The Impact of “Scratch” on Student Engagement and Academic Performance in Primary Schools

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Abstract: This study aimed to investigate the impact of the Scratch programming environment on student engagement and academic performance in primary informatics education. The research was conducted over three academic years (2020–2023) in educational organizations (ADAN and Navoiiy schools) involving 170 first and third-grade students. The Student Engagement Instrument (SEI) was used to assess cognitive, emotional, and behavioral engagement, and academic performance was evaluated based on trimester grades in informatics. The results indicated significant improvement in both student engagement and academic performance post-implementation of Scratch. Cognitive, emotional, and behavioral engagement scores showed a marked increase, from an average SEI score of 3.3 to 4.0 for first graders and 3.7 to 4.4 for third graders. Similarly, academic performance demonstrated a considerable enhancement, with average grades rising from 53.5 to 80.3 for first graders and 57.3 to 84.5 for third graders over four trimesters. Teachers’ observational data, complemented by qualitative focus group discussions, reinforced these findings.

Keywords: Scratch programming environment, primary education, student engagement, academic performance, informatics education

1 Introduction

The burgeoning significance of digital information technologies in school teaching has been acknowledged by educational experts globally, heralding an era of innovative instructional methodologies (Haleem, Javaid, Qadri, & Suman, 2022). The advent of these technologies has unequivocally revolutionized pedagogical practices, paving the way for a more immersive, interactive, and engaging learning experience. As the focus of modern-day education shifts towards cultivating learners who are adept at navigating the digital landscape, the relevance and importance of integrating these technologies in teaching become more pronounced (Kuhail, ElSayary, Farooq, & Alghamdi, 2022). In light of this educational paradigm shift, numerous proposals have been advanced by researchers advocating for the creation of information and educational environments within schools (Gussenova, Babaev, & Smagulov, 2020). These proposals (Irma, 2019; Tapia-Fonllem, Fraijo-Sing, Corral-Verdugo, Garza-Teran, & Moreno-Barahona, 2020) primarily emphasize the need to foster an academic culture that appreciates and harnesses the immense potential of digital technology in facilitating meaningful learning experiences. They propose the creation of comprehensive digital ecosystems in schools, encompassing various elements such as digitally enhanced curriculum design, e-learning platforms, and advanced pedagogical tools (Joshi, 2022; Nicolay, Erazo, Esteve-Gonzalez, & Vaca, 2015). Amid the array of technological innovations, a few have gained widespread recognition and have been instrumental in significantly contributing to the development of information and educational environments in schools (Mhlongo, Mbatha, Ramatsetse, & Dlamini, 2023). Such systems have been revolutionary in fostering a collaborative and engaging educational atmosphere, instilling in students critical digital literacy skills, and ultimately, preparing them for the challenges of a technologically driven world. Consequently, the transformation that these technologies induce in the educational environment substantiates their integral role in modern academic infrastructures, underlining the need for their widespread adoption and effective utilization (U.S. Department of Education, Office of Educational Technology, 2017).

The use of information and educational environments in school practice has been steadily gaining traction, serving as a transformative impetus driving pedagogical innovation. A specific illustration of this can be drawn from a
myriad of schools across the globe that have integrated Learning Management Systems, such as Google Classroom, into their teaching practices (Dash, 2019). This digital platform facilitates seamless interaction between teachers and students, allowing the provision and completion of assignments, exchange of ideas, and timely feedback, all within a consolidated virtual environment. As schools continue to explore the potential of these environments, there has been a marked shift towards the development of new and innovative approaches to create and integrate these systems into teaching practices. In one particular case, a school has deployed a school-wide Digital Learning Environment (DLE) (Brown, Dehoney, & Millichap, 2015), which, unlike traditional learning systems, offers a more personalized learning experience. The DLE effectively intertwines various resources, tools, and services, promoting a learner-centered educational approach. Furthermore, the emergence of immersive technologies, such as Virtual Reality (VR) and Augmented Reality, has inspired an entirely new paradigm for creating information and educational environments. A noteworthy case is the utilization of VR in history classes, where students are transported to different eras, providing them with a uniquely immersive learning experience (Calvert & Abadia, 2020). These instances underscore the dynamism in the creation and application of information and educational environments in schools, suggesting a promising trajectory for future educational practices.

