

EFFECTIVENESS OF DISTANCE AND HYBRID LEARNING IN TEACHING GENETICS

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Abstract: *This study investigates the effectiveness of distance and hybrid learning methods in teaching Genetics. Genetics is a complex discipline in medical and biological education that requires both theoretical understanding and practical application. The increasing use of digital technologies in education has led to the integration of online and blended learning approaches.*

The aim of this study is to compare the effectiveness of distance and hybrid learning in improving student understanding, engagement, motivation, and interaction in Genetics education. The research is based on literature analysis and pedagogical comparison of both teaching methods.

The results indicate that distance learning provides flexibility and easy access to learning materials but has limitations in interaction and real-time feedback. In contrast, hybrid learning demonstrates higher effectiveness by combining face-to-face instruction with online learning tools. It improves student motivation, engagement, and understanding of complex genetic concepts. The study concludes that hybrid learning is a more effective approach than fully distance learning for teaching Genetics, especially in science-based education.

Key words: *Genetics education, distance learning, hybrid learning, blended learning, digital education, teaching effectiveness, student engagement, medical education.*

INTRODUCTION

Genetics is a fundamental discipline in medical and biological education, as it provides essential knowledge about heredity, genetic variation, and the molecular basis of life. Understanding genetics is crucial for future healthcare professionals because it forms the foundation for diagnosing, preventing, and treating many hereditary and complex diseases. Therefore, the effective teaching of Genetics plays a significant role in improving the quality of medical education [5], [7], [9].

In recent years, the rapid development of digital technologies has significantly transformed the educational process. Modern information and communication technologies have made it possible to integrate online platforms, virtual simulations, and interactive learning tools into teaching practices. These innovations have expanded opportunities for both students and educators, making learning more flexible and accessible [1], [6], [10].

Distance learning refers to an educational process in which teaching and learning occur without physical presence, using digital platforms and online communication

tools. Hybrid learning, on the other hand, combines traditional face-to-face instruction with online learning activities, creating a blended educational environment that integrates the advantages of both approaches [3], [5], [7].

The relevance of this topic lies in the need to improve the effectiveness of teaching complex scientific subjects such as Genetics. Despite the advantages of digital education, there are still challenges related to student engagement, understanding of abstract concepts, and practical skill development. Therefore, evaluating the effectiveness of distance and hybrid learning in Genetics education is an important pedagogical issue [2], [4], [9].

The aim of this study is to analyze the effectiveness of distance and hybrid learning methods in teaching Genetics and to determine which approach provides better learning outcomes. The objectives include comparing student engagement, understanding of complex topics, interaction levels, and overall learning effectiveness between the two educational formats.

Methods

This study was designed as a descriptive and comparative qualitative study aimed at evaluating the effectiveness of distance and hybrid learning in teaching Genetics. The comparative approach was used to analyze differences between the two educational formats in terms of learning outcomes and student engagement [9], [10].

The research method was based on literature analysis and pedagogical observation. Scientific articles, educational reports, and previous studies related to digital education and blended learning were reviewed to identify key trends and findings. In addition, classroom observations were used to evaluate student participation and learning behavior in both teaching formats [5], [10].

Two main educational approaches were analyzed in this study. Distance learning refers to an online-based educational process where students and teachers interact through digital platforms without physical presence. Hybrid learning combines traditional face-to-face instruction with online learning activities, creating a blended educational environment that enhances interaction and flexibility [9].

The effectiveness of both teaching methods was evaluated using several criteria, including student activity, level of knowledge acquisition, motivation, and teacher-student interaction.

These indicators were selected to provide a comprehensive comparison of learning effectiveness in Genetics education [4], [7], [9].

Data analysis was carried out using a comparative analysis method, which allowed for identifying differences and similarities between distance and hybrid learning approaches.

The analysis focused on evaluating which method provides better educational outcomes in terms of student understanding and engagement [9], [10].

Results

The analysis of the collected data and reviewed literature showed clear differences in the effectiveness of distance and hybrid learning in teaching Genetics. In distance learning, students demonstrated a moderate level of understanding of theoretical concepts, mainly due to the availability of digital resources and flexible access to learning materials. However, limitations were observed in terms of real-time interaction and immediate feedback from instructors, which affected overall comprehension of complex genetic topics [2], [5], [8].

