

# The Effectiveness of Digital-Based COVID-19 Prevention Supplement Books to Empower High School Students' Scientific Literacy and Critical Thinking Skills

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**Abstract:** The development of teaching materials such as digital-based supplementary books really needs to be done considering that COVID-19 has not yet been integrated with biology subjects. Students need to dig up information about COVID-19 through scientific literacy and solve problems through critical thinking. This study aims to determine the effectiveness of digital-based supplement books through quasi-experiments by looking at the comparison of pre-test and post-test results. The data were analyzed quantitatively to determine the category of effectiveness and deepened by a qualitative analysis of the influencing factors. Sig. The value of (2-tailed) Paired T-test is 0.000, which shows that there is a difference in the average learning outcomes before and after using the supplement book. This means that the COVID-19 prevention supplement books greatly affect students' scientific literacy skills and critical thinking skills. Scientific literacy is enhanced because the content in the book explores COVID-19 information and is integrated into the material. Meanwhile, critical thinking is empowered with direction analysis and decision making in books. The book developed is predicted to be very useful and supportive in learning biology, especially relevant material such as material about viruses, the respiratory system, and the immune system.

**Keywords:** Critical thinking; Digital book; Literacy science

## Introduction

COVID-19 has been declared a global pandemic by the World Health Organization (WHO) since the end of February 2020 (Singh, 2020). The current condition explains that students actually have fear and anxiety about COVID-19, but do not have high awareness to make prevention efforts. In this regard, the integration of health education into learning themes is very important to do (Ketut Sudiana et al., 2020). There are still many students who are ignorant of health protocols. This is determined by the information students receive and is determined by scientific literacy skills and critical thinking skills regarding COVID-19. Preliminary analysis shows that scientific literacy skills and students' critical thinking skills are still relatively low (Ferdyan et al., 2022). Subjects that are able to play a role in this are

biology in high school, especially on viruses, the respiratory system, and the immune system.

The description of biology learning during a pandemic is digital-based learning. In digital learning, the limitations of structured learning resources are felt by teachers and students (Christopoulos & Sprangers, 2021). Based on interviews conducted with biology teachers at SMAN 16 Padang, learning biology, especially material about viruses and the respiratory system, which was carried out during a pandemic with digital learning, was less effective, especially in terms of the proportion of material obtained by students. The material obtained by students in learning biology only reaches 60% (Ferdyan, 2020). In addition, the availability of teaching materials that include preventive measures against COVID-19 does not yet exist in biology lessons held at SMAN 16 Padang during digital learning.

## How to Cite:

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Biology subjects can actually be an asset for students to prevent transmission of COVID-19 if learning is maximized by providing supplementary books to support learning.

The issue of COVID-19 is an issue that is synonymous with students. The problems faced by students during the pandemic varied, such as mobility restrictions, online, and several other problems. Students need to have analytical power over this situation in order to understand the dangers of COVID-19 and determine what to do. Students need scientific literacy skills because COVID-19 is a natural phenomenon. As well as students need critical thinking skills in selecting information and deciding on an action that leads to efforts to prevent COVID-19.

Science literate students are students who have the scientific knowledge to explain natural phenomena, acquire new knowledge through scientific investigations, and draw conclusions. Through literacy skills, students will be able to solve life's problems and create useful scientific products (Aiman et al., 2020). Thus students who already have scientific literacy skills will be able to face problems in global life (Firdaus et al., 2023). While students who have critical thinking skills are students who are able to think logically and in depth which is focused on making decisions about what to believe or what to do. Students can determine which information is important, irrelevant, or useless (Amin et al., 2020). These two abilities are expected to be able to equip students to prevent the spread of COVID-19.

Scientific literacy and critical thinking have a significant relationship in learning biology or learning science (Aiman et al., 2020). Critical thinking skills are factors that influence scientific literacy. Currently, students are not only required to be literate in science information but also need skills in thinking deeply about science. Scientific literacy makes students more proficient in utilizing scientific knowledge and has implications for students who must have critical thinking and problem-solving skills.

The development of this COVID-19 Preventive E-Module can be used as an innovation in biology learning to improve students' scientific literacy skills and the application of healthy living behaviors that depart from the Decree of the Minister of Health of the Republic of Indonesia No. HK 01.07/MENKES/382/2020 concerning health protocols for the community. Quality supplement books are books that have been tested for feasibility or validity. Book development certainly requires stages in carrying out inspection and extracting the contents of the book so that it can be used properly. The feasibility of the book can be done by testing the validity. The aim of this study was to determine the effectiveness of COVID-19 preventive supplement books in biology learning to empower high school

students' scientific literacy and critical thinking skills.

