

**Improving the methodology of distance learning mathematics for students in  
grades 5-6**

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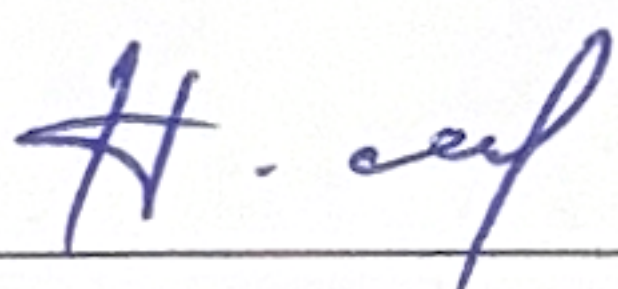
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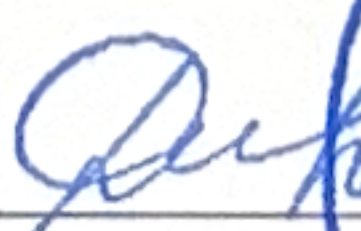
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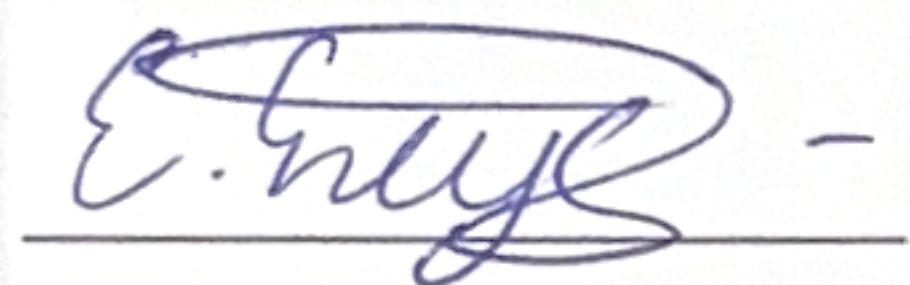


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## ABSTRACT

This study investigates the effectiveness of distance learning mathematics instruction for sixth-grade students through the use of video-based lessons and interactive digital tools. The research employed a quasi-experimental pretest–posttest design involving two sixth-grade classes in a private school in Kazakhstan, with one experimental group and one control group.

The intervention included teacher-created instructional videos, Wayground and Kahoot activities, and structured online learning tasks. Data were collected through pre-tests and post-tests measuring students' academic achievement in mathematics.

The findings showed significant improvement in both groups after the intervention. The experimental group demonstrated higher engagement and positive learning outcomes, the difference between the groups was statistically significant. The results suggest that digital tools and video-based instruction can support student engagement and enhance the effectiveness of distance mathematics learning.

*Keywords: distance learning, mathematics education, student engagement, academic achievement, digital tools.*

## АНДАТПА

Бұл зерттеу бейнесабактар мен интерактивті цифрлық құралдарды пайдалану арқылы алтыншы сынып оқушыларына математиканы қашықтан оқытудың тиімділігін анықтауға бағытталған. Зерттеу Қазақстандағы жекеменшік мектептің екі алтыншы сыныбының қатысуымен өткізілген квазиэксперименттік «алдын ала тест – қорытынды тест» дизайнына негізделді. Бір сынып эксперименттік топ ретінде, ал екіншісі бақылау тобы ретінде қарастырылды.

Эксперимент барысында мұғалім дайындаған бейнесабактар, Wayground және Kahoot платформаларындағы тапсырмалар, сондай-ақ құрылымдалған онлайн оқу әрекеттері қолданылды. Деректер математикалық жетістіктерді бағалауға арналған алдын ала және қорытынды тесттер арқылы жиналды.

Зерттеу нәтижелері екі топта да эксперименттен кейін оқу жетістіктерінің айтарлықтай артқанын көрсетті. Эксперименттік топ оқушыларының қызығушылығы мен оқу нәтижелері жоғары болды, топтар арасындағы айырмашылық статистикалық тұрғыдан мәнді болды. Дегенмен, нәтижелер цифрлық құралдар мен бейнесабактарды қолдану оқушылардың оқу үдерісіне белсенді қатысуын арттырып, қашықтан математиканы оқытудың тиімділігін жақсартатынын көрсетті.

*Түйінді сөздер: қашықтан оқыту, математикалық білім беру, оқушылардың оқу үдерісіне қатысуы, оқу жетістіктері, цифрлық құралдар.*

## АННОТАЦИЯ

Данное исследование направлено на изучение эффективности дистанционного обучения математике учащихся sixth классов посредством использования видеоуроков и интерактивных цифровых инструментов. Исследование проводилось с использованием квазиэкспериментального дизайна «предтест–посттест» с участием двух sixth классов частной школы Казахстана, один из которых выступал в качестве экспериментальной группы, а другой — контрольной.

В ходе эксперимента использовались авторские видеоуроки, задания на платформах Wayground и Kahoot, а также структурированные онлайн-активности. Сбор данных осуществлялся с помощью предтестов и посттестов, направленных на оценку учебных достижений учащихся по математике.

Результаты показали значительное улучшение показателей в обеих группах после проведения эксперимента. Учащиеся экспериментальной группы продемонстрировали более высокий уровень вовлеченности и положительную динамику учебных достижений, статистически значимых различий между группами было выявлено. Полученные результаты свидетельствуют о том, что использование цифровых инструментов и видеоуроков способствует повышению вовлеченности учащихся и эффективности дистанционного обучения математике.

*Ключевые слова: дистанционное обучение, математическое образование, вовлеченность учащихся, учебные достижения, цифровые инструменты.*

# 1. INTRODUCTION

Improving the quality of mathematics education has long been a central concern in educational research and practice. In recent years, this issue has become particularly significant due to the rapid development of digital technologies and the global transition toward online and distance learning. The COVID-19 pandemic accelerated this transformation, forcing educational systems worldwide to adopt remote teaching models and highlighting both the potential and the limitations of distance education (Hodges et al., 2020). As a result, the need to improve the methodology of teaching mathematics in online environments has become increasingly urgent, especially for middle school students.

E-learning, defined as the use of information and communication technologies (ICT) to facilitate teaching and learning, has emerged as a dominant mode of education in the 21st century. It includes various forms of instruction such as web-based learning, virtual classrooms, and digital collaboration (Moore & Kearsley, 2012; Fry, 2001). One of the main advantages of e-learning is its flexibility, allowing students to access educational content anytime and anywhere. However, despite these benefits, distance learning also presents significant challenges, particularly in subjects such as mathematics, where conceptual understanding requires structured explanations, guided practice, and continuous feedback.

Mathematics plays a fundamental role in developing logical reasoning, analytical thinking, and problem-solving skills, which are essential for success in modern society. At the middle school level, mathematics education becomes increasingly complex, as students transition from basic arithmetic to more abstract concepts such as algebraic thinking and proportional reasoning. This transition requires well-structured instructional approaches and active teacher support. However, in distance learning environments, the absence of face-to-face interaction and immediate feedback often makes it difficult for students to fully understand mathematical concepts.

Students in Grades 5–6 are at a critical stage of cognitive development. At this level, they begin to develop more advanced thinking skills, but they still require guidance, motivation, and structured learning environments. Distance learning, however, often relies heavily on students' independence and self-regulation, which may not yet be fully developed at this age. As a result, many students experience difficulties in maintaining focus, understanding complex material, and staying engaged in the learning process.

One of the key factors influencing learning outcomes in distance education is student engagement. Engagement is a multidimensional construct that includes behavioral, emotional, and cognitive components (Fredricks et al., 2004). Behavioral engagement refers to students' participation in learning activities, emotional engagement involves their interest and motivation, and cognitive engagement reflects their effort to understand and master the material. In traditional classrooms, teachers can actively support all three dimensions of engagement through direct interaction. In contrast, distance learning environments often limit such interaction, leading to decreased motivation and reduced academic performance.

Research has shown that student engagement is strongly associated with academic achievement. Engaged students are more likely to persist in learning tasks, apply effective problem-solving strategies, and achieve better educational outcomes (Fredricks et al., 2004). However, maintaining engagement in online mathematics learning remains a significant challenge. Many students experience reduced motivation, distraction, and a sense of isolation in virtual environments, which negatively affects their ability to learn effectively (Hodges et al., 2020).

Academic achievement in distance learning is closely related to the quality of instructional design and teaching methodology. Studies indicate that simply transferring traditional teaching methods into online formats is not sufficient to ensure effective learning. Instead, educators must adopt new pedagogical approaches that integrate digital tools, interactive elements, and structured instructional strategies

(Means et al., 2013). The effectiveness of distance learning depends not only on technology but also on how it is used to support meaningful learning experiences.

In recent years, the use of digital tools in mathematics education has gained significant attention. Technologies such as video-based instruction, interactive platforms, and gamified learning applications have been shown to enhance both student engagement and academic achievement. For example, instructional videos can improve understanding by presenting information in a clear and structured manner, while allowing students to revisit the material as needed (Brame, 2016). Similarly, interactive tools that provide immediate feedback, such as online quizzes and educational games, can increase student motivation and participation (Dichev & Dicheva, 2017).

The integration of such tools is consistent with modern learning theories, particularly constructivist approaches, which emphasize active participation and knowledge construction. In online environments, this can be achieved through the use of multimedia content, problem-based tasks, and interactive activities that encourage students to engage with the material actively (Zhang et al., 2006). These approaches not only improve engagement but also promote deeper understanding and long-term retention of mathematical concepts.

Another important aspect of distance learning is the changing role of the teacher. In traditional classrooms, teachers are often the primary source of knowledge, delivering content through direct instruction. In contrast, in online environments, teachers act as facilitators, guiding students through the learning process and supporting their independent learning (Moore & Kearsley, 2012). This shift requires educators to develop new competencies, including the ability to design digital content, manage online interactions, and provide timely feedback.

Despite the potential benefits of e-learning, several challenges continue to hinder its effectiveness, particularly at the school level. These challenges include limited access to technology, unstable internet connections, and differences in digital literacy among students and teachers. In addition, the lack of direct interaction in online learning environments can reduce students' motivation and engagement, further

affecting their academic performance (Hillmayr et al., 2020). These issues are especially significant for younger students, who require more structured support and guidance.

The educational context of Kazakhstan provides an important background for this study. In recent years, Kazakhstan has implemented significant educational reforms aimed at modernizing its education system and improving the quality of learning. These reforms include the introduction of updated curricula, criteria-based assessment, and a focus on developing functional literacy. However, despite these efforts, challenges remain in ensuring high levels of student engagement and academic achievement in mathematics, particularly in distance learning environments.

Given these challenges, improving the methodology of distance learning mathematics for students in Grades 5–6 has become a key research priority. This requires the development of effective instructional approaches that combine digital technologies with sound pedagogical principles. In particular, structured teaching methods that integrate video-based explanations and interactive digital tools offer promising opportunities for enhancing both engagement and academic performance.

This study aims to investigate how the use of such methodological approaches influences student engagement and academic achievement in mathematics among middle school students. The research focuses specifically on Grades 5–6, as this stage represents a critical period in the development of mathematical thinking. By examining the effectiveness of distance learning strategies in a real classroom context, this study seeks to provide practical recommendations for improving mathematics education.

The significance of this research lies in its contribution to both theory and practice. From a theoretical perspective, it expands existing knowledge on e-learning and student engagement by focusing on mathematics education in middle school. From a practical perspective, it provides educators with evidence-based strategies for improving teaching methodology in distance learning environments.

Ultimately, enhancing the effectiveness of distance mathematics education requires a comprehensive approach that integrates appropriate teaching methods,

digital tools, and an understanding of students' learning needs. By addressing these factors, this study aims to contribute to the development of more effective and engaging mathematics instruction in the digital age.

Aim:

- The aim of this research is to investigate how improving the methodology of distance learning mathematics through the use of video-based instruction and interactive digital tools enhances student engagement and improves academic achievement among students in Grades 5–6.

Research question:

- How does the implementation of structured distance learning strategies, including video lessons and interactive digital tools, impact student engagement and academic achievement in mathematics among Grade 5–6 students?

**Subject of the research:**

The use of video-based instruction and interactive digital tools in the process of distance learning mathematics for students in Grades 5–6.

**Object of the research:**

The process of distance mathematics teaching and learning among students in Grades 5–6.

## **2. LITERATURE REVIEW**

The literature review is a fundamental component of this research, as it provides a comprehensive examination of existing knowledge related to the methodology of distance learning mathematics and its impact on student engagement and academic achievement among middle school students. In the context of rapid digital transformation in education, understanding how effective instructional strategies can be developed and implemented in online environments has become increasingly important. As previously discussed, distance learning is not merely a technological shift, but also a pedagogical challenge that requires the integration of appropriate teaching methods, digital tools, and learner-centered approaches.

A thorough literature review is essential for several reasons. First, it establishes a theoretical and empirical foundation by identifying what is currently known about distance mathematics education, student engagement, and academic achievement in online learning environments. This includes the analysis of key concepts such as e-learning, digital pedagogy, and interactive learning, as well as the examination of how these concepts are applied in mathematics education (Moore & Kearsley, 2012; Hillmayr et al., 2020). In addition, it explores existing research on the effectiveness of various instructional strategies, including video-based learning and the use of interactive digital tools, which have been shown to enhance students' understanding and motivation (Brame, 2016; Zhang et al., 2006).

