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Effectiveness of Project-Based Scratch Programming to Improve Problem-Solving Skills of Elementary School Students

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ABSTRACT

Problem-Solving Skills as an Essential Competency for Elementary School Students is a critical area that can be enhanced through Project-based Scratch Programming technology. This study aims to evaluate the effectiveness of Scratch Programming, applied through projects, on the problem-solving skills of students at SD Negeri Jatisari in Semarang City. The research employed a Quasi-Experimental design using a Pretest-Posttest Non-Equivalent Control Group approach. Participants in the control and experimental groups were not randomly selected, with each group consisting of 27 students. Data analysis techniques included the Independent Sample T-Test and N-Gain Test. Results from the Independent Sample T-Test indicated a significance value of 0.009 (Sig.<0.05), while the N-Gain score for the Experimental Group was 0.40, categorized as Medium. These results demonstrate that the Experimental Group saw a notable improvement in problem-solving skills, particularly in their ability to re-evaluate the outcomes of their problem-solving efforts.

***Keywords*:**

Elementary School; Problem Solving Skills; Scratch Programming.

ABSTRAK

Problem-Solving Skills sebagai keterampilan esensial peserta didik Sekolah Dasar menjadi aspek penting untuk ditingkatkan melalui pemanfaatan tekonologi pemrogramman yaitu Scratch Programming berbasis Project. Penelitian ini bertjuan untuk menguji Efektivitas Scratch Programming berbasis Project untuk meningkatkan Problem-Solving Skills Peserta Didik

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di SD Negeri Jatisari, Kota Semarang. Metode penelitian yang digunakan yaitu Quasi Experiment dengan desain Pretest-Posttest Non-Equivalent Control Group. Kelompok Kontrol dan Eksperimen tidak dipilih secara acak dengan sampel pada tiap Kelompok sejumlah 27 Peserta Didik. Teknik analisis data yang digunakan yaitu Independent Sample T-Test dan N-Gain Test. Hasil Uji Independent Sample T-Test menunjukan nilai 0,009 (nilai Sig.< 0,05) dan skor N-Gain pada Kelompok Eksperimen 0,40 dengan kategori Sedang. Hasil penelitian menunjukkan peningkatan Problem-Solving Skills Peserta Didik pada Kelompok Ekperimen dominan pada aspek kemampuan memeriksa kembali hasil penyelesaian masalah.

***Kata kunci*:**

Keterampilan Pemecahan Masalah; Pemrograman Scratch; Sekolah Dasar.

1. Introduction

In the context of global life, individuals today are required to have essential skills. These essential skills are a form of Community adaptation to social dynamics. The essential skills referred to refer to (Saimon, Lavicza, and Dana-Picard, 2023; Andayani, et al., 2022) 4C's represent a set of four essential skills namely Communication, Collaboration, Critical thinking, and Creativity. These essential skills can be taught at formal and informal education levels. At the formal education level, it can start from elementary school. One of the essential skills that is important to be taught through the primary school education level is Problem-Solving Skills. According to (Yılmaz, Yel, and Griffiths, 2022; Simanjuntak and Sudibjo, 2019; Rejemiati, Nawir, and Basri, 2022; Dyah and Setiawati, 2019) stated that Problem-Solving Skills is an important aspect that is part of the Primary and Secondary Education levels.

Problem-Solving Skills are simply understood as the ability that individuals have as a basis for consideration in analyzing and planning solutions to problems through making appropriate decisions. Rahman (2019) emphasizes that Problem-Solving Skills are basic skills possessed by individuals. Individuals in the process of finding solutions to problems, it is necessary to be equipped with systematic and critical thinking patterns. Furthermore, Problem-Solving Skills are important to be taught at the elementary school level because it is an initial effort to prepare students to face more complex challenges and obstacles in the future. Mastery of Problem-Solving Skills as a response to 21st century challenges is in line with (Indraswati et al., 2020; Szabo et al., 2020)

In fact the level of Problem-Solving Skills of elementary school students is not optimal, even though Indonesia's ranking on PISA in 2022 rose 5-6 positions compared to 2018 (Nuryati et al., 2018; Furthermore, data in the field shows that students' Problem-Solving Skills in the aspects of the ability to understand problems, make problem-solving plans and carry out problem-solving plans by SD Negeri Jatisari Semarang City have not been used as the focus of the problem.

In the context of 21st century learning, students' Problem-Solving Skills at SD Negeri Jatisari Semarang City can be taught by utilising technology. One form of technology utilisation in improving Problem-Solving Skills is through programming technology (Çiftci and Bildiren 2020; Nurjanah et al., 2021). Programming is a series of stages or the process of making certain programmes with a

computer. Programming technology in learning in elementary schools can utilise the Scratch Programming application. Scratch Programming is an application to learn coding without having to master complex programming languages (Liao 2023. In Scratch Programming individuals learn to create digital characters in the form of 'sprites' by designing, selecting and combining available code blocks (Fagerlund et al., 2021). Scratch Programming includes problem-solving activities designed for learning purposes. Based on the explanation of the use of Scratch Programming in learning, the Problem-Solving Skills in this study are measured by the ability of students to complete the Sequencing and Recurrence Algorithm in the form of digital characters on the Scratch Programming worksheet. Students through Project-based Scratch Programming are taught to learn coding easily and interestingly by creating and completing a project.

Research on Scratch Programming has been conducted by Susanti et al., (2023); Susanto and Hapudin, (2024); Liu, Wu, Lu, & Zhu, (2023); Su, Shao, and Zhao, (2022); Molina-Ayuso et al., (2024); Li, et al., (2023); (Zhang & Nouri, 2019). In general, the results of these studies focus on improving aspects of (1). Computational Thinking Skills, (2). Critical Thinking and Problem-Solving Skills, (3). Creative Thinking, (4). Reflective Thinking Skills and (4). Measuring Problem-Solving Skills in terms of Mathematical aspects. The results showed that Computational Thinking Skills are linear to the improvement of Problem-Solving Skills. Research that specifically examines the Effectiveness of Scratch Programming based on Project has not been done much. This condition is seen as an opening for further research. This research focuses on the use of Project-based Scratch Programming. Project is a Sequencing and Looping Algorithm that is constructed as a problem and must be solved by students through Scratch Programming. This research focuses on improving the Problem-Solving of Elementary School Students using Scratch Programming based on solving Sequencing and Recurrence Algorithms (Winkler, Söllner, & Leimeister, 2021). The result in the form of animation, quiz, game or story is a form of Students' Problem-Solving Skills.

