Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Gamified Digital Learning in Primary Education: A Mixed-Methods Study of Scratch Integration in a Moroccan Context

Fatimazahra Ouahouda

fatimazohra.ouahouda-etu@etu.univh2c.ma

UNIVH2

Khadija Achtaich

UNIVH2

Naceur Achtaich

UNIVH2

Research Article

Keywords: Gamification, Digital Learning, Scratch

Posted Date: June 26th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9954239/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

This study investigates the impact of Scratch-based gamified learning on student engagement and academic performance in a Moroccan primary school. Although gamification has been widely examined in secondary and higher education, research in primary education, particularly in developing contexts, remains limited. A single-group pretest–posttest mixed-methods design was employed, combining quantitative assessments with qualitative observations and interviews. The eight-week intervention integrated Scratch activities into mathematics and language instruction. Findings revealed statistically significant improvements in academic performance ($p < .001$), alongside increased motivation, engagement, and collaboration. Students also demonstrated growth in computational thinking, creativity, and problem-solving skills. The results suggest that Scratch-based gamification can support both academic achievement and broader cognitive development in resource-constrained educational settings. Furthermore, the study provides evidence of the feasibility of implementing gamified digital learning in Moroccan primary schools characterized by large class sizes, limited technological infrastructure, and diverse socio-economic backgrounds, offering practical implications for digital education initiatives.

1. Introduction

In today's rapidly evolving educational landscape, ensuring sustained student engagement—particularly in primary education—remains a critical challenge. Engagement is widely recognized as a key determinant of effective learning, influencing not only academic achievement but also the development of cognitive, social, and emotional skills during the early years of schooling. However, conventional teaching approaches often fail to maintain the attention and motivation of young learners, who typically require interactive, stimulating, and meaningful learning experiences. When engagement is insufficient, it can negatively affect both learning outcomes and students' long-term attitudes toward education.

In Morocco, primary education faces several challenges, including overcrowded classrooms, unequal access to digital technologies, limited teacher training in educational technology, and disparities between urban and rural schools. These challenges make it difficult to implement innovative pedagogical approaches and highlight the need for scalable, low-cost digital learning solutions adapted to local realities.

In response to these challenges, educational systems are increasingly embracing innovative pedagogical approaches that align with the needs of 21st-century learners. Among these approaches, gamification has emerged as a powerful strategy for transforming traditional learning environments. By incorporating elements such as points, levels, challenges, and rewards into instructional activities, gamification introduces a playful and goal-oriented dimension to learning. This approach is particularly well suited to primary school students, whose natural inclination toward play, exploration, and achievement can be leveraged to enhance motivation and participation.

A growing body of research highlights the effectiveness of gamification in promoting active learning. Game-based environments are known to increase student engagement by providing clear objectives,

immediate feedback, and opportunities for progression. These features align with learners' intrinsic motivation and encourage sustained involvement in educational tasks. As a result, students are more likely to develop persistence and a deeper connection to the learning process.

Beyond engagement, gamification also contributes to the development of essential transversal skills. Activities designed within gamified environments often foster problem-solving, critical thinking, collaboration, and creativity. Such competencies are increasingly important in modern education, as they prepare learners to navigate complex and dynamic environments. Furthermore, the motivational structures embedded in gamified systems can support the development of a growth mindset, encouraging students to view challenges as opportunities for learning and improvement.

Advances in educational technology have further expanded the potential of gamified learning. Digital tools such as Scratch enable students to actively create, experiment, and solve problems through programming and interactive design. In addition, emerging technologies such as augmented reality and serious games offer immersive learning experiences that enhance conceptual understanding. The widespread use of mobile devices has also facilitated access to educational content, allowing students to engage in learning activities beyond the classroom and at their own pace.

This study contributes to the literature by examining how Scratch-based gamification can be implemented in a North African primary school context characterized by large classes and limited technological resources. Beyond evaluating learning outcomes, it explores how gamification supports autonomy, competence, and collaboration among young learners.

Despite these promising developments, the application of gamification in primary education remains relatively underexplored, particularly in developing contexts. Young learners have specific cognitive and developmental needs that require carefully adapted instructional strategies. Moreover, practical challenges such as limited resources, insufficient teacher training, and the need to align gamified activities with curricular objectives can hinder effective implementation. Ensuring that these approaches are inclusive, contextually relevant, and pedagogically sound is essential for maximizing their impact.