## Method

The research was conducted through a quasi-experimental design with a one group pretest posttest design. The implementation of learning with supplementary books is carried out using the Problem Based Learning (PBL) model. The selection of research samples used purposive sampling, namely class X MIPA students of SMAN 16 Padang. The variables in this study consist of independent variables and dependent variables. The independent variable in this study was a digital-based COVID-19 preventive supplement book, while the dependent variable in this study was; scientific literacy skills and critical thinking skills. Students' scientific literacy abilities are measured through test instruments in the form of questions referring to the dimensions of scientific literacy, including; scientific concepts, scientific processes, and scientific situations. Students' critical thinking skills are measured through test instruments that refer to the Watson Glaser Critical Thinking Appraisal (WGCTA) indicator with indicators of making inference, recognition of assumptions, deduction, interpreting information, and evaluation of arguments (evaluation of arguments). Scientific literacy skills and students' critical thinking skills were analyzed using the Paired Sample T Test and Normalized Gain Score.

## Result and Discussion

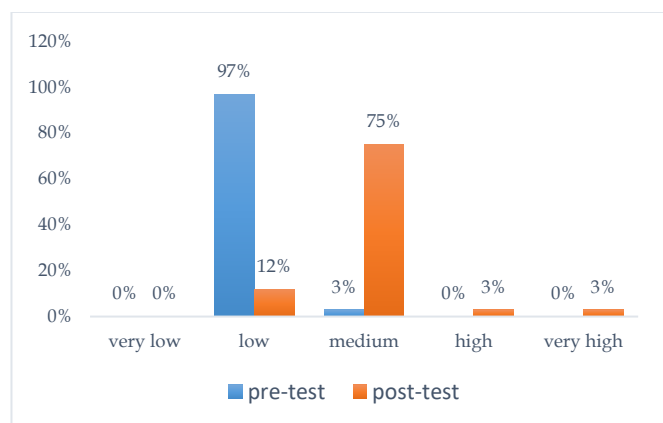
### *Results of Students' Science Literacy Ability*

The ability of students' scientific literacy is known from the results of the calculation analysis of the Paired Sample T-test and is strengthened by the Normalized Gain Score. Calculation of Normalized Gain Score is done when the pretest and posttest results of students have been obtained. Previously, the results of the pretest and posttest data were tested for equality. The normality test shows that the data is normally distributed with a value of 0.056. The results show the value of Sig. (2-tailed) > 0.05. While the homogeneity test also shows that the variance of the pretest and posttest data is not the same as the Sig value. 0.034. The results of the pretest and posttest as well as the results of the t-test in the sample class can be seen in Table 1.

**Table 1.** Average and Paired Sample T test Science Literacy Ability

Value	Pretest	Posttest	Sig. (2-tailed)
Lowest Value	0.00	46.70	0.000
The highest Value	66.70	86.70	
Average	18.30	64.60	

Based on the table above, the Sig. (2-tailed) Paired T-test 0.000. This value is less than 0.05 which indicates that there is an average difference between the pretest and posttest results. This means that the COVID-19 preventive supplement book influences students' scientific literacy skills. The average posttest result was 64.6 (moderate) and the average pretest result was 18.3 (very low). The post-test results also showed that the highest score obtained by students was 86.7 and the lowest score was 46.7. The results obtained by students on the average posttest are in the medium category, which can also be seen from the percentage. This is evidenced by the data of 75% of students in the medium category and only 12% of students in the low category. Other results also show that there are students who have high and very high categories with a percentage of as much as 3% each. See as figure 1.



**Figure 1.** Percentage of Science Literacy Ability in the Pretest and Posttest

If viewed based on the category of scientific literacy ability, the results obtained by students in the pretest are in the very poor category. This is evidenced by the data of 97% of students in the low category and only 3% of students in the medium category. All of this data can be used to see the effectiveness of supplementary books on scientific literacy skills. The data is strengthened by the Normalized Gain Score to see the increase in students' abilities after implementing the supplement book. The results of calculating students' scientific literacy abilities with the Normalized Gain Score can be seen in Table 2.

**Table 2.** Normalized Gain Score Results for Science Literacy Ability

Grade	Pretest	Posttest
Lowest Value	0.00	46.70
The highest Value	66.70	86.70
Average	18.30	64.60
Average Gain Score		0.67
Gain Score category		moderate

Based on the Table 2. above it can be seen that the

average value of the Normalized Gain Score obtained is 0.67. The score is determined by the increase in the score obtained by students in answering the scientific literacy ability test after using supplementary books which increases away from the score obtained from the pretest. Previously it was known that a score of 0 was found in the pretest and not found in posttest where the lowest score in the posttest was 46.7. The average Normalized Gain Score obtained by students in this effectiveness test is moderate. This means that the COVID-19 preventive supplement book is effective in empowering students' scientific literacy skills in the moderate category.

