Unnes.J.Biol.Educ. 13 (3) (2024)

Journal of Biology Education

http://journal.unnes.ac.id/sju/index.php/ujbe

Development of E-Atlas Anatomy of the Vertebrate Digestive System as a Teaching Material Supplement to Improve Student Learning Outcomes

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Article Info

Article History:

Received : July 2024

Accepted : July 2024

Published : November 2024

Keywords:

E-Atlas, Learning Outcomes, Digestive System, Teaching Supplement, Vertebrates

Abstract

This study aims to analyze the validity, practicality, and effectiveness of the E-Atlas Anatomy of the Vertebrate Digestive System as a Teaching Material Supplement to Improve Learning Outcomes of High School Students. This research design is Research and Development (R&D) with ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The subjects of this study were students of class XI SMA Negeri 14 Semarang. Data collection methods include interviews, student needs analysis questionnaires, media expert and matero expert validation questionnaires, teacher and student response questionnaires, and pretest-posttest questions. The results showed that the product developed in the form of E-Atlas contains anatomy and mechanism of the digestive system of humans and vertebrate animals, differences in the digestive system of humans and vertebrate animals, anatomical images of digestive system organs, and videos of digestive system mechanisms. Media validity with a very valid category (96%), material validation with a very valid category (87%), teacher responses with a practical category (77%) and students with a very practical category (85%), classical student completeness results 55%, n-gain test results 0.57 or 57% with a moderate category, and t-test results 0.000 which shows there is a significant average difference between pretest and posttest scores. This study can be concluded that the E-Atlas Anatomy of the Vertebrate Digestive System is valid, practical and effective to be used as a supplement to digestive teaching materials to improve high school learning outcomes.

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p-ISSN 2252-6579

e-ISSN 2540-833X

INTRODUCTION

Education is influenced by changes and all updates in educational components to achieve success. The components of education include curriculum, facilities and infrastructure, teachers, students, learning models, and the selection of appropriate learning media, all of which are closely related to achieving the goals that have been planned in education. The rapid progress of the times and the development of science and technology are efforts to renew and utilize technology in the learning process which is also increasing. This encourages teachers to be able to use tools that are in accordance with what has developed. One of the developments in the world of education can be carried out by a teacher (educator) to support himself to carry out his obligations. A teacher has a duty to teach and is obliged to share his knowledge with all students to the fullest. (Rizki et al., 2020).

The learning process in schools can run well by fulfilling three main components, namely educators (teachers), learners (students), and learning media. Good learning media is learning media that suits the needs of learning activities so that it can create effective and efficient learning. (Junaidi, 2019). Learning with a lecture model without being supported by learning media that is interesting and provides an overview of the content of the material to students, the learning outcomes achieved are not optimal as expected. (Permata & Mustaji, 2021) This shows that the success of teachers and students in achieving learning objectives is inseparable from the learning media used. The learning media received by students must respond to any changes and anticipate any developments that occur in the future.

There are many problems in biology learning media, one of which is the digestive system material. In high school, the material about the digestive system that discusses the human digestive system and the digestive system of ruminant animals with explanations using more text than supporting images, so students are not interested and lazy to learn it. The digestive system occurs not only in humans but in other living things. The digestive system of various living things is also different, such as in animals, especially vertebrate animals. Therefore, learning media can be used as a teaching supplement for digestion in animal groups, especially vertebrates, so that student knowledge is not only limited to the human digestive system and can improve student learning outcomes.

Based on the results of interviews with Biology teachers and students at SMA Negeri 14 Semarang that learning in class XI uses the independent curriculum. Some learning media that are usually used are modules, textbooks, PowerPoint, teaching aids, the surrounding environment, and the internet. The content of the learning media is mostly in the form of text covering the human digestive system and linking it to the digestive system in ruminants with colorless supporting images. Based on this, the available learning media is considered not to be able to function optimally even though it supports learning activities. The teacher revealed that it is necessary to develop learning media that will be able to support the learning process, be more interesting and increase reading interest and improve student learning outcomes in biology learning, especially on digestive system material. The teacher revealed that the level of motivation of students at SMA 14 Semarang towards learning biology, especially on the digestive system material is currently low. Teachers often ask students to read more biology books in the school library. Students themselves think that the available biology books contain more text material and rarely have color pictures so that students find it difficult to understand the material, especially the digestive system where the digestive system material is abstract material. Students are more interested in books that are equipped with many pictures with more diverse colors. Teachers and students also revealed that they had never used E-Atlas in the biology learning process, especially on digestive system material.

