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## Scratch-Assisted Computational Thinking in Physics: A Literature Review

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### Keywords :

Scratch; Computational Thinking; Physics

### ABSTRACT

*One of the competencies needed in 21st century learning is Computational Thinking. Computational Thinking is a type of analytical thinking that uses mathematical thinking as an approach to solving a problem, designing a system, and evaluating a large and complex system so that it can be operated in the real world. In the context of the link between physics learning and computational thinking, media is needed in the learning process. One learning media that can help students learn abstract concepts is Scratch. The purpose of this research is to analyze the use of scratch in Computational Thinking skills in physics learning. The method used in this research is a literature review. The literature review was carried out by searching for keywords, namely: scratch, computational thinking, and physics. Collection of literature sources obtained from various sources through national and international journals. We obtained 25 articles that matched the keywords. These articles have been filtered by year of publication, over the last ten years. In addition to the effectiveness of scratching we investigate the impact of scratching. The results showed that after playing scratch the students' Computational Thinking abilities increased significantly.*

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## INTRODUCTION

The world has now entered the 21st century, in the 21st century technological developments are so rapid. The 21st century learning system is a learning transition phase, in which the currently developing curriculum leads schools to change teacher-centered learning approaches to student-centered learning [1]. The skills and competencies of 21st century students include learning and innovation skills as well as information and media literacy skills, which are expected to be useful for students later and can be implemented in society [2]. The development of 21st century skills for students can be done by applying various methods, approaches and learning models that are combined with the subject matter in class. In addition to making lessons more meaningful, the use of methods, approaches, and learning models is also able to show the abilities that students have [3].

One of the competencies required in 21st century learning is Computational Thinking [4]. Computational Thinking is a type of analytical thinking using mathematical thinking as an approach to solving a problem, designing a system, and evaluating a large and complex system so that it can be operated in the real world. Computational thinking helps individuals solve complex general problems through steps of decomposition, pattern recognition, abstraction, and algorithm design [5]. Even Wing mentioned that computational reasoning is an important skill to master, along with literacy and numeracy [5]. Jeanette Wing introduced the term computational thinking in 2006. According to him, computational thinking is a fundamental skill that everyone has, not just computer scientists [6].

Learning is a process of helping students acquire knowledge, ideas, values, ways of thinking, skills and learning methods. One of the subjects that causes difficulties for students is physics. The essence of physics is students' awareness to acquire concepts through experimentation and use the knowledge they have learned to solve everyday problems [7] [8]. In fact, many students consider physics material difficult to learn because it is abstract [9]. Therefore we need media that can explain physics material in a more concrete and fun way. Interesting learning media can make it easy for students to understand material, enthusiasm for learning and facilitate learning [10].

Regarding the use of technology, students are required to use it wisely. Therefore, there is a need to integrate computational thinking in learning, especially in physics learning [11]. The media chosen certainly has a significant impact on computational thinking. One way to train computational thinking skills is to introduce an image-based programming language, because text and logo-based programming is time consuming and not very efficient [12]. This is in accordance with research showing that computer-assisted teaching is more effective than traditional teaching in physics lessons [13]. The advantage of using a computer is that it can have a different appearance during learning so that it can encourage students to learn [14]. One of the learning media that can help students learn abstract concepts is Scratch [15]. Scratch is considered a powerful tool for integrating computational thinking into education because it is a visually and multimedia rich program that allows users to create games and stories [11]. Scratch places users in the world of computers without much experience with programming languages.

Based on the context above, the aim of this research is to examine the scratch on computational thinking abilities in high school students' physics learning through analysis of research results from previous studies. Therefore, the focus of this research is on Scratch-Assisted Computational Thinking in Physics: A Literature Review.

## METHOD

The research design used was a literature review. Literature review study is a method used to collect data sources on a particular topic [16]. Literature review is a systematic, explicit, and reproducible method. The use of the literature review method is used to identify, evaluate, and synthesize the research results and thoughts of previous researchers [17]. Writing reviews in this study went through four stages, namely (1) selecting topics to be reviewed, (2) tracing and selecting relevant articles, (3) analyzing and synthesizing articles, and (4) compiling review writing. Collection of literature sources obtained from various sources through national and international journals. Search results were obtained using keywords including: Computational Thinking, Scratch, and Physics. Found 25 articles that match the keywords. These articles have been filtered by year of publication, over the last ten years. The articles used were selected and synthesized with high relevance for review. The article synthesis technique uses a synthesis matrix.

