



Development of a Teaching Supplement on the Threat of Degenerative Diseases of the Circulatory System to Improve Students' Scientific Literacy

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Abstract

This research aims to develop and test the validity, feasibility and effectiveness of an e-book on degenerative diseases of the circulatory system in increasing scientific literacy. This research is Research and Development using the ADDIE model which consists of five research steps including (1) analysis (2) design (3) development (4) implementation (5) evaluation. The research results show that the teaching supplement is very valid to use because based on the material expert's assessment it received a score of 93.5% and the media expert's assessment was 88.3%. The teaching supplement was also declared very worthy because it received a score of 94.2% from teacher responses and a score of 85.3% from student responses. The teaching supplement was declared effective in increasing scientific literacy with a classical completion percentage of 85.9% and a high N-Gain score of 0.71. Therefore, the e-book on degenerative diseases that has been developed is very suitable to be used as a complement and support for biology learning in class, especially in increasing students' scientific literacy.

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INTRODUCTION

Global Education Monitoring (GEM) 2020 shows that the quality of education throughout the world, including Indonesia, has experienced a decline due to the Covid-19 pandemic (UNESCO, 2020). As the era of globalization advances, 21st century education has emerged which has higher challenges. 21st century education encourages students to have scientific literacy skills to face the era of industrial revolution 4.0 (Sutrisna, 2021). Scientific literacy can be defined as the ability to use scientific knowledge, identify questions, and draw conclusions based on scientific evidence in order to understand and make decisions regarding science and changes due to human activities.

Scientific literacy plays an important role in the biology learning process, because through scientific literacy skills students can apply biological concepts to everyday life based on scientific evidence (Sutrisna, 2021). The results of the 2022 PISA survey placed Indonesia in 68th place, where Indonesia managed to climb 6 places compared to the 2018 PISA results. However, reading and science scores decreased to 359 and 383 (OECD, 2023). This decline in reading and science scores is a challenge for Indonesia to improve education. There are several factors that influence low scientific literacy, one of which is the choice of teaching materials.

The government's effort to overcome this is by providing a student handbook compiled by the Ministry of Education and Culture to be used as a reference in the learning process. However, Class XI Biology books are still dominated by rote theories and are less interesting for students. Based on an interview with the biology teacher at SMA N 1 Jakenan, he stated that the material on the human circulatory system is the most difficult material because students must be able to imagine the process abstractly.

Based on the research results of Pujiyanti *et al.*, (2022), the percentage distribution of scientific literacy components in the class .44% contains science as a way of thinking, 12.27% contains the investigative nature of science and 6.54% contains the interaction of science, technology and society. The highest percentage contains knowledge and the lowest percentage is about information or recent new phenomena associated with the interaction of science, technology and society. This is in line with the results of an interview with a biology teacher at SMA N 1 Jakenan, stating that biology learning only uses textbooks or print whose content is monotonous and lacks variety so it does not attract students' interest.

Observation results showed that 91.18% of students stated that one of the circulatory system materials that had not been discussed in detail was about diseases or disorders. In fact, until now the disease that causes the highest death rate in the world is disease related to the circulatory system, namely heart disease. Based on observation results, 70.59% stated that the obstacle to learning the circulatory system was that the material was a lot and complex, but the learning resources used were still monotonous and there had been no updates. Another fact is that 29.41% of students stated that the lack of supporting images in the textbook made it difficult to understand the material.

Based on these problems, it is necessary to develop material on various degenerative diseases of the circulatory system which are a current phenomenon. The development material will be realized in the form of teaching supplements in the form of e-books. Using e-books has several advantages, such as being more efficient and effective for students to access anywhere and anytime without being limited by place and time. The addition of an integrated barcode feature to YouTube videos is also able to encourage learning outcomes and improve students' scientific literacy skills. YouTube videos can facilitate students learning visually and auditorily because they can contain images and sound simultaneously so they are effective in learning (A'yuni *et al.*, 2022). Therefore, the development of an e-book supplement for teaching degenerative diseases of the circulatory system could be an alternative solution in increasing students' scientific literacy.