The novelty in this research lies in the project that is constructed as a problem that will be solved by students. The final project is used as a benchmark for improving students' Problem-Solving Skills. Research by Aslan (2021) showed that linear problem-based learning with increased Individual Problem-Solving. Furthermore, this research is based on the four aspects of Problem-Solving Skills according to Polya. Yayuk and Husamah (2020) in their research mentioned four stages of Problem-Solving Skills according to Polya, including the ability to understand problems, the ability to plan problems, the ability to act based on a plan, and the ability to re-check answers. In this context, it has never been studied by previous research. This study aims to identify the Problem-Solving ability and test the Effectiveness of Scratch Programming based on Project to Improve Problem-Solving of Students at SD Negeri Jatisari, Semarang City. The results of this study can be used as a consideration for educators to design and develop similar learning media that are innovative and effective in improving other essential skills, including Critical Thinking, Creative Thinking and Collaborative Thinking. Based on this, this research has contributed to the utilisation and implementation of learning media based on programming technology at the elementary school level.

2. Methods

2.1. Research Design

The research method used was Quasi Experiment with Pretest-Posttest Non-Equivalent Control Group design. In this research design, the experimental and control groups were not randomly selected. The Experiment Group was treated with Project-based Scratch Programming with Sequencing and Looping Algorithms, while the Control Group was not Project-based. The use of Quasi Experiment with Pretest-Posttest Non-Equivalent Control Group design aims to test the effectiveness of the intervention given to the Experimental Class through statistical tests of changes from Pretest to Posttest and compared to the Control Group.

2.2 Population and Sample

This research was conducted at SD Negeri Jatisari, Semarang City. The study population was all Class V students totalling 82 people. The sampling technique used was purposive sampling. Class VA as the Experimental Group and Class VC as the Control Group were not randomly selected but had balanced characteristics. There were 27 students in each group with the same characteristics, consisting of 13 male students and 14 female students.

2.3 Data Collection

Data collection techniques used Test and Non-test instruments. Test is used to measure the effectiveness of Project-Based Scratch Programming on Problem-Solving Skills of Learners through Pretest and Posttest. Non-test is used to identify the level of Problem-Solving Skills of Students through observation sheets. The research instrument was given before and after treatment to the Experimental and Control Groups.

2.4 Validity and Reliability

Validity and Reliability are carried out to ensure the accuracy and applicability of research instruments to ensure the quality of research data. Research Instruments in the form of Tests and Non-Tests used to measure the Level of Problem-Solving Skills of Students, compiled and developed based on Polya's Problem-Solving Criteria which consists of four main aspects. This instrument was tested on students before collecting research data. The results of the trial were used as the basis for readjusting the research instrument.

2.5 Data Analysis

The data analysis techniques used are Assumption Test and Statistical Test. Assumption Test consists of Normality and Homogeneity Test. Normality test serves to assess whether the data is normally distributed or not. If the data is normally distributed, then continue the Homogeneity Test. Homogeneity test is conducted as a prerequisite for Independent Sample T-Test. This statistical test aims to test and compare the average results of Problem-Solving Skills of Students between the Experimental and Control Groups. The N-Gain test was conducted to measure whether there was an increase in the Experimental Class after being given treatment or application of Project-Based Scratch Programming and compared to the Control Group.

3. Results and Discussion

3.1 Results

The purpose of this study is to test whether Scratch Programming based on Project is effective to improve Problem-Solving Skills of Students at SD Negeri Jatisari, Semarang City. The research method used is quasi experiment with pretest-posttest non-equivalent control group design. The variables in this study are Scratch Programming-based Project as the independent variable and Problem-Solving Skills of Students as the dependent variable. The stages of research carried out are as follows.

1. Compiling Research Instruments
   Researchers compiled research instruments in the form of observation sheets and Pretest-Posttest questions based on the criteria and indicators of Problem-Solving Skills of Students according to Polya.
2. Observing the Control and Experiment Groups
   Learner Problem Solving Skills are observed through observation sheets based on criteria according to Polya in Class 5A (Experimental Group) and 5C (Control Group).
3. Perform Pretest on Control and Experiment Groups
   Class 5A and 5C students were given Pretest Questions based on the criteria for Students' Problem-Solving Skills according to Polya.
4. Applying Scratch Programming to Control and Experiment Groups
   Students, after being given the Pretest Problem are then explained the material and practice using Project-based Scratch Programming in Class 5A and not project-based in Class 5C. Students in the Control and Experimental Groups after being explained the material and carrying out practice, in different periods are then given a Posttest.
5. Data Analysis
   Researchers then analyzed / processed data through normality tests, homogenity tests, statistical tests through independent sample T-Test and N-Gain Score.
6. Conclusion
   Researchers, after doing data processing and referring to the results of statistical tests, then draw conclusions from the research results.

Furthermore, the criteria for students' Problem-Solving Skills in this study were measured based on criteria according to Polya (Yayuk and Husamah, 2020) including (1). Ability to understand the problem, (2). Ability to make a problem-solving plan, (3). The ability to perform the plan, and (4). The ability to re-examine the results of problem solving. The four criteria are then operationalised according to the scope of the research as follows.

Table 1. Polya's Problem-Solving Skills Criteria

	Criteria	Interpretation
(1)	Problem Understanding Skills	Identify what algorithm assignments to create through the Scratch Programming worksheet
(2)	Ability to create a problem-solving plan	Identify the appropriate steps/algorithm to complete the assignment in Scratch Programming
(3)	Ability to implement a problem-solving plan	Apply appropriate steps/algorithms to complete assignments in Scratch Programming
(4)	Problem solving result rechecking ability	Checking the final result of the assignment whether it is in accordance with the

	instructions/conditions on the Scratch Programming worksheet.

Source: Yayuk and Husamah, (2020)

Based on the Problem-Solving Skills criteria in table 1. the data shows that students in Class 5C as the Control Group are dominant in aspect (3), namely the ability to carry out a plan with an average score of 0.83. While in Class 5A as the dominant Experimental Group in aspect (4), namely the ability to re-examine the results of problem solving with an average score of 0.81. The comparison of the average scores of the two groups is visualised through a bar chart as follows.

