THE EFFECTIVENESS OF REAL SCIENCE MASK WITH QR CODE ON STUDENTS' PROBLEM-SOLVING SKILLS AND SCIENTIFIC LITERACY

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ABSTRACT

This study aims to determine the effectiveness of Real Science Mask with QR Code on students' problem-solving skills and scientific literacy. This research is a type of experimental research that uses the Pretest Posttest Control Group Design model. The subjects of this study were students in the Integrated Science Education study program for the academic year 2020/2021 of Universitas Negeri Semarang. The sample from the population was divided into experimental class and control class. The observation instrument used an observation sheet based on the assessment indicators of students' activities during learning. Data analysis in this study used quantitative descriptive analysis, where each average value is described in each aspect of the assessment based on indicators. The results showed that the experimental class that applied the Real Science Mask with QR Code had the highest average score of Problem-Solving skills in the assessment aspect of discussing the suitability of scientific phenomena with a score of 9.4 and scientific literacy on the aspect of student assessment in seeking scientific references with a score of 8.8. The posttest results obtained a t-count value of 8,951 with df = 16, consulted with the t-table value at a significance level of 5%, and df = 16 obtained 2,120. These results indicate that the value of t-count is greater than the t-table value (8,951 > 2,120) it means that there is a significant difference between the experimental and control classes. Furthermore, the average of these two aspects of the assessment is higher when compared to the control class. These results indicate that the Real Science Mask with QR Code is effective in improving students' problem-solving skills and scientific literacy.

INTRODUCTION

The Covid-19 pandemic in 2020-2021 demands changes in all elements, especially in education. The usual face-to-face learning activities turn into online learning. This change requires adaptation and innovation from various parties, including teachers, lecturers, and students. It is hoped that online learning activities will form social sensitivity to the surrounding environment. The social sensitivity of students to the surrounding environment is needed to form students' caring character (Purwanti, 2017; Panjaitan et al., 2021; Suswanto et al., 2021). Innovative online learning media are needed to facilitate the direct social interaction of students with the environment.

Competition in the 4.0 Revolution-era requires all humans to compete globally because better communication technology will open access to extensive competition from all corners of the world. In the tight challenges facing society, a paradigm shift is needed in the education system to provide the 21st-century skill set required

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by students to deal with every aspect of global life (Soh et al., 2010; Shahroom & Hussin, 2018; Sylvana & Awaluddin, 2019). Good problem-solving skills and scientific literacy are needed to compete in the current era. Problem-solving skill originates and grows from the human cognitive system, namely a process consisting of four inter-related gradual activities: identifying problems, understanding problems, solving problems, and evaluating problems. Problem-solving is a process of applying previously acquired knowledge into a new and unknown situation (Sulaiman, 2011; Zunanda & Sinulingga, 2015; Frerejean et al., 2016). Problem-solving skill is one of the 21st-century skills that students must have. It can make students an innovative person, ready to compete in the 21st-century, change the world and behavior, improve the skill to face problems, solve problems, and think and analyze problems until they find solutions. A person with good problem-solving skills can be called a problem solver and is ready for all challenges in the 21st-century (ŽivkoviĹ, 2016; Dei et al., 2017; Rahmawati & Prasetyanti, 2019). To solve the problem at hand, an individual will take steps associated with cognitive processes. Research conducted by Guilford et al. (Patnani, 2013) concludes that several cognitive functions are involved in problem-solving problem as follows: (1) think quickly about the characteristics of an object or situation; (2) classification of objects or ideas; (3) forming or compiling relationships between objects or ideas; (4) think about the various possible outcomes; (5) list the characteristics of the goals and come up with a logical solution.

The concept of natural science is based on observing phenomena that occur in living things and their environment. Science is not only mastery of the knowledge pool in the form of facts, concepts, or principles only but also is a discovery process. Science lessons are a means for students to learn on their own and the surrounding nature and prospects further development in apply it in daily life (Mulyasa, 2010; Zhang et al., 2010; Annisa et al., 2018). The normal eyes without science abilities cannot see some observed things at the time of learning.