RESEARCH METHOD

This research uses a Research and Development (R&D) approach. This method is a research method that aims to develop and produce products and test the validity and effectiveness of these products (Sugiyono, 2021). The model used in this research is the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The ADDIE model is very suitable for developing products such as learning strategy models, learning methods, media and teaching materials (Megawati *et al.*, 2022). The advantage of the ADDIE model is that the steps and processes are easy and simple but flexible because each step is related to each other. In the ADDIE model, steps and objectives are clearly defined, and evaluation is carried out in a measurable, reliable and valid manner (Spatioti *et al.*, 2022). This research was carried out in June 2023-February 2024. The development of teaching supplement e-books was carried out at Semarang State University and product trials were carried out at SMA N 1 Jakenan. The research subjects for product validity testing involved two expert lecturers, namely material experts and media experts. The product feasibility test involved a response questionnaire from two biology teachers and 20 class XI students at SMA N 1 Jakenan. The effectiveness of teaching supplements in increasing scientific literacy was tested through pretests and posttests carried out by 71 students in classes XI-10 and XI-12 at SMA N 1 Jakenan.

The first stage is an analysis of potential problems and student needs. The results of the analysis based on interviews with biology teachers at SMA N 1 Jakenan obtained initial information that the textbooks used by students in learning were still conventional and did not attract students' interest. There is also little material in the disease section and there is a lack of detailed explanations so that students' insight into diseases of the circulatory system is still limited. The results of student interviews also showed that 91.18% stated that the material on disorders and diseases of the circulatory system had not been explained in detail and was often overlooked in learning, especially degenerative diseases of the circulatory system. Another fact found in the field was that 70.59% of students experienced problems because the material was large and complex but the learning resources used were still monotonous and had not been updated and 29.41% of students stated that there was a lack of supporting images in the textbook making it more difficult to understand. material.

The second stage is product design where the e-book being developed consists of 68 pages in A4 size. The e-book is designed with a red cover with representations of the circulatory system organs. The initial section is equipped with instructions for use, learning outcomes and learning objectives. This e-book section is divided into introduction, contents and conclusion. The introductory section is designed with supporting images relating to the material of blood components, organs and the working mechanism of the circulatory system. The content section discusses in depth the five types of degenerative diseases of the circulatory system including hypertension, coronary heart disease, myocardial infarction, arteriosclerosis and stroke. This section is also supported by a science investigation column and a barcode scan box to view linked YouTube videos. The final section consists of a bibliography, glossary and author profile.

The third stage is development which is a realization in the formation of teaching supplement product designs (Iftitah, 2023). Teaching supplements that have been produced will be tested for validity to detect errors so that suggestions for improvement can be obtained to evaluate the product (Taufiq *et al.*, 2022). The validity test carried out to determine the suitability of teaching supplements is the validity of the material and media. In the media validity test, the graphic aspect is assessed. The graphic aspect is the design of the book's appearance, such as the cover image and the combination of book colors (Savira & Darussyamsu, 2022). The material validity assessment component consists of three aspects, namely content/material, presentation, and language.

The fourth stage is implementation, which is the activity of applying teaching supplement products to students (Iftitah, 2023). This product trial will be carried out on a small scale involving responses from 36 class XI students of SMA N 1 Jakenan. Trials will also be carried out on high school biology teachers by filling out response questionnaires about the teaching materials. A large-scale trial was carried out with a scientific literacy test through pretest posttest questions in two classes, namely 71 class XI students of SMA N 1 Jakenan. The step before the large-scale test is to test the validity of the questions, where of the 35

questions tested in class XII MIPA 6, 20 questions were declared valid. Valid questions are used as a scientific literacy test in two classes, namely XI-10 and XI-12.

The fifth stage is evaluation which involves activities to improve teaching supplements according to needs based on the results of effectiveness tests that have been carried out (Ifitah, 2023). This stage is important because it ensures that the teaching supplement is evaluated to achieve the specified learning objectives. This final stage of development will produce teaching supplement products that are in line with the hope of increasing students' scientific literacy.

The needs analysis technique uses the interview method with interview guide instruments for both teachers and students. Validity test using material and media expert validation questionnaire sheets. The feasibility test is based on teacher and student responses via distributed questionnaires. The N-Gain score test uses a scientific literacy test with 20 multiple choice questions which have been declared valid for use in student pretests and posttests.

RESULTS AND DISCUSSION

The product resulting from this development research is a teaching supplement e-book entitled "Threats of Degenerative Diseases of the Circulatory System", which was prepared to increase the scientific literacy of high school students, on the material of the circulatory system.