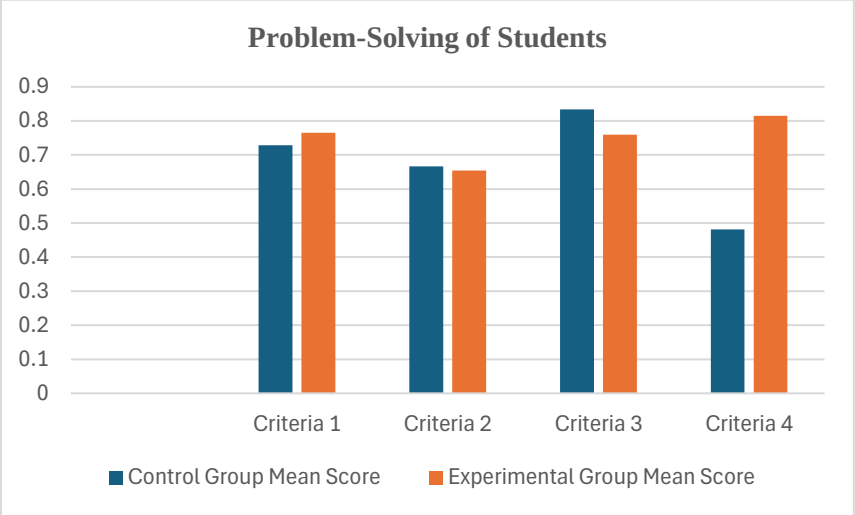

Figure 1. Comparison of Problem-Solving Skill Mean Scores

Furthermore, the comparison of the results of the Posttest of Problem-Solving Ability of Students data shows that Class 5A (Experimental Group) has a higher mean score than Class 5C (Control Group). The mean value of the Class 5A Posttest was 7.41 and the mean value of the Class 5C Posttest was 6.26. The next step, to test whether Project-based Scratch Programming is effective or ineffective to improve Problem-Solving Skills of Students at SD Negeri Jatisari, Semarang City, it is necessary to test normality and homogeneity, as well as statistical tests, namely Independent Sample T-Test and N-Gain.

Table 2. Test Of Normality

Group		Shapiro-Wilk		
		Statistic	**df**	**Sig.**
Result	Pretest 5C Control	0,956	27	0,298
	Posttest 5C Control	0,952	27	0,245
	Pretest 5A Experiment	0,936	27	0,097
	Posttest 5A Experiment	0,930	27	0,070

Source: Research Data Processing, *SPSS*

Because the total number of samples of each group is less than 50, the normality test in this study used the Shapiro-Wilk Test. Normality test serves to assess whether the data is normally distributed or not. Based on the Shapiro-Wilk Test, all groups show a Sig value. > 0.05, meaning that the data is normally distributed. Next, the Homogeneity Test was conducted. The following is a table 3 of homogeneity test results.

Table 3. Homogeneity Test

Methods	Levene Statistic	Sig.	Interpretation
Based on Mean	3,272	0,076	Homogen
Based on Median	2,470	0,122	Homogen
Based on Median	2,470	0,123	Homogen
Based on Mean	3,146	0,082	Homogen

Source: Research Data Processing, *SPSS*

Homogeneity test was conducted as a prerequisite for Independent Sample T-Test analysis. The data table 3. shows that the overall method shows a sig value. > 0.05 and based on the results of the levene test based on mean shows a Sig value. 0.076 > 0.05, then homogeneity is met. Since data homogeneity is fulfilled in all measurement methods, it can be continued with the Independent Sample T-Test statistical test.

After the Normality and Homogeneity Tests are fulfilled, then proceed with the statistical test, namely the Independent Sample T-Test. This statistical test aims to test and compare the average results of two different or unrelated groups. In this study, what was tested and compared was the Posttest results of Problem-Solving ability of Class 5A students as the Experimental Group and 5C as the Control Group. The results of the Independent Sample T-Test test are shown in the following table 4.

Table 4. Independent Sample T-Test

Variable	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval
Data is assumed to be equal	-2,735	52	0,009	-1,148	(-1,991, -0,306)
Data is assumed to be unequal	-2,735	45,522	0,009	-1,148	(-1,993, -0,303)

Source: Research Data Processing, *SPSS*

This Independent Sample T-Test test is carried out based on two conditions, namely when the data is assumed to be the same and the data is assumed to be unequal. Data table 4. shows the Sig. (2-tailed) for both conditions is 0.009. Because of the Sig. value of both conditions <0.05, it can be interpreted that there is a significant difference in the average Posttest results of the Problem-Solving Skills level between Class 5A as the Experimental group and Class 5C as the Control group at the 95% confidence level. The average Posttest results of the Problem-Solving Skills level of the Experiment Group showed higher results compared to the Control Group. This condition is in accordance with the results of previous studies which show that there is a difference in the level of Problem-Solving Skills of Learners who are higher in the Experimental Group, when compared to

the Control Group before and after receiving media treatment or intervention (Aminah et al., 2023; Apriyanto, 2024; Christina and Lukas, 2024).

The next statistical test is the N-Gain test. In this study, the N-Gain test was conducted to measure the effectiveness of an intervention on a group after being given a certain learning program. The data showed that the average N-Gain of Class 5C (control group) was 0.06 and the average N-Gain of Class 5A (experimental group) was 0.40. Comparison of N-Gain scores between the experimental and control groups is as follows.

Table 5. N-Gain Scores

Group	Mean Posttest	Mean N-Gain	Category
Experiment	7,41	0,40	Medium
Control	6,26	0,06	Low

Source: Research Data Processing, *SPSS*

Based on the interpretation of N-Gain the data showed an increase in Class 5A as an Experimental Group with a medium category and in Class 5C as a Control Group with a low category. Thus, if the average N-Gain of the two groups is compared, then the use of Project-based Scratch Programming in Class 5A is considered more effective in improving students' Problem-Solving Skills, when compared to Class 5C who received different treatments. This is in accordance with previous research that the use of Scratch Programming is proven to not only improve problem-solving skills but is able to improve learners' computational skills and perceived efficacy (Asmara and Ma, 2024; Olsson and Granberg, 2024; Ideris, Mastura Baharudin, and Hamzah, 2019; Koray and Bilgin, 2023).

