Jurnal Review Pendidikan Dasar:
Jurnal Kajian Pendidikan dan Hasil Penelitian
Vol 12(1), Februari 2026

e-ISSN: 2460-8475
http://journal.unesa.ac.id/index.php/PD
https://doi.org/10.26740/jrpd.v12n1.107-115

Effects of Scratch-Based Learning Media on Elementary Students' Creative Skills in Social Studies

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Abstract: Creative skills are central to 21st-century learning, and limited research has examined how block-based programming media can support these skills within elementary Social Studies. This study aims to examine whether Scratch-based learning media is associated with a greater improvement in fifth-grade students' creative skills in Social Studies than conventional digital presentation media, using a quasi-experimental pretest-posttest nonequivalent control group design with 60 students from one public elementary school (experimental class $n = 30$; control class $n = 30$) and a rubric-scored, project-based creativity task analyzed as normalized gain (N-Gain) with an independent-samples t-test. The experimental group showed a significantly higher N-Gain than the control group, $t(58) = 6.559$, $p < .001$, with a mean difference of 0.230, a 95% confidence interval from 0.160 to 0.300, and a large standardized effect ($d = 1.69$). Given the nonrandomized design and the single-site sample, the findings should be interpreted with caution, and they suggest that Scratch-based project activities are a feasible option for elementary Social Studies that warrants replication in randomized, multi-site, and longitudinal studies.

Keywords: Scratch, creative skills, Social Studies, quasi-experimental design, elementary education.

How to Cite: Larasati, D.A. & Roosyanti, A. (2026). Effects of Scratch-Based Learning Media on Elementary Students' Creative Skills in Social Studies. *Jurnal Review Pendidikan Dasar: Jurnal Kajian Pendidikan dan Hasil Penelitian, 12*(1), 107-115. https://doi.org/10.26740/jrpd.v12n1.p107-115

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Article Info:
Received: 29 January 2026; Accepted: 14 February 2026; Published Online: 28 February 2026

Published by:
Pendidikan Dasar Universitas Negeri Surabaya

INTRODUCTION

Creativity is an important competence in contemporary education, and studies in primary and lower secondary classrooms have examined how programming can support creative thinking, critical thinking, and problem solving as twenty-first century skills (Nouri et al., 2020; Wong & Cheung, 2020). Creativity in this literature has been examined with standardized creative thinking tests, log data from learning environments, and evaluations of student-designed game content (Israel-Fishelson et al., 2021; Su et al., 2024), and a robotics programming course for fifth and sixth graders was followed by significant improvements in creativity (Noh & Lee, 2020). In elementary Social Studies, topics such as population change and urbanization offer opportunities for students to develop and represent their own ideas. However, initial observations at the research site indicated that instruction relied mainly on static presentation media, including Canva and PowerPoint, and students often reproduced teacher-provided examples.

Scratch is a block-based programming environment used in primary education to develop programming concepts, computational practices, and computational thinking (Ma et al., 2021; Sáez-López et al., 2016). Studies have reported improvements in computational thinking and self-efficacy following interdisciplinary Scratch instruction (Ma et al., 2021), as well as significant gains among 132 children aged 9–12 years using metaphors and Scratch (Pérez-Marín et al., 2020). Related research has examined foundational coding through ScratchJr (Strawhacker & Bers, 2019), visual programming performance among fifth- and sixth-grade students (Wu & Su, 2021), and creativity through mind mapping and code-decomposition scaffolding in Scratch activities (Su et al., 2022; Su et al., 2024).

Programming instruction may also support creativity, although findings vary across outcomes and instructional designs. Robotics programming improved creativity among 155 Korean elementary students (Noh & Lee, 2020), while creative thinking, computational creativity, and computational thinking were positively associated among 174 middle school students (Israel-Fishelson et al., 2021). In contrast, Hershkovitz et al. (2019) found no association between general creative thinking and computational thinking, although computational creativity showed relevant associations in log-data analyses. Previous studies have also examined programming-related interest and collaboration (Kong et al., 2018), STEM learning attitudes (Sun, Hu, Yang, et al., 2021), programming concepts and computational practices in five Spanish schools (Sáez-López et al., 2016), Scratch animations for Art History learning (Sáez-López & Cózar-Gutiérrez, 2017), and programming in regular K–9 classrooms (Nouri et al., 2020). Despite these advances, the development of project-based creative skills through student-created digital representations in elementary Social Studies remains underexplored. This study therefore compares the improvement in fifth-grade students' creative skills between Scratch-based learning media and conventional digital presentations using a quasi-experimental design in one elementary school.