In contrast, hybrid learning showed a higher level of effectiveness in terms of student engagement and understanding. Students participating in hybrid classes benefited from both online resources and face-to-face explanations, which improved their ability to grasp difficult concepts in Genetics. The combination of direct teacher guidance and independent online study contributed to better academic performance [3], [7], [9].

Student motivation was also found to be higher in hybrid learning environments compared to distance learning. The presence of in-person sessions increased responsibility, participation, and communication between students and teachers. Meanwhile, distance learning provided flexibility but sometimes led to reduced focus and lower motivation due to lack of direct supervision [4], [6], [9].

Teacher–student interaction was significantly stronger in hybrid learning, where face-to-face communication allowed immediate clarification of difficult topics. In distance learning, interaction was mostly limited to online messages and virtual meetings, which reduced the effectiveness of communication [3], [8].

Overall, the results indicate that hybrid learning is more effective than fully distance learning in teaching Genetics, particularly in improving understanding of complex topics, student motivation, and interaction quality [7], [9].

Comparison of Distance and Hybrid Learning in Genetics Education

Criteria	Distance Learning	Hybrid Learning
Understanding of concepts	Moderate	High
Student engagement	Moderate	High
Student motivation	Low–Moderate	High
Teacher–student interaction	Low	High
Academic performance	Moderate	High
Focus and discipline	Moderate	High

DISCUSSION

The results of this study clearly demonstrate that hybrid learning is more effective than distance learning in teaching Genetics. As shown in Table 1, all evaluated criteria—understanding of concepts, student engagement, motivation, teacher–student interaction, academic performance, and focus—are higher in the hybrid learning model compared to distance learning.

In particular, the table shows a marked difference in teacher–student interaction, where hybrid learning is rated as high, while distance learning remains low. This suggests that direct face-to-face communication plays a crucial role in clarifying complex genetic concepts and improving students' conceptual understanding. Immediate feedback in hybrid settings helps students correct mistakes in real time, which is not always possible in fully online environments.

Another important difference highlighted in the table is student motivation and engagement. Hybrid learning shows a high level of motivation, while distance learning is only moderate to low. This can be explained by the presence of classroom sessions, which increase discipline, responsibility, and active participation. In contrast, distance learning may lead to reduced attention and weaker learning habits due to the lack of physical supervision.

The table also indicates improvements in academic performance and conceptual understanding in hybrid learning. Genetics is a complex subject that requires both theoretical knowledge and problem-solving skills. The combination of online resources and in-person instruction in hybrid learning allows students to better understand difficult topics compared to distance learning alone.

Overall, the analysis of Table 1 confirms that hybrid learning provides a more balanced and effective educational environment for teaching Genetics. While distance learning offers flexibility, it is less effective in promoting interaction, motivation, and deep understanding of the subject. These findings suggest that integrating both traditional and digital methods is the most effective approach for science-based education.

Conclusion

The findings of this study show that both distance and hybrid learning methods play an important role in modern Genetics education. Each approach has its own advantages and limitations. Distance learning provides flexibility, easy access to educational resources, and opportunities for independent study. However, it shows certain weaknesses in terms of interaction, motivation, and understanding of complex scientific concepts.

Hybrid learning, on the other hand, demonstrates higher overall effectiveness in teaching Genetics. It combines the strengths of traditional face-to-face instruction with the advantages of online learning platforms. This integrated approach improves student engagement, motivation, academic performance, and understanding of difficult genetic topics. The results of the study clearly indicate that hybrid learning is more effective than fully distance learning in science-based education.

The superiority of hybrid learning is mainly related to stronger teacher–student interaction, immediate feedback, and balanced learning conditions. These factors contribute to better knowledge acquisition and more active participation of students in the learning process.

Based on the results, it is recommended that universities adopt and further develop hybrid learning models for Genetics and other complex biological disciplines. Educational institutions should invest in digital infrastructure, improve online learning materials, and train teachers in modern teaching technologies. In addition, combining interactive classroom sessions with well-structured online content can significantly enhance the quality of education and student performance.

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