The matter of student engagement in primary schools represents a focal concern in contemporary pedagogical discourse, underpinning the broader objectives of academic achievement, social development, and lifelong learning. Student engagement, understood as the degree of attention, curiosity, interest, and passion that students exhibit in the learning process, is a multifaceted phenomenon intricately intertwined with cognitive, emotional, and behavioral components of student participation in educational activities. Recent research (Appleton, Christenson, & Furlong, 2008; Li & Xue, 2023) suggests a growing issue with student disengagement at the primary level, characterized by low academic performance, high dropout rates, and negative attitudes towards school, presenting serious implications for individual learning outcomes and systemic educational efficacy. This scenario underscores an exigent need to reimagine traditional teaching methodologies and embrace more innovative, student-centered approaches. It is widely recognized that traditional didactic pedagogies, with their emphasis on passive learning, have shown limitations in fostering active engagement, critical thinking, and problem-solving skills in students (Semple & Currie, 2022). Hence, the call for innovative teaching methodologies—those that leverage digital technologies, incorporate active learning strategies, and nurture a stimulating and inclusive learning environment—is compelling. Such approaches, pivoted on the learner's curiosity, creativity, and active participation, promise to reinvigorate the educational landscape, enhancing student engagement, improving learning outcomes, and fostering a lifelong love for learning. Therefore, addressing the issue of student engagement in primary schools through innovative teaching methods is not just timely, but of paramount importance, setting the course for the future of education.

In light of the burgeoning imperative to invigorate student engagement in primary schools and the promising potential of innovative teaching methodologies, this research endeavor sets forth a clear and significant objective. The focus of our investigation is to ascertain the impact of the Scratch learning platform on student engagement. Scratch, an educational tool developed by the MIT Media Lab, is aimed at introducing primary school students to the rudiments of programming, thus providing a creative outlet while fostering problem-solving skills (Scratch, 2023). The underlying premise of this study is rooted in the hypothesis that the use of such an interactive learning environment may enhance students' engagement in the learning process. Through its visually appealing, easy-to-use interface, Scratch enables students to create their own interactive stories, games, and animations, thereby offering an immersive learning experience. Therefore, the central objective of our research is to examine whether, and to what extent, the implementation of Scratch in a primary school curriculum influences students’ attention, curiosity, and interest in learning. This objective extends to evaluating the potential of Scratch as not only a pedagogical tool for improving not just the cognitive, but also the emotional and behavioral facets of student engagement. Ultimately, our study strives to contribute to the academic discourse surrounding the use of innovative digital tools in education and their impact on student engagement.

Our research endeavor, predicated on evaluating the impact of the Scratch learning platform on student engagement, seeks to address a series of specific research questions and hypotheses. First, to what degree does the use of Scratch in primary school classrooms enhance the cognitive engagement of students, marked by increased attention, curiosity, and interest in learning activities? This question is coupled with the hypothesis that the introduction of Scratch in the curriculum fosters a significant upswing in cognitive engagement, largely due to its interactive and immersive learning experiences. Second, we question whether the utilization of Scratch influences the emotional aspects of student engagement, manifesting as increased enjoyment, motivation, and positive attitudes towards learning. The corresponding hypothesis proposes that Scratch, by creating a more stimulating and enjoyable
learning environment, positively influences students’ emotional engagement. Lastly, we probe whether the use of Scratch encourages greater behavioral engagement, characterized by active participation, persistence, and effort in learning tasks. We hypothesize that the interactive nature of Scratch motivates students to become more actively involved in their learning, thereby enhancing behavioral engagement. These research questions and hypotheses, crafted with specificity and academic rigor, aim to illuminate the potential of Scratch as a pedagogical tool for augmenting student engagement in primary schools.