In accordance with the independent curriculum, phase F learning outcomes are that students have the ability to describe the bioprocesses that occur in cells, and analyze the relationship between the structure of organs in the organ system and their functions and abnormalities or disorders that arise in the organ system. These learning outcomes can be achieved by students by increasing student motivation so that student learning outcomes also increase.

The supplement product to be developed in this research is the E-Atlas. The atlas prepared in this study is in electronic form which is accessed through a link. The E-Atlas contains information on the anatomical structure of the vertebrate digestive system along with its mechanisms and differences with the human digestive system supported by schematic images and learning videos. The E-Atlas is organized by emphasizing clear images and video-supported material descriptions. The presentation of colorful images will foster a sense of student interest and can provide an overview to students compared to text on the material without having to directly observe the digestive system of vertebrate animals. Video presentation makes it easier for students to understand the material and gives students an overview of the material, especially on process material. The atlas developed is flexible in the form of an electronic atlas so that it can be accessed anywhere and anytime. E-Atlas is used as a teaching supplement that is used outside of class hours to support the learning process in the classroom.

Based on this background, this study aims to develop, test the feasibility, and effectiveness of E-Atlas in learning biology, especially digestive system material in high school using the Research and Development (R&D) research method with the ADDIE model.

RESEARCH METHOD

This research is a Research and Development (R&D) study and uses the ADDIE model which refers to five stages, namely analysis, design, development, implementation, and evaluation.

The problem and potential analysis stage is measured from the results of interviews with teachers and student needs analysis questionnaires. At the design stage, the design of the supplement product to be made is carried out, including the preparation of E-Atlas material, the selection of media to be used in developing the product, the selection of the E-Atlas format to be developed. In addition, at the design stage, the preparation of instruments used in research is carried out. At the development stage, the realization of the product from the design that has been prepared is carried out. The product was prepared using the Canva application with A4 paper size and 42 pages, the E-Atlas color display is dominated by blue and white. The components of the E-Atlas Anatomy of the Vertebrate Digestive System to be developed include the front cover page, preface, table of contents, instructions for use, introductory material, content of human and vertebrate digestive system material, exercise questions, bibliography, glossary, author profile, and notes on criticism and suggestions. At this stage, validation was also carried out by media experts and material experts. After the product was declared valid, then entered the implementation stage, the product was tested on a small scale by giving a response questionnaire to teachers and students of SMA Negeri 14 Semarang. After small-scale testing, the product was then tested on a large scale to class XI-6 SMA Negeri 14 Semarang, totaling 34 students who were then tested for effectiveness from pretest and posttest data. The evaluation stage was conducted to make revisions based on comments and suggestions obtained from media experts, material experts, teacher and student responses.

RESULTS AND DISCUSSION

The product of the development research of the E-Atlas Anatomy of the Vertebrate Digestive System can be accessed online through the following link https://bit.ly/E-AtlasAnatomiSistemPencernaanVertebrata.

Characteristics of E-Atlas

The Vertebrate Digestive System E-Atlas is A4 in size and has 42 pages. The characteristics of the E-Atlas Anatomy of the Vertebrate Digestive System developed by the page can be seen from several components contained in the E-Atlas, namely the title located on the front cover of the E-Atlas, preface, table of contents, instructions for using the E-Atlas, content section, exercise questions, bibliography, glossary, author profile, and notes on criticism and suggestions.