Based on this aim, the study addresses the following research questions. 1) Is there a significant difference in the improvement of creative skills (N-Gain) in Social Studies between fifth-grade students who learn with Scratch-based media and those who learn with conventional digital presentation media? 2) How large is the difference in N-Gain between the two groups? These questions guide the analysis of N-Gain reported in the Results section.

METHODS

Research Design

This study applied a quasi-experimental pretest-posttest nonequivalent control group design. Intact classes were used because random assignment of individual students was not feasible in the school setting. The hypothesis tested was that the mean N-Gain of creative skills differs between the experimental and control groups, evaluated with a two-tailed test at a significance level of 5%. Table 1 summarizes the sequence of measurement and treatment for each group.

Table 1. Pretest-Posttest Nonequivalent Control Group Design

Group	Class	*n*	Pretest	Treatment	Posttest
Experimental (E)	V-A	30	O1	X	O2
Control (C)	V-B	30	O1	–	O2

Note. O1 = pretest score; O2 = posttest score; X = learning with Scratch-based media; – = learning with conventional digital presentation media (PowerPoint and Canva).

Participants and Sampling

The population consisted of all fifth-grade students at a public elementary school (*Sekolah Dasar Negeri*, SDN Bangsal), totaling 90 students. Purposive sampling was used to select two intact classes from this population. Class V-A served as the experimental group (n = 30) and class V-B served as the control group (n = 30), giving a total sample of 60 students. Both classes were taught within the same school, which keeps the institutional context common to the two groups.

Instruments

Two instruments were used to collect data. The first was a creative skills test in the form of a project-based task related to Social Studies content, scored with a rubric on a scale of 1 to 5. The second was an observation sheet for the learning process, covering participation, initiative, and collaboration. Table 2 lists the dimensions and indicators of both instruments.

Table 2. Instruments, Dimensions, and Indicators

Instrument	Dimension / Aspect	Indicator	Scoring
Creative skills test (project-based task)	Fluency	Number of ideas produced	Rubric, 1 to 5
	Originality	Originality of ideas	Rubric, 1 to 5
	Elaboration	Development of ideas	Rubric, 1 to 5

	Relevance	Connection of ideas to the Social Studies topic	Rubric, 1 to 5
Observation sheet	Participation	Involvement in learning activities	Process observation
	Initiative	Self-started contributions during learning	Process observation
	Collaboration	Cooperation with peers during learning	Process observation

Intervention and Procedure

Both groups studied Social Studies topics related to population dynamics and urbanization. Before the intervention, both groups completed the pretest. The experimental group then created animation or simulation projects on these topics using Scratch, and the control group received lessons delivered with conventional digital presentation media (PowerPoint and Canva). After the lessons, both groups completed the posttest, and Figure 1 depicts the full procedure from sampling to analysis.