Validity of the Degenerative Circulatory System Disease Teaching Supplement Validity

The validity of the material is carried out by expert lecturers in the field of health biology who are competent and relevant according to the topic of the teaching supplement being developed. The assessment on the validation questionnaire consists of three main aspects, namely: 1) content validity 2) presentation validity 3) linguistic validity. Data from the assessment results by material expert validators are presented in Table 1.

Table 1 . Results of Validity Test Analysis of Teaching Supplement Material

Assessment Indicators	Skor (%)
content validity	91,1
validity of presentation	95,0
language validity	94,4
average score	93,5
criteria	very valid

The results of material validation show an average score of 93.4% so it is included in the very valid criteria. These results state that the material in the circulatory system teaching supplement is in accordance with the aim of increasing scientific literacy and is also very valid for use, but with several improvements. Assessment of teaching supplements based on material expert validators includes three main aspects. The first aspect is the validity of the content or material which consists of four indicators, namely conformity of the material with CP, accuracy of the material, up-to-date material and encouraging scientific literacy. This teaching supplement is prepared in line with the learning outcomes in the independent curriculum which requires students to be able to analyze the relationship between organ structures in organ systems and their functions as well as abnormalities or disturbances that arise in the circulatory system. The completeness of the material in this teaching supplement is good because it discusses in detail five degenerative diseases. The breadth and depth of the material also received a good score because the supplement explains in detail the types, causes, symptoms, how to treat and prevent

degenerative diseases.

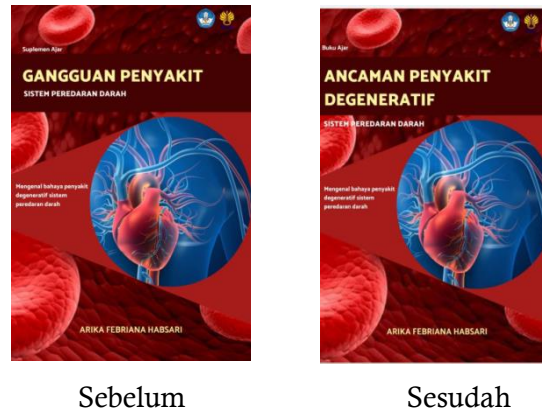


Figure 1. Improvements to the Title of the Teaching Supplement



Figure 2. Component Percentage Improvement Blood



Figure 3. Addition of the investigation box

The validity of teaching supplement media is based on assessments by validators who are expert lecturers in the field of learning media. Data from the assessment results by media expert validators are presented in Table 2.

Table 2. Media Validity Results

Assessment Indicators	Skor (%)
book size	100
book cover design	95,0
book content design	94,4
average score	93,5
criteria	very valid

Based on the results of the media validity test analysis, the average score was 88.3%, which is included in the very valid category. The results of this assessment show that based on graphic aspects, supplements for teaching degenerative diseases of the circulatory system can be used in learning. Media validity is carried out to assess the validity of teaching supplements that are developed so they can be used in learning. The main aspect of assessing the validity of this media is the graphic aspect which consists of three main indicators. The first indicator is the size of the book, where the assessment is based on two sub-indicators including 1) suitability of the size of the book to standards 2) suitability of the size to the contents of the book.

This positive response from media validators shows that the supplement is worth using. Book cover design plays an important role, because it can attract students' reading interest. This is in line with the research results of Mahendra *et al.*, (2023) which stated that book cover designs can increase students' enthusiasm for reading by up to 90%. According to the validator's assessment, the content illustrations are creative and interesting and not monotonous, because they are equipped with lots of pictures or illustrations. The use of relevant images or illustrations can make it easier for students to describe the information they read so that it will help students' understanding (Erlin *et al.*, 2021).

Teacher and Student Responses

Teacher and student responses to the circulatory system teaching supplement were determined based on teacher and student responses. The teacher and student response test was carried out using a teacher and student response questionnaire sheet which consisted of three main assessment indicators including 1) graphics 2) material 3) language. The response test for teachers and students was carried out by two biology teachers at SMA Negeri 1 Jakenan, while for students it was carried out by ten children from class XI-10 and ten children from class XI-12. It is very important to test the responses of teachers and students to find out the responses of teachers and students to the teaching supplements being developed and it is hoped that they can also get suggestions for improvements to improve the quality. The results of the percentage analysis of teacher responses to teaching supplements can be seen in Table 3.