2 Related Studies

The appraisal of past studies is instrumental in the context of our research, offering a comprehensive understanding of the theoretical and empirical landscape that underpins the exploration of Scratch’s impact on student engagement. Such reviews not only equip us with a nuanced understanding of existing knowledge but also illuminate potential gaps, which our study aims to address. In this regard, understanding the theoretical underpinnings of Scratch and its relationship with student engagement is crucial. Scratch, an interactive programming environment developed by the Lifelong Kindergarten Group at MIT Media Lab, is grounded in the constructivist learning theory (Scratch, 2023). This theory posits that learners actively construct knowledge through interaction with their environment. In the context of Scratch, this environment is a virtual platform that encourages learners to create, experiment, and innovate, thereby fostering active cognitive engagement. Additionally, Scratch embodies principles of situated learning by providing a context (creating animations, stories, and games) that makes the learning process meaningful and relevant for students (Hagge, 2017). This relevance and active engagement are pivotal in driving student engagement, both behaviorally and emotionally. Similarly, the theoretical underpinning of other comparable platforms is primarily linked to the tenets of active and constructivist learning theories. These platforms, much like Scratch, provide a hands-on, immersive environment where students can learn by doing, stimulating their interest, curiosity, and motivation – key elements of student engagement. Therefore, in both Scratch and similar platforms, the theoretical foundation suggests a strong potential to enhance student engagement by virtue of their interactive and immersive design (Cope & Kalantzis, 2009).

The literature on the impact of Scratch on student engagement presents key findings that underscore its pedagogical potential (Iyamuremye, Nsabayezu, & Habimana, 2022). For instance, several studies have reported significant improvements in students’ cognitive engagement (Campbell & Atagana, 2022), with increased curiosity, persistence, and enhanced problem-solving skills attributed to Scratch’s hands-on and creative environment (Fagerlund, Hakkinen, Vesisenaho, & Viiri, 2021; Iyamuremye et al., 2022). In terms of emotional engagement, students exposed to Scratch have shown elevated interest and enjoyment in learning, particularly owing to the platform’s interactive and gamified nature. These studies, predominantly utilizing quantitative methodologies like pre and post-tests, surveys, and observational metrics, have substantiated the positive relationship between Scratch and various aspects of student engagement (Ferrer-Mico, Prats-Fernandez, & Redo-Sanzhez, 2012). The implications of these methodologies for our research are manifold, offering rigorous approaches to measure engagement while highlighting the need for careful consideration of factors like sample characteristics and instructional context.

In terms of similar platforms, research encompassing platforms like Code.org, Blockly, and Alice also unveils promising impacts on student engagement. These platforms, like Scratch, adhere to the constructivist pedagogical approach, integrating coding and interactive learning (Dodge, 2023). Reported outcomes often mirror those associated with Scratch, particularly in terms of fostering cognitive and emotional engagement (Chang, 2014; Seraj, Katterfeld, Bub, Autexier, & Drechsler, 2019). The methodologies employed in these studies range from mixed methods, incorporating both qualitative and quantitative data, to case study approaches.

Drawing parallels and distinctions between Scratch and these platforms elucidates the universal impact of constructivist, interactive digital environments on student engagement. However, unique features of Scratch, such as its story-telling and animation capabilities, appear to provide additional layers of engagement, harnessing creativity, and imagination beyond the coding and logical thinking commonly emphasized in other platforms. Therefore, the overarching evidence from past studies reinforces the proposition that Scratch, along with similar platforms, significantly contributes to enhancing student engagement, albeit with unique nuances reflective of their individual features.

Research by de Almeida, Almeida, Rocha, and Ferreira (2021) discusses the Scratch4All project, which had a positive impact on the school environment by allowing young people to engage with technology educationally. It helped develop not only programming skills but also skills in other school subjects. Also another study by de Almeida, Teixeira, and Almeida (2019) indicates that Scratch programming language can significantly influence the skills acquired by students in the classroom, enhancing computational thinking.
and digital literacy. The study aimed to evaluate the impact on students’ knowledge, attitudes, and capacities, as well as the school community at large. Some research (Uluay, 2022) focuses on the views of pre-service elementary teachers about programming after experiencing Scratch. The study found a positive tendency towards programming among participants after the implementation process, with many expressing a desire to improve in this field and use programming technologies in their future professional lives.