The cover page of the E-Atlas contains the title of the Vertebrate Digestive System E-Atlas, anatomical images of the digestive system and 5 classes of vertebrate animals that illustrate the outline of the contents of the E-Atlas, the target of the E-Atlas which is high school students, the names of the authors and editors of the E-Atlas as well as the logo and name of the compiling institution. The preface is structured like a preface in general which aims to express the author's gratitude and convey the purpose of developing this E-Atlas. The table of contents is a section that contains a collection of titles from the chapters written, making it easier for readers to find information based on the page numbers that have been written. Instructions for using the E-Atlas contain how to use the E-Atlas. Introduction contains introductory material on the digestive system.

The design of the content section of the E-Atlas consists of an explanation of the human digestive system material as an initial introductory material that explains the anatomical structure of the human digestive system in general and the mechanism of the digestive system that occurs in humans. Furthermore, the vertebrate digestive system section is divided into 5 chapters, starting from the lowest class, namely pisces, amphibians, reptiles, aves, and mammals with an explanation of the anatomical structure and its functions equipped with pictures and the mechanism of the digestive system equipped with videos, besides that there are also differences in the digestive system between humans and each class of vertebrates.

In the closing section there are practice questions that serve to hone students' abilities. Bibliography that contains references in compiling E-Atlas material. Glossary that serves to assist readers in understanding important terms contained in the E-Atlas. The author's profile contains the author's biodata. Criticism and

suggestion notes in the form of a google form link that serves as a forum for criticism and suggestions from readers to the author regarding the developed E-Atlas. E-Atlas characteristics can be seen in the following figure.

