Use of Information Technologies in Improving the Academic Performance of Elementary School Students

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ABSTRACT
This study investigates the impact of information technology use on the academic performance of elementary school students between 2021 and 2023. With the implementation of educational technologies such as Artificial Intelligence, online learning platforms, and educational software, the research aims to assess how these tools influence students' learning and outcomes. The analysis is based on the students' average grades in specific subjects over three years. The statistical method used was the independent sample Student's t-test to verify if there is a significant difference between the group averages. The results indicate a statistically significant improvement in academic performance. The study also includes interviews with educators to assess their impressions of information technology use. The findings highlight the contribution of technological tools to students' performance throughout elementary education.

Author Keywords
Technology in Education; Academic Performance; Technological Integration; Interactive Learning; Digital Education.

ACM Classification Keywords
K.3.1. Computers and Education: Computer Uses in Education; K.3.2. Computers and Education: Computer Science Education.

INTRODUCTION

In recent years, education has undergone a significant transformation due to the rapid advancement of digital technology. This progress has not only reshaped educational practices but also altered the expectations and needs of both educators and students. As Prensky [27] observes, "today's students are not the same as those of decades ago; they do not speak the same language as their parents." The integration of technology in education has become an imperative to meet the demands of a globalized and interconnected world.

Mishra and Koehler [21] highlight that "technology, when used appropriately, can significantly enhance student learning and prepare them for future challenges." It is crucial to conduct a critical and comprehensive analysis of how technology is being integrated into educational practice and what the real impacts of this integration are on student learning.

This study investigates the impact of Information Technology (IT) use on the academic performance of elementary school students. The goal is to deepen the understanding of technology's transformative role at this educational level, evaluating how it influences students' learning experiences and academic outcomes. This analysis was conducted through a case study at Escola Estadual Professora Zina Porto, a Brazilian school located in city of Januária, state of Minas Gerais, providing valuable insights for educators, researchers, and educational policymakers.

Studies show that the integration of educational technologies can significantly improve students' performance and increase their engagement, as will be highlighted in Section 3 of this paper. The integration of technology in the educational environment can transform the way students learn and interact with content. Digital tools such as online learning platforms and educational software offer opportunities to personalize learning, allowing students to progress at their own pace and receive immediate feedback on their performance [2]. Despite the obvious benefits, the adoption of technology in education presents significant challenges. "The lack of adequate training for educators, inequalities in access to technological resources across different regions and schools, and the need to effectively integrate these tools into the existing curriculum are challenges that need to be overcome to maximize the potential of technology in the educational environment" [16].

Regarding the methodology adopted, the case study involved offering information technology training to a group of elementary school students, utilizing Google tools, Artificial Intelligence (ChatGPT), programming logic, and some applications supporting specific subjects (details are in the Studies Conducted section). Students' performance in several subjects was monitored over three years, and the performance difference between one year and the next was

assessed by applying the statistical method Student's t-test. Interviews were also conducted with educators to verify their perceptions of the students' learning progress. More details are provided in the Methodology section. The study involved students from the 6th to 9th grades of elementary education, along with their teachers (who also received training in information technologies), allowing for a comprehensive analysis of practices and the impacts of technology in the educational environment.

This paper is structured as follows: Literature Review – explores related studies on the use of information technologies in education and highlights the unique contributions of this research compared to existing knowledge; Methodology – details the methods and tools employed to conduct this research; Results – discusses the findings of this study; Conclusions – analyzes the results and how they can contribute to the academic community.

LITERATURE REVIEW

The integration of technology in primary education is associated with significant improvements in students' academic performance. This reality has been verified by several authors, as explored in this section. Silva, Hoed, and Saraiva [30] highlight that "the use of tools such as educational software and online learning platforms creates a more interactive and motivating environment, potentially increasing school performance." Koedinger and Corbett [19] emphasize that Google Classroom facilitates classroom time management, allowing teachers to quickly create and organize assignments, giving students greater autonomy in managing their activities and promoting a more personalized approach to learning. Gee [11] observed an increase in students' interest and motivation through the gamification of education, resulting in improved test performance. Mayer [20] points out that audiovisual resources, such as educational videos, make it easier to understand abstract scientific concepts, making learning more concrete. Collins and Halverson [7] show that Information and Communication Technologies (ICTs) promote greater participation and autonomy for students, especially those with special needs. Junco [18] explores the use of social media to promote interaction and collaborative knowledge construction, highlighting that tools such as blogs and wikis can enrich the educational experience.