3 Materials and Methods

3.1 Study Design and Participants

This experimental study was conducted within the ADAN and Navoiy secondary general education organizations, involving students from three first-grade classrooms and two third-grade classrooms, totaling 170 participants. The research, spanning over three years, adopted a longitudinal design to track changes in student engagement with informatics education through the use of the Scratch programming environment. The study was structured into three stages, each with specific objectives contributing to the overall research aim. The first stage focused on establishing a theoretical foundation, the second on developing educational materials and a teaching methodology, and the final stage on evaluating the effectiveness of these materials and methodologies (Figure 1).

3.2 Data Collection Methods and Instruments

Data were collected using a combination of instruments to assess student engagement and the effectiveness of the Scratch programming curriculum. The primary tool was a modified version of the Student Engagement Instrument (SEI) (Appleton, Christenson, Kim, & Reschly, 2006), which measured cognitive, emotional, and behavioral aspects of engagement. Additionally, a Scratch-based project was designed to evaluate students’ practical skills and engagement, complemented by an observation checklist used by teachers to monitor student behavior and engagement during Scratch sessions. Below are questions that were included in the pre-test and post-test of the SEI related to the impact of Scratch projects on student engagement (Table 1).

The validity of these instruments was ensured through a pilot study and expert reviews, adhering to established psychometric standards.

3.3 Participants and Procedure

The study’s participants comprised first- and third-grade students, selected through a purposive sampling method to represent typical students in the initial stages of primary education. Prior to the introduction of the Scratch curriculum, informed consent was obtained from the parents or guardians of all participating students. The study was conducted over a full academic year, allowing for pre- and post-intervention assessments using the SEI, observations during Scratch sessions, and end-of-semester focus group discussions to gather qualitative insights into the students’ experiences and engagement levels.

3.4 Data Analysis

Data were analyzed using statistical techniques appropriate for the study’s design and objectives. A paired t-test was employed to compare pre- and post-intervention...
SEI scores, assessing the impact of the Scratch curriculum on student engagement. Regression analysis was used to explore the influence of various factors on engagement levels. All analyses were conducted in compliance with ethical standards for educational research, ensuring the anonymity and confidentiality of student data.

4 Results

4.1 Results from the SEI

The research engaged a diverse population of students from three first-grade classrooms and two third-grade classrooms at the ADAN and Navoiy secondary general education organizations. Altogether, a total of 170 students were involved, ensuring a wide range of responses for a robust analysis. The participant pool was balanced in terms of gender, and students represented diverse socio-economic backgrounds. The age range of the first-grade participants was between 6 and 7 years, whereas the third-grade students were between 8 and 9 years.

Data were collected through multiple means to gain a comprehensive understanding of the impact of Scratch on student engagement.

The SEI was employed to measure the cognitive, emotional, and behavioral engagement of both first- and third-grade students. The instrument was administered twice during the academic year: at the start (pretest) and at the end (posttest). Each component of the SEI was scored on a scale from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating greater engagement.

The average pretest and posttest scores, along with the results of calculating the standard deviation values, are shown in the following Table 2:

The paired t-tests demonstrated that the increases in scores from pretest to posttest were statistically significant in all cases, with p-values less than 0.05. This indicates that the introduction of Scratch in the classroom significantly enhanced cognitive, emotional, and behavioral engagement across both grades.

Furthermore, the standard deviations suggest that there was a relatively small amount of variation in scores within each grade and time point. This strengthens the reliability of the mean score improvements and underpins the significant impact Scratch had on student engagement.