In this context, the present study investigates the integration of gamified digital learning using Scratch in a Moroccan primary school. Adopting a mixed-methods approach, the research examines both the academic and behavioral effects of this intervention on students. By combining quantitative and qualitative data, the study aims to provide a comprehensive understanding of how gamification can enhance engagement and learning outcomes.

Ultimately, this research seeks to demonstrate that the thoughtful integration of gamified digital tools can significantly improve the quality of primary education. By fostering active participation, motivation, and the development of essential skills, such approaches offer valuable opportunities for transforming learning experiences in diverse educational settings.

2. Literature Review

2.1 Gamification in Primary Education

Gamification has emerged as a promising pedagogical approach for enhancing student engagement and learning outcomes across educational settings. Defined as the integration of game design elements into non-game contexts, gamification incorporates features such as points, badges, levels, challenges, and rewards to create motivating learning experiences (Deterding et al., 2011). In primary education, where motivation and active participation are essential for effective learning, gamification aligns well with children's natural inclination toward play, exploration, and achievement.

Research has consistently shown that gamification can increase learner engagement, participation, and persistence. A systematic review by Alsawaier (2018) reported positive effects of gamification on motivation and academic achievement across various educational levels. Similarly, Hamari et al. (2014) found that game-based elements can significantly improve engagement when combined with meaningful learning objectives and timely feedback. More recently, Christopoulos and Mystakidis (2023) highlighted the growing role of gamification in supporting active learning and student-centered pedagogies.

In primary education specifically, gamified learning environments have been associated with improved attention, collaboration, and problem-solving skills. These benefits are particularly relevant for young learners, who often respond positively to interactive and goal-oriented activities. By transforming learning into an engaging experience, gamification encourages students to take a more active role in constructing knowledge and developing essential twenty-first-century competencies.

2.2 Self-Determination Theory and Scratch-Based Learning

The motivational foundations of gamification can be explained through Self-Determination Theory (SDT), which emphasizes the importance of autonomy, competence, and relatedness in fostering intrinsic motivation (Deci & Ryan, 2000). Effective gamified learning environments should support these three psychological needs to promote meaningful and sustained engagement.

In the context of Scratch-based learning, these dimensions can be operationalized through specific instructional activities. Students are provided with opportunities to design their own games, stories, and interactive projects, thereby supporting autonomy. Competence is fostered through progressive challenges, iterative problem-solving tasks, and immediate feedback provided by the Scratch environment. Relatedness is encouraged through collaborative activities, peer interactions, and team-based projects.

SDT Construct Scratch-Based Activity

Autonomy Students design their own games and stories

Competence Progressive challenges and immediate feedback

Relatedness Team-based collaborative activities

This alignment between Scratch activities and SDT constructs suggests that Scratch-based gamification can support not only academic learning but also deeper motivational processes that contribute to long-term learner engagement.

2.3 Scratch and Computational Thinking in Primary Education

Scratch has become one of the most widely used educational programming platforms for introducing computational thinking to young learners. Developed by the MIT Media Lab, Scratch enables students to create animations, stories, simulations, and games using a visual block-based programming language that reduces the complexity of traditional coding environments.

Several studies have demonstrated the educational value of Scratch in primary education. Research has shown that Scratch promotes computational thinking skills such as sequencing, algorithmic reasoning, debugging, and problem decomposition. Furthermore, creating interactive digital projects encourages creativity, critical thinking, and problem-solving while fostering student agency and self-expression.

Recent studies have reinforced these findings. Research published in 2024 on Scratch and computational thinking in primary education reported significant improvements in students' logical reasoning and digital literacy skills. Similarly, studies on block-based programming and student engagement (2024) found that learners participating in Scratch-based activities demonstrated higher levels of motivation, persistence, and classroom participation compared to traditional instructional approaches.

More recent investigations conducted in 2025 revealed that Scratch-based interventions contribute positively to computational thinking development while simultaneously improving collaboration and communication skills. These findings suggest that Scratch serves not only as a programming tool but also as a broader educational platform capable of supporting interdisciplinary learning and cognitive development.