Scratch Programming is one of the applications for learning coding without having to master programming languages. This is in accordance with the statement (Isnaini et al., 2021) that Scratch Programming is designed as an educational and easy way to learn coding for its users. Responding to the challenges of 21st century learning, coding through Scratch Programming is considered relevant to be integrated into learning (Lye & Koh, 2018). The utilisation of Scratch Programming in learning has the potential to improve Computational Thinking Learning, Creativity and Critical Thinking, and Problem-Solving Skills of students in Elementary School (Vourletsis & Politis, 2022). Guntari, Mustika, and Jofilla (2024) in their research revealed the main purpose of Scratch Programming is as a medium in developing computational learning in individuals including critical thinking and problem-solving skills through an easy programming language. Based on this in the context of education, Scratch Programming is designed to form a constructive learning atmosphere in seeking knowledge and improving students' problem-solving skills. Scratch Programming in the context of education and learning can be viewed from the theory of constructivism.

3.2 Discussion

Learning within the framework of constructivist theory is seen as a process of building knowledge carried out by individuals about something new around them through searching, collecting and interpreting information by correlating the new knowledge with previous experience. This is in

line with (Suryana, Aprina, & Harto, 2022) in this study Constructivist Theory is a theory that discusses the active process carried out by individuals to form and interpret their knowledge based on knowledge and experiences that have been formed in advance in themselves. Furthermore, Dewi and Fauziati (2021) in their research explained the same substance that Constructivism theory emphasizes the active participation of students to seek and build knowledge based on their experiences. Individuals form and build their knowledge based on their experiences through certain experiments.

Constructivist theory provides boundaries for individuals who have and have not had knowledge of something (Suryana et al., 2022). Individuals who have knowledge refer to those who successfully search, collect and interpret information that has been obtained through the interaction process they experience. Conversely, individuals who do not have knowledge mean those who have not been able to search, collect and interpret the information that has been obtained. Furthermore, the process of searching, collecting and interpreting information carried out by individuals in the context of this research is based on the findings of the research results as follows.

1. Information seeking
   The information search process occurs when Students get an explanation of the material about the use of Scratch Programming by researchers.
2. Information Gathering
   This process occurs when some Students ask about how to operate the code blocks that have been explained previously. This condition is usually because Students want to make sure that the steps chosen are correct or Students do not understand.
3. Information Interpretation
   This process is seen when Students independently explore how to use Scratch Programming starting from opening the application page on the search engine, logging in the application, opening the main page and using the code block functions contained in the application.

There are two processes experienced by individuals to gain knowledge, namely through cognitive abilities and social interactions. The success of individuals to build and shape their knowledge is influenced by their cognitive abilities and social interactions (Suryana et al., 2022). The varied cognitive abilities of Students are usually caused by differences in prior knowledge and experience. For example, there are Students who are used to using laptop devices while studying at home, but there are other Students who have never had this experience. The social interaction ability in question is the ability of Students to listen to and interpret the knowledge provided by their social environment. For example, there are Students who have not been able to understand and interpret the knowledge learned but do not ask questions to teachers or friends. These two abilities affect the learning patterns and methods of each learner differently, so that not all learner projects in the Experiment and Control groups are in accordance with the assignments on the Scratch Programming worksheet. The project created as the result is knowledge that has been successfully constructed by students.

Furthermore, the application refers to this theory Scratch Programming is a stimulus process to make Students as active individuals in seeking new knowledge. This is in accordance with (Dewi and Fauziati, 2021) statement, that Constructivism theory emphasises students as active Students. During

the process of using Scratch Programming in the Control and Experiment Groups, most Students looked enthusiastic. This is evidenced by the independence of Students in trying the code blocks contained in the Scratch Programming application, and there are even Students who try to make other algorithm assignments that are not assigned. The atmosphere of the Project-based Scratch Programming learning process is described as follows.

Figure 2. Teacher becomes a student facilitator

Figure 3. Students practicing Scratch Programming

New knowledge obtained by individuals is not immediately accepted, but there is a verification process in individuals based on previous knowledge experiences. The results of the verification process lead to two things, namely as a synthesis or antithesis of this knowledge. This is also explained by (Sugrah, 2019) where constructivism theory shows how individuals actively seek and form their knowledge based on an experienced event. In this case, the use of Scratch Programming as a knowledge event experienced by learners and the result of the completed assignment is a form of knowledge construction that represents the Problem-Solving Skills of Students.

The main objective in this study is to test whether there is an increase in Problem-Solving Skills of students at SD Negeri Jatisari, Semarang City through the application of Scratch Programming based on Project. Learners through Project-based Scratch Programming are taught to learn coding easily and interestingly by creating and completing certain assignments or algorithms. Assignments in the form of algorithms are described as ‘problems’ that learners must solve through programming code blocks contained in Scratch Programming. Learners must choose the right programming code block so that the given algorithm assignment can be solved appropriately. Assignments in the project-based Experimental Group used sequential and looping algorithms, while in the Control group with

a different form. A comparison of the assignment forms between the Experiment and Control Groups can be visualized through the following figure 4.

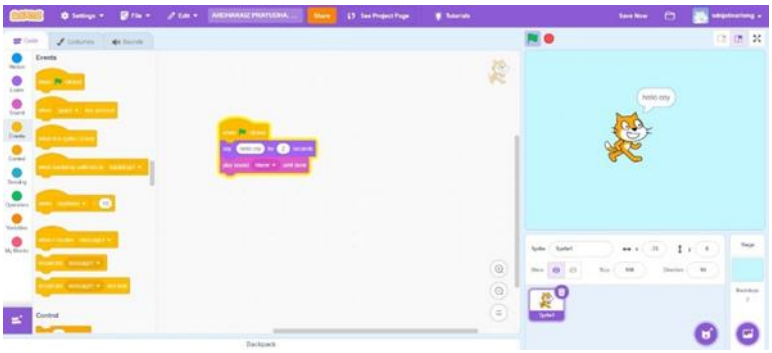

Figure 4. Control Group Assignment

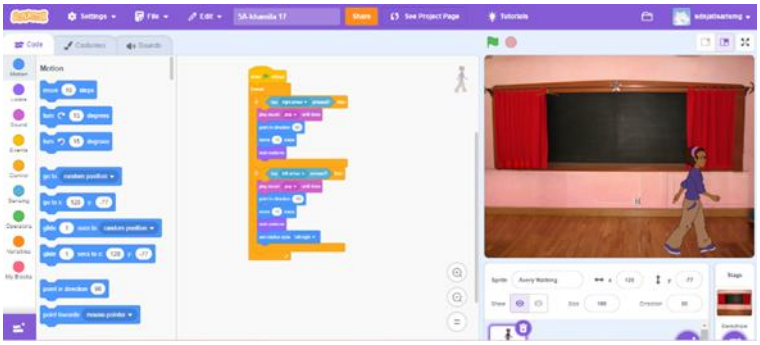

Figure 5. Experiment Group Assignment

Students in the Control and Experimental Groups who successfully select and combine code blocks to complete the algorithm assignment correctly, then have the potential for an increase in the Problem-Solving Skills aspect. The role of Project-based Scratch Programming on improving learners' Problem-Solving Skills referring to Polya (Yayuk & Husamah, 2020) is explained as follows.