The data in the table represents the average (mean) scores and the standard deviations (SD) of the first- and third-grade students’ responses on the SEI pretest and posttest for cognitive, emotional, and behavioral engagement. The scores

Table 1: Sample questions used for SEI

<table>
<thead>
<tr>
<th>SEI factors</th>
<th>Pretest Questions</th>
<th>Posttest Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td>I believe using Scratch will make it easier for me to understand complex concepts</td>
<td>Using Scratch has made it easier for me to understand complex concepts</td>
</tr>
<tr>
<td></td>
<td>I think that Scratch will help me to better express my ideas in schoolwork</td>
<td>Scratch has helped me to better express my ideas in schoolwork</td>
</tr>
<tr>
<td>Emotional</td>
<td>I am excited about using Scratch in the educational process</td>
<td>I have enjoyed using Scratch in the educational process this year</td>
</tr>
<tr>
<td></td>
<td>I am worried that using Scratch might negatively affect my academic performance</td>
<td>Using Scratch did not negatively affect my academic performance</td>
</tr>
<tr>
<td>Behavioral</td>
<td>I am willing to spend extra time on schoolwork if it involves using Scratch</td>
<td>I have spent extra time on schoolwork this year because it involved using Scratch</td>
</tr>
<tr>
<td></td>
<td>I might get distracted when I am supposed to be working on schoolwork involving Scratch</td>
<td>I was less likely to get distracted when I was working on schoolwork involving Scratch</td>
</tr>
</tbody>
</table>

Table 2: Results of SEI

<table>
<thead>
<tr>
<th>SEI factors</th>
<th>First-Grade Pretest Average (SD)</th>
<th>First-Grade Posttest Average (SD)</th>
<th>Third-Grade Pretest Average (SD)</th>
<th>Third-Grade Posttest Average (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td>3.3 (±0.2)</td>
<td>4.0 (±0.3)</td>
<td>3.7 (±0.2)</td>
<td>4.4 (±0.2)</td>
</tr>
<tr>
<td>Emotional</td>
<td>3.4 (±0.3)</td>
<td>4.3 (±0.1)</td>
<td>3.8 (±0.1)</td>
<td>4.5 (±0.1)</td>
</tr>
<tr>
<td>Behavioral</td>
<td>3.2 (±0.2)</td>
<td>4.1 (±0.1)</td>
<td>3.6 (±0.2)</td>
<td>4.5 (±0.1)</td>
</tr>
</tbody>
</table>
likely range from 1 to 5, with higher scores indicating higher levels of engagement.

Cognitive engagement: In the first grade, the average cognitive engagement score increased from 3.3 to 4.0, demonstrating an improvement in cognitive engagement over the academic year. Similarly, in the third grade, the average cognitive engagement score increased from 3.7 to 4.4. The small standard deviations in both grades suggest that the students’ scores did not vary widely from the average, indicating a general improvement in cognitive engagement.

Emotional engagement: The average emotional engagement scores also increased in both grades. In the first grade, the score rose from 3.4 to 4.3, while in the third grade, the score increased from 3.8 to 4.5. Again, the small standard deviations suggest that most students’ scores were close to the average, indicating a rise in emotional engagement as a result of the intervention.

Behavioral engagement: Similar trends were observed in behavioral engagement. The average score for the first grade increased from 3.2 to 4.1, while for the third grade, it increased from 3.6 to 4.5. The small standard deviations indicate that the scores were close to the average, suggesting a significant increase in behavioral engagement across the student body.

In conclusion, the data indicate that using Scratch in the classroom has had a positive impact on cognitive, emotional, and behavioral engagement in both first- and third-grade students. The low standard deviations suggest that these improvements were consistent across most students, further supporting the effectiveness of Scratch in enhancing student engagement.

4.2 The Impact of Scratch Project to the Academic Performance

Before getting to know Scratch, the students’ basic programming skills were assessed. This included a practice assignment where students were asked to solve certain problems using whatever programming knowledge they had. Students were introduced to the Scratch programming environment. This included several lessons in which students were taught the basics of Scratch and gradually introduced to more advanced concepts. During the implementation phase, student performance was regularly assessed. These were small tasks or tests designed to measure students’ understanding of the concepts they were learning and their ability to apply those concepts in Scratch. Post-test assessments were conducted every trimester. It was similar in structure and complexity to a pre-assessment to accurately measure the improvement in students’ programming skills (Table 3).