2.4 Gamification in Resource-Constrained Educational Contexts

While the majority of gamification research has been conducted in technologically advanced educational environments, growing attention has been directed toward developing countries and resource-constrained settings. Educational systems in these contexts often face challenges related to limited technological infrastructure, large class sizes, and varying levels of teacher digital literacy.

Recent studies conducted between 2024 and 2025 indicate that gamification can be successfully implemented even in low-resource educational environments when instructional activities are carefully designed and aligned with curricular objectives. Research on gamified learning in developing countries (2025) demonstrated that low-cost digital tools can significantly enhance student engagement and learning outcomes despite infrastructural limitations.

However, contextual factors remain critical determinants of success. Teacher preparation, institutional support, and access to basic technological resources have been identified as key factors influencing implementation effectiveness. These findings highlight the importance of investigating gamification within specific educational contexts rather than assuming universal applicability.

2.5 Critical Perspectives on Gamification

Despite the generally positive findings reported in the literature, evidence regarding the effectiveness of gamification remains mixed. While many studies report improvements in engagement and motivation, the impact on long-term academic achievement is less consistent.

Several researchers have found that gamification increases student participation without necessarily producing substantial gains in learning outcomes. Others argue that excessive reliance on rewards, badges, and external incentives may undermine intrinsic motivation when game elements are poorly designed or disconnected from meaningful learning objectives. In some cases, students may become more focused on earning rewards than on developing conceptual understanding.

These contrasting findings suggest that gamification should not be viewed as a universally effective educational solution. Rather, its success appears to depend on contextual factors, instructional design quality, teacher facilitation, and alignment with pedagogical goals. Well-designed gamified environments that support autonomy, competence, and relatedness are more likely to generate meaningful educational benefits than systems that rely primarily on extrinsic rewards.

2.6 Research Gap

Although previous studies have demonstrated the potential benefits of gamification and Scratch-based learning, significant gaps remain in the literature. Most empirical research has focused on secondary education, higher education, or technologically advanced settings. Comparatively few studies have examined Scratch-based gamification in primary schools located in developing countries, particularly in North African contexts.

Furthermore, limited attention has been given to how Scratch-based interventions function in classrooms characterized by large student populations, varying levels of teacher digital literacy, and restricted access to technological resources. As a result, there is insufficient evidence regarding the feasibility and effectiveness of gamified digital learning in such environments.

This study addresses these gaps by investigating the implementation of Scratch-based gamification in a Moroccan primary school. Through a mixed-methods approach, it examines both academic outcomes and learner engagement while considering the specific contextual challenges associated with primary education in a resource-constrained setting.

3. Methodology

3.1 Research Design

This study adopts a mixed-methods case study design to investigate the impact of gamified digital learning using Scratch on student engagement and academic performance in a real educational setting. The case study approach is particularly suitable for examining complex pedagogical interventions within their natural context, as it allows for an in-depth analysis of both processes and outcomes.

By combining quantitative and qualitative data, this research aims to provide a comprehensive understanding of how gamification influences learning experiences, behaviors, and performance among primary school students.

3.2 Research Context

The study was conducted in a public primary school : Ghandi located in the Hay Hassani district of Casablanca, Morocco. The school operates under the regional education authority and includes six grade levels (Grades 1 to 6).

The student population reflects diverse socio-economic backgrounds, with varying levels of access to digital resources outside the classroom. This diversity provides a relevant context for examining the inclusivity and effectiveness of digital learning approaches.

Class sizes in the school are relatively large compared to international standards, which presents both challenges and opportunities for implementing innovative pedagogical strategies such as gamification.

3.3 Participants

The sample consisted of approximately 120 students (62 girls and 58 boys) from Grades 4 to 6. Participants were selected through intact classroom sampling because the intervention was implemented at the class level.

Teachers who participated in the study were actively involved in the design and delivery of Scratch-based activities. Their participation was essential for ensuring the alignment of the intervention with curricular objectives and classroom realities.

3.4 Instruments

Survey items were reviewed by three experts in educational technology and primary education. A pilot study involving 20 students was conducted prior to implementation. Internal consistency analysis yielded a Cronbach’s alpha coefficient of 0.87, indicating satisfactory reliability.