Learning without using engaging science media, students will get bored quickly. Real Science Mask can help students overcome boredom because it uses interesting characters. Real Science Mask with QR Code is a Google Classroom-connected learning media in the shape of a mask with images of science material. It is

expected to facilitate learning activities to concretize an abstract science concept and not be directly observed. Furthermore, when used in connection with Google Classrooms, it can enable unrestricted access to the learning process, which can be performed anywhere and anytime. As a result, applied research is required to produce a Real Science Mask with a QR Code, intended to create a concrete learning experience while also improving science students' digital literacy.

Science literacy is defined as the skilled use of scientific knowledge, identify questions, and attract conclusions based on evidence, to understand and make decisions relating to nature and the changes that are carried out on nature through activities done by humans (Roberts, 2013; Bonney et al., 2016; Utama et al., 2019). The most crucial part in developing students' scientific literacy includes science knowledge, science process, the development of scientific attitudes, and students' understanding of science so that students not only know the concept of science but also apply science skills in solving various problems and can make decisions based on scientific considerations

According to Toharudin et al. (2011), Budiarti and Tanta (2021), Vieira and Tenreiro-Vieira (2016), a person who has scientific and technological literacy is characterized by several skills. Those skills are skills to solve problems using scientific concepts obtained in education according to their level, recognizing technology products around them and their impacts, being able to use technological products and maintain them, creative in making simplified technological results so that students can make decisions based on the values and culture of society.

There has previously been research on the development of both ICT-based and conventional-based learning media. For example, Android-based Smartphone Science-Physics Learning Media, Multimedia-based Science Learning Media, Flipbook Flash Media, Android-Based Augmented Reality (Fatimah & Mufti, 2014; Permana & Damiri, 2014; Mulyadi & Wahyuni, 2016; Rahman et al., 2017). However, these studies still focus on learning outcomes only. In its development, researchers adopted the importance of problem-solving skills and scientific literacy in facing the Industrial Revolution 4.0 in education.

The study results that took the theme of problem-solving skills and scientific literacy have been conducted by several researchers, including research on problem-solving skills that

can be improved using the Thinking Aloud Pair Problem-solving learning strategy. In addition, some studies use development that use google classroom to improve problem-solving skills. But merely to develop and not analyze the effect of media usage on problem-solving skills also conducted research measuring virtual learning skills that focus on student communication. This study looked at virtual learning skills that focused on communication skills (Rahmat & Zulaikah, 2014; Gunawan & Sunarman, 2018; VanLangen et al., 2021).

The research gap analysis compared to previous research is that it used technology and had to be carried out online. However, the media made could also be used offline, making it easier for students to use. This condition can be a solution for students who find it difficult to use complex equipment to study. The research aims to produce learning media in the form of Real Science Mask with QR Code that has been declared valid by experts and is appropriate in terms of readability and graphics and to obtain learning media that has been tested for its effectiveness in improving problem-solving skills and scientific literacy of science students. This research has characteristics and virtues, such as: (1) through this research, a learning media that will be produced is Real Science Mask with QR Code, science learning is not limited by space and time and can minimize costs incurred; (2) the learning media of Real Science Mask with QR Code was designed in such a way that it can build a substantial learning experience that is interesting and easy to understand; and (3) the study results are expected to help science students to improve their problem-solving skills and scientific literacy of science students. Moreover, the applied research carried out also utilized IT-based learning media (technology). The learning media used is the Real Science Mask with QR Code, in a mask containing illustrations of science material connected to Google Classroom. It was specifically designed as a learning medium to improve science students' problem-solving skills and scientific literacy. However, research on using science masks connected to the integrated QR Code google classroom has never been conducted.

Problem-solving is one of the essential skills in learning. Learning to solve problems can be obtained through formal education because understanding the process of problem-solving is still limited (Wahyuni et al., 2017; Nayazik, 2017). Problem-solving skills will help students solve problems in academic life and real life. Teachers need much information about how to help students improve problem-solving skills to be more efficient. The ability to decipher and summarize information for solving problems is often called analytical-synthetic capabilities and can be upgraded using the problem-solving method. The problem-solving process is described as a complex process that requires a lot of shared skills. The elements of this process are understanding the problem, selecting the necessary information, transforming the information obtained into a solution design, and reaching a solution after carrying out the design that has been made. The solution achieved through mastery of the problem-solving process and using the correct method will solve the problem and be a more effective solution to similar problems in the future (Kirmizi et al., 2015; Saygılı, 2017; Fahrina et al., 2018; Durax, 2020).