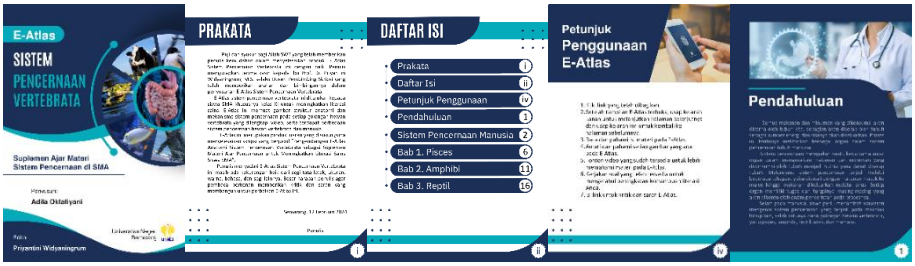

Figure 1. Opening section

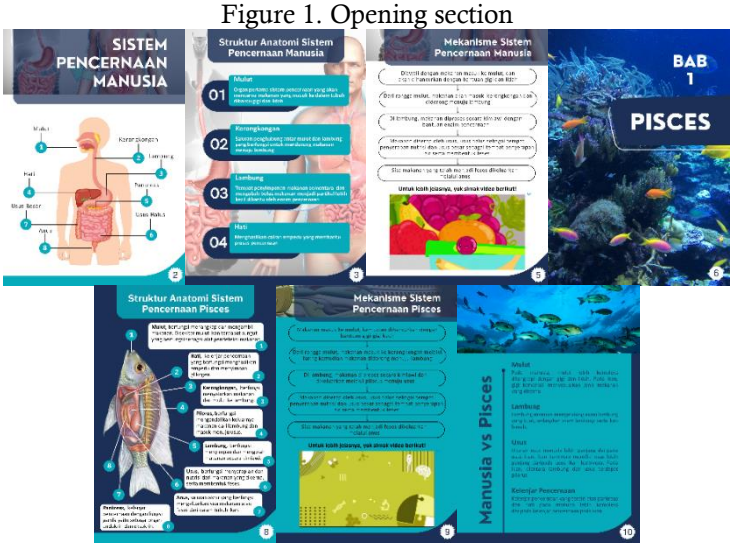

Figure 2. Contens

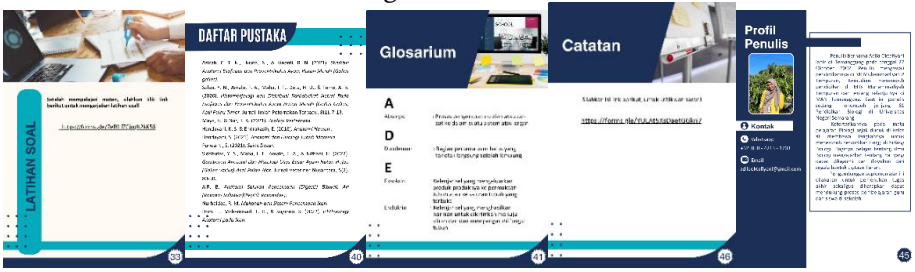

Figure 3. Closing section

E-Atlas Validity

The validation is carried out to assess the validity of the product developed by the researcher with a validity test. The validity test was carried out in two stages, namely media and material validity tests by media experts and material experts who are experts in their fields. The E-Atlas validity test was carried out through a questionnaire using a Likert scale. The score results were then analyzed and converted into a percentage. A recapitulation of the validation results of media experts and material experts can be seen in the following table.

Table 1. E-Atlas Validity Test Results

Description	Maximal score	Score obtained	Percentage (%)	Category
Media expert	92	89	96	Very valid
Material expert	80	70	87	Very valid

The results of media validation obtained a score of 89 out of a maximum score of 92 with a percentage of 96% indicating that the E-Atlas developed in the category is very valid. Aspects assessed by media experts include: practicality, software, consistency, language, graphics, and usability. The practicality aspect scored

100%, the software aspect 100%, the consistency aspect 100%, the language aspect 100%, the graphical aspect 100%, and the usability aspect 75%. Media experts commented that the developed E-Atlas does not need too much material covered in it because it is a supplement or additional material so that if there is too much material it is feared that it will increase the burden on students. So the advice given is to reduce several pages of material on the vertebrate digestive system, so that based on the results of the analysis of the assessment of the material expert, the E-Atlas of the vertebrate digestive system is suitable for use with revisions.

The material validation results obtained a score of 70 out of a maximum score of 80 with a percentage of 87% indicating that the E-Atlas developed in the category is very valid. Aspects assessed by material experts include: material, content feasibility, material presentation, and usability. The material aspect scored 75%, the content feasibility aspect 83%, the material presentation aspect 85%, and the usability aspect 91%. The material expert did not provide any suggestions or comments on the product of the E-Atlas teaching supplement development, so based on the results of the analysis of the assessment of the material expert, the E-Atlas of the vertebrate digestive system is suitable for use without revision.

Practicality of E-Atlas

The practicality test of E-Atlas was obtained from teacher and student responses through teacher and student response questionnaires using a Likert scale. E-Atlas practicality assessment is based on student responses with a total of 10 students and 1 Biology teacher of SMA Negeri 14 Semarang. A recapitulation of the results of the E-Atlas practicality test by teachers and students can be seen in the following table.

Table 2. E-Atlas Practicality Test Results

Description	Maximal score	Score obtained	Percentage (%)	Category
Teacher	40	31	77	Practical
Students	400	342	85	Very practical

Teacher responses regarding the practicality of the E-Atlas obtained a score of 31 out of a maximum score of 40 with a percentage of 77% in the practical category. This shows that the developed E-Atlas is practical to use in the learning process as evidenced by the results of the assessment percentage(60%. The teacher gave a very good assessment of the overall design of the E-Atlas with an assessment result of 100% so that the E-Atlas can be used as an attractive biology teaching media. In the aspect of cover design and content of the E-Atlas, the result is 75, the aspect of material presentation is 75%, the aspect of displaying the contents of the E-Atlas is 75%. The presentation of the atlas in electronic form is more effective because it can be accessed anywhere and anytime. This is supported by research from (Ardiana & Fitrah Dewi, 2023) that E-Atlas media is practical to use because it can be accessed through a link that has been disseminated and does not take up storage space on students' smartphones.