The presence of technology in classrooms has been linked to a significant increase in student engagement and motivation. Puentedura [29] asserts that "the integration of digital technologies into educational practices can enhance student engagement, promoting more active and engaging participation due to the interactive and dynamic characteristics of these tools." Borges and Fleith [3] observe that technological tools integrated into the curriculum provide a more engaging and adaptive learning experience.

Several studies have investigated the application of different ICTs in the educational environment, such as ChatGPT and Google Classroom, highlighting their impacts and results. The following table summarizes some studies found on the impact of information technology education on the performance of primary school students:

Author	Title	Subject
Holmes, Bialik and Fadel [14]	Artificial Intelligence in Education: Promises and Implications for Teaching and Learning	Studied the use of ChatGPT for planning and executing classroom activities in Mathematics. Results indicated that ChatGPT was useful in creating lesson plans and activities, facilitating teaching and student engagement. Discussed the impact of AI on education, including the potential of ChatGPT to personalize teaching and increase engagement.
Iftakhar [15]	Google Classroom: What Works and How?	Analyzed the use of Google Classroom and its impact on academic performance and student interaction. Results indicated an increase in interaction and improvement in academic performance.
Gravier, Thiriet,	Use of E-Learning in	Studied the impact of circuit simulations

Fayolle, Bayard and Lardon [12]	Electrical Engineering Education: A Comparative Study of Web-Based and Face-to-Face Courses.	on students' understanding of electronics concepts. Concluded that simulations improved understanding and practical application of concepts.
Chou, Lin and Chan [4]	Wireless Sensor Networks for Learning Electronics: A Case Study of Hands-on Learning with Real Circuits.	Analyzed the effectiveness of electronics kits in promoting active and practical learning in the classroom. Results indicated improved practical learning and increased student engagement.
Atmatzidou and Demetriadis [1]	Advancing Students' Computational Thinking Skills through Educational Robotics: A Study on Age and Gender Relevant Differences	Investigated the use of educational robotics to develop computational thinking and programming logic skills, facilitating the understanding of basic concepts.

Table 1 - Comparative Studies on Technology in Education

The Table 1 does not exhaust all studies on this topic. However, it is clear that existing literature indicates that information technology plays an undeniably relevant role in student development. Regarding the contribution of this study compared to others already published, it is worth noting that most studies analyze the impact of ICTs (Information and Communication Technologies) over relatively short periods, while this study examines students' performance up to the end of 2023 (during the ICT teaching phase), comparing it with classes from the previous two years (2021 and 2022), which had not yet been exposed to these technologies. This longitudinal perspective allows observation not only of the immediate impact but also the evolution of students over time. Furthermore, unlike the studies mentioned that focus on a single technology, this research examines the combination of several technological tools (ChatGPT, Google Classroom, circuit simulations, electronics kits, etc.) and their collective impact on the learning experience across various subjects. This integrated approach provides a more comprehensive view of the effect of ICTs in education.

METHODOLOGY

This research was conducted by offering ICT (Information and Communication Technology) training to students from October 2023 to April 2024. The training sessions with these students occurred five days a week (Monday to Friday) during the aforementioned period, totaling 480 hours of classes. Student performance from 2021 and 2022 was then compared with their performance at the end of the 2023 academic year, when the ICT training was already underway. At the conclusion of the study, interviews with teachers were conducted to explore their perceptions of student performance improvement. Academic performance was also evaluated to measure variations in results before and after the implementation of technology.