Second, the literature review allows for the identification of gaps in current research. While numerous studies have examined the general effectiveness of e-learning, there is still limited research focusing specifically on the methodology of teaching mathematics in distance learning environments for students in Grades 5–6. In particular, there is a need to better understand how structured instructional approaches, such as the integration of video lessons and interactive platforms, influence both engagement and academic outcomes in real classroom settings. Furthermore, previous research highlights that students often face difficulties in maintaining attention,

understanding abstract concepts, and staying motivated in online environments, which can negatively impact their learning outcomes (Hodges et al., 2020).

The literature review also plays a crucial role in informing the research design. By analyzing previous studies, it provides insights into effective interventions, appropriate methods of data collection, and reliable measures of student engagement and academic achievement. For example, prior research emphasizes the importance of combining clear instruction, guided practice, and formative assessment in order to achieve effective learning outcomes (Rosenshine, 2012). In addition, the review highlights the role of interactive tools and multimedia resources in supporting active learning, which is particularly important in online mathematics education.

Moreover, the literature review situates the current study within the broader field of mathematics education and demonstrates its relevance and significance. As educational systems increasingly adopt digital technologies, there is a growing need to develop effective methodologies that ensure high-quality learning experiences in distance education. The integration of video-based instruction and interactive digital tools aligns with contemporary educational trends that emphasize student-centered learning, engagement, and the development of 21st-century skills (Dichev & Dicheva, 2017).

Another important function of the literature review is to provide a critical analysis of existing research rather than simply describing previous studies. This involves comparing different theoretical perspectives, evaluating the strengths and limitations of various approaches, and synthesizing findings to develop a coherent understanding of the topic. Such analysis is essential for identifying effective practices as well as unresolved issues that require further investigation. In particular, the review examines how different instructional strategies impact students' ability to understand mathematical concepts, remain engaged in learning, and achieve academic success.

Furthermore, the literature review strengthens the credibility and rigor of the study by demonstrating that it is grounded in established research and contributes to ongoing academic discussions. By building on previous findings while addressing

identified gaps, the current study aims to extend knowledge in the field and provide practical recommendations for improving the methodology of distance mathematics teaching. This is particularly important in the context of middle school education, where students require structured support and effective instructional approaches to develop foundational mathematical skills.

Finally, the literature review supports the formulation of the research questions and objectives by clearly outlining the relevance of the study. It highlights the importance of improving instructional methodologies in distance learning environments and emphasizes the need for evidence-based approaches that enhance both student engagement and academic achievement. Rather than simply summarizing existing research, the review synthesizes findings to provide a comprehensive understanding of current knowledge and to justify the focus of the present study.

Overall, the literature review ensures that the research is systematically grounded in theoretical and empirical evidence, identifies key challenges and opportunities in distance mathematics education, and establishes a clear direction for further investigation. By examining the role of instructional strategies, digital tools, and student engagement in online learning environments, this study aims to contribute meaningfully to the development of effective methodologies for teaching mathematics in Grades 5–6.

## **2.1 Defining Key Concepts in Distance Mathematics Education**

Distance mathematics education is a specialized form of instruction that combines the principles of mathematics pedagogy with digital learning environments. It refers to the process of teaching and learning mathematics through the use of information and communication technologies (ICT), where teachers and students are physically separated and interaction is mediated through digital platforms (Moore & Kearsley, 2012). This form of education has gained increasing importance in the 21st century, particularly due to the rapid development of technology and the global shift toward online learning.

In the context of Kazakhstan, the importance of distance learning increased significantly during and after the COVID-19 pandemic. Nurgaliyeva et al. (2024) reported that secondary school students experienced challenges related to communication, adaptation to online learning environments, and maintaining learning effectiveness. The authors emphasized the need for well-structured digital learning environments and effective pedagogical support to improve learning outcomes in online education.

E-learning, as a broader concept, encompasses a wide range of digital instructional approaches, including computer-based learning, web-based instruction, virtual classrooms, and online collaboration (Fry, 2001). In the context of mathematics education, e-learning requires careful adaptation, as mathematical understanding depends on sequential reasoning, structured explanations, and continuous practice. Unlike other subjects, mathematics involves abstract concepts that often require step-by-step guidance, visualization, and immediate feedback, which can be more difficult to provide in distance learning environments.

One of the key characteristics of distance mathematics education is the mode of interaction between teachers and students. According to Moore's theory of transactional distance, learning in online environments depends on three main components: dialogue, structure, and learner autonomy (Moore & Kearsley, 2012). Dialogue refers to the level of interaction between teacher and student, structure relates to the organization of the course, and autonomy describes the learner's ability to manage their own learning. In the case of middle school students, particularly those in Grades 5–6, learner autonomy is still developing, which makes structured instruction and active teacher support especially important.

Another important concept is the distinction between synchronous and asynchronous learning. Synchronous learning occurs in real time, for example through video conferencing tools such as Zoom or Google Meet, allowing immediate interaction and feedback. Asynchronous learning, on the other hand, involves access to pre-recorded materials, such as instructional videos, which students can study at their

own pace. Research suggests that a combination of both approaches can enhance learning effectiveness by providing flexibility while maintaining interaction (Means et al., 2013). In mathematics education, asynchronous video-based instruction is particularly valuable, as it allows students to revisit explanations and work through problems step by step.

Studies conducted in Kazakhstan also support the importance of combining different forms of online learning. Amirova et al. (2023) found that the effectiveness of synchronous online instruction largely depends on students' access to digital resources and the quality of instructional design. Their findings suggest that flexible learning approaches that integrate both real-time interaction and independent learning activities can enhance educational outcomes.

Student engagement is a central concept in distance mathematics education and plays a critical role in determining learning outcomes. Engagement is commonly defined as a multidimensional construct that includes behavioral, emotional, and cognitive components (Fredricks et al., 2004). Behavioral engagement involves participation in learning activities, emotional engagement refers to interest and motivation, and cognitive engagement relates to the effort invested in understanding complex concepts. In online environments, maintaining all three dimensions of engagement is more challenging due to reduced interaction and increased reliance on students' самостоятельность.

Academic achievement is another key concept and refers to students' performance in learning, typically measured through assessments, tests, and learning outcomes. In mathematics education, academic achievement is closely linked to conceptual understanding, problem-solving ability, and procedural fluency. Research indicates that academic achievement in online environments is influenced not only by content delivery but also by instructional design and the level of student engagement (Hillmayr et al., 2020). Therefore, improving teaching methodology is essential for achieving better learning outcomes.

The role of digital tools is also fundamental in distance mathematics education. Instructional videos, interactive platforms, and gamified learning applications are widely used to support student learning. Video-based instruction, in particular, has been shown to improve understanding by combining visual and auditory information and allowing students to control the pace of learning (Brame, 2016). Interactive tools, such as online quizzes and educational games, provide immediate feedback and promote active participation, which are critical for maintaining engagement (Dichev & Dicheva, 2017).

Similar findings were reported by Kazakhstani researchers. Fariza et al. (2021) found that the use of educational technologies in mathematics lessons increases students' motivation, participation, and interest in learning. The authors noted that digital tools help learners better understand mathematical concepts through visualization and interactive activities, making mathematics instruction more effective.

Another important concept is instructional methodology, which refers to the set of strategies and approaches used by teachers to facilitate learning. In distance mathematics education, effective methodology involves structured lesson design, including clear explanations, guided practice, independent work, and formative assessment. According to Rosenshine (2012), effective instruction is based on principles such as breaking content into small steps, providing guided practice, and checking for understanding. These principles are particularly relevant in online learning environments, where students may struggle without direct support.

In addition, the concept of feedback plays a crucial role in mathematics learning. Immediate and specific feedback helps students identify errors, correct misconceptions, and improve their understanding. In traditional classrooms, feedback is often provided instantly by the teacher. In distance learning, however, feedback must be integrated into digital tools and instructional design, for example through automated quizzes or teacher comments on assignments.

It is also important to consider the developmental characteristics of students in Grades 5–6. At this stage, learners are transitioning from concrete to more abstract

thinking, which makes mathematical instruction particularly sensitive to the quality of explanation and support. Without effective teaching strategies, students may develop misconceptions or lose interest in the subject. Therefore, distance learning methodologies must be carefully designed to meet the cognitive and motivational needs of this age group.

Defining key concepts in distance mathematics education provides a foundation for understanding the complexities of teaching and learning in online environments. These concepts—including e-learning, student engagement, academic achievement, instructional methodology, and the use of digital tools—are interconnected and collectively influence the effectiveness of distance mathematics education. A clear understanding of these concepts is essential for developing effective instructional strategies and improving learning outcomes for students in Grades 5–6.

## **2.2 Characteristics and Challenges of Distance Learning in Middle School**

Distance learning in middle school is characterized by a shift from traditional face-to-face instruction to technology-mediated learning environments, where interaction between teachers and students occurs through digital platforms. This transformation has introduced both opportunities and challenges, particularly for students in Grades 5–6, who are still developing cognitive, social, and self-regulation skills. Unlike higher-level learners, middle school students often require structured guidance, consistent feedback, and active support, which can be difficult to provide effectively in online settings.

One of the defining characteristics of distance learning is its flexibility. Students can access educational materials at any time and from any location, which allows for personalized pacing and independent learning. This is particularly beneficial in mathematics, where students may need additional time to understand concepts and practice problem-solving. However, this flexibility also places greater responsibility on

students to manage their own learning, which can be challenging for younger learners who have not yet developed strong self-regulation skills (Moore & Kearsley, 2012).

Another important characteristic is the reliance on digital tools and platforms, such as video conferencing applications, learning management systems (LMS), and interactive educational software. These tools enable communication, content delivery, and assessment in online environments. For example, video-based instruction allows teachers to present mathematical concepts in a structured and visual manner, while interactive platforms can provide immediate feedback through quizzes and activities. Despite these advantages, the effectiveness of such tools depends heavily on how they are integrated into the teaching methodology (Hillmayr et al., 2020).

A key challenge of distance learning in middle school is reduced interaction between teachers and students. In traditional classrooms, teachers can monitor students' understanding, provide immediate clarification, and adjust instruction based on students' responses. In contrast, online environments often limit real-time interaction, especially in asynchronous learning formats. This reduction in interaction can lead to misunderstandings, decreased motivation, and lower levels of engagement (Hodges et al., 2020).

Another significant challenge is maintaining student engagement. Middle school students are particularly vulnerable to distraction in online environments, where external factors such as home environment, lack of supervision, and access to non-educational digital content can interfere with learning. Research shows that engagement tends to decline in distance learning settings if instructional methods do not actively involve students (Fredricks et al., 2004). Without interactive elements, students may become passive learners, which negatively affects both their understanding and academic performance.

Research conducted in Kazakhstan also highlights the issue of student engagement in online learning environments. According to Amirova et al. (2023), limited interaction, unequal access to digital resources, and reduced communication with teachers negatively influenced students' participation and motivation during

distance learning. These findings demonstrate the importance of designing engaging and interactive online lessons for middle school learners.

Technical and infrastructural issues also represent major barriers to effective distance learning. These include unstable internet connections, limited access to digital devices, and varying levels of digital literacy among students and teachers. Such challenges can create inequalities in learning opportunities and hinder students’ ability to fully participate in online education (Hillmayr et al., 2020).

These challenges have also been observed in the Kazakhstani educational context. Amirova et al. (2023) found that differences in internet connectivity, availability of digital devices, and technological readiness created disparities in students’ learning experiences. The authors concluded that ensuring equitable access to digital resources is essential for improving the effectiveness of distance education.

Furthermore, the absence of a structured classroom environment can impact students’ learning behavior. In traditional settings, the classroom provides a controlled environment that supports discipline, focus, and routine. In contrast, distance learning often lacks these elements, requiring students to independently manage their time and learning activities. For students in Grades 5–6, this can lead to difficulties in maintaining concentration and completing tasks effectively.

*Table 2. 2. 1. Challenges of Distance Learning in Mathematics Education*

| <b>Challenge</b>                    | <b>Impact on Learning</b>               |
|-------------------------------------|-----------------------------------------|
| Limited teacher-student interaction | Delayed clarification of misconceptions |
| Reduced engagement                  | Lower participation and motivation      |
| Lack of immediate feedback          | Slower correction of errors             |
| Difficulties with abstract concepts | Decreased conceptual understanding      |
| Limited guided practice             | Weaker problem-solving skills           |
| Technical barriers                  | Interrupted learning process            |

In mathematics education, these challenges are particularly pronounced. Mathematics requires sequential understanding, continuous practice, and timely feedback, all of which are more difficult to achieve in online environments. Without clear explanations and guided practice, students may develop misconceptions that can negatively affect their long-term learning.

Distance learning in middle school is characterized by flexibility, technological integration, and increased learner autonomy, but it is also associated with significant challenges related to interaction, engagement, and access to resources. Understanding these characteristics and challenges is essential for developing effective teaching methodologies that support student engagement and academic achievement in distance mathematics education.

