

THE IMPACT OF ICT INTEGRATION AND TEACHING METHODS ON KNOWLEDGE ACQUISITION: A COMPARATIVE ANALYSIS BETWEEN NATURAL SCIENCES AND MATHEMATICS VS. SOCIAL SCIENCES AND HUMANITIES IN ELEMENTARY SCHOOL

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Abstract: The integration of Information and Communication Technology (ICT) in education is a transformative process that continuously reshapes teaching methods and learning experiences. The importance of ICT in modern education is undeniable, providing new opportunities for interaction, knowledge acquisition, and skill development. Various teaching approaches incorporate ICT, enhancing student engagement and facilitating a deeper understanding of subject matter. However, the effectiveness of ICT depends on factors such as accessibility, teacher readiness, and the suitability of technological tools for specific subjects. This study examines the impact of ICT-enhanced teaching on third-grade students in two distinct subject areas: natural sciences and mathematics versus social and humanities subjects. Different pedagogical approaches are required for these fields, as the use of ICT varies depending on subject specificity. In natural sciences and mathematics, ICT facilitates visualization, experimentation, and problem-solving, making abstract concepts more comprehensible. Conversely, in social and humanities subjects, ICT fosters creativity, discussion, and critical thinking, encouraging students to engage in interactive and collaborative learning experiences. Teachers' perceptions and the challenges they encounter in implementing ICT are also analyzed. While ICT has proven beneficial, its effectiveness depends on proper implementation, accessibility, and teacher training. A structured approach to ICT integration enhances learning efficiency, but obstacles such as digital literacy, resource availability, and pedagogical adaptation must be addressed. Additionally, the study highlights the role of student motivation and adaptability in technology-driven learning environments. The level of interactivity and engagement is closely linked to the effectiveness of ICT-based instruction, making it crucial to develop subject-specific strategies tailored to student needs. The findings suggest that the impact of ICT on knowledge acquisition varies depending on the subject and the teaching methods used. While some disciplines benefit from increased visualization and interactivity, others emphasize critical thinking and creative application. This study contributes to a better understanding of how ICT affects learning processes in different academic fields, emphasizing the need for further exploration of its role in elementary education.

Keywords: ICT integration, teaching methods, knowledge acquisition, primary education.

1. INTRODUCTION

In the contemporary educational context, the integration of Information and Communication Technologies (ICT) represents a fundamental aspect of the teaching process, enabling new ways of learning and enhancing teaching practices. Rapid technological advancements and increased digitization significantly impact traditional teaching methods, fostering the development of innovative approaches that enhance student engagement and academic achievement. Primary education, as the foundation of cognitive and intellectual development, represents a critical phase for the implementation of such technologies, with the aim of promoting early digital and critical approaches to learning. Despite the recognized benefits, the question of the optimal application of ICT in various subject areas remains open. This paper explores the effects of ICT application in teaching third-grade students, with a particular focus on natural-mathematical and socio-humanistic sciences. These two academic fields have distinct pedagogical needs, which creates a challenge in adapting digital tools to the specific characteristics of the curriculum content. While natural-mathematical sciences rely on visualization, simulations, and experimentation for easier mastery of abstract concepts, social and humanistic sciences prefer approaches that stimulate creative and critical thinking through digital collaboration and interactive discussions.

The aim of this research is to analyze the advantages and challenges associated with the integration of ICT into the teaching process, as well as to examine the perceptions of teachers and students regarding the effectiveness of digital educational tools. By analyzing the ways in which ICT is applied in natural-mathematical and socio-humanistic sciences, the research seeks to identify the effects of digital tools on visualization, experimentation, and critical thinking among students. Furthermore, the study examines teachers' views on the opportunities and challenges of digital education, as well as potential strategies for improving teaching methods through the optimized application of ICT. The degree of interactivity and student engagement is a key factor in the effective acquisition of knowledge. The analysis also focuses on how different approaches to using ICT influence students' motivation and academic

progress. The contribution of this research lies in the better understanding of the role of ICT in various academic disciplines and in defining strategies for its more effective application in primary education.

2. THEORETICAL BASIS

Definition of ICT and Teaching Methods

Information and Communication Technologies (ICT) represent the integration of digital tools and resources that enable the storage, processing, and transmission of information. In the educational context, ICT is applied as a means of enhancing teaching processes, enabling interactive learning methods through digital platforms, multimedia content, and advanced software solutions. This technology provides faster and more efficient access to global sources of information, simulations, and visualizations, contributing to the individualization of teaching and encouraging independent learning among students. Modern teaching methods focus on stimulating active student participation in the learning process. Some of the most effective approaches include project-based learning, collaborative learning, and the flipped classroom model, along with other advanced teaching strategies. These methods promote critical thinking, teamwork, and the practical application of theoretical knowledge. The integration of ICT into these teaching approaches creates an interactive, motivating, and dynamic learning environment, which, according to research, leads to improved academic performance.