Problems in science are essential ideas to build students' problem-solving capacities, make science lessons more fun, and motivate students to achieve more. Problem-solving skills are used in solving scientific problems in the form of mathematics and environmental phenomena. However, in reality, students experience difficulties because the strategies taught in learning only solve problems that require mathematical calculations. Indicators of problem-solving skills, according to Polya are the following: (1) understanding the problem; (2) planning for solutions; (3) solving problems according to plan; (4) rechecking all steps. Researchers have found that students' problem-solving skills can be trained and facilitated by integrating problem-solving strategies and computer technology. Problem-solving skill has been recognized as an essential skill to adapt to the 21st-century environment. The role of education in the 21st-century must prepare students to meet the challenges of a dynamic and interconnected world. Problem-solving skills use logic to solve real-life problems and make decisions (Gunawan et al., 2017; Wahyuni et al., 2017; Jayadiningrat & Ati, 2018).

Problem-solving skill is a strategic competence to understand and choose approaches and strategies to solve a problem (Syukriani, 2017; Tanjung & Nababan, 2019; Widyanti & Khabibah, 2020). The procedure for problem-solving is to find and solve the main cause of a problem. This activity requires the skill to identify and analyze the causes of the problem, generate various solutions, and apply them.

The characteristics of students mastering the problem-solving skills in science also agree, according to Pisaba (2018), are presented in the Table 1.

Table 1. The Characteristics of Students Mastering the Problem-solving Skills

No	Indicators	Characteristics
1	Understanding the problem	The information provided is sufficient to find what is being asked.
2	Planning a solution	Finding the previous problem, paying attention to the problem being asked, thinking about whether the solution used for the previous problem can be used for this problem.
3	Solving the problem according to plan	Solving the problem according to plan
4	Rechecking the process and results	Checking the correctness of the answer, whether the steps are according to plan, and can be used for other problems

The problem-solving skill has three main characteristics: (1) problem-solving is a series of learning activities, meaning that there are several activities that students must do in implementing Problem-solving. Problem-solving encourages students to actively think, communicate, find and process data, and finally conclude; (2) learning activities are directed at solving problems. Problem-solving places the problem as the keyword of the learning process. There will be no learning process without problems; (3) problem-solving is done using a scientific thinking approach. Thinking using the scientific method is a deductive and inductive thought process. This thinking process is carried out systematically and empirically. Systematic means that scientific thinking is carried out through certain stages, while empirical means that the problem-solving process is based on precise data and facts (Komariah, 2011; Apino & Retnawati, 2017; Simamora et al., 2017).

The difference between students who have low (novice) and high (expert) skills in problem-solving is how students organize and use knowledge and connect one concept to another when solving problems. For example, students with high problem-solving skills tend to use qualitative arguments based on the concepts underlying the problem (deep features), evaluate solutions, and use representational tools. On the contrary, students with low problem-solving skills tend to recognize problems based on the problem presentation (surface feature), do not evaluate, and use formulas to solve problems (De Cock, 2012; Lin & Singh, 2013). The advantages possessed by students when mastering problem-solving skills are the following: (1) it can make students live their daily lives more; (2) it can train and accustom students to face and solve problems skillfully; (3) it can develop students' thinking skills creatively; (4) students begin to be trained to solve the problem; (5) students will show an active attitude to think and act creatively; (6) in real life, students can solve the problems; (7) students can identify and carry out investigations; (8) in observing activities, students can interpret and evaluate the results of these observations; (9) it stimulates the development of the progress of students' thinking to solve the problems appropriately; (10) it can make school education more relevant to life, especially the work life. Moreover, this research aims to overcome students' boredom in learning science and aims to determine the effectiveness of the Real Science Mask.

METHODS

This research used the experimental method. The experimental method is a research method used to find the effect of specific treatments on other variables in controlled conditions (Sugiyono, 2010; Sartika, 2012; Cresswell, 2015). This experimental method used an experimental class that applied Real Science Mask with QR Code in class and applied a control class as a comparison that applies the lecture method with text media in PowerPoint. Instructional media used in the classroom experimentation is Real Science Mask with QR Code, a mask containing science illustration material connected with Google Classroom. It was explicitly designed as a learning medium to improve the scientific literacy of science students.