Data provided are pre-test and post-test mean scores and standard deviations (SD) for first- and third-grade students over the four trimesters. The scores reflect students’ programming skills measured before (pre-test) and after (post-test) using Scratch.

In the first trimester, first-grade students have an average pretest score of 53.5 with an SD of 7.4, suggesting that initially, the students’ programming skills vary around an average level. After using Scratch, the average posttest score rises to 61.9, with an SD of 7.3, indicating a marked improvement in programming skills.

The trend of improvement is also seen in the third-grade students, whose average pretest score of 57.3 (SD = 5.8) rises to an average posttest score of 65.1 (SD = 4.7) in the first trimester. This trend continues across all four trimesters for both first and third grades, indicating a positive impact of Scratch on students’ programming skills. The increase in average scores and the decrease in SDs suggest that not only did the students improve their skills, but they also became more consistent in their performances.

By the final trimester, both first- and third-grade students display further improved posttest scores (80.3 for first grade and 84.5 for third grade), with even lower standard deviations (2.2 for first grade and 3.2 for third grade), demonstrating consistent mastery of programming skills gained through Scratch over time.

In summary, these data indicate that using Scratch in teaching programming significantly enhances students’ programming skills across different grade levels over time. The decrease in standard deviation values shows that the variance in the students’ performance also decreases over time, which implies more consistent learning outcomes.

<table>
<thead>
<tr>
<th>Trimester</th>
<th>First Grade</th>
<th>Third Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest Average (SD)</td>
<td>Posttest Average (SD)</td>
</tr>
<tr>
<td>1</td>
<td>53.5 (±7.4)</td>
<td>61.9 (±7.3)</td>
</tr>
<tr>
<td>2</td>
<td>65.0 (±5.3)</td>
<td>73.7 (±4.3)</td>
</tr>
<tr>
<td>3</td>
<td>71.6 (±4.1)</td>
<td>78.1 (±2.9)</td>
</tr>
<tr>
<td>4</td>
<td>78.3 (±3.4)</td>
<td>80.3 (±2.2)</td>
</tr>
</tbody>
</table>
4.3 Insights from Teacher Observations

Teacher observation data was collected using a checklist that focused on how effectively students interacted with the Scratch program. This checklist included items related to student attention, participation, interaction with software, problem-solving ability, and creativity in programming tasks (Table 4).

Each of these categories was rated on a scale from 1 to 5, where 1 is “very poor” and 5 is “excellent.”

Analysis and interpretation of such data are as follows: The observational data from teachers, as reflected in the checklist, indicate a strong engagement of students with the Scratch program across both grades. In both the first and third grades, students scored highly on attention and participation, with averages of 4.0 and 4.1, respectively, for first grade and 4.5 and 4.6, respectively, for third grade. This suggests that students were actively engaged and attentive during Scratch programming activities.

The average score for software interaction is 3.9 for first grade and 4.4 for third grade, indicating that students were able to interact well with the Scratch software, with a slightly higher ability observed in the third graders.

Problem-solving, a key aspect of programming, had average scores of 3.8 for first grade and 4.3 for third grade, demonstrating that students were progressively improving their problem-solving skills through the use of Scratch.

Finally, students in both grades showcased high creativity levels, with first graders scoring an average of 4.2 and third graders averaging 4.7. This suggests that the Scratch program facilitates and encourages creative thinking in programming tasks among primary students.

The standard deviations are relatively small in all cases, indicating that the ratings by the teachers were generally consistent, further validating the positive impact of the Scratch program.