A total of 60 students from Escola Estadual Professora Zina Porto, aged between 11 and 15 years, from 6th to 9th grades of elementary education, participated in this project. This number was selected based on the capacity limits of the computer labs where the research was conducted, ensuring that each student had individual access to a computer. Student selection was based on their interest in technology classes, with assistance from the teachers involved with these students. Additionally, 10 teachers directly involved with these students participated in the research. These teachers were trained in the technologies taught to the students so they could continue using and adapting them to the context of their subjects after the course ended. Teacher meetings lasted four months (October to January), with three weekly sessions, each lasting 60 minutes (totaling three hours per week). Participating teachers were chosen based on their interest in ICT and willingness to use it in the classroom. To determine interest, teachers were consulted beforehand. The selected teachers were from the following subjects: Science, Geography, English, Portuguese, and Mathematics. The project leader suggested to these teachers integration proposals for tools that would be useful for teaching, which are detailed in the Results section. The proposal was well-received by all.

During the project's implementation, students' grades from 2021 and 2022 were observed and compared with those from 2023 (the year the project was in progress). Questionnaires using a Likert scale via Google Forms were also administered to teachers to gather their perceptions on

the use of ICT in educational practice, and some teachers were interviewed. Data analysis was conducted using NVivo software (for interview analysis) and SPSS (for grade analysis). The statistical hypothesis test, Student's t-test for independent samples, was used to verify whether there was a statistically significant difference in grades over the years observed, comparing the period before and after contact with ICTs. This test was chosen because the grades of 2023 students represent those who participated in the ICT training, while the grades from 2021 and 2022 come from other students who studied at the same institution and followed the same curriculum but did not undergo ICT training. Therefore, the 2023 grades of the 60 students (6th to 9th grade elementary school students) who underwent training were compared with the grades of 60 other students from the same grades in 2022 and with 60 others from the same grades in 2021. The student grade data used in the test can be found in the following file (student names have been omitted): https://l1nk.dev/u26Iw. Since the grades from one year are not directly related to those from another year, because each group consists of different individuals, the independent t-test is the most appropriate method to compare average grades between distinct groups.

Regarding the curriculum used in the ICT course offered to the students, the following summary was compiled:

Month 1: Exploring the World of Technology: Presentation of the project and its objectives; Introduction to programming and technology; Discussion of the relevance of programming in the current scenario; Overview and optimized use of AI; Overview and use of Google tools and support tools for the subjects studied by students (details in the Results section).

Month 2: Fundamentals of Programming Logic: Understanding programming logic concepts; Solving elementary challenges through algorithms.

Month 3: Exploring Programming Languages: Practical immersion in various languages, including Python and Scratch; Development of small-scale projects for practical application of concepts.

Month 4: Creative Project Development with Scratch: In-depth exploration of the Scratch platform for creating games and interactive animations; Encouragement of creativity and teamwork for the conception of original projects.

Month 5: Introduction to Web Development and Applied Projects: Introduction to web development with HTML, CSS, and JavaScript; Design of simple websites and web applications to practice acquired knowledge.

Month 6: Final Project and ExpoTech: Design and implementation of the final project with an open theme; Preparation for ExpoTech, where students showcased their projects to the school community and invited guests.

It is important to note that all participants involved in this research were informed of the study's objectives and were previously notified that the anonymity of each participant would be respected.

According to feedback from several teachers and the administration of the school where the research was conducted, before the training, few or no technological resources were adopted. Predominantly, printed materials and blackboards were used in the classroom. After the course, classes became more dynamic, with digitally enriched content, online collaboration even outside conventional class hours, and more personalized student follow-up. More details can be seen in the Studies Conducted section.

The course for both students and teachers was led by the first author of this paper, a graduate student in Information Systems at the Instituto Federal do Norte de Minas Gerais – Campus Januária, under the supervision of the second and third authors of this paper.

STUDIES CONDUCTED

Initially, a comparative analysis was conducted on the academic performance of students before and after the implementation of technological initiatives at the school. The academic analysis of the students' grade averages for the 2023 school year, who participated in the project, reveals a scenario of significant improvement compared to previous years, as will be detailed through statistical testing in this section. There is evidence pointing to the fact that the use of ICTs contributed to this performance gain, which will also be addressed in this section.