1. Identification of the assignment of sequence and looping algorithms carried out by Students in the Experimental and Control Groups through worksheets shows the ability of Students to understand the problem.
2. The identification and analysis done by Students to select and determine icons such as motion, look, sound, or control to complete the project represents the ability to make a problem-solving plan.
3. Students choose and determine what program blocks to use, then apply in the worksheet in the application to create and complete the Project, then this condition represents the ability to carry out a problem-solving plan.
4. Students recheck the final results of the Project that has been made, starting from the form of the project that must be made, the code blocks that have been selected, applying the code blocks to the worksheet and making sure they are in accordance with the instructions / provisions, then this condition shows the ability to recheck the results of problem solving.

Rahman (2019) in his research stated that there are two frameworks of Problem-Solving Skills that are important for individuals to master in their problem-solving process, namely Observation Skills and Critical thinking skills. Observation skills in question are when individuals can optimize all five senses and they must search, collect, understand and interpret the information or data needed. Meanwhile, critical thinking skills are the ability of individuals to reason logically and analytically in applying certain strategies for solving a problem. Problem-Solving Skills not only require critical thinking skills, but also Creative Thinking Skills to apply ideas practically.

Referring to the framework (Rahman, 2019), the results of this study can be explained as follows. First, the initial process of students being introduced and learning how Scratch Programming works in creating projects. Second, students can translate commands and assignments that have been given through Scratch Programming. Third, the criteria for Problem-Solving Skills whose levels are relatively the same in the Experimental Group and Control Group are aspects of the ability to understand problems with an average score of 0.76 and 0.72, respectively. Furthermore, Problem-Solving Skills in the Experiment and Control groups are seen when students apply certain strategies, so that the project is done according to the instructed algorithm and completed on time. One of the strategies applied by students is to choose a seat at the front desk of the classroom to listen to the explanation of Scratch Programming material. However, not all students are able to create and complete the assigned algorithm as instructed and finish on time.

Problem-Solving Skills can be understood as the skills that individuals have in analyzing and planning solutions to problems by making the right decisions. Furthermore, the Problem-Solving Skills referred to in this study are measured by the skills of students to complete the Project in the form of Sequencing and Looping Algorithms using Scratch Programming. The following table 6 presents a comparison with another research.

Table 6. Comparison with Related Research

No.	Author	Methods	Result
1	Olsson & Granberg, (2024)	The present study is guided by the theoretical framework of creative mathematical reasoning (CMR),	Emphasizing the teacher's responsibility and the teacher-student interaction meant to help students' learning by means of programming, pupils solved a mathematics issue with Scratch under the direction of their teacher.
2	Aminah et al., (2023)	This study uses a mixed method, using an exploratory sequential design, namely data collection begins with qualitative and then	This study sought to find whether utilizing the Scratch program to teach computational thinking (CT) might help children solve mathematical problems more effectively. Students solved

		continues with quantitative data	mathematical problems using ideas of abstraction, algorithmic thinking, decomposition, and assessment, according to the findings.
3	Rodríguez-Martínez, González-Calero, & Sáez-López, (2020)	The study is based on a quasi-experimental design that consisted of two phases for both the exper-imental and the control group.	Show the findings of a quasi-experimental study with sixth-grade children on the effects of Scratch on the acquisition of mathematical ideas as well as on the growth of computational thinking. The findings seem to show that Scratch can help pupils build their computational thinking as well as their mathematics concepts.
4	Saito-Stehberger, Garcia, & Warschauer, (2021)	Van den Akker's Framework of Curriculum Component	The current Scratch-based CT curriculum was modified to make it more accessible to English language learners and to assist classroom teachers with less CT experience.
5	Calder, (2018)	An interpretive research methodology, contemporary hermeneutics, was used for this project both to analyse the data and to better understand the development of the students' mathematical thinking.	The results imply that this procedure promoted mathematical thinking, including geometry and problem-solving techniques.
6	Tucker-Raymond, Cassidy, & Puttick, (2021)	Qualitative Research	The goal of this study was to find out how science instructors who were new to computing and incorporating computational thinking into their lessons helped students solve computational problems.

Based on table data, what distinguishes this research from previous research lies in the variable Problem-Solving Skills of Students. Previous research generally focuses on improving Computational Thinking in terms of Mathematical Aspects, Reflective Thinking Skills to Improved Problem-Solving Skills, and Linearity of Computational Thinking to Improved Problem-Solving Skills (Olsson and Granberg, 2024; Aminah et al., 2023; Rodríguez-Martínez, González-Calero, and Sáez-López, 2020; Saito-Stehberger, Garcia, & Warschauer, 2021; Calder, 2018). Furthermore, this research focuses on improving the Problem-Solving of Primary School Learners, this is different from the research by Tucker-Raymond, Cassidy, & Puttick, (2021) focus on improving teachers' problem-solving. Based on the data in Table 6. the method used in this study is the same as the research by Rodríguez-Martínez, González-Calero, and Sáez-López, (2020) which is quasi-experimental design, but different methods with other studies.

Previous research shows that Computational Thinking and Reflective thinking skills are significant in improving students' Problem-Solving Skills. However, Computational Thinking and Reflective thinking skills do not significantly affect the improvement of students' Problem-Solving skills in the presence of media. Media in this context is a problem packaged through Project-based Scratch Programming in the form of Sequencing and Repetition Algorithms that must be solved by Students. This condition is what distinguishes it from research that has been done before. Projects in the form of Sequencing and Recurrence Algorithms in this study are constructed as Problems. The project constructed as a problem based on constructivist theory is a novelty in this research. This research focuses on the use of Project based Scratch Programming. Project is a Sequencing and Looping Algorithm that is constructed as a problem and must be solved by students through a digital worksheet on Scratch Programming. This is different from Apriyanto, (2024), in his research, the learning model consisting of learning stages is the main strategy in improving students' Problem-Solving Skills.