<table>
<thead>
<tr>
<th>Teacher Observation</th>
<th>First-grade average (SD)</th>
<th>Third grade average (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>4.0 (±0.5)</td>
<td>4.5 (±0.4)</td>
</tr>
<tr>
<td>Participation</td>
<td>4.1 (±0.5)</td>
<td>4.6 (±0.4)</td>
</tr>
<tr>
<td>Software Interaction</td>
<td>3.9 (±0.6)</td>
<td>4.4 (±0.5)</td>
</tr>
<tr>
<td>Problem-Solving</td>
<td>3.8 (±0.6)</td>
<td>4.3 (±0.5)</td>
</tr>
<tr>
<td>Creativity</td>
<td>4.2 (±0.5)</td>
<td>4.7 (±0.4)</td>
</tr>
</tbody>
</table>

5 Discussion

The findings from this study provide compelling evidence in support of our initial research questions and align with the existing literature on the use of Scratch and similar platforms in primary school education. Our primary research question focused on understanding the impact of the Scratch program on student engagement. Both the quantitative data from the SEI and the qualitative data from focus group discussions support a positive impact of Scratch on student engagement in both the first and third grades.

The quantitative analysis demonstrated an increase in cognitive, emotional, and behavioral engagement scores after the implementation of the Scratch program. The pretest and posttest results showed a consistent pattern of improvement, which was echoed in the teachers’ observations. Moreover, these findings correlate with the increased academic performance observed across the four trimesters of the study, indicating that enhanced engagement might be contributing to better learning outcomes.

The qualitative data provided deeper insights into the increased engagement, with teachers highlighting the usefulness of Scratch in enhancing students’ attention, participation, software interaction, problem-solving, and creativity. These findings align well with the existing literature, which posits that practical and interactive platforms like Scratch can facilitate a more active and engaging learning experience, thereby improving key skills like problem-solving and creativity (Brennan & Resnick, 2012; Resnick, Maloney, Hernandez, & Kafai, 2009).

The study also found that the use of Scratch stimulated improved academic performance in programming teaching, demonstrated through increased scores over the academic year. This result confirms previous research suggesting that Scratch can effectively support learning in computer science education, providing a beneficial and student-friendly introduction to key programming concepts (Zhang & Nouri, 2019).

However, it should be noted that while the results indicate a positive impact of the Scratch program, some teachers suggested room for improvement in catering to students with varying skill levels. Future studies might explore ways to differentiate Scratch activities to challenge students at different proficiency levels and investigate long-term impacts on students’ computational thinking skills.

In summary, the present study reinforces and extends the existing literature, confirming that the use of the Scratch program in primary education can enhance student engagement, stimulate creativity, and improve academic performance in programming.

Comparative analysis of our study with past research offers valuable insights into the nuanced impacts of...
Scratch and similar platforms in the field of primary education. Consistent with previous studies (Brennan & Resnick, 2012), our research found that Scratch positively influences student engagement and academic performance.

In terms of engagement, our quantitative data, complemented by qualitative teacher observations, revealed significant improvement in cognitive, emotional, and behavioral engagement. These results mirror findings by Piedade and Dorotea (2022), who noted that Scratch fosters motivation and engagement among learners. Similarly, our findings parallel a study by Roque, Dasgupta, and Costanza-Chock (2016), which highlighted how Scratch encourages creative thinking, a theme echoed in our qualitative data. However, our study further expanded on these dimensions by offering a graded comparison between first and third graders, providing new insights into the varying effects of Scratch at different educational stages.

In terms of academic performance, our study found a notable improvement in scores after the implementation of Scratch in teaching programming. This aligns with (Resnick et al., 2009), who found Scratch to be an effective tool for learning basic programming concepts. Yet, our study offers additional granularity by tracking performance over four trimesters, thereby demonstrating the sustained impact of Scratch over a longer period.

Despite these similarities, differences emerge when considering the instructional approach and the depth of qualitative data. While earlier studies (Benton, Hoyles, & Kalas, 2017) have often used Scratch as part of a broader curriculum or after-school activities, our study focused on Scratch as the primary tool in formal programming education.

In summary, our study reaffirms the positive impact of Scratch found in previous studies, while offering a more detailed understanding of its influence across different grade levels and in the context of formal education. It also sheds light on potential areas of enhancement, thereby contributing to the continued refinement of the application of Scratch in primary education.

The findings from this study bear significant implications for teaching practice and student learning, particularly in the domain of informatics education within the primary school context. First, the demonstrated effectiveness of Scratch in fostering student engagement underscores its utility as an instructional tool. By promoting cognitive, emotional, and behavioral engagement, Scratch can motivate students and make learning more enjoyable, which is critical in facilitating effective learning. Thus, teachers should consider incorporating Scratch into their lesson plans as a means of enhancing student interaction with the material and fostering a more active learning environment.

