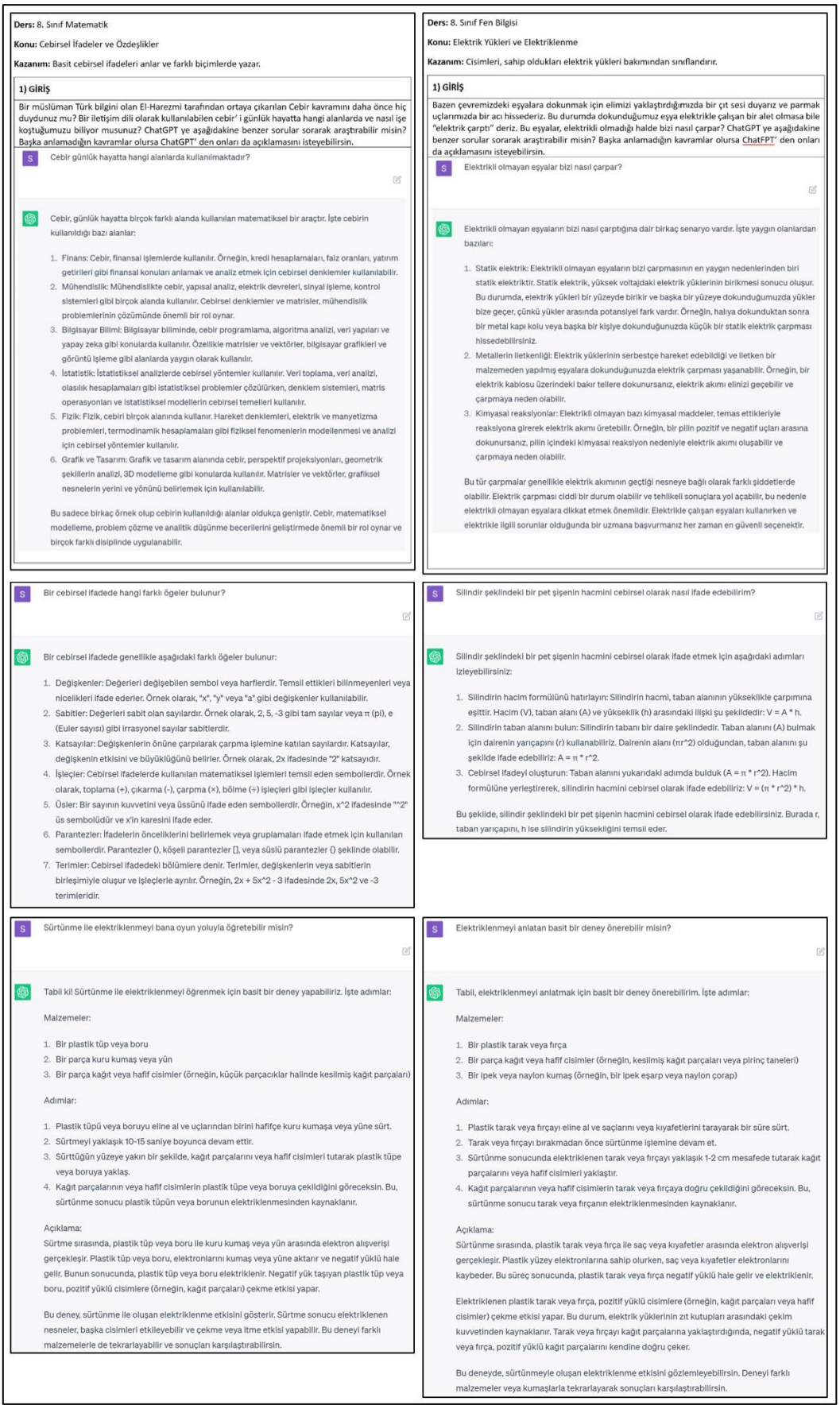

Figure 3. Some images from the sample student activity guide prepared for Mathematics and Science lessons.

The findings derived from the implementation of sample activities designed for mathematics and science courses suggest that CAFLM is positioned at a level capable of enhancing the quality of the flipped learning-teaching process. Implementing this model can positively affect students' success, motivation, and the permanence of their knowledge. Quantitative and qualitative studies are needed to evaluate the developed model's aspects. Experimental research can be conducted by comparing classical flipped learning teaching with CAFLM. In addition, qualitative research can be conducted to reveal student and teacher experiences related to CAFLM.

In this research, mathematics and science courses were selected to show the application steps of CAFLM. Further research could explore the use of CAFLM in different courses. In this research, sample applications were carried out using the free version of ChatGPT. The paid version and plugins of ChatGPT can help create more prosperous learning activities.

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