## RESULTS AND DISCUSSIONS

In this research, we have synthesized 25 articles that are most relevant to the topic being discussed. The synthesis results can be seen in Table 1.

**Table 1.** Synthesis Results

No	Identity	Method	Findings
1.	Serevina, Nasbey, & Andriana	Research development (R&D) with the ADDIE model	Scratch can increase high school students' understanding of the physics learning process. Scratch is open-source software developed by the MIT Media Lab
2.	Maloney et al	Qualitative descriptive analysis	The advantage of using Scratch learning media is to make it easier for students to learn in making scratch projects by adding photos and videos, recording sound, and making graphics.
3.	Chandrashekar et al	Qualitative descriptive analysis	Scratch can change students' mindsets into a simple and fun programming language and scratch deserves to be used as a learning medium
4.	Martanti, Hardyanto, & Sopyan	Development research with 4D models. The collection method uses a questionnaire and documentation	Scratch as a learning medium that can help students to understand physics concepts that are still abstract
5.	Nugraha & Widiyaningrum	Pre-experimental with the pattern of pre-test and post-test one group design	Scratch-based interactive media is effectively applied to learning
6.	Lopez and Hernandez	Descriptive analysis	Scratch is used as a computational modeling tool
7.	Fidai, Capraro, & Capraro	Meta-analysis	Scratch can improve Computational thinking skills
8.	Sutikno, Susilo, dan Hardiyanto	Research and Development with 4D models	Scratch can be used as an alternative learning media.
9.	Lee & Jiang	Mixed method	Scratch can improve Computational thinking skills
10	Marcelino et al	Qualitative descriptive analysis	Scratch can improve Computational thinking skills
11	Widiningrum et al	Systematic Literature Review with qualitative descriptive analysis	Scratch can improve computational thinking skills because it is designed to develop creativity
12	Soo-Bum Shin	Qualitative descriptive analysis	Scratch can improve Computational thinking skills
13	Quispe & Jump	Quantitative	Scratch is designed to develop creativity, the ability to think systematically and learn in groups, these three are fundamental skills that must be mastered in the 21st century.
14	Intana, Hardyanto, Akhlis	Research development (R&D) with 4D models	Scratch-based physics learning multimedia in the form of a simulation on Oersted's law material in the very feasible category
15	Arfiansyah & Susilo	Research development (R&D) with 4D models	Scratch-based learning media about optical devices is suitable for use as a physics learning medium in the learning process at school

No	Identity	Method	Findings
16	Dewi, Juliyanto, & Rahayu	The research design used a quantitative approach using a quasi-experimental method with a non-equivalent control group design.	There is a large influence and there is a high increase in problem solving abilities through learning linear motion with a scratch-assisted computational thinking approach
17	Monteiro et al	pre-experimental, with a pre-test and post-test design involving a group of 9 students attending a class 12 mathematics support class of the Portuguese education system.	Students who use this computational application have better results in the post-test than in the pre-test and, increasing student learning with scratch can have a positive impact on learning vector equations
18	Permatasari, Yuana, & Maryono	Classroom action research. The data used in this study are learning outcomes and learning motivation	Utilization of scratch applications can improve student learning outcomes and can increase student motivation
19	Nouri & Zhang	Systematic review presents a synthesis of 55 empirical studies	Computational thinking skills student in K-9 can learn through Scratch
20	Dewi et al	Development was carried out using the ADDIE model	The scratch programming learning model by means of a team-based project can train CTS for the pre-service science teachers
21	Dewi, Juliyanto, & Rahayu	Quasi Experimental tipe non-equivalent control group design	There is a high increase in problem solving abilities through science learning with a scratch-assisted computational thinking approach
22	Johnson & Louw	The research was qualitative and descriptive	Scratch can also be used in teaching at universities
23	Psycharis & Kotzampasaki	The research was conducted using a quantitative survey.	Educational games have a positive influence on the dimensions of Computational Thinking and self-confidence
24	Kusumawati	Quantitative research with a quasi-experimental design.	Scratch-based games can be used as an effective learning medium and can be recommended in improving student learning outcomes.
25	Arfiansyah, Akhlis, & Susilo	development was carried out using the 4D development model according to Thiagarajan.	Scratch-based learning media on the subject of optical instruments is suitable for use as a physics learning media