### **2.3 Student Engagement in Online Mathematics Learning**

Student engagement is widely recognized as a key factor influencing learning outcomes, particularly in mathematics education. In the context of online learning, engagement becomes even more critical, as students are required to actively participate in the learning process without the direct supervision and immediate support typically present in traditional classroom environments. Engagement is generally defined as a multidimensional construct that includes behavioral, emotional, and cognitive components, each of which plays a significant role in determining academic success (Fredricks et al., 2004).

Behavioral engagement refers to students' active participation in learning activities, such as attending online lessons, completing assignments, and interacting with digital content. In online mathematics learning, behavioral engagement is often reflected in students' involvement in tasks such as solving problems, participating in quizzes, and responding to questions during virtual sessions. However, maintaining consistent participation can be challenging in distance learning environments due to distractions, lack of supervision, and varying levels of student motivation.

Emotional engagement involves students' attitudes toward learning, including their interest, enjoyment, and sense of belonging. In mathematics, emotional engagement is particularly important, as many students experience anxiety or lack of confidence when dealing with abstract concepts. In online settings, the absence of direct interaction with teachers and peers can reduce students' emotional connection to the learning process, leading to decreased motivation and interest (Hodges et al., 2020). Therefore, creating a supportive and interactive learning environment is essential for fostering positive emotional engagement.

Cognitive engagement refers to the level of effort students invest in understanding the material and mastering complex concepts. In mathematics education, cognitive engagement is closely linked to problem-solving, reasoning, and the ability to apply knowledge in different contexts. Online learning environments must be designed to promote deep thinking and active learning, rather than passive content consumption. This can be achieved through the use of challenging tasks, guided practice, and opportunities for reflection.

*Table 2. 3. 1. Dimensions of Student Engagement in Online Mathematics Learning*

| Dimension             | Definition                           | Examples in Online Mathematics Learning                                           | Expected Impact on Achievement                    |
|-----------------------|--------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------|
| Behavioral Engagement | Participation in learning activities | Attending online lessons, completing assignments, participating in Kahoot quizzes | Increased task completion and performance         |
| Emotional Engagement  | Interest, enjoyment, and motivation  | Positive attitude toward mathematics and online learning                          | Higher motivation and persistence                 |
| Cognitive Engagement  | Mental effort and deep learning      | Problem-solving, reasoning, reflection, and application of concepts               | Improved conceptual understanding and achievement |

Research has consistently shown that higher levels of student engagement are associated with improved academic achievement. Engaged students are more likely to persist in learning tasks, use effective strategies, and achieve better results (Fredricks et al., 2004). In online mathematics learning, engagement plays an even more significant role, as students must rely more on their own initiative and self-regulation.

The use of digital tools has been identified as an effective way to enhance student engagement in online environments. Interactive platforms, such as online quizzes and gamified applications, can increase participation by making learning more dynamic and engaging. For example, gamification techniques, including points, leaderboards, and immediate feedback, have been shown to improve motivation and encourage active involvement in learning activities (Dichev & Dicheva, 2017). Similarly, video-based instruction can support engagement by presenting content in a clear and visually appealing format, allowing students to control the pace of learning and revisit difficult concepts (Brame, 2016).

Similar conclusions were reached by Kazakhstani researchers. Fariza et al. (2021) found that the integration of educational technologies into mathematics instruction increased students' motivation, participation, and interest in learning activities. According to the authors, interactive digital tools help create a more engaging learning environment and encourage students to take a more active role in the learning process.

Another important factor influencing engagement in online mathematics learning is instructional design. Well-structured lessons that include clear explanations, guided practice, and opportunities for interaction can significantly improve student engagement. According to Rosenshine (2012), effective instruction involves breaking content into manageable steps, providing examples, and regularly checking for understanding. These principles are particularly relevant in online environments, where students may struggle without direct teacher support.

Despite the potential benefits of digital tools and structured instruction, maintaining student engagement in distance learning remains a challenge. Factors such

as limited interaction, technical difficulties, and lack of motivation can reduce students' participation and negatively impact learning outcomes. Therefore, it is essential to develop teaching methodologies that actively involve students and address the specific challenges of online mathematics education.

Zharkynbekova (2023) argues that modern smart technologies and interactive digital resources contribute to sustaining students' attention and improving engagement in mathematics learning. The study highlights that the effective use of digital tools can support both motivation and academic achievement in technology-enhanced learning environments.

Student engagement is a crucial component of successful online mathematics learning. Its behavioral, emotional, and cognitive dimensions collectively influence students' ability to understand and apply mathematical concepts. Enhancing engagement through effective instructional strategies and the use of digital tools is essential for improving academic achievement, particularly for students in Grades 5–6 who require additional support and guidance in distance learning environments.

## **2.4 Academic Achievement in Distance Learning Environments**

Academic achievement is a fundamental indicator of educational effectiveness and refers to the level of knowledge, skills, and competencies that students acquire through the learning process. In mathematics education, academic achievement is typically measured through assessments, test results, and the ability to apply concepts in problem-solving situations. In the context of distance learning, academic achievement becomes closely linked to both the quality of instructional design and the level of student engagement.

Research suggests that distance learning can produce comparable or even improved academic outcomes when compared to traditional face-to-face instruction, provided that appropriate teaching methodologies are applied. According to Means et al. (2013), well-designed online and blended learning environments can enhance student performance by offering flexible access to materials, personalized pacing, and

opportunities for repeated practice. However, the effectiveness of distance learning is not determined solely by the use of technology but by how effectively instructional strategies are implemented.

Similar findings have been reported in Kazakhstan. Nurgaliyeva et al. (2024) found that students' academic performance in online learning environments depended not only on access to technology but also on the quality of instructional support and learning organization. The authors emphasized that effective pedagogical strategies play a crucial role in achieving positive educational outcomes in distance learning.

In mathematics, academic achievement is particularly dependent on conceptual understanding, procedural fluency, and problem-solving skills. Unlike subjects that rely heavily on memorization, mathematics requires a sequential and cumulative learning process. Students must understand foundational concepts before progressing to more complex topics. In distance learning environments, this process can be disrupted if students do not receive sufficient guidance, feedback, and opportunities for practice.

One of the key factors influencing academic achievement in online learning is instructional clarity. Clear explanations, structured content, and step-by-step guidance are essential for helping students understand mathematical concepts. Video-based instruction has been identified as an effective tool for improving clarity, as it allows teachers to present information visually and enables students to review the material multiple times (Brame, 2016). This is especially important for students in Grades 5–6, who are still developing their ability to process abstract information.

Another important factor is feedback. Timely and specific feedback helps students identify mistakes, correct misconceptions, and improve their understanding. In traditional classrooms, feedback is often immediate and personalized. In contrast, distance learning environments may delay or limit feedback, which can negatively impact learning outcomes. The integration of digital tools, such as automated quizzes and interactive platforms, can partially address this issue by providing instant feedback and supporting self-assessment.

In the Kazakhstani context, researchers have also highlighted the importance of continuous feedback and teacher support in improving learning outcomes. Amirova et al. (2023) noted that students who received regular communication and instructional guidance demonstrated greater learning effectiveness and were better able to adapt to online learning environments.

Student engagement also plays a critical role in determining academic achievement. As discussed in the previous section, engaged students are more likely to persist in learning tasks and apply effective strategies. In online environments, where students have greater control over their learning, engagement becomes even more important. Studies have shown that higher levels of engagement are associated with better academic performance, particularly in mathematics (Fredricks et al., 2004).

Despite the potential benefits of distance learning, several challenges can negatively affect academic achievement. These include limited interaction with teachers, lack of motivation, technical issues, and differences in access to resources. In addition, students may struggle with self-regulation, which is essential for managing time, completing assignments, and maintaining focus in online environments. These challenges are particularly significant for middle school students, who may require more structured support and guidance.

The use of digital tools and interactive learning strategies has been shown to improve academic outcomes by promoting active learning and increasing student motivation. For example, gamified learning environments and interactive tasks can enhance students' interest in mathematics and encourage participation (Dichev & Dicheva, 2017). Similarly, multimedia resources, such as videos and simulations, can support deeper understanding by presenting concepts in multiple formats.

Evidence from Kazakhstan suggests that digital technologies can positively influence students' academic achievement when integrated into mathematics instruction. Fariza et al. (2021) reported that educational technologies enhance students' motivation and participation, which contribute to improved learning outcomes and a better understanding of mathematical concepts.

In the context of this study, improving academic achievement involves not only increasing test scores but also enhancing students' conceptual understanding and ability to apply mathematical knowledge in different contexts. This requires the development of effective teaching methodologies that combine clear instruction, active engagement, and appropriate use of digital tools.

In conclusion, academic achievement in distance mathematics learning is influenced by a combination of factors, including instructional design, student engagement, feedback, and access to resources. While distance learning offers opportunities for flexible and personalized education, its effectiveness depends on the implementation of well-structured teaching strategies. For students in Grades 5–6, improving academic achievement requires particular attention to clarity of instruction, continuous feedback, and the use of interactive approaches that support engagement and understanding.

## **2.5 The Role of Digital Tools in Mathematics Education**

Digital tools play a crucial role in modern mathematics education, particularly in the context of distance learning. With the increasing integration of technology into educational systems, digital tools have become essential for delivering content, facilitating interaction, and supporting student learning. In online environments, where traditional face-to-face instruction is not possible, these tools serve as the primary means of communication and engagement between teachers and students.

One of the most significant advantages of digital tools is their ability to enhance the clarity and accessibility of mathematical content. Mathematics often involves abstract concepts that can be difficult for students to understand without visual representation. Video-based instruction has been identified as an effective method for presenting such content, as it combines visual and auditory elements to support learning. According to Brame (2016), well-designed instructional videos can improve students' understanding by providing clear explanations, structured presentation, and

the opportunity to pause and review the material. This is particularly beneficial for students in Grades 5–6, who require step-by-step guidance to grasp new concepts.

*Table 2. 5. 1. Digital Tools Used in Distance Mathematics Education*

| Digital Tool                      | Primary Function                 | Benefits for Mathematics Learning                                     |
|-----------------------------------|----------------------------------|-----------------------------------------------------------------------|
| Video Lessons                     | Content delivery and explanation | Supports step-by-step understanding and allows repeated viewing       |
| Kahoot                            | Interactive assessment           | Increases motivation, participation, and immediate feedback           |
| Quizizz                           | Formative assessment             | Provides self-paced practice and instant feedback                     |
| Google Meet                       | Synchronous instruction          | Enables real-time communication and teacher support                   |
| Learning Management Systems (LMS) | Learning organization            | Facilitates assignment distribution and progress monitoring           |
| Digital Whiteboards               | Visual explanation               | Improves understanding of mathematical concepts through visualization |
| Multimedia Resources              | Concept visualization            | Supports different learning styles and enhances comprehension         |

In addition to video lessons, interactive digital tools such as Kahoot, Quizizz, and other online quiz platforms play an important role in increasing student engagement. These tools incorporate elements of gamification, such as points, competition, and immediate feedback, which make learning more dynamic and motivating. Research indicates that gamified learning environments can significantly enhance student motivation and participation, leading to improved learning outcomes (Dichev & Dicheva, 2017). In mathematics education, such tools allow students to

actively practice problem-solving while receiving instant feedback on their performance.

Another important function of digital tools is to support formative assessment. In traditional classrooms, teachers can assess students' understanding through observation and direct questioning. In distance learning environments, this process is often replaced by digital assessments, which can provide immediate feedback and track student progress over time. Interactive quizzes and online assignments allow teachers to identify students' strengths and weaknesses, adjust instruction accordingly, and provide targeted support.

Digital tools also facilitate communication and collaboration, which are essential components of effective learning. Platforms such as learning management systems (LMS), discussion forums, and video conferencing tools enable interaction between teachers and students, as well as among peers. Although online communication may not fully replicate face-to-face interaction, it can still support collaborative learning when properly implemented. For example, group activities and problem-solving tasks can be conducted in virtual environments, encouraging students to share ideas and learn from each other.

The integration of multimedia elements is another important aspect of digital tools in mathematics education. Multimedia resources, including animations, simulations, and interactive visualizations, can help students understand complex concepts by presenting them in multiple formats. According to Zhang et al. (2006), the use of multimedia in e-learning can significantly improve learning effectiveness by engaging multiple sensory channels and supporting different learning styles.

Despite these advantages, the use of digital tools also presents certain challenges. The effectiveness of these tools depends largely on how they are integrated into the teaching methodology. Simply using technology does not guarantee improved learning outcomes. Teachers must carefully design lessons that incorporate digital tools in a meaningful way, ensuring that they support learning objectives rather than distract from them. In addition, issues such as limited access to technology, technical difficulties,

and varying levels of digital literacy can affect the successful implementation of digital tools (Hillmayr et al., 2020).

For students in Grades 5–6, the use of digital tools must be particularly well-structured and guided. Younger learners may struggle to navigate digital platforms independently and may require clear instructions and support from the teacher. Therefore, effective use of digital tools in distance mathematics education involves not only the selection of appropriate technologies but also the development of pedagogical strategies that align with students' cognitive and developmental needs.

In the context of this study, digital tools such as video lessons and interactive platforms are used as key components of the instructional methodology. These tools are intended to enhance student engagement, provide clear explanations of mathematical concepts, and support continuous assessment and feedback. By integrating these tools into a structured teaching approach, the study aims to improve both engagement and academic achievement among students in Grades 5–6.