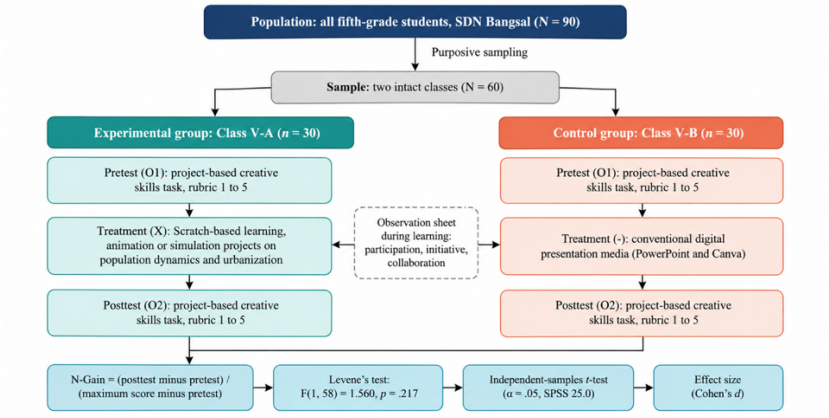


Figure 1. Research Procedure of the Quasi-Experimental Study

Data Analysis

Following Hake (1998), improvement in creative skills was expressed as normalized gain (N-Gain), calculated as (posttest score minus pretest score) divided by (maximum score minus pretest score). Normality and homogeneity checks were conducted before the comparison, with Levene's test used for homogeneity of variance. The N-Gain of the two groups was compared with an independent-samples *t*-test at a significance level of 5% using SPSS 25.0 for Windows. Because *p* values alone do not convey the size of a difference (Sullivan & Feinn, 2012), Cohen's *d* was calculated from the *t* value and group sizes as $d = t \times \sqrt{(1/n_1 + 1/n_2)}$.

RESULTS

Assumption Testing for the Group Comparison

Levene's test assessed homogeneity of variance for the experimental and control groups (n = 30 each). The result was not significant, F(1, 58) = 1.560, p = .217, supporting the use of the equal-variance independent-samples t-test. The result is presented in Table 3.

Table 3. Levene's Test for Homogeneity of Variance (N-Gain)

F	*df*	*p*	Interpretation
1.560	1, 58	.217	$p > .05$; variances are homogeneous

Comparison of N-Gain Between Learning Conditions

The independent-samples t-test showed a significant difference in N-Gain between the experimental and control groups, t(58) = 6.559, p < .001. The mean difference was 0.230 (SE = 0.03507), with a 95% confidence interval of [0.160, 0.300] and a large standardized effect (d = 1.69). Table 4 presents the comparison statistics.

Table 4. Independent-Samples *t*-Test of N-Gain

t	*df*	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI of Difference	*d*
6.559	58	< .001	0.2300	0.03507	[0.160, 0.300]	1.69

Precision and Magnitude of the Difference

The 95% confidence interval for the mean N-Gain difference ranged from 0.160 to 0.300, entirely above zero. The standardized effect was large (d = 1.69), and the learning condition was associated with approximately 43% of the variance in N-Gain (r = .65). Figure 2 presents the estimated mean difference and its confidence interval.

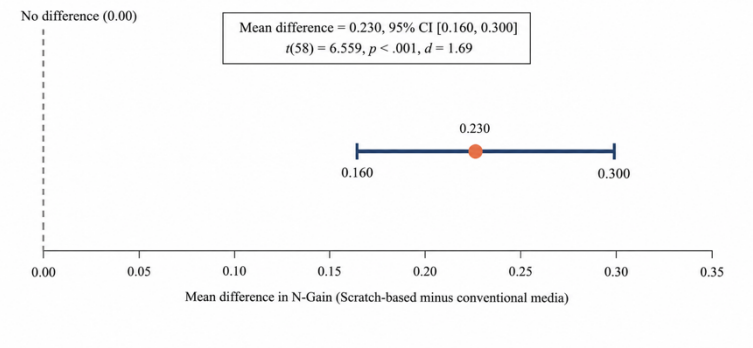


Figure 2. Mean Difference in N-Gain Between the Scratch-Based and Conventional Media Groups with 95% Confidence Interval

DISCUSSION

Meaning of the Improvement in Creative Skills

The experimental group achieved a higher N-Gain than the control group, with a mean difference of 0.230 and a large standardized effect (d = 1.69). Coding has been framed as a playground in which young children engage in content creation, creativity, and collaboration (Bers et al., 2019), and students who programmed video games and simulations produced code that could be analyzed to examine their computational thinking (Garneli & Chorianopoulos, 2018), which may help explain why project-based Scratch work coincided with higher N-Gain in rubric-assessed creative skills. Findings vary across outcomes, because educational robotics produced higher achievement and

computational thinking self-efficacy perceptions than block-based programming in one study (Kert et al., 2020), and higher programming success and transfer of learning but no significant difference in computational thinking in another (Yolcu & Demirer, 2023). The present results therefore provide context-specific evidence concerning rubric-assessed, project-based creative skills in Social Studies.