Students' responses regarding the practicality of E-Atlas with a total of 10 respondents obtained a score of 342 out of a maximum score of 400 with a percentage of 85% in the very practical category. The results of the analysis of the practicality of the E-Atlas based on several aspects of the assessment, namely the overall design of the E-Atlas is attractive 60% of students gave a strongly agreed assessment and 40% of students gave an agreed assessment; cover design and content of the E-Atlas with the display of color variations, letters, and interesting ornaments 100% of students gave a strongly agreed assessment; the presentation of material that can help improve learning outcomes 30% of students gave an assessment strongly agree, 60% of students agreed, and 10% of students gave an assessment less agree; the material presented in each chapter is clear and systematic 20% of students gave an assessment strongly agree and 80% of students gave an assessment agree; the presentation of communicative material that helps make it easier for students to learn the contents of the E-Atlas obtained a student assessment 50% strongly agree and 50% agree; the material presented is equipped with pictures and captions as well as interesting videos 30% of students gave an assessment strongly agreed and 70% of students agreed; the display of E-Atlas content equipped with varied images and videos makes E-Atlas not boring 2% of students strongly agreed, 70% of students agreed, and 10% of students disagreed; the language used in the E-Atlas is clear and easy to understand 60% of students strongly agreed, 30% of students agreed, and 10% of students disagreed; the presentation of supporting information in the E-Atlas can increase learning outcomes students strongly agreed 50% and 50% agreed; the presentation of the atlas in electronic form is effective and can be studied anywhere 30% of students gave an assessment strongly agreed and 70% of students gave an assessment agreed.

From the results of the analysis based on several aspects, it can be concluded that the E-Atlas of the

vertebrate digestive system is practical to use in supporting the biology learning process, especially on digestive system material and can help improve student learning outcomes. This is supported by the statement (Kusuma et al., 2018) that atlas learning media can be used in the learning process as a supporting book that helps students learn.

Effectiveness of E-Atlas

Measurement of the improvement of student learning outcomes in this study was carried out using test instruments in the form of pretests and posttests. The data generated are the results of pretest and posttest scores which are then analyzed for the results of students' classical completeness, the improvement of student learning outcomes through the N-gain test and the average difference in pretest and posttest results on the use of E-Atlas Anatomy of the Vertebrate Digestive System. The product was given after students did the pretest questions, then continued the posttest after giving the product to students. The product effectiveness test was conducted in class XI-6 SMA Negeri 14 Semarang with 34 students. The results of classical completeness can be seen in the following table.

Table 3. Classical Completion Results

Description	Number of students
Number of students who completed	19
Number of students who did not completed	15
Classical completense (%)	55%

Then the N-gain test was conducted to determine the increase in student learning outcomes. The results of the N-gain test based on pretest and posttest scores can be seen in the following table.

Table 4. N-gain Test Calculation Results

N-gain score	Number of students	Percentage (%)	Category
g < 0,3	9	25	Low
0,3 ≤ g < 0,7	16	50	Medium
g ≥ 0,7	9	25	High

Based on the results of the N-gain test calculation, it shows that the results obtained by the average N-gain value are 0.57 or 57% which means in the moderate category. This is related to the unfamiliarity of students in using E-Atlas teaching supplements in previous learning. The teaching supplement E-Atlas Anatomy of the Vertebrate Digestive System can be declared quite effective in improving student learning outcomes as evidenced by the results of the N-gain calculation which reached the target of 0.3(. Thus, this shows that after the use of E-Atlas in the learning process of the digestive system, students experience a fairly high increase in learning outcomes. This is in line with the statement Febrianti (2021) that digital book media equipped with various features can encourage students to participate more actively in the learning process so that students' ability to understand the material also increases.

The difference in student learning outcomes before and after using E-Atlas based on hypothesis testing is done with a t-test. The t-test can be done if it meets the prerequisite tests, namely the normality test and the homogeneity test. The results of the calculation and explanation of the prerequisite test are as follows.

a. Normality Test

The normality test was carried out using the One Sample Kolmogorov technique: Smirnov Test technique using the SPSS ver 25 for windows application. The provisions of this test are, if the sig value(0.05 then the data is declared normal and if the sig value <0.05 then the data is declared abnormal. The normality test results obtained are as follows.