*Results of critical thinking skills*

Skills Students' critical thinking skills are known from the results of the analysis of the Paired T-test and the calculation of the Normalized Gain Score. Calculations are made when the pretest and posttest of the students have been obtained. is first carried out a pretest of students' critical thinking skills on COVID-19 Then at the end of the lesson and after the product is used, a posttest. Previously, the results of the pretest and posttest were tested for equality with normality and homogeneity. The normality test shows that the data is normally distributed with a value of 0.20. The results show the value of Sig. (2-tailed) > 0.05. While the homogeneity test also shows that the variance of the pretest and posttest is not the same as the Sig value. 0.000. The results of pretest and posttest as well as the Paired T test in the sample class can be seen in Table 3 below.

**Table 3.** Results of the Average Critical Thinking Skills

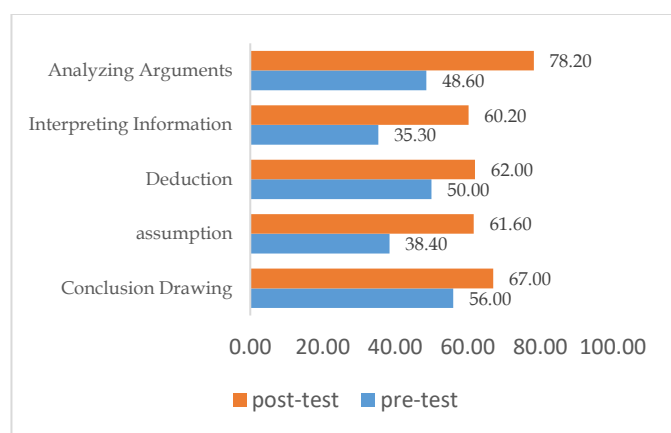
Grade	Pretest	Posttest	Sig. (2-tailed)
Lowest Value	13.3	46.7	0.000
Highest Value	73.3	76.7	
Average Value	45.6	65.8	

Based on the table above, the value of Sig. (2-tailed) Paired T test 0.000. This value is less than 0.05 which indicates that there is an average difference between the pretest and posttest. This means that the COVID-19 preventive supplement book is very influential on students' critical thinking skills. The average value of the posttest is 65.8 with the moderate category. While the average pretest obtained a value of 45.6 with a low category. The highest score on pretest was 73.3 and the lowest was 13.3. The pretest also show that the conclusion indicator has an average of 56.0 and is the indicator that has the highest average. While the indicators interpret the information to be an indicator with the lowest average, namely 35.2. The average score can be seen in Table 4.

**Table 4.** Results of the average critical thinking skills average score on pretest and posttest

Indicator	Average (pretest)	Average (posttest)
Conclusion	56.00 (low)	67.10 (medium)
Drawing assumption	38.40 (very low)	61.60 (low)
Deduction	50.00 (low)	62.00 (low)
Interpreting Information	35.20 (very low)	60.20 (low)
Analyzing Arguments	48.60 (low)	78.20 (high)

The results posttest showed that the highest score obtained by students was 76.7 and the lowest score was 46.7. If seen based on the indicators and categories of critical thinking skills, the results obtained by students on the posttest average are in the medium category. The indicator analyzing arguments has an average of 78.2 and is the indicator that has the highest average. While the indicator of interpreting information is still an indicator with the lowest average of 60.2. However, all indicators still show that students' critical thinking skills are at a moderate level. Comparison of pretest and posttest can also be seen by the different criteria for each of these critical thinking indicators, starting from drawing conclusions to analyzing arguments. See as figure 2.



**Figure 2.** Comparison of Critical Thinking Skills in Pretest and Posttest

All of these data can be used to see the effectiveness of supplementary books on critical thinking skills. The data is strengthened by the Normalized Gain Score. The calculation results can be seen in Table 5.

**Table 5.** Normalized Gain Score Thinking Skills

Grade	Pretest	Posttest
Lowest Value	13.3	46.7
The highest Value	73.3	76.7
Average	45.6	65.8
Average Gain Score		0.59
Gain Score category		moderate

Based on the table above it can be seen that the *Normalized Gain Score* obtained is 0.59. The score is determined by the increase in the score obtained by students in answering the critical thinking skills test which increases away from the score obtained from the *pretest*. Previously it was known that a score of 13.3 was found in the *pretest* and was not found in *posttest* where the lowest score was 46.7. *Normalized Gain Score* obtained by students in this test is moderate. This means that preventive supplement books are effective in empowering students' critical thinking skills in the moderate category.