Comparison with Previous Studies

Previous studies have reported varied findings on programming activities and thinking skills in primary and middle school classrooms. Elementary school studies have examined computational thinking skills and self-efficacy after an OwlSpace programming course, where students' skills improved regardless of gender, grade, and prior experience (Li & Lu, 2024), and after partial pair programming (Wei et al., 2021). In contrast with the positive pattern in the present study, the presence or absence of guidance had no significant effect on student learning in a primary school robotics task, while delayed feedback supported computational thinking (Chevalier et al., 2022). Sáez-López et al. (2019) reported significant improvements in mathematical and scientific understanding among 93 sixth-grade students who programmed with mBot, which indicates that programming can be linked with subject content. Young children's thinking during coding tasks has been analyzed in a numeracy topic, where coding tasks embedded in a curriculum topic drew on a range of thinking skills (Falloon, 2016), and collaborative learning, contextualized tasks, and scaffolding are also relevant strategies (Sentance & Csizmadia, 2017). Although programming activities have most often been connected with computational thinking and learning attitudes (Deng et al., 2020; Sun, Hu, & Zhou, 2021), the present study's results may reflect both programming and active project creation because the control group used presentation materials. The effect size ($d = 1.69$) is large, but differences in outcomes, age groups, intervention conditions, and measurement tools across the studies above limit direct comparison of magnitudes. Rodrigues et al. (2022) also reported changes in effects over time in a longitudinal study, and because N-Gain expresses improvement relative to the maximum possible gain, the observed 0.230 difference indicates a 23-percentage-point advantage in normalized gain and should be interpreted cautiously pending further replication.

Practical Implications

Teachers could use scaffolded Scratch projects to explore population change and urbanization, while schools could provide devices, technical support, and sufficient project time. Teacher training could emphasize scaffolding, reflection, collaboration, and contextualized tasks (Chevalier et al., 2022; Park et al., 2024; Sentance & Csizmadia, 2017). Assessors should apply explicit rubrics covering fluency, originality, elaboration, and relevance, and report scoring reliability, in line with studies that examined several outcomes of coding activities within one design (Yang et al., 2022). These recommendations require further testing across educational settings.

Limitations and Directions for Future Research

The study used intact classes without random assignment, involved 60 students from one school, measured only immediate outcomes, and compared Scratch with

presentation-based instruction, which did not include an active production task. Since effects may vary by intervention design and comparison condition (Kert et al., 2020; Yang et al., 2022) and change over time (Rodrigues et al., 2022), future studies should use stronger comparison designs and delayed follow-up. The lack of dimension-level scores and rubric-reliability data limits interpretation in relation to previous studies of children's creative and computational thinking (Bers et al., 2019; Falloon, 2016), while analysis of students' code could help examine how students think during project work (Garneli & Chorianopoulos, 2018). Further research should include multiple schools, active non-programming comparisons, longitudinal measurements, reliable scoring, separate analyses of creativity dimensions, and direct measures of learning processes.

CONCLUSION

The experimental group using Scratch-based learning media showed a significantly higher N-Gain in creative skills in Social Studies than the control group using conventional digital presentation media, $t(58) = 6.559$, $p < .001$. The mean difference was 0.230 with a 95% confidence interval from 0.160 to 0.300, and the standardized effect was large ($d = 1.69$), which answers both research questions. These results come from a quasi-experimental, single-site study, so they support the view that Scratch-based project activities are a feasible option for elementary Social Studies without establishing general effectiveness. Replication with randomized, multi-site, and longitudinal designs, together with dimension-level analysis, is needed before broader conclusions are drawn.

AI Use Statement

AI-assisted tools were used, if applicable, to improve language clarity and readability. The authors reviewed the manuscript and take responsibility for its content.

Author Contributions

DAL: led the research, conducted data analysis, and prepared the manuscript. AR: contributed to data collection, interpretation of findings, and manuscript revision. Both authors approved the final manuscript.

Funding Statement

This study received no external funding.

Conflict of Interest

The authors declare no competing interests.

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