In Figure 1, we compare the grade averages of the students who participated in the project in 2023 (while the training was underway) with those of students who took the same subjects in 2022 and 2021. As evidence that the difference between these two periods is statistically significant, the means and standard deviations of the grades for each year were calculated, and the Student's t-test for independent samples was used. The following results were obtained from comparing the grades from 2021 and 2023:

- t-statistic: -14.33
- p-value: 0.00014

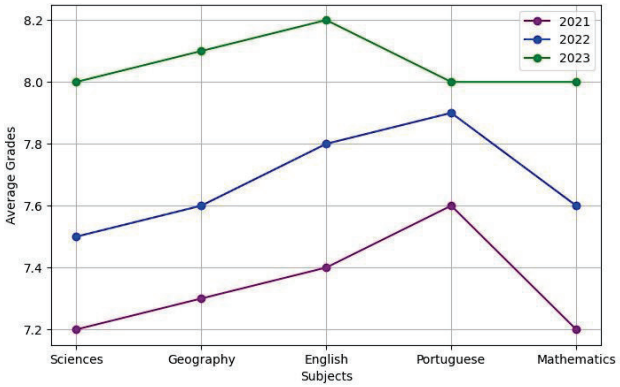

Figure 1 - Comparison of Average Grades – 2021, 2022, and 2023.

The t-statistic of -14.33 indicates the magnitude of the difference between the two groups' averages in terms of the number of standard deviations. A value of -14.33 suggests that the group averages are significantly different. As for the p-value of 0.00014, it indicates a very low probability that the observed difference between the two groups of grades (2021 and 2023) is due to chance.

Next, we compared the students' average grades between 2022 and 2023. To determine whether the difference between these two periods is statistically significant, we again calculated the means and standard deviations for each year and applied the Student's t-test for independent samples, obtaining the following results:

- t-statistic: -8.32
- p-value: 0.00003

The t-statistic of -8.32 indicates the magnitude of the difference between the two groups' averages in terms of standard deviations. A value of -8.32 suggests that the group averages are considerably different. The p-value of 0.00003 indicates a very low probability that the observed difference between the two groups of grades (2022 and 2023) is due to chance. This, combined with the teachers' reports (which will be presented later in this section), is evidence of the positive impact of ICT knowledge and use on students' performance.

The study focused on specific subjects, with the selection criteria being the teachers' willingness to learn and use ICT tools in the classroom. The following is a description of the subjects and corresponding tools taught to both students and teachers for in-class practices:

Science: Technologies such as virtual simulations with PhET Interactive Simulations, remote labs using platforms like Labster, and augmented reality resources through apps like Google Expeditions. Example of Use: Students conducted virtual experiments in physics and chemistry, simulating reactions and processes that would be difficult to reproduce in a school lab.

Geography: Technologies such as interactive maps with Google Earth, satellite imagery, and geolocation tools like ArcGIS Online. Example of Use: Students analyzed climate change through satellite images and created research projects on different ecosystems using interactive mapping tools.

English and Portuguese: Language learning apps like Duolingo, vocabulary games such as Kahoot!, and grammar and translation tools like Grammarly. Example of Use: Students practiced grammar and vocabulary exercises through interactive apps, participated in collaborative writing challenges, and used translation tools to enhance their understanding of complex texts.

Mathematics: Problem-solving software like Symbolab and Graphing Calculator.

Example of Use: Students solved complex mathematical problems using symbolic computation software, participated in online math competitions, and followed step-by-step tutorials to learn new concepts.

As evidence that ICT training contributed to academic performance improvement, interviews were conducted with teachers to gauge their perceptions regarding ICTs. These interviews were conducted via Google Forms, using Likert scale questions where teachers could indicate how each technology contributed to their teaching practice. Teachers were also invited to openly share if any technology not covered in the research had been useful in their teaching practice or, conversely, if any technology had hindered their practice (in this case, there were no responses). This survey involved 10 teachers from the school's teaching staff. Such forms are highly useful for assessing the impact of each technology on academic practice and how teachers adapt to these technologies after receiving training.