The Role of ICT in Primary Education

Information and Communication Technologies (ICT) play a crucial role in transforming traditional teaching practices, enabling innovative approaches in the learning process. In primary education, where students acquire fundamental knowledge from various subject areas, the application of ICT significantly contributes to a better understanding of complex concepts through visualization, simulation, and interaction. Examples of successful ICT applications in teaching include digital simulations for natural sciences, interactive math games, and virtual tours of historical and cultural sites. These tools not only make learning more accessible and interesting but also allow students to work at their own pace and level of understanding. According to empirical studies, the use of ICT in teaching leads to improved creativity, independence, and motivation for learning among students. Furthermore, teachers are given the opportunity to use analytical tools to track individual student progress, which contributes to more effective planning and adaptation of teaching strategies according to their needs.

Integration of ICT in Natural-Mathematical and Socio-Humanistic Subjects

Natural science and mathematics subjects, such as mathematics and natural sciences, require an analytical approach, logical reasoning, and an understanding of abstract concepts. The integration of Information and Communication Technologies (ICT) into these disciplines enables the use of interactive simulations, 3D models, and virtual laboratories, helping students visualize complex scientific phenomena. This approach not only enhances cognitive engagement but also facilitates the comprehension and application of theoretical knowledge in a practical context. On the other hand, social sciences and humanities subjects, such as social studies and the Macedonian language, focus on narrative interpretation, cultural analysis, and the expression of ideas. The application of ICT in these disciplines includes the creation of interactive digital storytelling, virtual tours of historical sites, and the use of language learning platforms and text analysis tools. These digital resources enhance the interactivity of the teaching process, fostering creativity and critical thinking among students. The integration of ICT into the teaching of both subject groups not only contributes to a higher level of engagement and personalized learning but also allows for the adaptation of teaching methods according to students' individual needs. However, to achieve maximum effectiveness, systematic teacher training is essential, along with careful planning regarding the implementation of digital tools in the teaching process.

3. RESEARCH METHODOLOGY

Research Objective

This study aims to analyze the integration of Information and Communication Technology (ICT) and teaching methods in the knowledge acquisition process of third-grade students. The focus is on a comparative analysis of natural-mathematical and socio-humanistic subjects to examine how different teaching approaches influence students' comprehension of educational content, the development of creative and critical thinking, as well as their motivation and engagement.

Additionally, the research seeks to identify the main challenges teachers face in implementing ICT in the teaching process and to explore differences in the effects of digital tools across various subject areas. Based on the collected data, recommendations will be formulated to improve teaching practices through the effective and pedagogically appropriate use of ICT.

Research questions and hypotheses

This study examines how the integration of ICT influences students' comprehension of educational content in the third grade, whether there are significant differences in the effectiveness of ICT implementation between natural-mathematical and socio-humanistic subjects, and what impact ICT has on student motivation and engagement in the learning process.

Based on these considerations, the following hypotheses are proposed. The first hypothesis (H1) suggests that the use of ICT significantly enhances the understanding of educational content in natural-mathematical subjects, particularly through visualization, experimentation, and problem-solving. The second hypothesis (H2) posits that in socio-humanistic subjects, ICT fosters a higher level of creative expression, discussion, and critical thinking among students.

Sample and instruments

The study is conducted on a purposefully selected sample of 20 third-grade students to obtain representative data on the effects of ICT in teaching. Data collection is carried out using a combination of quantitative and qualitative methods. Students' academic progress is measured through knowledge tests, while their perceptions and motivation are assessed using survey questionnaires. Additionally, teachers participate in structured interviews to identify challenges and the impact of ICT implementation in the classroom. For a more in-depth analysis of the teaching process, classroom observations are conducted with a special focus on student interactions with digital tools. The collected data will be analyzed using descriptive statistics, correlation analysis, and thematic analysis of qualitative responses.

4. RESULTS AND DISCUSSION

Analysis of Results for Natural-Mathematical Subjects

The research findings indicate that the integration of Information and Communication Technologies (ICT) significantly contributes to improving students' academic performance in natural-mathematical subjects. Students who participated in lessons incorporating digital tools demonstrated increased accuracy and efficiency in solving mathematical problems, as well as a deeper conceptual understanding of natural sciences. These findings suggest that the use of interactive technologies, such as simulations and virtual laboratories, facilitates the connection between theoretical knowledge and practical applications, thereby significantly enhancing students' cognitive engagement. Furthermore, the analysis reveals that visual and auditory educational resources play a crucial role in easing the assimilation of complex scientific concepts. Interactive multimedia resources, such as animated presentations, graphic simulations, and digital experiments, foster active student involvement in the learning process, leading to better comprehension and longer retention of information. It has been observed that students exhibit greater interest and motivation when instructional activities incorporate modern technologies, reaffirming the importance of adaptive and innovative teaching approaches. Further analysis indicates that teachers who actively integrate digital tools into their lessons achieve better outcomes in conveying complex concepts, particularly through demonstration and simulation methods. This underscores the need for continuous professional training for teachers, aimed at effectively utilizing digital technologies in the teaching process. In summary, the findings suggest that the successful implementation of ICT in natural-mathematical subjects requires a comprehensive approach that combines technological resources, appropriate teaching strategies, and support for both teachers and students. Based on these insights, it is recommended to further expand the digitalization of educational materials and encourage students to engage in inquiry-based learning through the use of advanced digital tools and interactive platforms.