3.5 Research Objectives

The study aimed to:

Examine the effect of Scratch-based gamification on student engagement and motivation.

Evaluate the impact of gamified learning on academic performance in mathematics and language.

Explore students' and teachers' perceptions of digital game-based learning.

Identify practical strategies for integrating gamification into primary education.

3.6 Intervention Design and Implementation

The gamified learning intervention was implemented over a period of eight weeks and consisted of three main phases:

3.6.1 Teacher Preparation

Prior to implementation, participating teachers received targeted training on gamification principles and the use of Scratch in education. The training included:

Introduction to game-based learning and constructivist pedagogy

Practical workshops on Scratch programming

Collaborative lesson planning sessions

This phase aimed to equip teachers with the necessary pedagogical and technical skills to effectively integrate gamification into their teaching practices.

3.6.2 Curriculum Integration

Gamified activities were incorporated into two core subjects: mathematics and language arts. Lessons were designed to align with national curriculum standards while integrating interactive and game-based elements.

Examples of activities included:

Problem-solving tasks embedded in Scratch-based games

Interactive storytelling to reinforce language skills

Student-created digital games integrating academic content

These activities were adapted to students' age and skill levels to ensure accessibility and engagement.

3.6.3 Classroom Implementation

During the intervention, students participated in both individual and collaborative activities. Key features of the classroom implementation included:

Team-based challenges encouraging collaboration

Individual exploration and creative expression

Gamified assessment using progress tracking and rewards

Teachers provided continuous guidance, facilitating learning while encouraging autonomy and creativity.

3.7 Data Collection

A triangulated data collection approach was employed to ensure reliability and validity.

3.7.1 Student Surveys

Pre- and post-intervention surveys were administered to assess changes in engagement, motivation, and learning perceptions. The surveys included Likert-scale items and open-ended questions adapted to students' age.

3.7.2 Teacher Interviews

Semi-structured interviews were conducted with participating teachers to gather insights into implementation processes, challenges, and observed student outcomes.

3.7.3 Classroom Observations

Systematic observations were carried out throughout the intervention using structured protocols to document student participation, interaction, and behavior.

3.7.4 Academic Assessments

Students completed pre-tests and post-tests in mathematics and language to measure learning gains. The assessments were aligned with curriculum standards and focused on core competencies.

3.8 Data Analysis

Quantitative data were analyzed using descriptive statistics and inferential methods, including paired-sample t-tests, to determine the significance of performance changes.

Qualitative data were analyzed following Braun and Clarke's (2006) six-step thematic analysis framework, including familiarization, coding, theme generation, theme review, theme definition, and reporting.

The integration of quantitative and qualitative findings enabled a comprehensive interpretation of the results.

3.9 Ethical Considerations

Participation in the study was voluntary, and informed consent was obtained from parents or legal guardians. Students were informed of their right to withdraw at any time without any consequences.

All data were anonymized to ensure confidentiality and privacy.

4. Results

This section presents the quantitative and qualitative findings of the study, providing a comprehensive evaluation of the impact of Scratch-based gamified learning on students' academic performance, engagement, motivation, and learning experiences.

4.1 Quantitative Results: Academic Performance

4.1.1 Pre- and Post-Intervention Performance

The comparison of pre-test and post-test results revealed notable improvements in students' academic achievement across both mathematics and language subjects.

In mathematics, the mean score increased from 58.0% (SD = 12.4) before the intervention to 72.0% (SD = 11.1) after the intervention, representing a gain of 14 percentage points.

Similarly, in language, the mean score improved from 64.0% (SD = 10.8) to 78.0% (SD = 9.6), corresponding to an increase of 14 percentage points.

These improvements suggest that the Scratch-based gamified learning environment was associated with enhanced understanding and application of academic concepts across multiple disciplines.

4.1.2 Development of Coding Skills

Students also demonstrated substantial progress in coding competencies throughout the intervention.

The average coding assessment score increased from 45.0% (SD = 14.3) at pre-test to 70.0% (SD = 12.5) at post-test, representing a gain of 25 percentage points.

This improvement indicates that Scratch provided an accessible and effective environment for introducing programming concepts and fostering computational thinking skills among primary school learners.