The results of the study based on the Problem-Solving Skills Criteria according to Polya (Yayuk and Husamah, 2020) showed that there was an increase in the Pretest and Postest scores between the Experimental and Control Groups. Thus, it can be understood that the use of Project-based Scratch Programming in the Experimental Group with a different form of assignment from the Control Group, is able to improve the Problem-Solving Skills of Students. In line with Apriyanto, (2024); Chen and Wang, (2023) in his research showed Scratch Modular Programming significantly improves not only students' problem-solving abilities, but includes improving computational skills, critical thinking skills and collaborative skills.

The potential increase of students' Problem Solving Skills is supported by an increase in the average score of the Posttest of Problem Solving Skills, according to the results of research by Apriyanto, (2024). In the Experimental Group, it increased from 5.74 to 7.40 and the Control Group increased from 5.88 to 6.25. Furthermore, the level of Problem-Solving Skills of Students is reviewed from the Polya Criteria, then in the Experimental Group in order is dominant in aspect number (4). The ability to re-examine the results of problem solving, (1) the ability to understand the problem, (3) the ability to plan, and (2) the ability to make a problem-solving plan. Meanwhile, the Control Group is dominant in aspect number (3) the ability to plan, (1) the ability to understand the problem, (2) the ability to make a problem-solving plan and (4) the ability to re-examine the results of problem

solving. The Experimental and Control Groups experienced an increase in the same Problem-Solving Skills Aspect, namely in the aspect of the ability to understand the problem,

Referring to the results of the Independent Sample Test statistical test, there is a significant difference between the Experimental Group and the Control Group with a significant value of 0.009 (Sig. <0.05). This result is consistent with research by Apriyanto, (2024) that the Experiment Group that was given the treatment scored higher than the Control Group. Furthermore, although there was an increase based on the N-Gain test in the Experimental Group, the score was still in the medium category. This condition is influenced by factors (1). The characteristics of students in the form of academic background and knowledge experience are different, (2). The level of initial ability of learners to understand and master Scratch Programming varies (3). The complexity of Scratch Programming material and (4). The limited time that learners have to master new knowledge about project-based scratch programming.

Based on the explanation of the statistical test results, Scratch Programming is considered effective for improving the Problem-Solving Skills of Students in the Experimental Group compared to the Control Group at SD Negeri Jatisari, Semarang City. This research is in line with the results of other studies which shows that the utilisation and use of Scratch-based digital learning media is effective for increasing the engagement and reflective thinking skills of problem-solving Students (Durak, 2020; Prykhodchenko et al., 2020; Rosydiana, Sudjimat, and Utama, 2023). Furthermore, in the research Gökçe & Yenmez, (2023) of Scrath Programming was shown to significantly strengthen reflective thinking skills for problem solving. However, the results of research by Jiang & Li (2021) show different conditions. Scratch Programming learning does not lead to significant differences in problem solving ability and alogortimic thinking ability in students in elementary school. This condition according to Lye & Koh, (2018) can be solved by integrating Scratch Programming into classroom learning or school curriculum.

The implications of the results of this study for learning in elementary schools include: (1). Poroject-based Scratch Programming can be integrated through classroom learning in science and social subjects, (2). Project-based Scratch Programming can be used as part of the syntax of problem-based and/or project-based learning models or methods so that students actively build their knowledge through simple programming technology and (3). The increase in Problem-Solving Skills of Students represents the quality of Education as a response to the increasingly complex challenges and needs of the 21st century.

The limitations of this study are that the sample size is relatively small so that the results of the study do not necessarily represent a larger population. Learners have limited time to learn Scratch-Programming as a result the improvement in the aspects of Problem-Solving Skills measured is moderate. The criteria and indicators of Problem-Solving Skills used as the basis for the preparation of research instruments, have not covered all aspects of Problem-Solving Skills.

4. Conclusion

Project-based Scratch Programming is proven to be effective in improving Problem-Solving Skills of Students. This condition is evidenced by the results of the Independent Sample T-Test test and the N-Gain Score in the Experimental Group which shows higher than the Control Group. In the

Experimental Group, the Learner Problem-Solving Level is dominant in the aspect of the students' ability to re-examine the results of problem solving, while in the Control Group this aspect is not dominant.

Knowledge of Project-based Scratch Programming that is constructed based on the direct experience of students, has a positive impact on improving Problem-Solving Skills. Thus, to further influence the improvement of Problem-Solving Skills of Learners, it is recommended to (1) Schools to make Scratch Programming learning as intracurricular and extracurricular. (2) Teachers are asked to integrate Scratch Programming learning in the form of model syntax or learning methods in Science and Social subjects. (3) Students can make Scratch Programming learning as an Edugame to improve other essential skills. Based on this, further research is recommended to combine Scratch Programming with other similar media to significantly influence the improvement of Problem-Solving Skills of Students.

5. References

Aminah, N., Sukestiyarno, Y. L., Cahyono, A. N., & Maat, S. M. (2023). Student Activities in Solving Mathematics Problems with A Computational Thinking Using Scratch. *International Journal of Evaluation and Research in Education, 12*(2), 613–621. doi: https://10.11591/ijere.v12i2.23308.

Andayani, E., Mustikowati, R. I., Setiyowati, S. W., & Firdaus, R. M. (2022). Case Method: Mengoptimalkan Critical Thinking, Creativity Communication Skills dan Collaboratively Mahasiswa sesuai MBKM di Era Abad 21. *Jurnal Penelitian dan Pendidikan IPS, 16*(1), 52–60. doi: https://doi.org/10.21067/jppi.v16i1.6973.

Apriyanto, A. (2024). Utilization of Visual Programming Scratch to Improve Problem-Solving Skills. *AIP Conference Proceedings, 2926*(1). doi: https://10.1063/5.0182757.

Aslan, A. (2021). Problem-based learning in Live online classes: Learning achievement, problem-solving skill, communication skill, and interaction. *Computers and Education, 171*(1). doi: https://doi.org/10.1016/j.compedu.2021.104237.

Asmara, A., & Ma, H. (2024). Ubiquitous Learning with Online Project-Scratch Programming: Enhancing Student Engagement and Developing Problem-Solving Skills. *Jurnal Edukasi Elektro, 8*(2). doi: https://dx.doi.org/10.21831/jee.v8i2.78719.