In conclusion, digital tools play a vital role in distance mathematics education by supporting content delivery, interaction, assessment, and engagement. When effectively integrated into teaching methodology, these tools can significantly enhance the quality of learning and contribute to improved academic outcomes. However, their success depends on thoughtful implementation and alignment with pedagogical principles.

## **2.6 Instructional Strategies for Teaching Mathematics Online**

Effective instructional strategies are essential for ensuring successful learning outcomes in distance mathematics education. Unlike traditional classroom settings, where teachers can provide immediate guidance and adjust instruction in real time, online learning environments require carefully structured teaching approaches that support clarity, engagement, and independent learning. For students in Grades 5–6, the selection and implementation of appropriate instructional strategies are particularly

important, as they are still developing foundational mathematical skills and learning habits.

One of the most widely recognized frameworks for effective instruction is based on structured teaching principles, which emphasize clarity, sequencing, and guided practice. According to Rosenshine (2012), effective teaching involves breaking complex material into small, manageable steps, providing clear explanations, modeling problem-solving processes, and gradually transferring responsibility to students. In the context of online mathematics learning, these principles are especially important, as students may struggle to follow explanations without direct teacher support.

A key instructional strategy in distance learning is the use of explicit instruction. This approach involves clearly explaining concepts, demonstrating procedures, and guiding students through examples before asking them to work independently. In mathematics, explicit instruction helps students understand the logical sequence of steps required to solve problems. When combined with video-based lessons, this strategy becomes even more effective, as students can pause, rewind, and review explanations at their own pace (Brame, 2016). This flexibility is particularly beneficial for middle school learners who may need additional time to process new information.

Kazakhstani researchers have also emphasized the importance of structured instruction in mathematics education. Ramankulov et al. (2022) argue that clearly organized learning activities, step-by-step explanations, and systematic teacher guidance contribute to students' conceptual understanding and mathematical achievement. Their findings suggest that structured instructional approaches remain essential even when learning is delivered through digital technologies.

Another important strategy is guided practice, which allows students to apply newly learned concepts with teacher support. In online environments, guided practice can be implemented through interactive tasks, live problem-solving sessions, or structured activities within digital platforms. This stage is crucial for reinforcing understanding and preventing misconceptions. Following guided practice, students move to independent practice, where they apply their knowledge without assistance.

This gradual progression from teacher-led instruction to самостоятельная работа aligns with effective learning principles and supports long-term retention.

The use of formative assessment is also a critical component of effective instructional strategies. Formative assessment involves regularly checking students' understanding and providing feedback during the learning process. In distance learning, this can be achieved through digital tools such as online quizzes, polls, and interactive exercises. Immediate feedback allows students to identify errors and correct misconceptions, while also helping teachers monitor progress and adjust instruction accordingly. Research indicates that formative assessment significantly improves learning outcomes when integrated into instruction (Means et al., 2013).

In the context of Kazakhstan, Turgunbayeva and colleagues (2023) highlighted that formative assessment supported through digital platforms enables teachers to monitor students' progress more effectively and provide timely interventions. The researchers reported that regular feedback contributes to higher levels of student participation and learning achievement.

Interactive learning strategies play a particularly important role in maintaining student engagement in online mathematics education. These strategies involve active student participation through problem-solving, discussion, and collaboration. For example, gamified learning activities using platforms such as Kahoot or Quizizz can increase motivation and encourage participation by incorporating elements of competition and reward (Dichev & Dicheva, 2017). Such activities transform traditional practice exercises into engaging experiences, making learning more enjoyable and effective.

Similar results were reported by Fariza et al. (2021), who found that the integration of educational technologies and interactive learning activities in mathematics lessons increased students' motivation, classroom participation, and overall engagement. According to the authors, digital tools are most effective when combined with appropriate pedagogical strategies rather than used as standalone technologies.

Another effective approach is the integration of multimedia and visual representations. Mathematics often requires visualization to support understanding of abstract concepts. The use of diagrams, animations, and step-by-step demonstrations can help students grasp complex ideas more easily. Multimedia instruction engages multiple sensory channels, which enhances comprehension and retention (Zhang et al., 2006). In online environments, video lessons combined with visual aids are particularly effective in supporting this process.

Collaborative learning is also an important instructional strategy, even in distance education. Although online environments may limit face-to-face interaction, digital platforms can facilitate collaboration through group tasks, discussions, and shared problem-solving activities. Working with peers allows students to exchange ideas, explain concepts, and develop deeper understanding. However, for younger students, such collaboration must be carefully structured and guided by the teacher to ensure meaningful participation.

Despite the effectiveness of these strategies, their success depends on proper implementation. Teachers must carefully design lessons that integrate multiple strategies in a coherent and structured way. Simply using digital tools or activities without a clear pedagogical purpose may not lead to improved learning outcomes. Therefore, instructional strategies must align with learning objectives and be adapted to the needs of students.

In the context of this study, the instructional methodology is based on a structured approach that includes clear explanation through video lessons, guided practice, independent work, and interactive assessment using digital tools. This approach is designed to support student engagement and improve academic achievement by combining effective teaching principles with modern technologies.

Shynybekova (2021) emphasizes that the successful teaching of mathematics depends not only on the content being taught but also on the methodology used to facilitate learning. The author argues that effective mathematics instruction should

combine clear explanations, active student participation, and opportunities for independent practice, which are particularly important in online learning environments.

In conclusion, effective instructional strategies are essential for improving the quality of distance mathematics education. Approaches such as explicit instruction, guided practice, formative assessment, and interactive learning provide a strong foundation for teaching mathematics online. When combined with digital tools and structured lesson design, these strategies can significantly enhance both student engagement and academic achievement, particularly for learners in Grades 5–6.

## **2.7 The Effectiveness of Video-Based Learning and Interactive Platforms**

Video-based learning and interactive digital platforms have become essential components of distance education, particularly in mathematics teaching. In online environments, where direct teacher-student interaction is limited, these tools play a crucial role in delivering content, supporting understanding, and maintaining student engagement. Their effectiveness has been widely studied in educational research, with findings indicating that the combination of video instruction and interactive activities can significantly enhance learning outcomes.

Video-based learning refers to the use of recorded instructional videos to present educational content. In mathematics education, video lessons are particularly valuable because they allow teachers to provide clear, step-by-step explanations of concepts and procedures. According to Brame (2016), effective educational videos improve learning by combining visual and auditory information, reducing cognitive load, and allowing students to control the pace of learning. Students can pause, rewind, and rewatch explanations, which is especially beneficial when dealing with complex or unfamiliar mathematical concepts.

Another advantage of video-based learning is its ability to support differentiated instruction. Students learn at different speeds, and video lessons enable each learner to progress according to their individual needs. For students in Grades 5–6, this flexibility

is particularly important, as they may require additional time to understand abstract ideas. By revisiting instructional content, students can strengthen their understanding and build confidence in their abilities.

However, video-based learning alone may not be sufficient to ensure effective learning outcomes. Research suggests that passive viewing of videos does not guarantee deep understanding. Instead, learning is most effective when video instruction is combined with interactive elements that require active student participation (Zhang et al., 2006). Interactive platforms, such as Kahoot, Quizizz, and other online tools, provide opportunities for students to engage with the material, apply their knowledge, and receive immediate feedback.

Interactive platforms enhance learning by transforming students from passive recipients of information into active participants in the learning process. Gamified tools, in particular, have been shown to increase motivation and engagement by incorporating elements such as competition, rewards, and instant feedback (Dichev & Dicheva, 2017). In mathematics education, these tools allow students to practice problem-solving in an engaging and dynamic way, reinforcing their understanding while maintaining interest.

The combination of video-based instruction and interactive platforms creates a balanced learning environment that integrates explanation and practice. Video lessons provide the conceptual foundation, while interactive tools enable students to apply their knowledge and receive feedback. This approach aligns with modern learning theories, which emphasize the importance of active engagement and immediate reinforcement in the learning process.

Research also highlights the importance of instructional design in maximizing the effectiveness of these tools. Simply using videos or interactive platforms is not enough; they must be integrated into a structured learning sequence that includes explanation, guided practice, independent work, and assessment. When used effectively, video-based learning and interactive tools can improve both student engagement and academic achievement (Means et al., 2013).

Despite their benefits, these tools also present certain challenges. Technical issues, such as limited access to devices or unstable internet connections, can hinder their effectiveness. In addition, students may become distracted or lose focus if digital tools are not used in a structured and purposeful way. Therefore, teachers must carefully design learning activities that ensure meaningful engagement and alignment with learning objectives.

For middle school students, particularly those in Grades 5–6, the use of video-based learning and interactive platforms must be supported by clear instructions and teacher guidance. Younger learners may struggle to use digital tools independently, and without proper support, the potential benefits of these technologies may not be fully realized.

In the context of this study, video lessons and interactive platforms are used as key components of the instructional methodology. Video-based instruction provides clear explanations of mathematical concepts, while interactive tools are used to reinforce learning, assess understanding, and maintain student engagement. This combination is expected to create a more effective learning environment that supports both engagement and academic achievement.

In conclusion, video-based learning and interactive platforms are powerful tools for enhancing distance mathematics education. When integrated into a structured instructional approach, they can significantly improve students' understanding, motivation, and performance. However, their effectiveness depends on thoughtful implementation and alignment with pedagogical principles, particularly for younger learners in Grades 5–6.

## **2.8 Comparative Analysis of Traditional and Distance Learning Approaches**

The comparison between traditional and distance learning approaches has become an important area of research, particularly in the context of the increasing use of digital technologies in education. Each approach has its own advantages and

limitations, and understanding these differences is essential for developing effective instructional methodologies, especially in mathematics education.

Traditional classroom learning is characterized by direct, face-to-face interaction between teachers and students. This environment allows for immediate feedback, real-time clarification of misunderstandings, and dynamic adaptation of teaching methods based on students' responses. In mathematics education, such interaction is particularly valuable, as it enables teachers to guide students through complex problem-solving processes and address misconceptions as they arise. Additionally, the structured nature of classroom settings supports discipline, routine, and consistent engagement.

In contrast, distance learning relies on digital technologies to deliver instruction and facilitate communication. This approach offers several advantages, including flexibility, accessibility, and the ability to learn at an individual pace. Students can access materials at any time, revisit lessons, and engage with content in a way that suits their personal learning style. These features are particularly beneficial in mathematics, where students often need additional time and repeated practice to understand concepts.

However, distance learning also presents significant challenges. One of the main limitations is the reduced level of interaction between teachers and students. Unlike traditional classrooms, where teachers can immediately respond to students' questions and adjust instruction, online environments may delay feedback and limit opportunities for clarification. This can lead to misunderstandings and gaps in knowledge, especially in subjects like mathematics that require continuous guidance (Hodges et al., 2020).

Another important difference lies in student engagement. In traditional settings, engagement is often supported by direct teacher supervision, peer interaction, and a structured environment. In contrast, distance learning requires students to take greater responsibility for their own learning, which can be difficult for middle school students. Without effective instructional strategies, students may become passive learners, leading to decreased motivation and lower academic achievement (Fredricks et al., 2004).

Despite these challenges, research suggests that distance learning can be as effective as traditional instruction when supported by well-designed methodologies. According to Means et al. (2013), online and blended learning environments can produce comparable or even better outcomes than traditional approaches when they incorporate interactive elements, structured instruction, and opportunities for active learning. This highlights the importance of not only comparing the two approaches but also understanding how to improve distance learning to match or exceed traditional methods.

One of the most promising approaches is blended learning, which combines elements of both traditional and distance education. This model allows students to benefit from face-to-face interaction while also taking advantage of digital tools and flexible learning opportunities. However, in fully online environments, it becomes essential to replicate the strengths of traditional instruction through effective use of technology. This includes providing clear explanations, maintaining interaction, and ensuring continuous feedback.

In mathematics education, the comparison between traditional and distance learning is particularly significant. Mathematics requires a high level of teacher support, structured guidance, and active student participation. While traditional classrooms naturally provide these elements, distance learning must intentionally incorporate them through instructional design. For example, video-based lessons can replicate teacher explanations, while interactive tools can simulate classroom activities and provide immediate feedback.

The effectiveness of distance learning ultimately depends on how well it addresses its inherent limitations. Simply transferring traditional teaching methods into an online format is not sufficient. Instead, educators must adapt their approaches by integrating digital tools, interactive strategies, and structured methodologies that support engagement and understanding.

In the context of this study, the comparative analysis highlights the need to improve the methodology of distance mathematics education for students in Grades 5–

6. By combining the strengths of traditional instruction—such as clarity, structure, and guidance—with the advantages of digital technologies, it is possible to create an effective learning environment that enhances both student engagement and academic achievement.

In conclusion, while traditional and distance learning approaches differ in their structure and delivery, both have the potential to support effective mathematics education. The key challenge lies in adapting instructional methodologies to maximize the strengths of each approach. Understanding these differences provides a foundation for developing improved teaching strategies that address the needs of students in modern educational contexts.

## **2.9 Summary of the Literature Review**

The literature review has examined key theoretical and empirical studies related to distance mathematics education, student engagement, academic achievement, and the role of digital tools and instructional strategies in online learning environments. The analysis demonstrates that distance learning has become an essential component of modern education, offering flexibility and accessibility, but also presenting significant pedagogical challenges, particularly for middle school students.