4.1.3 Statistical Analysis

A paired-samples t-test was conducted to compare students' academic performance before and after the intervention.

The analysis revealed a statistically significant difference between pre-test and post-test scores, $t(119) = 10.22$, $p < .001$, indicating that students achieved significantly higher scores following participation in

the Scratch-based gamified learning activities.

Furthermore, the effect size was large (Cohen's d = 0.93), suggesting substantial educational significance. These findings indicate that the intervention was associated with meaningful improvements in academic performance.

4.2 Qualitative Results: Engagement and Motivation

4.2.1 Student Perceptions

Survey findings indicated a substantial increase in students' engagement and motivation.

Interest in coding activities increased from 45% before the intervention to 82% after the intervention. Similarly, the proportion of students reporting that learning activities were enjoyable and effective increased from 52% to 85%.

Students frequently described Scratch activities as enjoyable, interactive, and motivating.

Representative student comments included:

Student 12: "Creating my own game made mathematics more enjoyable."

Student 34: "I liked working with my classmates and solving challenges together."

Student 21: "Scratch helped me understand difficult lessons because I could see the results of my work immediately."

These comments suggest that students valued the opportunity to learn through creativity, experimentation, and collaboration.

4.2.2 Teacher Perspectives

Teachers reported positive changes in student participation, classroom atmosphere, and willingness to engage in learning activities.

One teacher explained:

Teacher A: "Students became much more active and willing to participate."

Another participant stated:

Teacher B: "Even students who were usually quiet became engaged when working on Scratch projects."

Teachers also observed increased peer support and collaborative problem-solving during classroom activities.

However, they noted that some students initially struggled with basic programming concepts and required additional scaffolding during the early stages of the intervention.

4.3 Classroom Observations

Classroom observations corroborated the survey and interview findings.

Active participation increased from approximately 60% during traditional lessons to nearly 90% during gamified sessions.

Students collaborated more frequently, shared ideas, and demonstrated greater persistence when confronted with challenging tasks.

Observation records also revealed that students increasingly adopted trial-and-error strategies and showed greater confidence in exploring alternative solutions to problems.

4.4 Integrated Analysis of Findings

The integration of quantitative and qualitative findings provides convergent evidence supporting the effectiveness of Scratch-based gamified learning.

The observed improvements in academic performance were accompanied by increased engagement, motivation, collaboration, and problem-solving behaviors. Students' reflections, teacher interviews, and classroom observations consistently indicated that the intervention created a more interactive and learner-centered educational environment.

Taken together, these findings suggest that Scratch-based gamification can support not only academic achievement but also the development of computational thinking, creativity, collaboration, and learner autonomy.

Figure 1: Comparison of student performance in mathematics and language before and after the gamified intervention. The results show a clear improvement in both subjects following the integration of Scratch-based activities.

5. Discussion

The present study examined the implementation of Scratch-based gamified learning in a Moroccan primary school and explored its association with students' academic performance, engagement, motivation, and computational thinking development. By combining quantitative and qualitative evidence, the findings provide valuable insights into the potential role of gamified digital learning in resource-constrained primary education settings.

5.1 Interpretation of Academic Performance Outcomes

The quantitative findings revealed notable gains in mathematics, language, and coding performance following the implementation of Scratch-based activities. Given the single-group pretest-posttest design, these results should be interpreted cautiously. Rather than establishing direct causality, the findings suggest an association between participation in the gamified learning activities and improvements in academic outcomes.

The observed gains may reflect several complementary mechanisms. Scratch activities required students to engage in logical reasoning, sequencing, problem decomposition, and iterative problem-solving processes. These cognitive practices are closely related to the skills required in mathematics and language learning and may have contributed to the observed academic progress. Furthermore, the interactive nature of Scratch-based learning may have encouraged active participation and deeper cognitive engagement with educational content.

The substantial improvement in coding performance is particularly noteworthy. The results suggest that Scratch provides an accessible entry point to computational thinking and programming concepts for young learners, even in educational contexts where students have limited prior exposure to digital technologies.

5.2 Engagement, Motivation, and Learning Experience

The qualitative findings indicate increased student engagement, enthusiasm, and willingness to participate in classroom activities. Students frequently described the learning experience as enjoyable, interactive, and meaningful. These observations are consistent with previous research suggesting that gamified learning environments can enhance learner motivation by providing clear goals, immediate feedback, and opportunities for creative expression.