Table 5. Normality Test Results

	Kolmogorov : *Smirnov Test*		
Value result	N		34
	Normal parameters	*Mean*	0,00
		Std. Deviation	20,195
	Most extreme differences	*Absolute*	0,145
		Positive	0,118
		Negative	-0,145
	Test statistic		0,145
	Asymp. Sig. (2-tailed)		0,66

Based on the results of the normality test on the pretest and posttest scores contained in the table above, it is known that the results obtained a sig value of 0.66 which indicates that these results have a significance value of(0.05 so that the data from the pretest and posttest scores are normally distributed.

b. Homogeneity Test

The homogeneity test was carried out using the SPSS ver 25 for windows application with the provisions that if the sig value was(0.05 then the data was declared homogeneous and if the sig value was <0.05 then the data was declared inhomogeneous. The homogeneity test results obtained are as follows.

Table 6: Homogeneity Test Results

Test of Homogenity of Variances		*Lavene Statistic*	df1	df2	Sig.
Pretest and posttest result	*Based on mean*	5,373	1	66	0,024
	Based on median	3,538	1	66	0,064
	Based on median and with adjusted df	3,538	1	47,4664	0,066
	Based on trimmed mean	4,839	1		0,31

Based on the results of the homogeneity test analysis of the pretest and posttest scores contained in the table above, it can be seen that the results obtained with a sig value of 0.024 indicate that these results have a sig value <0.05 so that the data is declared inhomogeneous, meaning that the data does not have the same variance.

Because the results of the pretest and posttest data analysis obtained are normally distributed and not homogeneous, the t-test requirements are met. The t-test is a parametric test, in conducting a parametric test there are conditions that must be met, namely the data used must be normally distributed and homogeneous (not mandatory). (Raoda et al., 2022).

c. Independent Sample t-test

After the data obtained from the pretest and posttest scores were tested for normality and homogeneity, then the average difference test was carried out using the Independent Sample T-Test test using the SPSS ver 25 for windows application with a significance level of 0.05. The results of the Independent Sample T-Test test can be seen in the following table.

Table 7. T-test Results

		Lavene's Test for Equality of Variances		T-test Equality of Means				
		F	Sig	T	Df	Sig (2-tailed)	Mean Difference	Std. Error Difference
Pretest and posttest result	Equal variances asssumed	5,373	0,024	-8,859	66	0,000	-36,02941	4,06680
	Equal variances not asummed			-8,859	54,820	0,000	-36,02941	4,06680

Based on the analysis results presented in the table above, it is known that the sig value of 0.000 is obtained, which means that the sig value <0.05, it can be stated that H0 is rejected and Ha is accepted. Thus, it can be concluded that there is a significant difference between the results of the pretest and posttest scores. This shows that the use of teaching supplements E-Atlas Anatomy of the Vertebrate Digestive System is effective in helping improve student learning outcomes. This is in line with the statement Musdalifa (2021) that the use of learning media greatly helps the effectiveness of the learning process in terms of delivering information, namely subject matter. In addition, it can also improve student understanding, motivation, and student learning outcomes with the development of learning media that are interesting and in accordance with the needs of teachers and students.

Based on the results of the research and data analysis that has been carried out, the E-Atlas can be declared valid, practical, and effective in helping improve the learning outcomes of high school students in digestive system material. Biology learning using this E-Atlas can add new knowledge and can develop students' scientific thinking process, besides that the presence of colored images is more interesting and not boring so that it makes it easier for students to understand the material and students feel happier when learning

activities take place. E-Atlas Anatomy of the Vertebrate Digestive System has the advantage of making it easier for students to be able to access anywhere and anytime with the link that has been given using a cellphone or laptop. E-Atlas also has disadvantages, namely the use of E-Atlas must use an internet connection so that if the internet network is weak it will make it difficult for students to access E-Atlas.

CONCLUSION

Based on the results of research and discussion, it can be concluded that the characteristics of the E-Atlas teaching supplement for the vertebrate digestive system developed have met all the characteristics designed, namely the form of atlas media in the form of an electronic atlas or E-Atlas, full color display with the dominance of blue and white, A4 size, 42 pages, material equipped with color images and supporting videos, The content of the material presented is the anatomy and mechanism of the vertebrate digestive system and its differences with humans, the E-atlas consists of an opening, content, and closing section, the E-Atlas can be accessed using software through the link provided The developed E-Atlas is very valid, practical, and effective to be used as a teaching supplement on the digestive system and helps improve the learning outcomes of high school students.

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