The form consisted of 12 questions, where each teacher was asked to indicate how each contributed or has contributed to their teaching practice after the training. The scale used had 5 levels, as outlined below:

1 – No contribution at all

2 – Little contribution

3 – Regular contribution

4 – Good contribution

5 – Essential contribution

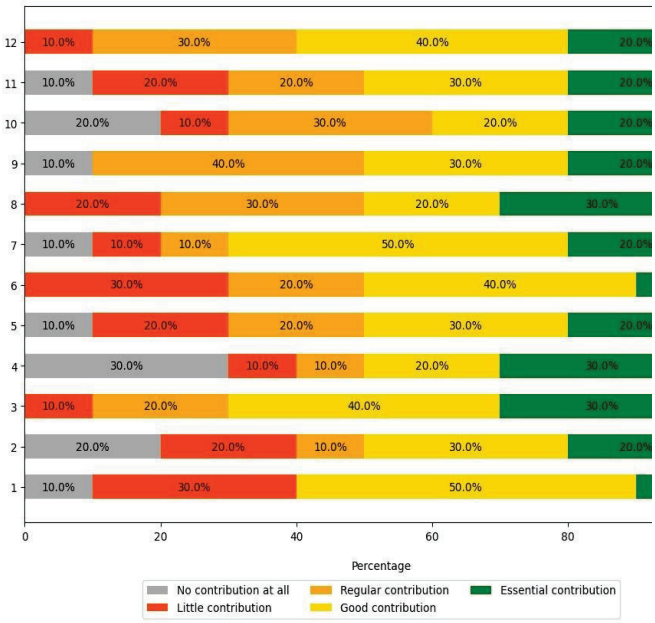

Figure 2 - Likert scale form applied to teachers

The 12 questions used in the Likert scale form are as follows:

1 - Use of ChatGPT to explain complex topics.

2 - Use of Google Docs and Google Classroom to improve communication and collaboration between students and teacher.

3 - Teaching programming logic to develop critical thinking and problem-solving skills.

4 - Use of circuit simulations and electronics kits to understand theoretical physics and electronics concepts.

5 - Integration of new educational technologies to increase student engagement in school activities.

6 - Immediate feedback provided by digital tools for academic development.

7 - Organization and communication of school tasks through Google Classroom.

8 - Use of educational technologies to promote autonomous learning among students.

9 - Teacher training for the effective use of educational technologies.

10 - Use of circuit simulations and electronics kits to increase student interest in science and technology.

11 - Use of ChatGPT to encourage students to explore topics beyond the traditional curriculum.

12 - Use of Google Docs to facilitate collaborative work and resource sharing among students.

When analyzing these survey items and summing the responses for “essential” and “good contribution” (the highest-weighted options) as seen in Figure 2, for all items, at least 50% selected one of these two options, except for question 10, where the two options together accounted for 40%. This is evidence that learning ICTs had a positive impact on teaching practice.

In addition to the Likert scale form, the teachers involved in the project were invited to give open-ended testimonials about their impressions of the students after learning ICTs. This is an important piece of data, as the improvement in students' grades could have occurred due to other factors not controlled in this study. In this sense, teachers are the best-qualified individuals to identify whether these variables were present or not.

The following testimonies highlight the training's contribution and provide a good understanding of the difference between students before and after the course. The compilation was made with the help of NVivo software:

Portuguese Teacher:

Before Technological Training: "I remember that before we introduced technologies into the classroom, students faced significant challenges engaging with Portuguese content. Many seemed uninterested in reading and writing activities, which was a barrier to learning."

After Technological Training: "But after receiving the training and starting to use technological resources, I saw a remarkable transformation. Students became more actively engaged in classes, especially in interactive activities. It was gratifying to see how the use of apps like Grammarly for grammar correction and Google Docs for collaborative writing enhanced their writing skills."

Mathematics Teacher:

Before Technological Training: "When I started teaching mathematics, I noticed that many students struggled to understand abstract concepts. Traditional teaching methods centered around textbooks did not always effectively convey the topics clearly and engagingly."

After Technological Training: "However, with the introduction of software such as GeoGebra for problem-solving and Prodigy for interactive math games, I witnessed an incredible change. Students became more confident in their abilities and approached the content more practically. It was inspiring to see how educational technologies helped them engage more with the subject."

English Teacher:

Before Technological Training: "When I started teaching English, I noticed that many students struggled to develop their listening and speaking skills. Traditional classes focused mainly on reading and grammar did not fully meet their needs."