The results may reflect the motivational affordances of Scratch-based learning. Unlike traditional instructional approaches, Scratch allows students to become creators rather than passive recipients of information. The opportunity to design games, animations, and interactive stories appeared to increase students' sense of ownership over their learning process.

In addition, collaborative activities encouraged peer interaction and collective problem-solving. Classroom observations revealed increased communication and cooperation among students, suggesting that gamified learning can contribute to the development of both academic and social competencies.

5.3 Relationship to Self-Determination Theory

The findings support Self-Determination Theory (Deci & Ryan, 2000) by demonstrating how Scratch-based activities addressed the three fundamental psychological needs associated with intrinsic motivation: autonomy, competence, and relatedness.

Autonomy was supported through opportunities for students to design and personalize their own digital projects. Competence was reinforced through progressively challenging activities and immediate

feedback provided by the Scratch environment. Relatedness emerged through collaborative learning experiences, peer support, and team-based challenges.

The positive motivational outcomes observed during the intervention may therefore reflect the extent to which these psychological needs were satisfied. This interpretation is consistent with previous studies suggesting that educational gamification is most effective when it promotes intrinsic rather than purely extrinsic motivation.

5.4 Comparison with Previous Research

The observed gains are consistent with findings reported by Sailer et al. (2017), Manzano-León et al. (2021), and recent Scratch-based studies conducted in primary education settings. Previous research has demonstrated that gamified learning environments can increase student engagement, motivation, and academic achievement while simultaneously promoting higher-order thinking skills and creativity.

However, the effect size observed in the present study appears slightly higher than those reported in some previous investigations. This difference may be attributed to several contextual factors, including the novelty of programming activities for participants, the strong integration of Scratch within classroom instruction, and the intensive teacher support provided throughout the intervention.

At the same time, the findings contribute to a growing body of evidence indicating that gamification can be successfully implemented in primary education environments characterized by limited technological resources. This contribution is particularly important because most existing studies have been conducted in technologically advanced educational settings.

5.5 Implications for Educational Practice in Morocco

The findings have several implications for educational policy and practice in Morocco. First, they suggest that Scratch-based gamification may represent a practical and cost-effective approach for strengthening computational thinking, creativity, and problem-solving skills in primary education.

For Moroccan educational authorities, integrating Scratch into digital literacy initiatives could provide a cost-effective approach to strengthening computational thinking skills. National teacher training programs should include progressive certification modules focused on gamified learning and educational programming. Additionally, offline and low-bandwidth versions of Scratch could support implementation in schools with limited technological infrastructure.

Furthermore, successful implementation requires sustained professional development opportunities for teachers. Beyond technical training, educators should be supported in designing pedagogically meaningful gamified activities that align with national curriculum objectives and students' developmental needs.

5.6 Limitations and Future Research

Although the findings are encouraging, several limitations should be considered when interpreting the results. The absence of a control group limits the ability to attribute observed improvements exclusively to the intervention. Similarly, the relatively short duration of the study does not allow conclusions regarding the long-term sustainability of the reported outcomes.

Additionally, the study was conducted in a single school context, which may limit the generalizability of the findings to other educational settings. Future research should include multi-site studies involving larger and more diverse samples across different Moroccan regions.

Longitudinal investigations would also be valuable for examining whether improvements in engagement, academic performance, and computational thinking are maintained over time. Future studies may further explore the role of teacher digital competence, school infrastructure, and socio-economic factors in shaping the effectiveness of gamified learning initiatives.

5.7 Integrated Interpretation

Overall, the convergence of quantitative and qualitative findings suggests that Scratch-based gamified learning may offer significant educational benefits within primary school settings. The results are consistent with the view that meaningful gamification can support both academic achievement and learner engagement when it is grounded in sound pedagogical principles and aligned with students' psychological needs.

Rather than viewing gamification solely as a motivational tool, the findings suggest that Scratch can serve as a comprehensive learning environment that integrates creativity, collaboration, computational thinking, and curriculum-based learning. These characteristics make it a promising educational approach for supporting digital transformation efforts in Moroccan primary education.