### Discussion

Good scientific literacy and critical thinking skills are needed so that students have sufficient competence and are able to compete in the current and future information and globalization era (Jamaluddin et al., 2019). The covid-19 pandemic has had a serious impact on public institutions including education (Kelly et al., 2020) and learning (Hindun et al., 2021) including biology learning. Learning directs the online biology learning process, namely the teaching process that is tried remotely using educational applications and social networks (Haryanto et al., 2022). Furthermore, the learning process in biology does not direct students only to acquire knowledge but students must also be actively involved in learning such as finding knowledge or information itself, proving this knowledge through a practicum or experiment, and concluding it and in the end can create a tool or technology that will be able to solve the problems faced by society.

Based on the results obtained, it cannot be denied that students' scientific literacy in Indonesia really needs to be empowered. The results obtained from the PISA survey from 2000 to 2018 placed Indonesia as one of the countries with a low scientific literacy rating (Jailani et al., 2020). Likewise, in terms of all aspects of literacy, namely content, context, and process. Learning should be able to foster fun and interest in building a positive attitude, awareness and responsibility towards the environment (Oliver & Adkins, 2020).

The information that students receive regarding COVID-19 through the supplementary book has been designed in such a way and adapted to the basic competencies of the biology curriculum that are relevant to the integration of COVID-19 knowledge. The moderate category obtained by students in learning outcomes represents that students only receive basic and main information about COVID-19 which is presented in the supplement book. On the other hand, the role of supplementary books which are only additional books also has an effect where students are still focused on the main material.

Scientific literacy that can be used by students regarding COVID-19 can be started from the characteristics of the SARS CoV-2 virus which are studied along with studying the characteristics of viruses in general. Then it can spread to the concepts of virus classification which defines SARS CoV-2 as an RNA virus. The life cycle of SARS CoV-2 also needs to be studied and becomes an initial capital for students' knowledge in preventing themselves from getting infected with COVID-19. This process actually underlies real science learning which involves dimensions of scientific literacy skills including scientific concepts, scientific processes, and scientific situations. With the advantages of supplementary books that have presented information about COVID-19 integrated into biology material collected from various sources, it should have become a reference for students to improve their scientific literacy skills.

Actually the empowered scientific literacy ability aims to build the concept of "scientific literacy". This concept holds the view that scientific literacy is linear with the development of life skills, which prioritizes the need for thinking skills and emphasizes that scientific literacy is intended for everyone, not just for people who choose careers in science or specialists in science (Narut & Supradi, 2019). Literature in the field of science education also shows that scientific literacy is increasingly being accepted and valued by educators as an expected learning outcome.

In general, the books developed have implemented scientific literacy, especially regarding COVID-19 which directs students to understand information about COVID-19 as an asset in prevention. The concepts obtained can be evaluated and applied by students in everyday life in dealing with a pandemic. The book has also prepared steps in empowering scientific literacy.

The average gain score of students' critical thinking skills is 0.59. The score is determined by the increase in the score obtained by the students in answering the critical thinking skills test after using the supplementary book which increases away from the score obtained from the pretest. The category of the average gain score obtained by students in this effectiveness test is moderate. This means that the designed supplementary book is effective in the moderate category and has succeeded in improving students' critical thinking skills.

One of the efforts to empower critical thinking skills is embedded instruction (Zubaidah & Arsih, 2021). This activity provides evaluation and predictions to improve student understanding conceptually which focuses on embedding the concept of material and learning resources (DİK MEN, 2022)

The developed supplement book presents information that is conceptually easy for students to understand. Then information that is well organized and

clear will more quickly instill the concept of COVID-19 in students. Critical thinking skills will increase when students are successful in organizing and presenting information found critically and giving personal arguments (Frerejean et al., 2019). The clarity contained in the material helps students to be able to make conclusions easily based on existing explanations for students to understand (Barus et al., 2021).

The implementation of supplementary books in the learning process is carried out using a model that is also appropriate, namely problem-based learning, where the problem or issue of COVID-19 is presented first and students are asked to solve or provide solutions (problem solving) because it is related to everyday life. The formation of a critical thinking mindset must certainly use methods that can stimulate critical thinking skills. The learning methods based on critical thinking are problem solving, problem posing, discovery, observation, and debate (Persov et al., 2020).