Based on several Physics experiments using Scratch Assisted Computational Thinking shown in Table 1. Scratch is a programming language developed by the Lifelong Kindergarten Group at the Massachusetts Institute of Technology (MIT) Media Laboratory, United States. Scratch is an easy-to-use visual language for creating games and animations [18]. Scratch programs consist of scripts created using drag-and-drop techniques and graphical blogs are used to create programs [19]. According to Resnick, the advantage of using Scratch learning media is that it supports a variety of projects (stories, games, animations, and simulations), so that students may be interested in making projects in scratch, namely, to make it easier for students to learn in making scratch projects by adding photos and videos, recording sound, and create graphs. Creating learning materials with Scratch is also relatively easy and simple compared to other applications such as Adobe Flash and similar applications

This can be seen in a study [20] which found that Scratch is an application to introduce programming languages, because Scratch uses a programming language that is simpler and can change the mindset of what they consider programming to be difficult and complex into a programming language that is simple and pleasant. Even though it's easy and simple, Scratch can and deserves to be used as a learning medium. Based on Meerbaum's research it was concluded that the use of scratch learning media can be used in formal and informal learning [21]. This is supported by the Scratch learning media which is a computer-assisted tool that can be used in primary and secondary schools [21] [22]. In addition, Scratch can also be used in teaching at universities [23]. In school and university learning, Scratch is used to study abstract material.

Capabilities that can be improved through scratch learning media are computational thinking skills [24]. This is supported by research conducted by Sutikno et al [25] who argues that scratch is a simulation program used to design, develop and analyze simulations that are displayed in the form of moving animations to demonstrate basic functions or principles of a lesson. Therefore, this scratch environment is very important and considered as a suitable tool for learning and developing computational thinking skills. Widiningrum et al [26] said that the use of scratch has a positive effect [27] and improves Computational Thinking [28]. Scratch as a learning tool, Scratch programming is like a puzzle that makes it easier for students to learn abstract concepts from simple to complex. Scratch can also be used online or offline. However, offline implementation requires additional programs in the form of database programs and web servers [15]. Therefore, scratch media is very important and is considered a suitable tool for learning and developing computational thinking.

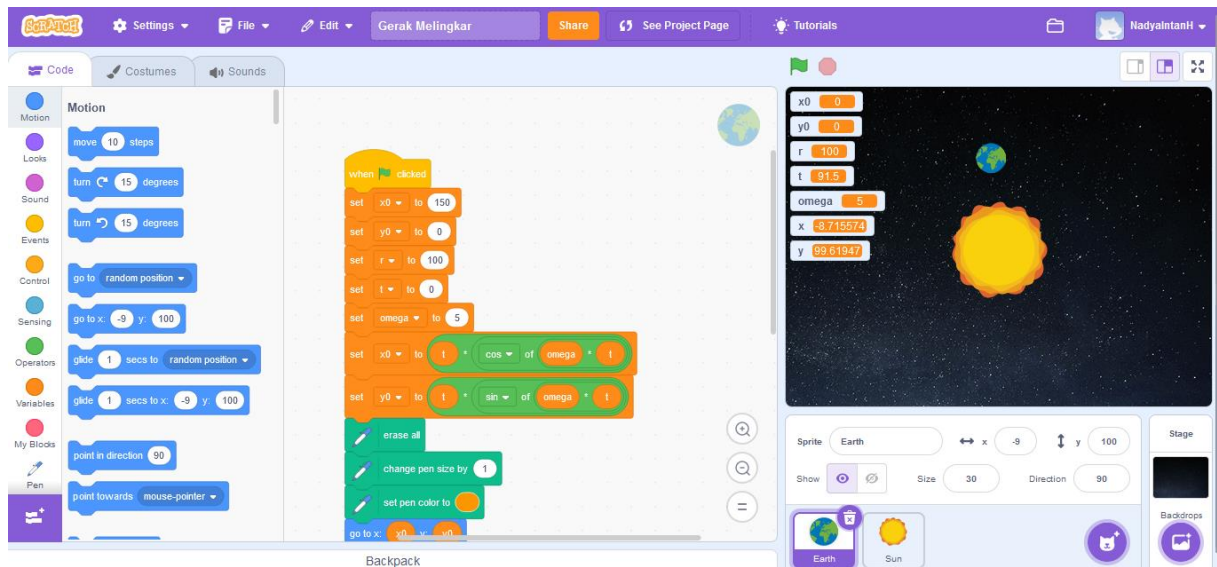
The benefits of Scratch are supported by research showing that students can use Scratch learning resources to make animated characters move, jump, dance and sing, and research shows that Scratch can be used for many types of creation, namely animation, simulation, and shows, stories, interactive images, games and others [29].