7. Conclusion

This study examined the implementation of Scratch-based gamified learning in a Moroccan primary school and explored its association with students' academic performance, engagement, and computational thinking development. Using a mixed-methods approach, the research combined quantitative and qualitative evidence to provide a comprehensive understanding of students' learning experiences.

The findings suggest that Scratch-based gamification is associated with improved academic outcomes in mathematics, language, and coding, while also supporting higher levels of motivation, participation, collaboration, and creativity. Students demonstrated increased engagement in learning activities, and teachers reported more active classroom interactions and greater student involvement.

Beyond academic achievement, the study highlights the educational potential of Scratch as an accessible tool for fostering computational thinking, problem-solving, and digital literacy skills among young learners. The results further suggest that well-designed gamified learning environments can

support meaningful and learner-centered educational experiences, even in contexts with limited technological resources.

The study contributes to the growing body of evidence supporting Scratch-based gamification in resource-constrained educational environments and provides practical insights for implementing digital learning innovations in Moroccan primary schools.

Future research should investigate the long-term effects of Scratch-based gamification across multiple schools and regions, while exploring factors such as teacher digital competence, infrastructure availability, and student diversity. Such research would strengthen understanding of how gamified learning can support educational transformation in developing contexts.

Declarations

Ethical approval

This study was reviewed and approved by the Ethics Committee of the Provincial Directorate of National Education of Hay Hassani, Casablanca (Morocco). All procedures involving human participants were conducted in accordance with ethical standards and the 2013 revision of the Declaration of Helsinki.

Consent to participate

Written informed consent to participate in the study was obtained from all participants. For students under the age of 18, informed consent was obtained from their parents or legal guardians.

The consent process included full disclosure of the study's purpose, procedures, potential risks, and confidentiality measures.

Participation was voluntary, and participants had the right to withdraw from the study at any time without any consequences. The school administration also granted formal approval.

Consent to publish Not Applicable.

Funding

This research received no external funding.

References

1. Aytekin, A., & Topçu, M. S. (2024). Improving 6th grade students' creative problem-solving skills through plugged and unplugged computational thinking approaches. *Journal of Science Education and Technology, 33*, 867–891. https://doi.org/10.1007/s10956-024-10130-y
2. Campbell, C., McGill, M., & Calder, N. (2024). Advancing young students' computational thinking: An investigation of structured curriculum in early years primary schooling. *Computers & Education,*

215*, 105045. https://doi.org/10.1016/j.compedu.2024.105045

3. Cantlon, J. F., Becker, K. T., & DeLong, C. M. (2024). Computational thinking during a short, authentic, interdisciplinary STEM experience for elementary students. *Journal for STEM Education Research, 7*, 425–443. https://doi.org/10.1007/s41979-024-00117-0
4. Christopoulos, A., & Mystakidis, S. (2023). Gamification in education. *Encyclopedia, 3*(4), 1223–1243. https://doi.org/10.3390/encyclopedia3040087
5. Fang, X., Ng, D. T. K., Tam, W. T., & Yuen, M. (2023). Integrating computational thinking into primary mathematics: A case study of fraction lessons with Scratch programming activities. *Journal of Computers in Education, 2*(2). https://doi.org/10.1177/27527263231181963
6. Gundersen, S. W., & Lampropoulos, G. (2025). Using serious games and digital games to improve students' computational thinking and programming skills in K–12 education: A systematic literature review. *Technologies, 13*(3), 113. https://doi.org/10.3390/technologies13030113
7. Konstantina, L., & Papadakis, S. (2024). Enhancing computational thinking in early childhood education through ScratchJr integration. *Heliyon, 10*(10), e30482. https://doi.org/10.1016/j.heliyon.2024.e30482
8. Moreno-Guerrero, A. J., & Cabero-Almenara, J. (2024). Computational thinking with Scratch: A tool to work on geometry in the fifth grade of primary education. *Sustainability, 16*(1), 110. https://doi.org/10.3390/su16010110
9. Nordby, S. K., Mifsud, L., & Bjerke, A. H. (2024). Computational thinking in primary mathematics classroom activities. *Frontiers in Education, 9*, Article 1414081. https://doi.org/10.3389/feduc.2024.1414081
10. Ouahouda, F., Achtaich, K., & Achtaich, N. (2026). Enhancing algorithmic thinking in primary education through Scratch programming using a practical framework and classroom case study. *Discover Education*. https://doi.org/10.1007/s44217-026-01498-7