Analysis of Results for Socio-Humanistic Subjects

The research findings indicate that the integration of Information and Communication Technologies (ICT) in the teaching of socio-humanistic subjects significantly contributes to the development of students' analytical and critical thinking skills. Specifically, improvements have been observed in students' competencies in writing, interpretation, and analysis of historical and sociological contexts. These findings suggest that the use of digital tools, such as interactive applications for visualizing historical events and simulations of social scenarios, fosters deeper discussions and encourages the formation of diverse perspectives. Additionally, students who utilized digital platforms to create multimedia content, such as presentations, research projects, and virtual exhibits, demonstrated higher levels of engagement and creativity. These tools not only facilitate the learning process but also enable more interactive and innovative knowledge transfer, which positively influences student motivation. Beyond technological solutions, the analysis highlights the significant role of problem-based learning in this subject domain. This methodological approach enables students to actively engage in solving real-world problems, thereby developing their logical reasoning, teamwork, and argumentative expression skills. Through such instructional strategies, students not only acquire new knowledge but also apply it in different contexts, enhancing their preparedness for addressing complex situations. In conclusion, the findings of this research confirm the effectiveness of integrated

technological and pedagogical approaches in the teaching of socio-humanistic subjects. These approaches not only increase students' active involvement but also significantly contribute to their personal and intellectual development. Consequently, the recommendations from this analysis suggest the continued implementation of digital tools in the teaching process, as well as the advancement of instructional methodologies that promote critical thinking and creative expression.

Comparison of Results

The analysis of the collected data highlights the varying effectiveness of integrating Information and Communication Technologies (ICT) in the teaching process, depending on the subject area. While in natural-mathematical subjects, digital tools significantly enhance accuracy, speed, and depth of conceptual understanding, in socio-humanistic disciplines, their impact is primarily directed towards fostering creativity, critical thinking, and independent expression. This distinction underscores the necessity of a strategic approach to ICT integration, wherein each subject area is addressed according to its specific objectives and requirements. Additional analyses indicate that the methods of ICT implementation play a crucial role in their effectiveness. For instance, the use of simulations and interactive software in natural-mathematical subjects significantly enhances the visualization of complex concepts and enables practical application through an experimental approach. On the other hand, in socio-humanistic subjects, digital platforms for online discussions, virtual debates, and multimedia presentations have proven particularly effective in developing analytical skills and argumentative expression. An important factor emerging from this research is the level of digital literacy among students and teachers, which proves to be a critical element in the successful integration of ICT into the teaching process. High digital competence directly correlates with more effective technology application, highlighting the need for continuous teacher training. In this context, it is especially important for schools to invest in improving technical infrastructure, providing access to modern digital resources and platforms. In conclusion, ICT integration should not be implemented uniformly but should be adapted to the specific requirements of each teaching discipline. The strategic use of digital technologies can significantly improve teaching effectiveness when technological resources are aligned with pedagogical methodologies. Future development in this field should focus on creating personalized strategies for ICT implementation, strengthening technical infrastructure in schools, and ensuring continuous professional support for teachers in using innovative digital methods. Only through such a holistic approach can the digital transformation of the educational process fully realize its potential.

5. CONCLUSION

Information and Communication Technologies (ICT) and innovative teaching methods represent a significant factor in improving the quality of learning among third-grade students. The research conducted indicates that these technologies not only facilitate the process of knowledge acquisition but also encourage the development of creativity, critical thinking, and problem-solving skills. The analysis of the results shows that science and mathematics subjects particularly benefit from the use of visualizations and simulations, which enable a deeper understanding of complex concepts and processes. These methods not only increase student motivation in the classroom but also foster active participation in the learning process. On the other hand, in social sciences and humanities subjects, the application of ICT contributes to stimulating discussions, enhancing analytical skills, and encouraging students' individual expression. Interactive tools and digital resources create a dynamic learning environment where students are encouraged to explore, argue, and collaborate. However, the integration of ICT in teaching should not be uniform but carefully adapted to the specific needs and objectives of each subject area. This approach allows for the maximum utilization of technology's potential and creates conditions for inclusive and effective education. Furthermore, teachers' role is pivotal in the digitalization of education, underscoring the necessity of continuous professional training and development in this field. The practical implications of this research emphasize the need for systematic integration of digital tools into teaching through the use of interactive presentations, educational applications, and simulations. Furthermore, organizing training programs for teachers is essential to ensure their readiness for implementing innovative methods and digital resources. Finally, developing curricula that combine traditional and modern approaches will enable a flexible and adaptive teaching practice, thereby creating conditions for more effective and inclusive education. The integration of ICT and innovative teaching methods is not merely a technological advancement but a critical step toward enhancing the educational process. Digital technologies enable the creation of a dynamic, interactive, and engaging learning environment, preparing students for the challenges of the 21st century.

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