The noted improvement in academic performance associated with Scratch use further emphasizes its potential as a teaching tool in informatics education. As the data suggest, Scratch not only engages students but also enhances their understanding and application of programming concepts, which is a key learning outcome in informatics education.

Furthermore, the study’s findings suggest that Scratch can help cultivate essential twenty-first-century skills such as problem-solving and creativity, as observed in the teacher’s observations. Given the increasing importance of these skills in today’s digital age, their development should be an integral part of contemporary education. By integrating Scratch into the curriculum, teachers can provide students with an opportunity to practice and hone these skills.

However, the qualitative data also point to the need for differentiation in Scratch activities to cater to students with varying skill levels, which is a critical aspect of effective teaching. Hence, while using Scratch, teachers should strive to customize and adapt activities to meet the diverse needs and abilities of their students, ensuring an inclusive learning environment that promotes success for all learners (Belessova, Ibashova, Bosova, & Shaimerdenova, 2023).

In summary, the study’s findings highlight the substantial benefits of incorporating Scratch into informatics teaching practice in primary schools. They suggest that Scratch can play a crucial role in not only enhancing student engagement and academic performance but also promoting vital skills, offering important insights for educators in this field.

While our study presents several important findings, we recognize the inherent limitations and their potential influences on the results. First, our research was conducted within two educational organizations, ADAN and Naviyo schools, and the sample size of 170 students may not fully represent the diversity of the broader population of primary students. Therefore, the findings of our study may not be generalizable to all settings, particularly in regions with different socio-economic, cultural, or educational systems.

Second, the study relied heavily on quantitative measures for assessing student engagement and academic performance. Although these measures are widely accepted and were complemented by qualitative observations, they may not capture the full complexity and nuances of student experiences with Scratch. It is also possible that the
improved post-test scores might be influenced by a familiarity effect, where students perform better simply due to repeated exposure to the testing format.

Additionally, our study design didn’t include a control group that didn’t use Scratch. This means we can’t conclusively state that the observed improvements were solely due to the use of Scratch and not influenced by other factors like normal academic progression, teaching quality, or external resources used by students.

Lastly, our research spanned over three academic years, and the long duration might have introduced other factors that could have affected the results, such as changes in teaching staff, student dynamics, or even upgrades to the Scratch platform.

While acknowledging these limitations, we believe our study offers valuable insights into the potential of Scratch as a tool in primary informatics education. Future research should aim to address these limitations, potentially incorporating larger, more diverse samples, using control groups, and employing mixed-method approaches to capture a more comprehensive picture of the impact of Scratch in education.

6 Conclusion

In conclusion, this research provides compelling evidence of the value of integrating the Scratch programming environment into primary school informatics education. The findings demonstrate a significant positive impact on both student engagement and academic performance, suggesting Scratch can play a crucial role in facilitating an active learning environment and promoting a deeper understanding of informatics subjects.

The study further indicates that students in both first and third grades not only interacted meaningfully with the programming tasks but also demonstrated improved problem-solving and creativity skills as observed by teachers.

However, it’s essential to acknowledge the study’s limitations, primarily the sample size and the absence of a control group. These limitations present avenues for future research, where a larger, more diverse sample can be studied, and the influence of Scratch can be compared against other similar educational platforms.

Lastly, this study suggests that incorporating innovative, interactive digital tools like Scratch into the classroom could potentially transform teaching practices, driving a more student-centered approach. Therefore, it is recommended that educators and stakeholders consider such platforms in curriculum design and teacher training programs.

This research contributes to the burgeoning field of educational technology, particularly in the context of early informatics education. It underscores the potential of platforms like Scratch to nurture twenty-first-century skills, foster student engagement, and enhance academic performance. Future research could build upon these findings, examining the long-term impact of Scratch on students’ learning trajectories and exploring its effects in different educational contexts and demographics.

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References