There are advantages to the services offered on the Scratch site. The Scratch site provides a social media platform for Scratch users to share their Scratch projects, receive feedback and support from other users, and learn about other users' projects [30]. In addition, Scratch has a weakness in how it is used. The downsides of Scratch are the inability to export scratch results to other formats, limited commands for implementing the algorithm, and only available on Mac and Windows. In addition, the weakness of Scratch is that it requires additional programs for offline implementation in the form of database programs and web servers, and when using scratch animation media, records are needed to find out student user activities [15].

The use of Scratch as a learning medium includes [15] [31] which states that the use of Scratch in learning improves conceptual understanding, performance, critical thinking and creativity. Scratch is designed to develop creativity, the ability to think systematically and learn in groups, these three are fundamental skills that must be mastered in the 21st century [32]. This is reflected in the services offered on the Scratch site. Scratch engages students in systematic thinking through critical thinking and solving problems with their ideas. Scratch encourages students to work collaboratively by discussing their friend's simulation scripts.

Scratch learning media can improve student learning outcomes. This is in line with research on scratch-based games, one of the effective learning media in improving student learning outcomes [27] [33]. Another study on scratch was also carried out by Husna evaluating differences in learning outcomes with scratch media and learning with simple media and described student reactions to learning material about the solar system [34]. In this study, it can be observed that there are differences in learning outcomes with scratch media and learning with simple media. Scratch Media has a positive impact on learning success. As for AM Ortiz-Colon and J.L. Maroto Romo analyzed the effect of using Scratch on high school students [35]. The results of the research show that by using Scratch, students are happier in learning and get better grades. In addition to influencing student motivation and grades, using Scratch can also improve academic achievement. One of the reasons for

this increase is because students often prefer learning through games [36] [37] [38] [39]. Using games can increase students' interest in learning compared to traditional approaches [39].



*Fig 1. Scratch View*

Physics is a subject that is considered abstract and difficult to understand [40]. Scratch media is widely used in physics learning. Each learning media developed must pass the validity and feasibility test stages. Based on the results of the validity and reliability tests, several scratch learning media in physics developed by previous researchers are included in the feasible category to be applied to students [7]. In addition, effective Scratch modules and teaching materials have been developed for use by teachers in the classroom and are suitable for use by students [41] [42]. Several materials in physics developed by previous researchers using scratch media, namely Oersted's Law [43], optics [30], straight motion [20], vectors [44], and the kinetic theory of gases [15].

By using scratch media, students develop physics concepts step by step algorithmically and then apply physics formulas or equations to physics simulations or problems. In this way, students know the abstract form of physical problems through visualization of these problems [45]. Scratch programming provides experiences to students in the form of media such as simulations or animations. Students will learn how to identify, manipulate, and integrate various media for their effective use during learning.

## CONCLUSION AND SUGGESTION

Based on the explanation above, it can be concluded that scratch can improve students' computational thinking skills, because it is designed to develop creativity by making animations and simulations, the ability to think systematically and collaboratively, as well as algorithms to be implemented so that they can apply a logical way of thinking that can create simple concepts. become complex when studying physics.

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