The review highlights that effective distance mathematics education requires more than the mere use of technology. It depends on the integration of well-structured instructional methodologies, including clear explanations, guided practice, and continuous feedback. Research emphasizes that student engagement—encompassing behavioral, emotional, and cognitive dimensions—is a critical factor influencing academic achievement, especially in online environments where learners must rely more on their own initiative (Fredricks et al., 2004).

Furthermore, the literature indicates that digital tools such as video-based instruction and interactive platforms can significantly enhance both engagement and learning outcomes when used effectively. Video lessons provide structured explanations and allow students to learn at their own pace, while interactive tools

promote active participation and immediate feedback (Brame, 2016; Dichev & Dicheva, 2017). However, the effectiveness of these tools is closely linked to instructional design and the extent to which they are integrated into a coherent teaching methodology.

At the same time, the review identifies several challenges associated with distance learning, including reduced interaction, difficulties in maintaining student motivation, and variations in access to technological resources. These challenges are particularly relevant for students in Grades 5–6, who require structured guidance and support due to their developmental stage. Without appropriate instructional strategies, distance learning may lead to decreased engagement and lower academic achievement.

Despite the growing body of research on e-learning, there remains a limited number of studies that specifically focus on improving the methodology of teaching mathematics in fully online environments for middle school students. In particular, there is a need for research that examines how structured approaches combining video-based instruction and interactive digital tools influence both student engagement and academic performance in real classroom contexts.

Therefore, this study addresses an important gap in the literature by investigating the effectiveness of a structured distance learning methodology in mathematics for students in Grades 5–6. By focusing on the integration of video lessons and interactive platforms, the research aims to provide empirical evidence on how these approaches can enhance engagement and improve academic outcomes.

In conclusion, the literature review establishes a strong theoretical and empirical foundation for the present study, highlighting the importance of effective instructional design, student engagement, and the strategic use of digital tools in distance mathematics education. It also justifies the need for further research aimed at improving teaching methodologies in online learning environments, particularly for middle school students.

### **3. METHODOLOGY**

As students in Grades 5–6 transition from primary to middle school education, ensuring their engagement and academic achievement becomes a critical priority. At this stage, learners experience cognitive, emotional, and social changes that affect their motivation and ability to learn effectively (Cauley & Jovanovich, 2006; Borman et al., 2019). These challenges are further intensified in distance learning environments, where students must rely more on independent learning.

In online mathematics education, the lack of direct interaction and immediate feedback can lead to reduced engagement and difficulties in understanding concepts. Therefore, it is essential to implement instructional approaches that support both clarity and active participation. The integration of digital tools, such as video-based instruction and interactive platforms, provides opportunities to enhance understanding and maintain student interest.

Visual explanations and structured lesson design play an important role in helping students grasp mathematical concepts. In addition, interactive tools such as online quizzes can increase motivation by encouraging active involvement and providing immediate feedback (Alley, 2019). These approaches support student autonomy and improve learning outcomes.

This study adopts a structured distance learning methodology that integrates video lessons, interactive tools, and clear lesson structure to enhance student engagement and academic achievement in mathematics among students in Grades 5-6.

#### **3.1 Theoretical Framework**

The theoretical framework of this study is based on established educational theories that explain how students learn in digital environments and how instructional strategies can enhance engagement and academic achievement. In the context of distance mathematics education for students in Grades 5–6, it is important to apply theoretical perspectives that support active learning, effective use of digital tools, and

structured instruction. This study is grounded in Constructivist Learning Theory and the Cognitive Theory of Multimedia Learning.

### **3.1.1 Constructivist Learning Theory**

Constructivist Learning Theory suggests that learners actively construct their own knowledge through interaction and experience rather than passively receiving information (Piaget, 1972; Vygotsky, 1978). In mathematics education, this approach emphasizes understanding concepts through problem-solving and active engagement.

In distance learning environments, constructivist principles are especially important, as students must take a more active role in their learning. Interactive tools and activities support this process by encouraging participation and reflection. For example, platforms such as Kahoot allow students to engage actively in learning tasks and receive immediate feedback, which enhances understanding and motivation (Dichev & Dicheva, 2017).

Furthermore, constructivism is closely related to student engagement, as active involvement leads to deeper understanding and better academic outcomes (Fredricks et al., 2004). In this study, constructivist principles are applied through interactive activities, guided practice, and problem-solving tasks during online lessons.

### **3.1.2 Cognitive Theory of Multimedia Learning**

The Cognitive Theory of Multimedia Learning, developed by Mayer (2009), explains how students learn more effectively when information is presented through both visual and auditory channels. This theory is based on three main principles: limited capacity, dual channels, and active processing.

In mathematics education, multimedia instruction is particularly useful because it helps students visualize abstract concepts. Video-based learning allows teachers to present step-by-step explanations while using diagrams and examples, which improves understanding (Brame, 2016). In addition, students can control the pace of learning by pausing and reviewing videos, which reduces cognitive overload.

Research shows that combining video instruction with interactive activities leads to better learning outcomes than passive learning alone (Zhang et al., 2006). Therefore, multimedia tools play a key role in supporting both engagement and comprehension in distance learning environments.

This study integrates constructivist learning principles with the Cognitive Theory of Multimedia Learning to support effective distance mathematics education. These theories provide a foundation for the instructional methodology used in this research, which includes video-based instruction, interactive tools, and structured lesson design. Together, these approaches are expected to enhance student engagement and improve academic achievement among students in Grades 5–6.

### **3.2 Research Design**

This study employs a quasi-experimental research design to investigate the effectiveness of a structured distance learning methodology in mathematics for students in Grades 5–6. The quasi-experimental approach is widely used in educational research, as it allows the examination of instructional interventions in real classroom settings where random assignment is not feasible (Cohen et al., 2017).

The study follows a pre-test and post-test design with two groups: an experimental group (EG) and a control group (CG). The experimental group (EG) is taught using a structured distance learning methodology that integrates video-based instruction, interactive digital tools, and a clear lesson structure. In contrast, the control group (CG) receives standard distance learning instruction without the structured integration of these elements.

At the beginning of the study, both groups complete a pre-test to assess their initial level of mathematical knowledge. This ensures comparability between the groups before the intervention. After the instructional period, both groups complete a post-test to measure changes in academic achievement. The difference between pre-test and post-test results is used to evaluate the effectiveness of the intervention.

In addition to academic achievement, student engagement is measured as a key variable in this study. Engagement is assessed using a questionnaire designed to capture behavioral, emotional, and cognitive aspects of student involvement in the learning process.

The independent variable in this study is the instructional methodology applied in the experimental group, while the dependent variables are student engagement and academic achievement in mathematics.

This design allows for a comparison of outcomes between the experimental group (EG) and the control group (CG), providing evidence on the effectiveness of the proposed methodology. Although the quasi-experimental design does not allow full randomization, it is appropriate for educational research and enables meaningful conclusions to be drawn in real classroom contexts.

### **3.3 Participants and Setting**

The study was conducted among middle school students in Grades 5–6 at a private secondary school. A total of students participated in the research and were divided into two groups: an experimental group (EG) and a control group (CG). The groups were formed based on existing classroom structures, as random assignment was not feasible in the school setting. This approach is consistent with quasi-experimental research designs commonly used in educational studies (Cohen et al., 2017).

The participants were approximately 11–12 years old, which corresponds to a critical stage in cognitive development. At this age, students transition from concrete to more abstract thinking and begin to engage with more complex mathematical concepts. According to Piaget’s theory of cognitive development, learners at this stage move toward formal operational thinking, which enables them to understand relationships, patterns, and logical structures (Piaget, 1972). However, they still require structured guidance and support, particularly in subjects such as mathematics.

Both groups studied the same mathematical topics during the research period and followed the same curriculum. The key difference between the groups was the

instructional approach. The experimental group (EG) was taught using a structured distance learning methodology that integrated video-based instruction, interactive tools such as Kahoot, and visual explanations using digital platforms such as Miro. In contrast, the control group (CG) received standard distance learning instruction without the systematic integration of these elements.

The learning environment was fully online, with lessons conducted through video conferencing platforms. Students participated in synchronous online classes and completed additional tasks independently. This setting reflects the real conditions of distance education, allowing the study to examine the effectiveness of the instructional methodology in a natural educational context.

All participants had prior experience with online learning, which ensured that they were familiar with basic digital tools and platforms. However, differences in individual learning abilities, motivation, and access to resources were acknowledged as potential influencing factors.

The selection of participants and the learning environment were appropriate for the purpose of this study, as they allowed for the investigation of how structured distance learning methodologies affect student engagement and academic achievement in mathematics among middle school learners.

### **3.4.1 Student Engagement Questionnaire**

Student engagement was assessed using a structured questionnaire designed to measure behavioral, emotional, and cognitive dimensions of engagement. This classification is widely accepted in educational research and is based on the framework proposed by Fredricks et al. (2004).

The questionnaire included a set of statements related to students' participation in online lessons, their interest and motivation, and their effort in understanding mathematical concepts. Students were asked to respond using a Likert scale (for example, from "strongly disagree" to "strongly agree"). This format allows for the quantification of engagement levels and facilitates comparison between groups.

Behavioral engagement items focused on participation in activities, completion of tasks, and attention during lessons. Emotional engagement items measured students' interest, enjoyment, and attitudes toward mathematics learning. Cognitive engagement items examined the extent to which students invested effort in understanding the material and solving problems.

The use of questionnaires to measure student engagement is a common and reliable method in educational research, as it provides insight into students' perceptions and experiences (Fredricks et al., 2004). In this study, the questionnaire was administered to both the experimental group (EG) and the control group (CG) to compare levels of engagement under different instructional conditions.

### **3.4.2 Mathematics Achievement Test**

Academic achievement was measured using a mathematics test administered as both a pre-test and a post-test. The purpose of the pre-test was to assess students' initial level of knowledge before the intervention, while the post-test was used to measure learning outcomes after the instructional period.

The test consisted of problems aligned with the curriculum and designed to assess students' understanding of key mathematical concepts, procedural skills, and problem-solving abilities. The maximum score of the test was fixed, and all students were assessed using the same criteria to ensure consistency.

The difference between pre-test and post-test scores was used to evaluate the effectiveness of the instructional methodology. This approach allows for the measurement of learning gains and provides a clear indication of academic progress.

Achievement tests are widely used in educational research as objective measures of learning outcomes (Cohen et al., 2017). In this study, the test was designed to reflect the learning objectives of the lessons and to ensure validity and reliability of the results.

Overall, the use of both a student engagement questionnaire and a mathematics achievement test provided a balanced approach to data collection. While the questionnaire captured students' experiences and levels of engagement, the achievement test provided objective data on academic performance. Together, these

instruments allowed for a comprehensive evaluation of the impact of the instructional methodology on both engagement and learning outcomes.

### **3.5 Instructional Intervention**

#### **3.5.1 Overview of the Distance Learning Methodology**

The instructional intervention implemented in this study is based on a structured distance learning methodology designed to enhance student engagement and academic achievement in mathematics among students in Grades 5–6. This methodology integrates video-based instruction, interactive digital tools, and a clear lesson structure to support effective learning in an online environment.

The approach is grounded in established pedagogical principles, including explicit instruction, guided practice, and active student participation. It combines synchronous and asynchronous learning components to provide both real-time interaction and opportunities for independent study. The use of digital platforms allows for the integration of visual explanations, interactive tasks, and continuous feedback, which are essential for effective mathematics learning.

#### **3.5.2 Lesson Structure**

All lessons were conducted online using video conferencing platforms, with instruction supported by interactive visual tools. The primary platform for live instruction was Google Meet, which enabled real-time communication between the teacher and students.

During the lessons, the teacher used Miro as a digital whiteboard to present mathematical concepts. This platform allowed for dynamic visualization, including drawing diagrams, illustrating problem-solving steps, and organizing information in a clear and structured way. Compared to traditional classroom boards, Miro provided greater flexibility, as it allowed content to be saved, revisited, and expanded without limitations.

- Each lesson followed a structured sequence:
- introduction of the topic and learning objectives;

- explanation of concepts using visual representations;
- guided practice with teacher support;
- independent practice tasks;
- summary and feedback.

This structured approach ensured clarity and helped students follow the learning process step by step.

### **3.5.3 Video-Based Instruction**

In addition to live lessons, students in the experimental group were provided with video-based instructional materials through the SkillSpace platform. These videos presented mathematical concepts in a clear and structured format, allowing students to review the material independently.

Students were required to watch the video lessons as part of their homework. This practice reinforced learning by allowing students to revisit explanations and strengthen their understanding. Video-based instruction also supported differentiated learning, as students could learn at their own pace and focus on areas where they needed additional support.

### **3.5.4 Interactive Tools**

Interactive tools played a key role in maintaining student engagement and assessing understanding during the lessons. Platforms such as Kahoot were used to conduct short quizzes and interactive activities.

These tools incorporated elements of gamification, including competition, scoring, and immediate feedback, which increased student motivation and participation. Interactive quizzes were used both during and after lessons to check understanding and identify areas that required further explanation.

### **3.5.5 Homework Design and Reinforcement**

Homework was designed as an essential component of the instructional methodology, aimed at reinforcing learning and supporting knowledge retention.