After Technological Training: "However, with the introduction of apps like Duolingo for language learning and Quizlet for vocabulary games, I saw a noticeable change. Students became more engaged and motivated to practice the language."

Unfortunately, we were unable to gather testimonials from all teachers involved in the project. However, the ones presented in this article reflect, albeit partially, the contribution of ICT teaching to improving student performance.

Although this study has shown evidence that ICTs positively impact the performance of elementary school students and is therefore promising, it is important to emphasize that other variables, beyond ICT learning, may have contributed to the improvement in student performance. It is beyond the scope of this work to track, isolate, and elucidate what these factors might be. Therefore, it cannot be claimed that ICTs were the sole factor responsible for the improvement in academic performance.

CONCLUSION

This study investigated the impact of ICT use through a case study applied to Escola Estadual Professora Zina Porto, exploring how the integration of technological resources in the classroom influences student performance.

One of the main findings of this study is that the integration of technology in education contributes to the improvement of elementary school students' academic performance. The results showed a significant improvement in test scores after students and teachers learned about ICTs.

Additionally, the qualitative data highlighted the benefits perceived by teachers regarding the use of technology in the classroom, including increased engagement, motivation, and content understanding. However, challenges were also identified, such as the need for teacher training and ensuring equitable access to technological resources, as the reality showed that many students have limited or no access to technology in the 21st century. This scenario raises a red flag for authorities to focus both on improving the infrastructure of elementary schools and on training the teaching staff to include technologies, like those mentioned in this study, in their teaching methodology. There is no longer room for schools that do not adequately prepare their students for the conscious and balanced use of ICTs, especially considering today's competitive job market.

It is important to acknowledge that this study faced some limitations, including the number of teachers willing to participate and collaborate in the research. This highlights another problem, which is that many educators are still reluctant to self-evaluate and refresh their teaching practices. Staying in a state of continuous learning and improvement is an important requirement not only for students but also for those who teach.

Although this research covered a variety of available technologies, it did not explore the entire range of ICT options. This would require a much more extensive project with more time and probably more course hours. Future research could investigate other types of technology in education, as well as effective strategies for integrating technology meaningfully and sustainably in the educational environment.

As mentioned in the STUDIES CONDUCTED section, other variables besides ICT training may have contributed to the improvement in student performance in 2023. One factor that could have contributed to the lower performance in 2021 and 2022 is the aftermath of the COVID-19 pandemic, where many schools remained closed for long periods, and many students, especially those from disadvantaged backgrounds, struggled to study during isolation. However, these other variables are beyond the scope of this study and deserve a more in-depth, dedicated investigation. Thus, they were not explored in this study.

It is hoped that this work can serve as a model and inspiration for related research in the field of educational informatics.

ACKNOWLEDGMENTS

We would like to thank the Instituto Federal do Norte de Minas Gerais – Campus Januária, the institution where I am an undergraduate student in Information Systems, for the support provided in carrying out this research, as well as the support of my supervising professors: Raphael Magalhães Hoed and Pedro Fábio Saraiva.

REFERENCES

1. Atmatzidou, S., & Demetriadis, S. (2016). Advancing Students' Computational Thinking Skills through Educational Robotics: A Study on Age and Gender Relevant Differences. Descrição: Investiga como a robótica educacional pode melhorar as habilidades de pensamento computacional e lógica de programação. Retrieved from Advancing Students' Computational Thinking Skills through Educational Robotics.
2. Bates, A. W. (2019). Teaching in a Digital Age: Guidelines for Designing Teaching and Learning. BCcampus. Retrieved from https://pressbooks.bccampus.ca/teachinginadigitalagev2/
3. Borges, C. N., & Fleith, D. S. (2018). Uso da Tecnologia na Prática Pedagógica: Influência na Criatividade e Motivação de Alunos do Ensino Fundamental. Psicologia: Teoria e Pesquisa, 34, e3435. https://doi.org/10.1590/0102.3772e3435.
4. Chou, C.-Y., Lin, P.-H., & Chan, T.-W. (2002). Wireless Sensor Networks for Learning Electronics: A Case Study of Hands-on Learning with Real Circuits.