Calder, N. (2018). Using Scratch to Facilitate Mathematical Thinking. *Waikato Journal of Education, 23*(2), 43–58. doi: https://10.15663/wje.v23i2.654.

Chen, X., & Wang, X. (2023). Computational Thinking Training and Deep Learning Evaluation Model Construction Based on Scratch Modular Programming Course. *Computational Intelligence and Neuroscience, 12*(1). doi: https://doi.org/10.1155/2023/3760957.

Christina, D., & Lukas, S. (2024). Efektivitas Pembelajaran Coding terhadap Kemampuan Computational thinking, Problem solving dan Matematika Siswa TK B TK XYZ Jakarta Utara. *Jurnal Teknologi Pendidikan, 23*(3), 2024. doi: https://doi.org/10.17509/e.v23i3.73291.

Çiftci, S., & Bildiren, A. (2020). The effect of coding courses on the cognitive abilities and problem-solving skills of preschool children. *Computer Science Education, 30*(1), 3–21. doi: https://doi.org/10.1080/08993408.2019.1696169.

Dewi, L., & Fauziati, E. (2021). Pembelajaran Tematik di Sekolah Dasar dalam Pandangan Teori Konstruktivisme Vygotsky. *Jurnal Papeda, 3*. doi: https://10.36232/jurnalpendidikandasar.v3i2.1207.

Durak, H. Y. (2020). The Effects of Using Different Tools in Programming Teaching of Secondary School Students on Engagement, Computational Thinking and Reflective Thinking Skills for Problem Solving. *Technology, Knowledge and Learning, 25*(1), 179–195. doi: https://doi.org/10.1007/s10758-018-9391-y.

Dyah, A. D. M., & Setiawati, F. A. (2019). The Problem-Solving Skills in Kindergarten Sudent Based on the Stages of Problem Solving. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, 3*(1), 265. doi: https://10.31004/obsesi.v3i1.160.

Fagerlund, J., Häkkinen, P., Vesisenaho, M., & Viiri, J. (2021). Computational thinking in programming with Scratch in primary schools: A systematic review. *Computer Applications in Engineering Education, 29*(1), 12–28. doi: https://10.1002/cae.22255.

Gökçe, S., & Yenmez, A. A. (2023). Ingenuity of Scratch Programming on Reflective Thinking Towards Problem Solving and Computational Thinking. *Education and Information Technologies, 28*(5), 5493–5517. doi: https://10.1007/s10639-022-11385-x.

Guntari, P. S., Mustika, & Jofilla, S. (2024). Implementasi Visual Programming with Scratch untuk Membangun Literasi Bahasa Inggris Peserta Didik SD dan SMP. *Jurnal Mahasiswa Ilmu Komputer, 5*(2), 52–61. doi: https://doi.org/10.24127/ilmukomputer.v5i2.6243.

Ideris, N., Baharudin, S. M., & Hamzah, N. (2019). The Effectiveness of Scratch in Collaborative Learning on Higher-Order Thinking Skills in Programming Subject Among Year-Six Students. *4th ASEAN Conference on Psychology, Counselling, and Humanities (ACPCH 2018), 304(ACPCH 2018)*, 421-425. doi: https://10.2991/acpch-18.2019.99.

Indraswati, D., Marhayani, D. A., Sutisna, D., Widodo, A., & Maulyda, M. A. (2020). Critical Thinking Dan Problem Solving Dalam Pembelajaran IPS untuk Menjawab Tantangan Abad 21. *In Jurnal Pendidikan Sosial, 7*(1), 12–28. doi: https://doi.org/10.31571/sosial.v7i1.1540.

Isnaini, M., Fujiaturahman, S., Sekar Utami, L., Anwar, K., & Sabaryati, J. (2021). Pemanfaatan Aplikasi Scratch Sebagai Alternatif Media Belajar Siswa "Z Generation" untuk Guru-Guru SDN 1 Labuapi. *Jurnal Pengabdian Masyarakat Berkemajuan, 5*(1), 871–875. doi: https://10.31764/jpmb.v5i1.6554.

Jiang, B., & Li, Z. (2021). Effect of Scratch on computational thinking skills of Chinese primary school students. *Journal of Computers in Education, 8*(4), 505–525. doi: https://10.1007/s40692-021-00190-z.

Koray, A., & Bilgin, E. (2023). The Effect of Block Coding (Scratch) Activities Integrated into the 5E Learning Model in Science Teaching on Students' Computational Thinking Skills and Programming Self-Efficacy. *Science Insights Education Frontiers, 18*(1), 2825–2845. doi: https://10.15354/sief.23.or410.

Li, X., Xie, K., Vongkulluksn, V., Stein, D., & Zhang, Y. (2023). Developing and Testing a Design-Based Learning Approach to Enhance Elementary Students' Self-Perceived Computational Thinking. *Journal of Research on Technology in Education, 55*(2), 344–368. doi: https://10.1080/15391523.2021.1962453.

Liao, S. M. (2023). SCRATCH to R: Toward an Inclusive Pedagogy in Teaching Coding. *Journal of Statistics and Data Science Education, 31*(1), 45–56. doi: https://10.1080/26939169.2022.2090467.

Liu, H., Wu, Z., Lu, Y., & Zhu, L. (2023). Exploring The Balance Between Computational Thinking and Learning Motivation in Elementary Programming Education: An Empirical Study with Game-Based Learning. *IEEE Transactions on Games, 15*(1), 95–107. doi: https://10.1109/TG.2022.3143701.

Lye, S. Y., & Koh, J. H. L. (2018). Case Studies of Elementary Children's Engagement in Computational Thinking Through Scratch Programming. *In Computational Thinking in the*

STEM Disciplines: Foundations and Research Highlights (pp. 227–251). doi: https://10.1007/978-3-319-93566-9_12.

Molina-Ayuso, Á., Adamuz-Povedano, N., Bracho-López, R., & Torralbo-Rodríguez, M. (2024). Computational Thinking with Scratch: A Tool to Work on Geometry in the Fifth Grade of Primary Education. *Sustainability (Switzerland), 16*(1). doi: https://10.3390/su16010110.