Figures

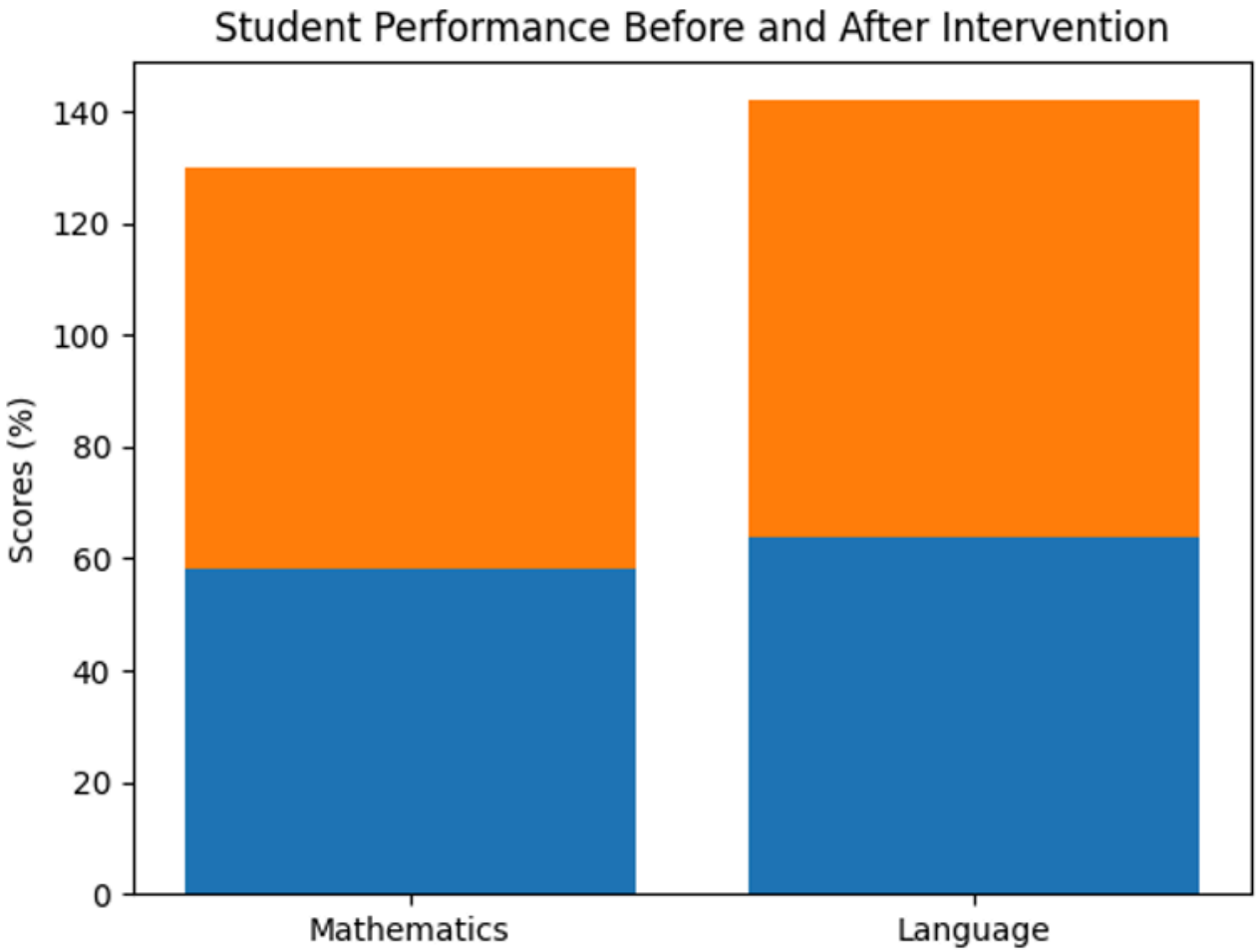


Figure 1

Comparison of student performance in mathematics and language before and after the gamified intervention. The results show a clear improvement in both subjects following the integration of Scratch-based activities.