Table 4. Results of analysis of teacher responses

No.	Assessment indicators	Score (%)	
		Teacher I	Teacher II
1.	Graphic aspect	100	95
2.	Material aspects	90	90
3.	Language aspect	100	95
	Average score	96,7	91,7
	Total average	94,2	
	Criteria	Very good	

The results of the analysis of the percentage of teacher responses obtained a score of 94.2% with very adequate criteria. This good teacher response shows that teaching supplements are suitable for use to support biology learning, especially regarding the circulatory system material. The material update with a detailed discussion of degenerative diseases brings new things that not many students know. According to the teacher, the existence of this supplement for teaching degenerative diseases will help in learning about the circulatory system, which is known to be complicated due to the complexity of the material. Learning by looking at the phenomenon of degenerative diseases that often appear in society will also increase students' curiosity so that it can encourage students' learning motivation.

Interesting and up-to-date learning media can influence students' psychology so that it can increase motivation and learning stimulation (Orkha *et al.*, 2020). Learning media must also be arranged according to needs in order to achieve the learning objectives that have been set. The teaching supplement for degenerative diseases of the circulatory system was prepared based on the need for the lack of reference books that discuss abnormalities and disorders of the circulatory system. The choice of degenerative diseases which are often found in everyday life is the main reason to attract students' interest in scientific literacy.

Student responses were made by 20 class XI students of SMA N 1 Jakenan. The results of the analysis of student responses can be seen in Table 4.

Table 4 Results of analysis of student responses

No.	Assessment indicators	Score (%)
		Students
1.	Graphic aspect	87,5
2.	Material aspects	87,25
3.	Language aspect	87,25
	Average score	87,3
	Criteria	Very Good

Student responses showed very good results, namely with a score percentage of 87.3%. This positive response was obtained because students felt helped and interested in the teaching supplement being developed. Their interest is because so far there have been no other reference books that can be used to learn about diseases or disorders of the circulatory system. Even in the biology worksheet books they use, there is no discussion about diseases or disorders of the circulatory system. Discussions about degenerative diseases of the circulatory system provide students with new knowledge that was previously unknown, making it interesting in learning. Selecting diseases that are close to students or often encountered in everyday life also increases students' curiosity to learn. This makes the supplement for teaching degenerative diseases of the circulatory system very good for use as a support for biology learning.

Effectiveness of Teaching Supplements in Increasing Students' Scientific Literacy

Scientific literacy is important in today's learning, especially since Indonesia has quite low scientific literacy. The teaching supplement for degenerative diseases of the circulatory system that was developed was designed to increase students' scientific literacy. The successful influence of teaching supplements on scientific literacy can be seen in the results of students' classical mastery scores. The classical completion score is if students get a score more than the KKM, namely 75. Teaching supplements are said to be successful in increasing scientific literacy if they get a percentage of students who have completed more than 75%. The results of students' scientific literacy test completion can be seen in the Table 5.

Table 5. Percentage of Classical Completion of Students' Scientific Literacy Test

No	Indicator	Amount
1	The number of students	71
2	Graduating Students	61
3	Students Fail	10
Percentage of classical completion (%)		85,9

The results of the analysis of the percentage of students' classical completeness in the scientific literacy test showed a result of 85.9%. This score shows that the supplement for teaching degenerative diseases of the circulatory system can be said to be effective in increasing students' scientific literacy because the percentage of classical completion is more than 75%. This completion provides positive results for the development of teaching supplements that are able to provide new knowledge and are able to train to improve scientific literacy. Developing teaching supplements that are interesting and suit students' needs can help students deepen the circulatory system material that has previously been studied.

The effectiveness of teaching supplements can be measured by calculating the normality-gain (N-gain) value based on the pretest and posttest scores. This effectiveness test was carried out to determine the level of achievement of students' scientific literacy. The results of the N-gain value test can be seen in Table 6.

Table 6. Student Science Literacy N-Gain Score Test Results

Range	Criteria	The number of students	Percentage
$0,71 \leq g \leq 1,0$	High	71	52,1 %
$0,31 \leq g < 0,7$	Moderate	61	40,8%
$0,02 \leq g < 0,3$	Low	10	7,1%
Average n-gain score		0,71	high category

The results of the N-gain value analysis show that the scientific literacy achieved by students is included in the high category with a value of 0.71. This average N-gain score proves that the supplement for teaching degenerative diseases of the circulatory system is effectively used in learning to increase students' scientific literacy.