Learning activities using Real Science Mask with QR Code were carried out in several stages, including: (1) the stage of media introduction; (2) the stage of utilizing the media Real Science Mask with QR Code by using a barcode scanning application on student smartphones; (3) the stage of utilizing Digital applications that are connected to the Real Science Mask with QR Code, including the website, Google Classroom, and Google Drive. During their learning activities using Real Science Mask with QR Code, their learning activities were observed on the problem-solving skill and mastery of scientific literacy. The research design used was the Posttest Only Control Design. There was an experimental class with Real Science Mask with QR Code treatment and a control class given the treatment in Power-Point. There are two types of variables observed, problem-solving skills and scientific literacy. The research design is illustrated in the illustration below:

$$R_1 \quad X \quad O_1 \quad O_3$$

$$R_2 \quad \quad O_2 \quad O_4$$
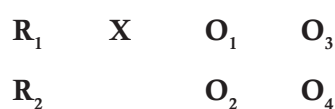
Description:
R_1 : Experimental class
R_2 : Control class
X : Treatment
O_1, O_2 : Problem-solving skills
O_3, O_4 : Scientific Literacy

The research sample was obtained by a simple random sampling method. The simple random sampling technique is a technique of taking samples from members of the population, which is carried out randomly without regard to the strata that exist in the population (Sugiyono, 2010; Datey & Kuthe, 2015).

Subjects in this study were students of the Integrated Science Education Study Program in the Basic Biology course at Universitas Negeri Semarang (UNNES). The students' responses observed were problem-solving skills and scientific literacy using a test. Data collection techniques in this study include: (a) initial survey to determine the sample in experimental class and control class using a previous score; (b) observing basic Biology class using the media Real Science Mask with QR Code; (c) data collection in the form of test scores using written test questions that have met the criteria for measuring the problem-solving skill and scientific literacy; (d) data analysis where problem-solving skills and scientific literacy scores were analyzed descriptively quantitatively and then analyzed using inferential analysis independent sample t-test.

RESULTS AND DISCUSSION

Learning activities by utilizing the media of Real Science Mask with QR Code allow students to care about the problems presented in the image on the mask. Through the QR Code printed on the mask, students are invited to scan the code to the related application to find solutions to the problems. Applications related to the QR Code are websites, Google Classroom, and Google Drive. Student activities during learning activities were observed from the aspects of problem-solving skills and scientific literacy.

In observing student learning activities, the skill indicator is problem-solving described in several aspects of assessment adjusted to the pattern of learning activities in the experimental and control classes. The assessment aspects of problem-solving skills developed based on these indicators: analyzing the phenomena in the learning media, compiling follow-ups related to scientific phenomena, realizing the implementation following scientific principles, describing the scientific phenomena based on the facts, reporting the observation results, discussing the suitability of scientific phenomena with facts, finding scientific references related to the phenomena, collaborating the results of scientific references with the results of independent analysis, publishing the results of analysis through scientific reference media. Indicators of problem-solving skills are: (1) understanding the problem; (2) planning the solution; (3) solving the problem according to the plan; (4) rechecking the results obtained (Ulya et al., 2014; Dewi & Septa, 2019; Mustofa & Slamet, 2020).

The development of a problem-solving test uses basic problem-solving abilities that align with the basic biology course material. Each indicator is described following the basic competencies listed in the semester learning plan. Based on the consideration of problem-solving indicators, student learning activities, and learning materials, specific testing instruments can be developed. The assessment results of problem-solving skills can be seen in Table 2.

Table 2. The Assessment Results of Problem-Solving Skills

Indicators	Aspects of Assessment	The Average Score	
		Experiment Class	Control Class
Skill to identify scientific phenomena	Analyzing the phenomena in learning media	9,2	7,2
	Compiling follow-ups related to scientific phenomena	9,0	7,5
	Realizing of implementation following scientific principles	8,8	8,0
Skill to explain scientific phenomena	Describing the scientific phenomena based on the facts	9,3	7,0
	Reporting the observation results	8,7	7,8
	Discussing the suitability of scientific phenomena with facts	9,4	7,1
Skill to use scientific references	Finding scientific references related to the phenomena	8,5	7,4
	Collaborating scientific reference results with independent analysis results	8,7	7,0
	Publishing the results of the analysis through scientific reference media	9,1	8,0