Supplement books are basically additional books or books that provide enrichment material. There have been many relevant studies that have tried to develop supplemental or enrichment books and have been able to improve students' critical thinking skills. In line with the research results obtained, the development of enrichment books can improve students' critical thinking skills significantly (Maksum et al., 2022) (Retnowati et al., 2020). The concept of critical thinking involves students in the knowledge construction process through reflection and deep thinking. The characteristics of someone who has critical thinking skills is to have curiosity and various questions at the same time will try to find answers to the questions he asks. The available supplementary books are able to answer the concepts provided by these critical thinking skills, where the material is presented more broadly, especially related to COVID-19.

The designed book content also facilitates students in developing their critical thinking skills. The information presented prompts students to think more deeply about COVID-19. The existence of a special column for critical thinking also presents information that can be analyzed by students. The information provided can be in the form of analyzing information, drawing conclusions, or providing arguments regarding the development of COVID-19 which is relevant to viral material in class X and the respiratory system and immune system in class XI. Then a special video column is also presented as a form of information analysis and student deduction about COVID-19 in order to make decisions and steps to deal with COVID-19.

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Student information is presented with links that can be accessed and elaborated by leading students to problems to be answered or solved. The video presented is a video related to COVID-19 which contains the development of COVID-19, its prevention, and the forms of treatment that have been carried out so far.

Based on the alternative forms of answers given by students in the posttest, students' critical thinking skills have not yet been produced to the maximum level. The form of reasons given in the critical thinking skills test, especially in the indicators of evaluating arguments, does not fully use scientific and scientific concepts. Critical thinking skills which are still in the moderate category after using the supplementary book are in accordance with the alternative forms of answers or reasons given by these students (Damopolii et al., 2022). Students still need to practice their argumentative skills in expressing their answers (Huang et al., 2021).

The reasons (reasoning) of the students are not entirely related to the existing theory regarding COVID-19, however, most of the answer choices have been answered correctly by the students. Therefore, limitations in understanding concepts become a problem in efforts to empower students' critical thinking skills.

Supplementary books that are implemented in learning are to provide additions to the existing subject matter with COVID-19 material. The learning environment and reinforcement provided by the teacher actually determine the students' ability to draw conclusions, assume, deduce, interpret information, and even argue. When the implementation of the reinforcement given by the teacher is still not optimal. Adjustment of the teacher with the proportion and breadth of the material is also very decisive. Understanding of the material by the teacher is the most important thing when the learning process takes place (Saripudin et al., 2022). The use of preventive supplement books for COVID-19 also requires teacher mastery of the material and skills in discussing material, especially related to COVID-19.

The supplement book that was developed really shows well the relevance between critical thinking skills and scientific literacy discussed earlier. The supplement

book presents science concepts, especially COVID-19 with the aim of increasing students' scientific literacy. The material basically contains a lot of facts which are integrated into concepts according to the limitations of the curriculum. Material that is scientifically literate is material that is presented with a relationship between facts and theory, emphasizing empirical nature, describing the use of assumptions, to show cause and effect relationships, and to present scientific methods in solving problems (Goodsett, 2020) This is very closely related to critical thinking skills, where these skills prioritize the principles contained in the material in developing scientific literacy. This means that the principles in scientific literacy also support and are highly relevant to the development of critical thinking skills.

The results of the critical thinking skills test obtained from the research results show scientific literacy skills related to critical thinking, where aspects of deduction, assumptions, and interpreting information are still in the low category. This is relevant to the results of the scientific literacy ability test which are also still at a moderate stage. It is this literacy ability that affects students' ability to interpret information, including COVID-19. Critical thinking skills are more directed to the ability to analyze, understand, and digest information because critical thinking is seen from the aspect of skills (Karan & Brown, 2022). High ability in this information basically determines the high or low critical thinking skills of students (Al-Mahrooqi & Denman, 2020).

The link between the two can also be seen that one of the components of attitude in scientific literacy is the ability to think critically. So the relationship between the two lies in the indicator of critical thinking in the form of interpreting information as part of scientific literacy. Previously it was known that the components of attitude in scientific literacy were independence in learning, the ability to think scientifically, curiosity, and the ability to think critically (Arsih et al., 2021). Supplementary books developed on a digital basis have actually made it easier for students to be independent in learning, the concept within them requires students to think scientifically which is an asset for students to develop critical thinking skills, especially in making conclusions, steps, and behavior in dealing with the COVID-19 pandemic.

## Conclusion

Based on the results of the effectiveness test, preventive supplement books for COVID-19 are generally classified as effective in increasing students' scientific literacy and critical thinking skills. The material contained in the supplement book must also be adapted to current scientific developments, of course

related to COVID-19. The book developed is predicted to be very useful and supportive in learning biology, especially relevant material such as material on viruses, the respiratory system, and the immune system.

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