Supplements for teaching degenerative diseases are feasible and can be applied in learning about the circulatory system. Teaching supplements can be used as learning companions to increase students' scientific literacy related to degenerative diseases. Teaching supplements prepared using examples of degenerative diseases of the circulatory system which are often found in society, are very effective in attracting students' interest in learning and motivation. The use of interesting videos and images is also the reason why students easily understand the material so that it influences students' level of scientific literacy (Rahili *et al.*, 2024). The percentage of each indicator obtained based on the scientific literacy test can be seen in Table 7.

Table 7. Recapitulation of Percentage of Scientific Literacy Indicators

No	Scientific Literacy Indicators	Percentage (%)
1	Knowledge of science	84,5
2	Science investigation	78,0
3	Science as a way of thinking	78,6
4	Interaction of science, technology and society	77,4

The first indicator of scientific literacy is knowledge about science, which based on research

results shows a percentage of 84.5%. This percentage is based on the number of students who answered correctly on scientific literacy questions with indicators of scientific knowledge. The results of this analysis show that the level of students' scientific literacy in the scientific knowledge indicator is very good or high. Indicators of scientific knowledge present concepts, principles, laws and questions that require students to remember knowledge (Ulinniam *et al.*, 2024).

The second indicator of scientific literacy is scientific investigation which trains students to investigate scientific phenomena or facts. The results of data analysis show that scientific investigations on the scientific literacy test obtained a score of 78%. This percentage is included in the good category, so that supplements for teaching degenerative diseases of the circulatory system are able to increase students' scientific literacy, one of which is scientific investigation. Sub-indicators in scientific investigations include 1) using material and knowledge to answer questions 2) communicating findings 3) drawing conclusions based on data. Scientific investigations train students to actively participate in finding facts based on scientific methods. The preparation of teaching supplements for degenerative diseases of the circulatory system which is prepared by linking investigations into diseases found in society is able to attract students' curiosity to learn. The use of cases or health issues that are discussed will increase students' curiosity and investigation to study them in depth so as to increase students' scientific literacy (Kundi & Ducha, 2024).

The third indicator is scientific as a way of thinking which received a score of 78.6% which is included in the good category. Scientific as a way of thinking arises when the desire or curiosity to understand phenomena or facts that occur (Ulinniam *et al.*, 2024). Scientific sub-indicators as a way of thinking include 1) discussion of cause and effect and proven facts 2) emphasis on the empirical and objective nature of science 3) presentation of problem solving based on knowledge. This good percentage result shows that the supplement for teaching degenerative diseases of the circulatory system is able to improve students' thinking processes through disease-based learning.

The final indicator of scientific literacy is the interaction between science, technology and society. The results of the analysis show that this indicator reaches a percentage of 77.4% with good criteria. The use of teaching supplements about degenerative diseases of the circulatory system has a positive influence on students' scientific literacy test results. The selection of types of diseases that are often found in the surrounding environment makes students interested in learning and understanding them in depth. The interaction between science, technology and society is closely related to the teaching supplements that are developed, where the types of diseases and the technology for treating them are connected to each other. Sub-indicators of the interaction of science, technology and society include 1) explanation of the use of science and technology in society 2) the influence of science and technology on society 3) discussion of social problems related to science and technology and their solutions in real life. The influence of the dominant category that emerges is that it can form positive character in students so that they become wiser individuals in responding to environmental and social problems. For this reason, technology must be included as an element in learning because we are aware that science and technology are related in terms of a reciprocal relationship, meaning that technological development can produce ways or means of solving existing scientific problems. The dominant indicators that emerge are indicators of the positive impact of science, technology and society (Lutviana & Laelasari, 2023).

CONCLUSION

Based on the results and discussion, it can be concluded that the supplement for teaching degenerative diseases is very good to use because it received a score of 93.5% from material experts and 88.3% from media experts. Teaching supplements are also very suitable for use based on the teacher assessment score of 94.2% and student assessment with a score of 85.3%. Teaching supplements are also

effectively used to increase scientific literacy with a classical completion percentage of 85.9% and a high N-Gain score of 0.71. Therefore, supplements for teaching degenerative diseases of the circulatory system can be used as a support for classroom learning. The teaching supplement only focuses on five degenerative diseases of the circulatory system which include hypertension, coronary heart disease, myocardial infarction, arteriosclerosis and stroke. Therefore, it is hoped that a more diverse variety of circulatory system diseases can be developed. It is also hoped that the teaching supplement developed can be used in a wider scope, not only at SMA N 1 Jakenan.

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