The highest average score in the experimental class was achieved in discussing the suitability of scientific phenomena with the facts. It proves that using the initial image presented on the Real Science Mask will arouse students' interest in the discussion. The discussion was carried out to prove the initial hypothesis regarding the problem in the mask image of Real Science Mask with facts, where some of these truths are available in the material on other application platforms that are connected to the QR Code so that students can discuss with fellow students and lecturers based on the learning material guidelines. The lowest average score is found in the control class in describing scientific phenomena based on the facts and collaborating the scientific reference results with independent analysis. Both of these aspects have low scores because the control class does not apply the learning media of Real Science Mask with QR Code so that students cannot describe the initial problem clearly and continue to find it difficult for students to collaborate with scientific reference sources. Thus, Real Science Mask with QR Code has been proven to increase students' curiosity about the problems and find solutions and answers using several references to scientific literacy that they have mastered.
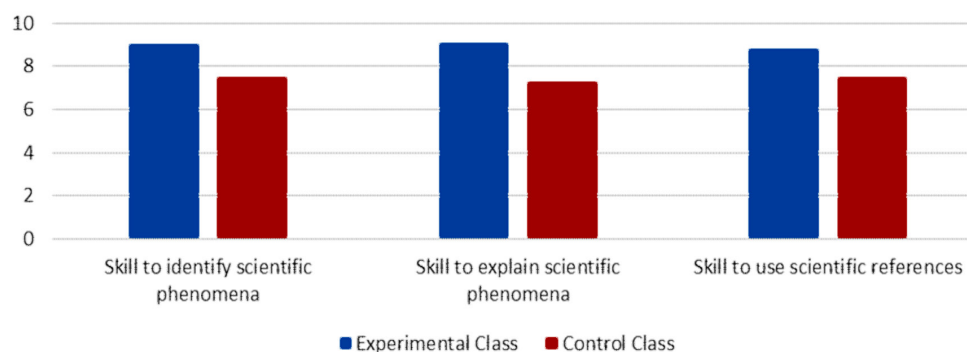
Figure 1. Comparison of Problem-Solving Skills in the Control Class and the Experiment Class

Based on research data as shown in Figure 1, the highest average score was achieved by the indicator of the skill to explain scientific phenomena, which is at 9.3. Thus, with the initial thing in the form of an image in the Real Science Mask with QR Code, it can invite students to hone their problem-solving skills with the support of good scientific literacy skills to open an explanation of the scientific phenomenon. The advantages of problem-solving learning are: (1) educating students to think systematically; (2) finding solutions to the situation; (3) learning to analyze a problem from various aspects; (4) educating students to be confident; (5) thinking and acting creatively; (6) solving problems realistically; (7) making school education more relevant to life, especially the work-life; (8) stimulating the development of progress in student thinking to solve the problems faced appropriately. On the other hand, weaknesses of problem-solving learning are the following: (1) it takes much time; (2) students' skill to solve different problems is different; some are perfect in solving problems, but some are not (Roll et al., 2014; Haryanti, 2020).

Indicators of scientific literacy according to PISA include: (1) identifying scientific problems for scientific investigation; (2) explaining scientific phenomena to describe or interpret scientific phenomena and provide explanations; (3) using scientific evidence to support predictions, make conclusions and communicate (Bybee, 2009; Sadler & Zeidler, 2009). Science skill indicators represent every scientific activity carried out during learning activities so that they are adjusted to several aspects of assessment as a basis for the preparation of a questionnaire. Student learning activities that reflect the indicators of the assessment of scientific literacy are measured in the following aspects of the assessment: identifying the problems, classifying types of problems, analyzing background problems, planning actions to solve problems, taking real action to solve problems, looking for scientific sources/references related to the problem, carrying out a thorough reflection of all taken actions, receiving criticism and suggestions related to the process. The results of scientific literacy assessment is shown in Table 3.