Retrieved from Wireless Sensor Networks for Learning Electronics.

5. Clark, R. C., & Mayer, R. E. (2016). E-learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning. John Wiley & Sons.
6. Cohen, L., Manion, L., & Morrison, K. (2018). Research Methods in Education. Routledge.
7. Collins, A., & Halverson, R. (2018). Rethinking Education in the Age of Technology: The Digital Revolution and Schooling in America. Teachers College Press.
8. Creswell, J. W., & Plano Clark, V. L. (2017). Designing and Conducting Mixed Methods Research. Sage Publications.
9. Dalgarno, B., & Lee, M. J. (2010). What are the Learning Affordances of 3-D Virtual Environments? British Journal of Educational Technology, 41(1), 10-32.
10. European Commission. (2013). Survey of Schools: ICT in Education. Retrieved from https://ec.europa.eu/digital-single-market/en/survey-schools-ict-education.
11. Gee, J. P. (2007). What Video Games Have to Teach Us About Learning and Literacy. Palgrave Macmillan.
12. Gravier, C., Thiriet, J.-M., Fayolle, J., Bayard, B., Ates, M., & Lardon, J. (2008). Use of E-Learning in Electrical Engineering Education: A Comparative Study of Web-Based and Face-to-Face Courses. Retrieved from Use of E-Learning in Electrical Engineering Education.
13. Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. Educational Technology Research and Development, 55(3), 223-252.
14. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. Retrieved from Artificial Intelligence in Education: Promises and Implications for Teaching and Learning.
15. Iftakhar, S. (2016). Google Classroom: What works and how? Journal of Education and Social Sciences, 3(1), 12-18.
16. Johnson, L., Estrada, V., & Freeman, A. (2015). Digital Technology in the Classroom: Benefits and Barriers. Journal of Educational Technology,
17. 26(3), 401-418.
18. Junco, R. (2012). The relationship between frequency of Facebook use, participation in Facebook activities, and student engagement. Computers & Education, 58(1), 162-171.
19. Koedinger, K. R., & Corbett, A. T. (2006). Cognitive Tutors: Technology bringing learning sciences to the classroom. In R. K. Sawyer (Ed.), The Cambridge Handbook of the Learning Sciences (pp. 61-78). Cambridge University Press.
20. Mayer, R. E. (2009). Multimedia Learning. Cambridge University Press.
21. Mishra, P., & Koehler, M. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Teachers College Record, 108(6), 1017-1054.
22. Mishra, P., & Koehler, M. J. (2009). Too cool for school? No way! Learning and leading with technology. Learning & Leading with Technology, 36(7), 14-18.
23. National Education Association (NEA). (2017). Integrating Technology in the Classroom. Retrieved from http://www.nea.org/tools/52217.htm.
24. OECD. (2015). Students, Computers and Learning: Making the Connection. Retrieved from https://www.oecd.org/education/students-computers-and-learning-9789264239555-en.htm.
25. Papert, S. (1980). Mindstorms: Children, Computers, and Powerful Ideas. Basic Books.
26. Patton, M. Q. (2014). Qualitative Research & Evaluation Methods: Integrating Theory and Practice. Sage Publications.
27. Prensky, M. (2001). Digital Natives, Digital Immigrants. On the Horizon, 9(5), 1-6.
28. Puentedura, R. R. (2006). Transformation, Technology, and Education. Retrieved from https://www.hippasus.com/rrpweblog/archives/000095.html.
29. Puentedura, R. (2014). The SAMR Model: A Framework for Evaluating Technology Integration in Education.
30. Silva, A. F., Hoed, R. M., & Saraiva, P. F. (2023). Comparação entre a educação brasileira e a de países com bons resultados no exame do PISA: um estudo a partir da TALIS. Revista Foco, 16(2), e899. https://doi.org/10.54751/revistafoco.v16n2-041.
31. Subrahmanyam, K., & Smahel, D. (2011). Digital Youth: The Role of Media in Development. Springer Science & Business Media.
32. UNESCO. (2017). Reading in the Mobile Era: A Study of Mobile Reading in Developing Countries. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000246728.
33. Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. Review of Research in Education, 34(1), 179-225.