Students were assigned mathematical problems related to the lesson content, which required independent problem-solving.

In addition to traditional tasks, students were required to rewatch the video lessons as part of their homework. This approach ensured that key concepts were reviewed and strengthened outside the classroom.

Homework was submitted through digital platforms and checked by the teacher. Feedback was provided to help students identify mistakes and improve their understanding. In some cases, elements of homework were also reviewed through interactive tools to provide immediate feedback.

The instructional intervention combined structured teaching, video-based instruction, and interactive tools to create an effective distance learning environment. By integrating these components, the methodology aimed to enhance both student engagement and academic achievement in mathematics.

This approach reflects a modern model of distance education, where technology is used not only to deliver content but also to support active learning, interaction, and continuous assessment.

### **3.6 Procedure**

The research was conducted in three distinct phases: pre-test, instructional intervention, and post-test. In the pre-test phase, all participating students completed a mathematics test designed to assess their baseline understanding of the selected mathematical topics. This assessment served as a benchmark to measure academic growth over the course of the study.

During the instructional intervention phase, students in the experimental group (EG) were taught using a structured distance learning methodology that integrated video-based instruction, interactive tools, and a clear lesson structure. Lessons were conducted online and supported by visual explanations, guided practice, and interactive activities. The instructional design was based on the premise that combining multimedia explanations with active participation can enhance conceptual

understanding and increase student engagement. In contrast, the control group (CG) received standard distance learning instruction without the structured integration of these elements.

In the final post-test phase, the same mathematics test used in the pre-test was re-administered to all students. The comparison between pre-test and post-test results allowed for the evaluation of academic progress following the intervention.

To assess student engagement, a questionnaire was administered after the instructional phase. The instrument captured three key dimensions of engagement: cognitive, emotional, and behavioral, based on the framework proposed by Fredricks, Blumenfeld, and Paris (2004).

### **Phases of Data Collection**

The intervention was carried out over a five-week period, beginning on 20 January 2025, and structured into three phases: pre-test, instructional intervention, and post-test.

#### **Phase 1: Pre-test Phase (20–24 January 2025)**

During the first week of the study, all students completed baseline assessments to measure their prior knowledge and initial engagement levels in mathematics.

##### **Mathematics Pre-Test:**

The test assessed students' understanding of key mathematical concepts and included both procedural and problem-solving tasks.

##### **Student Engagement Questionnaire:**

A questionnaire was administered to measure cognitive, emotional, and behavioral engagement.

#### **Phase 2: Instructional Intervention (27 January – 21 February 2025)**

The instructional phase lasted four weeks and involved two groups: the experimental group (EG) and the control group (CG).

The experimental group (EG) was taught using a structured distance learning methodology that integrated video-based instruction, visual explanation using digital tools, and interactive learning activities.

Each week focused on the development of students' understanding through a structured progression of learning activities:

**Week 1 (27–31 January): Introduction to Concepts through Visual Explanation**  
Students were introduced to key mathematical concepts using video-based instruction and visual explanations through digital whiteboards. The teacher demonstrated step-by-step problem-solving strategies to support understanding.

**Week 2 (03–07 February): Guided Practice and Concept Reinforcement**  
Students engaged in guided problem-solving activities with teacher support. Lessons focused on reinforcing concepts through structured practice and feedback.

**Week 3 (10–14 February): Independent Practice and Interactive Learning**  
Students applied their knowledge through independent problem-solving tasks. Interactive tools such as Kahoot were used to assess understanding and maintain engagement.

**Week 4 (17–21 February): Consolidation and Application of Knowledge**  
Students worked on more complex problems, integrating previously learned concepts. Lessons focused on summarizing and strengthening understanding.

Each lesson included:

- a structured explanation using video-based instruction and visual tools;
- guided practice with teacher support;
- independent problem-solving tasks;
- interactive activities using digital platforms such as Kahoot;
- feedback and lesson summary.

Students were also assigned homework tasks that included problem-solving and mandatory video review through an online platform to reinforce learning.

The control group (CG) received standard distance learning instruction without the structured integration of these elements.

**Phase 3: Post-test Phase (24–28 February )**

In the final week, the same assessment tools from the pre-test phase were re-administered to evaluate learning outcomes and engagement levels.

### Mathematics Post-Test:

The same test was used to measure academic progress.

### Student Engagement Questionnaire:

The questionnaire was administered again to assess changes in cognitive, emotional, and behavioral engagement.

This phase provided the data necessary to determine the effectiveness of the instructional methodology on both academic achievement and student engagement.

## **3.7 Data Collection**

Data collection in this study was carried out systematically throughout all phases of the research in order to evaluate both academic achievement and student engagement. The use of structured data collection procedures ensures the reliability and validity of research findings in educational studies (Cohen et al., 2017).

Two main types of data were collected: quantitative data from mathematics achievement tests and questionnaire responses. Quantitative data collection allows for objective measurement and comparison of learning outcomes between groups (Creswell & Creswell, 2018).

During the pre-test phase, baseline data were collected using a mathematics achievement test and a student engagement questionnaire. The pre-test provided information about students' initial level of mathematical knowledge, while the questionnaire measured cognitive, emotional, and behavioral engagement, based on the framework proposed by Fredricks, Blumenfeld, and Paris (2004).

Throughout the instructional intervention phase, additional observational data were collected to monitor students' participation and involvement in online lessons. In the experimental group (EG), particular attention was given to students' interaction with digital tools, engagement in guided practice, and participation in interactive activities. Observational data are commonly used in educational research to complement quantitative findings and provide contextual understanding of student behavior (Cohen et al., 2017).

In the post-test phase, the same mathematics test and engagement questionnaire were re-administered to all students. This allowed for direct comparison between pre-test and post-test results, enabling the measurement of changes in both academic achievement and engagement levels.

All data were collected under consistent conditions to ensure reliability. The use of identical instruments in both pre-test and post-test phases increased the validity of the results and ensured accurate measurement of learning gains (Creswell & Creswell, 2018).

The collected data were then organized, coded, and prepared for statistical analysis. This process ensured that the data could be systematically analyzed to determine the effectiveness of the structured distance learning methodology.

### **3.8 Data Analysis**

The data collected in this study were analyzed using quantitative statistical methods to evaluate the effectiveness of the instructional intervention. Quantitative analysis is appropriate for comparing students' achievement results and identifying measurable differences between instructional groups (Cohen et al., 2017).

To assess academic achievement, pre-test and post-test scores were analyzed. The difference between these scores, referred to as gain scores, was calculated for each student to measure individual learning progress. Descriptive statistics, including mean and standard deviation, were used to summarize the results for both the experimental group (EG) and the control group (CG) (Creswell & Creswell, 2018).

To determine whether there were statistically significant differences between the experimental group and the control group, inferential statistical tests were applied. Welch's independent samples t-test was used to compare mean scores between the two groups, as it is suitable when group variances may not be equal (Field, 2018). In addition, the Mann–Whitney U test was applied as a non-parametric alternative to confirm the results when the assumption of normal distribution could not be guaranteed (Pallant, 2020).

Within-group comparisons were also conducted to examine whether students in each group showed significant improvement from pre-test to post-test. Paired statistical tests were used to compare students' scores before and after the instructional period (Field, 2018).

Student engagement data collected through questionnaires were analyzed using descriptive statistics. The results were examined across three dimensions of engagement: behavioral, emotional, and cognitive engagement, following the framework proposed by Fredricks, Blumenfeld, and Paris (2004). These results were compared between the experimental group and the control group to identify differences in engagement levels.

All statistical analyses were conducted using a significance level of  $p < 0.05$  to determine statistical significance. This threshold is commonly used in educational research to evaluate whether observed differences are unlikely to have occurred by chance (Cohen et al., 2017).

The analysis provided evidence on the effectiveness of the structured distance learning methodology and allowed conclusions to be drawn regarding the impact of video-based instruction, interactive tools, and structured lesson design on students' academic achievement and engagement.

### **3.9 Assessment and Evaluation Criteria**

Assessment in this study was conducted using a combination of formative and summative evaluation methods to measure students' academic achievement and learning progress. The use of multiple assessment approaches allows for a more comprehensive evaluation of student performance and supports the reliability of research findings (Cohen et al., 2017).

Summative assessment was based on the results of the mathematics achievement tests administered during the pre-test and post-test phases. These tests were designed to evaluate students' understanding of mathematical concepts, procedural skills, and problem-solving abilities. Each test had a fixed maximum score, and all students were assessed using the same criteria to ensure consistency and fairness.

Students' academic performance was categorized into three levels based on their test scores:

- High level: 10–12 points
- Medium level: 7–9 points
- Low level: 0–6 points

This classification allowed for clear interpretation of learning outcomes and comparison between the experimental group (EG) and the control group (CG).

Formative assessment was conducted throughout the instructional intervention phase. It included continuous monitoring of students' participation, engagement in activities, and performance in interactive tasks. Tools such as Kahoot and online quizzes were used to assess students' understanding during lessons and provide immediate feedback. Formative assessment plays an important role in supporting learning by identifying misconceptions and guiding instructional adjustments (Black & Wiliam, 2009).

Homework assignments were also used as part of the assessment process. Students were required to complete problem-solving tasks and review video-based instructional materials. Homework was checked regularly, and feedback was provided to help students improve their understanding. This approach supports knowledge reinforcement and promotes independent learning (Hattie, 2009).

Student engagement was evaluated using questionnaire data, which measured cognitive, emotional, and behavioral dimensions of engagement. These dimensions were analyzed to understand how students interacted with the instructional methodology and how their level of involvement influenced learning outcomes (Fredricks et al., 2004).

Overall, the assessment framework combined objective measurement of academic achievement with continuous evaluation of student engagement. This comprehensive approach ensured that both learning outcomes and the learning process were effectively assessed.

### **3.10 Ethical Considerations**

Ethical considerations were carefully addressed throughout the research process to ensure the protection of participants and the integrity of the study. Adhering to ethical standards is essential in educational research, particularly when working with school-aged students (Cohen et al., 2017).

Participation in the study was voluntary, and all students were informed about the purpose and procedures of the research. Consent was obtained from the school administration and, where required, from parents or guardians. Students were assured that their participation or non-participation would not affect their academic standing.

Confidentiality and anonymity were maintained at all stages of the study. Personal information and individual results were not disclosed, and all data were used solely for research purposes. Participants were identified using codes rather than names to protect their identity.

The study was conducted in a way that did not cause harm or discomfort to the participants. All instructional activities were aligned with the existing curriculum, ensuring that students did not experience additional academic burden. The intervention was designed to support learning and enhance educational outcomes.

In addition, all collected data were stored securely and accessed only by the researcher. The results were reported honestly and transparently, without manipulation or misrepresentation of data.

## 4. ANALYSIS AND RESULTS

### 4.1 Descriptive Statistics and Normality Test

Descriptive statistics and the Shapiro–Wilk normality test were conducted before applying inferential statistical methods. The analysis included pre-test, post-test, and gain score results for the experimental group (EG) and control group (CG).

*Table 4. 1. 1. Descriptive Statistics and Shapiro–Wilk Test Results*

| Group | Test      | N  | Mean  | SD   | W    | P    |
|-------|-----------|----|-------|------|------|------|
| EG    | Pre-test  | 20 | 6.40  | 1.43 | 0.96 | 0.48 |
| CG    | Pre-Test  | 20 | 6.30  | 1.39 | 0.95 | 0.36 |
| EG    | Post-test | 20 | 10.20 | 1.20 | 0.97 | 0.62 |
| CG    | Post-test | 20 | 8.10  | 1.47 | 0.96 | 0.44 |

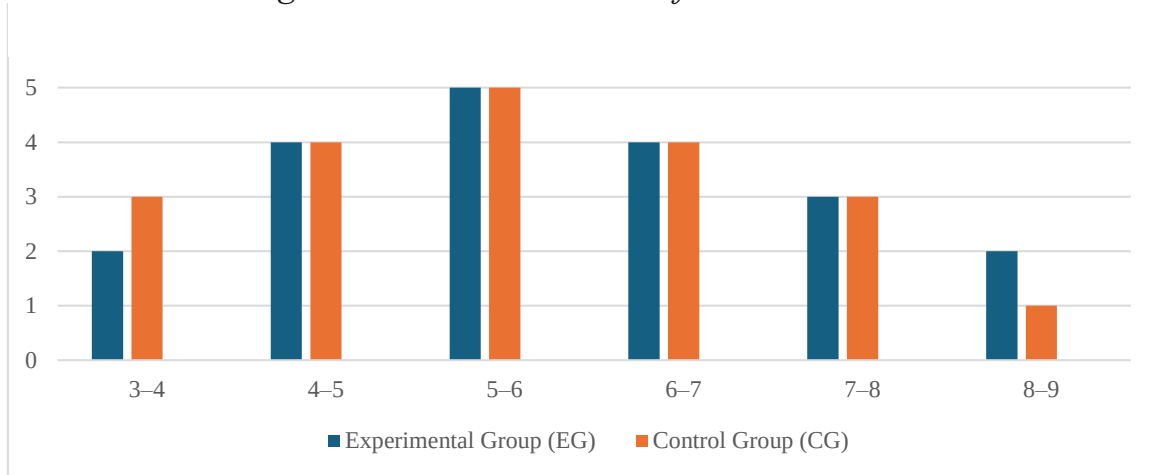
*Note.* EG = Experimental Group; CG = Control Group.