Table 3. The Assessment Results of Scientific Literacy

Indicators	Aspects of Assessment	The Average Score	
		Experiment Class	Control Class
Problem-Understanding Skills	1. Identifying the problems	8,5	7,0
	2. Classifying the types of problems	8,2	7,3
Problem-Solving Skills 1	1. Analyzing the background of the problem	8,4	6,8
	2. Planning actions to solve problems	8,5	6,6
Problem-Solving Skills 2	1. Taking real action to solve the problem	9,1	6,7
	2. Looking for scientific sources/references related to the problem	8,8	6,5
Results-Evaluation Skills	1. Carrying out a thorough reflection of all taken actions	8,7	7,0
	2. Receiving criticism and suggestions related to the process	8,5	7,2

The highest average score was in taking real action to solve the problem, which is at 9.1. This condition proved that the media of Real Science Mask with QR Code made students' curiosity very big so that they are motivated to develop their scientific literacy skills. All concrete actions taken to solve the problems faced must have scientific guidelines, and it reflects the mastery of good scientific literacy skills. In the control class that does not apply the media of Real Science Mask with QR Code, the lowest average score was finding scientific sources/references related to the problem. Students do not have a clear picture of the problem, so the desire to find a problem-solving solution is also deficient. From the facts that occurred in the control class, it can be concluded that students do not have a strong desire to look for scientific reference sources without any apparent problems. Moreover, The Figure 2 shows the average score of scientific literacy skills mastered by students.
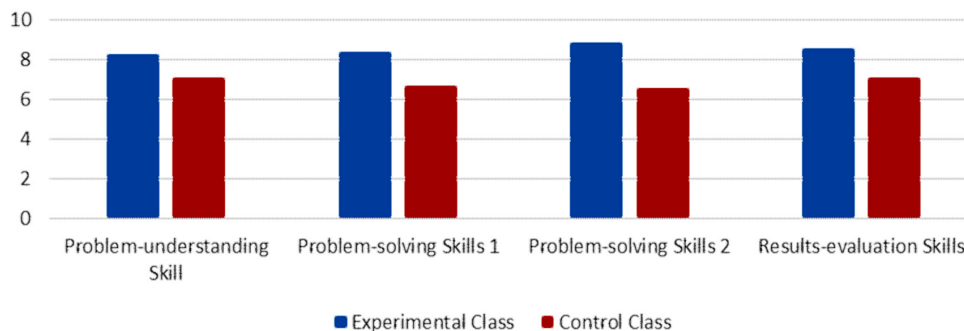
Figure 2. The Assessment of Scientific Literacy

Problem-solving skills 2 obtained the highest average score of 8.9. Real Science Mask with QR Code integrated with several other digital application platforms can provide students with planning and real action to find a solution to solve the problems. The presentation of the image initially that does not have a written description makes students' curiosity stronger. Equipped with a QR Code, it will further increase students' desire to immediately find an answer to the image on the Real Science Mask. Furthermore, the independent t-test result is presented in Table 4.

Table 4. Independent t-test Result

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
									Lower	Upper
Value	Equal variances assumed	1.005	.331	8.951	16	.000	15.222	1.701	11.617	18.827
	Equal variances not assumed			8.951	14.913	.000	15.222	1.701	11.596	18.849

The posttest results obtained a t-count value of 8,951 with df = 16, consulted with the t-table value at a significance level of 5%, and df = 16 obtained 2,120. These results indicate that the value of t-count is greater than the t-table value (8,951 > 2,120) it means that there is a significant difference between the experimental and control classes. Furthermore, the average of these two aspects of the assessment is higher when compared to the control class. These results indicate that the Real Science Mask with QR Code is effective in improving students' problem-solving skills and scientific literacy.

The unique phenomenon found during the implementation of this research is in problem-solving skills, especially aspects of explaining scientific phenomena. For example, with Real Science Mask media, students become highly curious after observing the images presented on the masks. Scientific evidence that has been obtained from various reliable sources is then interpreted and reduced by students who direct students to problem solutions. Thus, to find answers to problems and explain scientific phenomena well, students try to find scientific evidence to strengthen their opinions.

CONCLUSION

Face-to-face learning activities during the Covid-19 pandemic are not allowed to avoid crowds of students in class. Therefore, learning activities are carried out online. Hence, simultaneous innovation is needed to do not get boring and achieve the learning goals. The Real Science Mask with QR Code is an innovation in learning media integrated with multiple digital platforms, such as YouTube, G-drive, and website. The results showed that the problem-solving skills in explaining scientific phenomena had the highest score, and in scientific literacy, the problem-solving skills two also received the highest score. These two results indicate that Real Science Mask with QR Code can be an alternative media solution that can improve students' problem-solving skills and scientific literacy.

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