Nurjanah, N. E., Hafidah, R., Syamsuddin, M. M., Pudyaningtyas, A. R., Dewi, N. K., & Sholeha, V. (2021). Dampak Aplikasi ScratchJr terhadap Ketrampilan Problem-Solving Anak Usia Dini. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, 6*(3), 2030–2042. doi: https://10.31004/obsesi.v6i3.1531.

Nuryati, I. D., Sunardi, W, S. A., & Gunarhadi. (2018). Effectiveness of PBL through Concept Map to Improve Problem Solving Skills of Primary School Students. *International Journal of Educational Technology and Learning, 2*(2), 41–47. doi: https://10.20448/2003.22.41.47.

Olsson, J., & Granberg, C. (2024). Teacher-student interaction supporting students' creative mathematical reasoning during problem solving using Scratch. *Mathematical Thinking and Learning, 26*(3), 278–305. doi: https://10.1080/10986065.2022.2105567.

Prykhodchenko, S. D., Prykhodchenko, O. Y., Shevtsova, O. S., & Semenov, S. Y. (2020). Gamification of Learning Scratch in Elementary School. *1st International Computer Programming Education Conference (ICPEC 2020), 81*(ICPEC 2020), 2-11. 81. doi: https://doi.org/10.4230/OASIcs.ICPEC.2020.20.

Rahman, Md. M. (2019). View of 21st Century Skill Problem Solving: Defining the Concept. *Asian Journal of Interdisciplinary, 2*(1), 64–74. doi: https://10.34256/ajir1917.

Rejemiati, Nawir, M., & Basri. (2022). Model Pembelajaran Berbasis Masalah (PBM) Terhadap Penguasaan Konsep IPS dan Kemampuan Memecahkan Masalah. *Briliant: Jurnal Riset Dan Konseptual, 7*(4), 946–958. doi: https://10.28926/briliant.v7i4.

Rodríguez-Martínez, J. A., González-Calero, J. A., & Sáez-López, J. M. (2020). Computational Thinking and Mathematics Using Scratch: An Experiment with Sixth-Grade Students. *Interactive Learning Environments*, *28*(3), 316–327. doi: https://10.1080/10494820.2019.1612448.

Rosydiana, E. A., Sudjimat, D. A., & Utama, C. (2023). Effect of Digital Learning Media Using Scratch Game Based Learning on Student Problem Solving Skills. *Journal of Research in Science Education, 9*(11), 10010–10015. doi: https://10.29303/jppipa.v9i11.4876.

Saimon, M., Lavicza, Z., & Dana-Picard, T. (Noah). (2023). Enhancing the 4Cs among college students of a communication skills course in Tanzania through a project-based learning model. *Education and Information Technologies*, *28*(6), 6269–6285. doi: https://10.1007/s10639-022-11406-9.

Saito-Stehberger, D., Garcia, L., & Warschauer, M. (2021). Modifying Curriculum for Novice Computational Thinking Elementary Teachers and English Language Learners. *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE*, *Association for Computing Machinery*, 136–142. doi: 10.1145/3430665.3456355.

Simanjuntak, M. F., & Sudibjo, N. (2019). Improving Students' Critical Thinking Skills and Problem Solving Abilities Through Problem-Based Learning. *JOHME: Journal of Holistic Mathematics Education, 2*(2), 108. doi: https://10.19166/johme.v2i2.1331.

Su, Y. S., Shao, M., & Zhao, L. (2022). Effect of Mind Mapping on Creative Thinking of Children in Scratch Visual Programming Education. *Journal of Educational Computing Research, 60*(4), 906–929. doi: https://10.1177/07356331211053383.

Sugrah, N. (2019). Implementasi Teori Belajar Konstruktivisme dalam Pembelajaran Sains. *Humanika: Kajian Ilmiah Mata Kuliah Umum, 19*(2), 121–138. doi: https://10.21831/hum.v19i2.29274.

Suryana, E., Aprina, M. P., & Harto, K. (2022). Teori Konstruktivistik dan Implikasinya dalam Pembelajaran. *Jurnal Ilmiah Ilmu Pendidikan, 5*(7), 2070-2080 (Vol. 5). doi: https://doi.org/10.54371/jiip.v5i7.666.

Susanti, M., Suyanto, S., Jailani, J., & Retnawati, H. (2023). Problem-based learning for improving problem-solving and critical thinking skills: A case on probability theory course. *Journal of Education and Learning, 17*(4), 507–525. doi: https://10.11591/edulearn.v17i4.20866.

Susanto, R., & Hapudin, M. S. (2024). Improving Primary School Students Critical Thinking Abilities with the Help of Online Media: Effective Learning Strategies in Elementary Schools. *Mimbar Sekolah Dasar, 11*(2), 252–267. doi: https://10.53400/mimbar-sd.v11i2.71790.

Szabo, Z. K., Körtesi, P., Guncaga, J., Szabo, D., & Neag, R. (2020). Examples of Problem-Solving Strategies in Mathematics Education Supporting The Sustainability of 21st-Century Skills. *Sustainability (Switzerland), 12*(23), 1–28. doi: https://10.3390/su122310113.

Tucker-Raymond, E., Cassidy, M., & Puttick, G. (2021). Science Teachers Can Teach Computational Thinking Through Distributed Expertise. *Computers and Education, 173*(4), 104284. doi: https://10.1016/j.compedu.2021.104284.

Vourletsis, I., & Politis, P. (2022). Exploring The Effect of Remixing Stories and Games on The Development of Students' Computational Thinking. *Computers and Education Open, 3*,100069. doi: https://10.1016/j.caeo.2021.100069.

Winkler, R., Söllner, M., & Leimeister, J. M. (2021). Enhancing problem-solving skills with smart personal assistant technology. *Computers and Education, 165*(1), 1–15. doi: https://10.1016/j.compedu.2021.104148.

Yayuk, E., & Husamah, H. (2020). The difficulties of prospective elementary school teachers in item problem solving for mathematics: Polya's steps. *Journal for the Education of Gifted Young Scientists, 8*(1), 361–378. doi: https://10.17478/jegys.665833.

Yılmaz, E., Yel, S., & Griffiths, M. D. (2022). Comparison of children's social problem-solving skills who play videogames and traditional games: A cross-cultural study. *Computers and Education, 187*, 1–13. doi: https://10.1016/j.compedu.2022.104548.

Zhang, L., & Nouri, J. (2019). A Systematic Review of Learning Computational Thinking Through Scratch in K-9. *Computers and Education, 141*, 103607. doi: 10.1016/j.compedu.2019.103607.