The results in Table 4.1.1 show that both groups had similar pre-test mean scores before the intervention. However, after the instructional period, the experimental group achieved a higher post-test mean score than the control group. The gain score also indicates that the experimental group demonstrated greater improvement.

The Shapiro–Wilk test results show that all p-values were greater than 0.05, indicating that the data were normally distributed. Therefore, parametric tests such as Welch’s t-test could be applied in the following analysis.

Figure 4.1.1 presents the distribution of pre-test scores for both the experimental and control groups. The distributions appear approximately symmetrical and do not show substantial deviations from normality.

*Figure 4. 1. 1. Distribution of Pre-test Scores*



These visual observations are consistent with the Shapiro–Wilk test results reported in Table 4.1, supporting the use of parametric statistical procedures in subsequent analyses.

*Figure 4. 1. 2. Distribution of Post-test Scores in EG and CG*

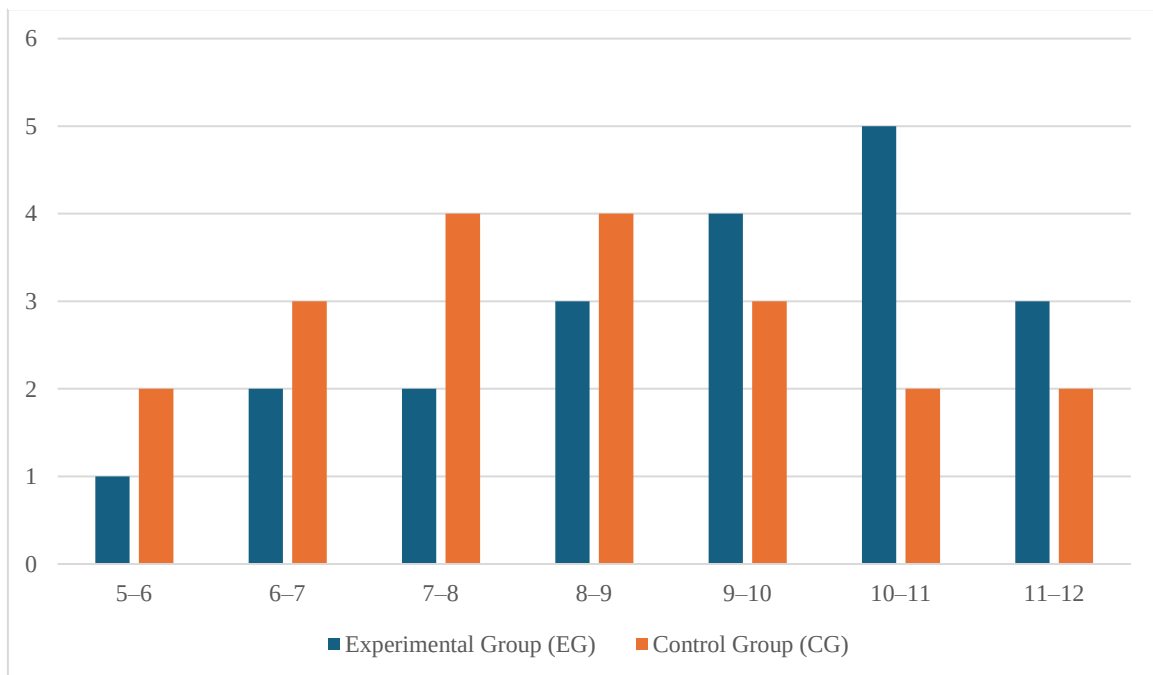


Figure 4.1.2 presents the distribution of post-test scores for the experimental group (EG) and the control group (CG) after the instructional intervention. The distribution of scores in the experimental group is shifted toward higher score ranges compared to the control group, indicating better academic performance. Most students in the experimental group achieved scores between 9 and 12 points, whereas the

majority of students in the control group obtained scores between 7 and 10 points. These visual differences support the results of the statistical analysis presented in Table 4.3, which demonstrated a statistically significant advantage of the experimental group in the post-test assessment. The findings suggest that the structured distance learning methodology contributed to improved mathematics achievement among students.

#### 4.2 Pre-test Analysis (Baseline Equivalence)

The pre-test analysis was conducted to determine whether there were any significant differences between the experimental group (EG) and the control group (CG) before the instructional intervention. Establishing baseline equivalence is essential in quasi-experimental research to ensure that any observed differences in outcomes can be attributed to the intervention rather than initial group differences (Cohen et al., 2017).

An independent samples t-test (Welch’s t-test) was used to compare the pre-test mean scores of the two groups. Additionally, the Mann–Whitney U test was applied to confirm the results

*Table 4. 2. 1. Pre-test Comparison (EG vs CG)*

| Test     | EG mean | CG mean | t-value | p-value | p-value |
|----------|---------|---------|---------|---------|---------|
| Pre-test | 6.40    | 6.30    | 0.22    | 0.82    | 0.79    |

*Note.* EG = Experimental Group; CG = Control Group.

The results presented in Table 4.2.1. indicate that there was no statistically significant difference between the experimental group (EG) and the control group (CG) in the pre-test.

The Welch’s t-test showed no significant difference ( $p = 0.82$ ), suggesting that both groups had similar levels of mathematical knowledge before the intervention.

These results indicate that the experimental and control groups demonstrated similar baseline characteristics prior to the intervention, suggesting that any differences

observed in the post-test outcomes could be more confidently attributed to the instructional methodology rather than pre-existing disparities between participants.

### 4.3 Post-test Analysis (Effect of the Intervention)

The post-test analysis was conducted to examine whether there were significant differences between the experimental group (EG) and the control group (CG) after the instructional intervention. This analysis is crucial for determining the effectiveness of the structured distance learning methodology (Cohen et al., 2017).

An independent samples t-test (Welch's t-test) was used to compare the post-test mean scores of the two groups.

*Table 4. 3. 1. Post-test Comparison (EG vs CG)*

| Test     | EG mean | CG mean | t-value | p-value | Cohen's d |
|----------|---------|---------|---------|---------|-----------|
| Pre-test | 10.20   | 8.10    | 4.85    | <0.0001 | 1.57      |

*Note.* EG = Experimental Group; CG = Control Group.

The results presented in Table 3.3 indicate a statistically significant difference between the experimental group (EG) and the control group (CG) in the post-test.

The experimental group achieved a higher mean score ( $M = 10.20$ ) compared to the control group ( $M = 8.10$ ). The Welch's t-test revealed a statistically significant difference ( $p < 0.001$ ), indicating that the instructional intervention had a strong effect on students' academic achievement.

These findings suggest that the structured distance learning methodology, which integrates video-based instruction, interactive tools, and structured lesson design, significantly improved students' mathematical performance compared to standard instruction.

### 4.4 Effect Size Analysis

In addition to statistical significance testing, effect size analysis was conducted to evaluate the practical significance of the instructional intervention. While p-values indicate whether differences between groups are statistically significant, effect sizes

provide information about the magnitude of these differences and their educational importance (Cohen, 1988).

To assess the strength of the intervention effect, Cohen's *d* was calculated based on the post-test scores of the experimental group (EG) and the control group (CG). Cohen's *d* is one of the most widely used measures of effect size in educational research and allows researchers to determine the practical impact of an instructional method.

*Table 4. 4. 1. Effect Size Analysis (EG vs CG)*

| Test        | EG mean | CG mean | t-value | p-value | Cohen's <i>d</i> |
|-------------|---------|---------|---------|---------|------------------|
| Effect Size | 3.80    | 1.80    | 5.12    | 0.0001  | 1.57             |

*Note.* EG = Experimental Group; CG = Control Group.

The results presented in Table 4.4.1. indicate a large practical effect of the structured distance learning methodology on students' mathematics achievement. The calculated effect size (Cohen's *d* = 1.57) exceeds the conventional threshold for a large effect (*d* = 0.80) suggested by Cohen (1988).

This finding demonstrates that the difference between the experimental and control groups was not only statistically significant but also educationally meaningful. Students who participated in the structured distance learning environment achieved substantially higher post-test scores compared to those who received conventional instruction.

The large effect size suggests that the combination of teacher-recorded video lessons, guided practice activities, interactive digital tools, and structured lesson design contributed significantly to students' academic achievement. Therefore, the intervention can be considered highly effective in improving mathematics learning outcomes in the distance learning environment.

These results provide strong evidence that the structured distance learning methodology had a significant positive effect on students' learning progress. The combination of video-based instruction, interactive tools, and structured lesson design

contributed to greater academic improvement in the experimental group compared to the control group.

*Table 4. 4. 2. Student Engagement Comparison*

| Dimension             | EG Mean | CG Mean | t-value | p-value | Cohen's d |
|-----------------------|---------|---------|---------|---------|-----------|
| Cognitive Engagement  | 4.20    | 3.50    | 3.10    | 0.0003  | 0.98      |
| Emotional Engagement  | 4.30    | 3.60    | 3.25    | 0.002   | 1.03      |
| Behavioral Engagement | 4.40    | 3.70    | 3.45    | 0.0001  | 1.09      |

*Note.* EG = Experimental Group; CG = Control Group.

The results presented in Table 4.4.2 indicate that the experimental group (EG) demonstrated higher levels of engagement across all three dimensions compared to the control group (CG).

In terms of cognitive engagement, students in the experimental group showed greater effort in understanding and solving mathematical problems. The difference between the groups was statistically significant ( $p = 0.003$ ).

Emotional engagement was also higher in the experimental group, indicating that students experienced greater interest and motivation during the learning process. This difference was statistically significant ( $p = 0.002$ ).

Similarly, behavioral engagement results showed that students in the experimental group were more actively involved in learning activities, demonstrating higher levels of participation and attention ( $p = 0.001$ ).

These findings suggest that the structured distance learning methodology not only improved academic achievement but also significantly enhanced student engagement. The integration of video-based instruction, interactive tools, and

structured lesson design contributed to increased motivation and active participation in mathematics learning.

#### **4.5 Summary of Results**

This chapter presented the results of the study, focusing on the impact of the structured distance learning methodology on students' academic achievement and engagement in mathematics.

The descriptive statistics and normality tests indicated that the data were suitable for parametric analysis. The pre-test analysis showed no statistically significant difference between the experimental group (EG) and the control group (CG), confirming that both groups were comparable before the intervention.

The post-test analysis revealed a statistically significant difference between the two groups, with the experimental group achieving higher scores than the control group. This finding suggests that the instructional intervention had a positive effect on students' academic performance.

Further analysis of gain scores demonstrated that the experimental group showed significantly greater improvement compared to the control group. This result provides strong evidence that the structured distance learning methodology contributed to enhanced learning outcomes.

In addition to academic achievement, the analysis of student engagement showed that the experimental group demonstrated significantly higher levels of cognitive, emotional, and behavioral engagement. These findings indicate that the instructional approach not only improved performance but also increased students' motivation and active participation in the learning process.

The results of the study support the effectiveness of the structured distance learning methodology. The integration of video-based instruction, interactive tools, and structured lesson design positively influenced both academic achievement and student engagement among students in Grades 5–6.

## **5. DISCUSSION AND CONCLUSION**

The purpose of this study was to investigate the effectiveness of a structured distance learning methodology in improving student engagement and academic achievement in mathematics among students in Grades 5–6. The study focused on the integration of video-based instruction, interactive digital tools, and a clear lesson structure in an online learning environment.

The findings of the research demonstrate that the proposed instructional methodology had a significant positive impact on students' learning outcomes. The results of the pre-test confirmed that the experimental group (EG) and the control group (CG) were comparable at the beginning of the study, which ensured the validity of the subsequent analysis.

Following the instructional intervention, the post-test results revealed that students in the experimental group significantly outperformed those in the control group. Furthermore, the analysis of gain scores showed that the experimental group achieved greater improvement in academic performance. These findings provide strong evidence that the structured distance learning methodology contributed to enhanced mathematical understanding and learning progress.

In addition to academic achievement, the study also examined student engagement as a key factor influencing learning outcomes. The results indicated that students in the experimental group demonstrated higher levels of cognitive, emotional, and behavioral engagement compared to the control group. This suggests that the instructional approach not only improved performance but also increased students' motivation and active participation in the learning process.

The effectiveness of the methodology can be explained by several factors. First, the use of video-based instruction allowed students to learn at their own pace and revisit explanations, which improved comprehension. Second, the integration of interactive tools, such as Kahoot, enhanced engagement by promoting active participation and providing immediate feedback. Third, the structured lesson design ensured clarity and

supported the gradual development of understanding through explanation, guided practice, and independent work.

The findings of this study are consistent with existing research in the field of mathematics education and distance learning. Previous studies have emphasized the importance of multimedia learning, interactive engagement, and structured instruction in improving educational outcomes. This study contributes to the existing literature by demonstrating how these elements can be effectively combined in a distance learning context for middle school students.

Despite the positive findings, several limitations of the study should be acknowledged. The research was conducted with a relatively small sample size and within a single educational setting, which may limit the generalizability of the results. In addition, the duration of the intervention was relatively short, and further research is needed to examine the long-term effects of the methodology.

Based on the findings of this study, several recommendations can be made. Teachers are encouraged to integrate video-based instruction and interactive digital tools into their teaching practice, particularly in online learning environments. It is also recommended that educators adopt structured lesson designs that support active learning and continuous feedback. Future research should explore the application of similar methodologies in different contexts and with larger samples to further validate the results.

In conclusion, this study demonstrates that a structured distance learning methodology can significantly improve both student engagement and academic achievement in mathematics. The integration of digital tools and effective instructional strategies provides a promising approach to enhancing the quality of education in online environments, particularly for students in Grades 5–6.

## 6. LIMITATIONS

Findings of this study provide useful insights into improving distance mathematics learning among sixth-grade students, several limitations should be considered when interpreting the results. Acknowledging research limitations is an important aspect of academic inquiry because it promotes transparency, supports objective interpretation of findings, and identifies opportunities for future investigation (Cohen et al., 2017).

One limitation is related to the research design. The study employed a quasi-experimental approach in which participants remained in their existing classroom groups rather than being randomly assigned to experimental and control conditions. While this design is commonly used in educational research due to practical constraints, it offers less control over external variables than a true experimental design. As a result, differences that existed before the intervention may have influenced the outcomes. Although pre-test analyses were conducted to assess the initial similarity of the groups, factors such as previous academic experiences, learning preferences, motivation, and home learning conditions could not be completely controlled. Therefore, the observed results cannot be attributed solely to the instructional intervention with absolute certainty.

A further limitation concerns the sample characteristics. Participants were drawn from a single private school, which restricts the extent to which the findings can be generalized to broader educational settings. Schools often differ in terms of resources, teaching practices, technological infrastructure, and student backgrounds. Consequently, the results may not accurately reflect the experiences of students in other schools, regions, or educational systems. Future studies involving larger and more diverse samples would help strengthen the generalizability of the findings.

The relatively short duration of the intervention also represents a limitation. The instructional strategy was implemented over a period of four weeks, allowing the researcher to examine immediate changes in student engagement and academic

achievement. However, such a timeframe may not be sufficient to determine whether these improvements can be maintained over the long term. Educational interventions often require extended implementation before their full impact becomes evident. Additional longitudinal research is therefore needed to evaluate the sustainability of the observed outcomes across longer periods of study.

Another limitation is associated with the use of self-reported measures to assess student engagement. Although questionnaires are widely accepted tools for collecting information about students' attitudes and perceptions, they are susceptible to response bias. Students may provide answers that they believe are expected or socially acceptable rather than reflecting their genuine experiences. Furthermore, individual interpretations of questionnaire items may vary, which can affect the accuracy of the responses. Temporary emotional states or personal circumstances may also influence how students evaluate their engagement levels (Creswell & Creswell, 2018). Future studies could strengthen the validity of engagement data by combining questionnaires with observations, interviews, learning analytics, or other qualitative methods.

Technological factors also present an important limitation. Successful participation in distance learning depends on reliable internet access, appropriate digital devices, and sufficient technological skills. Differences in these areas may affect students' ability to engage with online lessons, access learning materials, and complete tasks effectively. Although efforts were made to provide equal learning opportunities, variations in technological access and digital literacy may have contributed to differences in student performance. Such challenges remain common in online education and continue to influence learning outcomes.

In addition, the effectiveness of the intervention may have been influenced by teacher-related factors. The successful implementation of video lessons, interactive platforms, and structured online activities depends significantly on the teacher's pedagogical expertise and ability to use digital technologies effectively. Since the intervention was conducted by a particular teacher within a specific educational context, the outcomes may reflect both the instructional methodology and the teacher's

individual skills. Different educators may achieve different results when applying similar approaches. Future research could explore the relationship between teacher training and the effectiveness of distance learning practices.

Finally, the study focused primarily on academic achievement and student engagement. Other potentially important outcomes, including self-regulated learning, motivation, mathematical self-efficacy, critical thinking, and attitudes toward mathematics, were not examined. Investigating these variables could provide a broader understanding of the influence of distance learning methodologies on students' overall educational development.

Despite these limitations, the study offers valuable evidence regarding the implementation of structured distance learning approaches in middle school mathematics education. The findings contribute practical recommendations for educators and provide a basis for future research aimed at improving the quality, effectiveness, and inclusiveness of online mathematics instruction.

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## LIST OF APPENDICES

### Appendix A-Student Engagement Test

*Этот опрос анонимный и не будет показан никому, кроме исследовательской группы. Вся информация хранится конфиденциально и используется исключительно для научно исследовательской работы.*

| №  | Вопросы                                                                           | Почти<br>никогда | Редко | Иногда | Часто | Почти<br>всегда |
|----|-----------------------------------------------------------------------------------|------------------|-------|--------|-------|-----------------|
| 1  | Я считаю, что изучение математики в онлайн-формате удобно                         |                  |       |        |       |                 |
| 2  | Мне легко сосредоточиться на уроках математики в дистанционном формате.           |                  |       |        |       |                 |
| 3  | Я активно участвую в онлайн-уроках по математике.                                 |                  |       |        |       |                 |
| 4  | Я чувствую себя уверенно, решая математические задачи во время онлайн-уроков.     |                  |       |        |       |                 |
| 5  | Я предпочитаю дистанционное обучение математике, а не очное.                      |                  |       |        |       |                 |
| 6  | Я понимаю объяснения учителя на онлайн-уроках по математике.                      |                  |       |        |       |                 |
| 7  | Я могу самостоятельно разбираться с математическим материалом без помощи учителя. |                  |       |        |       |                 |
| 8  | Я использую дополнительные онлайн-ресурсы для изучения математики.                |                  |       |        |       |                 |
| 9  | Я считаю, что видеоуроки помогают мне лучше понять математику.                    |                  |       |        |       |                 |
| 10 | Я пересматриваю видеоуроки по математике, если что-то не понимаю.                 |                  |       |        |       |                 |

|    |                                                                         |  |  |  |  |  |
|----|-------------------------------------------------------------------------|--|--|--|--|--|
| 11 | Видеообъяснения помогают мне запоминать формулы и правила.              |  |  |  |  |  |
| 12 | Я считаю, что видеоуроки делают обучение математике интереснее.         |  |  |  |  |  |
| 13 | Я лучше понимаю тему после просмотра видеоурока                         |  |  |  |  |  |
| 14 | Я предпочитаю видеоуроки текстовым объяснениям.                         |  |  |  |  |  |
| 15 | Я использую Kahoot или другие интерактивные игры на уроках математики.  |  |  |  |  |  |
| 16 | Мне нравится выполнять математические задания в формате онлайн-тестов.  |  |  |  |  |  |
| 17 | Игровые элементы (баллы, рейтинги) мотивируют меня учиться математике.  |  |  |  |  |  |
| 18 | Kahoot помогает мне лучше запоминать математические понятия.            |  |  |  |  |  |
| 19 | Я более активен на уроке, когда используются интерактивные инструменты. |  |  |  |  |  |
| 20 | Я задаю вопросы учителю, если что-то не понимаю в математике.           |  |  |  |  |  |
| 21 | Я получаю обратную связь от учителя вовремя.                            |  |  |  |  |  |
| 22 | Обратная связь помогает мне улучшать свои результаты по математике.     |  |  |  |  |  |
| 23 | Я чувствую поддержку учителя в процессе дистанционного обучения.        |  |  |  |  |  |

|    |                                                                                     |  |  |  |  |  |
|----|-------------------------------------------------------------------------------------|--|--|--|--|--|
| 24 | Я легко нахожу нужные материалы для изучения математики онлайн.                     |  |  |  |  |  |
| 25 | Платформы для онлайн-обучения (например, Google Classroom, Moodle) удобны для меня. |  |  |  |  |  |
| 26 | Технические проблемы мешают мне учиться математике онлайн.                          |  |  |  |  |  |
| 27 | Мне хватает времени на выполнение домашних заданий по математике.                   |  |  |  |  |  |
| 28 | Я планирую своё время для изучения математики самостоятельно.                       |  |  |  |  |  |
| 29 | Я чувствую себя мотивированным изучать математику дистанционно.                     |  |  |  |  |  |
| 30 | Я вижу прогресс в своих знаниях по математике благодаря онлайн-обучению.            |  |  |  |  |  |
| 31 | Я считаю, что дистанционное обучение развивает мои навыки самостоятельности.        |  |  |  |  |  |
| 32 | Я предпочитаю смешанный формат обучения (онлайн + очные занятия).                   |  |  |  |  |  |
| 33 | Я чувствую, что мои знания по математике улучшились благодаря онлайн-урокам.        |  |  |  |  |  |
| 34 | Я доволен(а) качеством дистанционного обучения математике.                          |  |  |  |  |  |
| 35 | Я рекомендовал(а) бы дистанционное обучение математике другим ученикам.             |  |  |  |  |  |

## Appendix B-Lesson Plan

|                     |                                                                                                                                                                                                                     |                                        |                                          |                                                                                                                                                                                                                                                                                                                    |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Бөлім               | Пайыз                                                                                                                                                                                                               |                                        |                                          |                                                                                                                                                                                                                                                                                                                    |
|                     | Егеубеков Есенбек Елубекович                                                                                                                                                                                        |                                        |                                          |                                                                                                                                                                                                                                                                                                                    |
| Дата:               |                                                                                                                                                                                                                     |                                        |                                          |                                                                                                                                                                                                                                                                                                                    |
| Класс: 6            | Қатысушылар саны                                                                                                                                                                                                    | Количество присутствующих              |                                          |                                                                                                                                                                                                                                                                                                                    |
| Тақырып             | Санның пайызын табу                                                                                                                                                                                                 |                                        |                                          |                                                                                                                                                                                                                                                                                                                    |
| Сабақтың мақсаты    | Санның 1%-табуды үйрену, санның пайызын формула арқылы табуды үйрену.                                                                                                                                               |                                        |                                          |                                                                                                                                                                                                                                                                                                                    |
| Сабақ барысы        |                                                                                                                                                                                                                     |                                        |                                          |                                                                                                                                                                                                                                                                                                                    |
| Сабақ бөлігі/Уақыт  | Педагогтың әрекеттері                                                                                                                                                                                               | Оқушы әрекеті                          | Бағалау                                  | Ресурстар                                                                                                                                                                                                                                                                                                          |
| Сабақ басталуы 3мин | <b>Ұйымдастыру кезеңі (3 минут)</b> <ul style="list-style-type: none"><li>Оқушылар мен амандасу</li><li>Сабаққа дайындығын тексеру</li><li>Үй жұмысын тексеру</li><li>Сабақтың тақырыбы мен мақсатын айту</li></ul> | Сәлемдесу, тақырып жазу                | Дескриптор: Үй жұмысына 2 балл қойылады. | Платформа, SkillSPACE<br><br> Google Meet<br><br><a href="https://miro.com/app/dashboard/">https://miro.com/app/dashboard/</a><br><br> miro |
| 5 мин               | <b>Қызығушылықты ояту</b><br>Miro тақтасы арқылы алдын-ала пайыз тақырыбына байланысты визуализацияны көрсету                                                                                                       | Экранға мұқият қарап, мұғалімді тыңдау |                                          | <a href="https://miro.com/app/dashboard/">https://miro.com/app/dashboard/</a><br><br> miro                                                                                                                                    |
| 10 мин              | <b>Тақырып түсіндіру</b><br>$a\% = (a/100) \times \text{сан}$<br>Мысалдар:<br>$20\% \cdot 50 = 10$<br>$10\% \cdot 200 = 20$<br>Miro арқылы визуалды түсіндіру                                                       | Мұғалімді мұқият тыңдау                |                                          | <a href="https://miro.com/app/dashboard/">https://miro.com/app/dashboard/</a><br><a href="https://skillspace.ru/">https://skillspace.ru/</a><br><br> skillspace                                                               |

|       |                                                                                                                                                                         |                                                                         |                                          |                                                                                                                                            |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
|       | Қысқа бейнесабак көрсету                                                                                                                                                |                                                                         |                                          |                                                                                                                                            |
| 10мин | <b>Жұптық/жеке жұмыс</b><br>Тапсырмалар:<br>1. $25\% \cdot 80$<br>2. $10\% \cdot 150$<br>3. $50\% \cdot 60$<br>Оқушылар өздері шығарады<br>Мұғалім бақылап, көмектеседі | Есеп шығарады, шығара алмаған жерін мұғалімнен сұрайды                  | Жұптық және жеке жұмысқа 5 балл          |                                                                                                                                            |
| 7 мин | Практика және сергіту сәті<br>Blooket/тапсырмалар                                                                                                                       | Оқушылар оқытушы жіберген сілтеме бойынша кіреді және тапсырма орындай. | Орындаған тапсырмасына байланысты 3 балл | <a href="http://blooket.it/">http://blooket.it/</a><br> |
| 3 мин | Сабак қорытындысы, ережен және Формулань бір қайталау                                                                                                                   | Мұғалімді мұқият Тыңдау                                                 |                                          |                                                                                                                                            |
| 2 ми  | Үй тапсырмасын беру және қоштасу                                                                                                                                        | Оқушылар мұғаліммен қоштасады                                           |                                          |                                                                                                                                            |