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Development and Validation of E-Books Based on Socio-Scientific Issues to Improve The Argumentation Skills of High School Students

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Abstract: This study aims to develop and analyze the validity of the e-book on environmental pollution based on socio-scientific issues to improve students' argumentation skills. The development of the e-book uses the ADDIE design (Analysis, Design, Development, Implementation, and Evaluation), but this research has only reached the development stage (Development/D). This study used a qualitative descriptive analysis using a validation sheet instrument in the form of a questionnaire by two experts: material experts and technology/application experts. Data analysis technique using Content Validity Ratio (CVR). The validation results of material experts got a score of 98.38% in the very feasible category, while the application/technology expert for evaluating the application of content and language feasibility, respectively, got a score of 85.94% and 81.58% in the very feasible category. Based on the assessment results of the two validators, the e-book on environmental pollution based on socio-scientific issues was declared valid and suitable for use in the learning process. The conceptual implication of this study is that environmental pollution e-books based on socio-scientific issues can facilitate students in developing argumentation skills. As for the practical implications, the e-book can be used as an innovation as a Biology learning resource that makes it easier for students to learn independently and streamlines the delivery of material in learning activities in the classroom for teachers.

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Introduction

21st-century learning has four components that students must master. The four components include communication skills, collaboration, critical thinking, problem-solving, innovation, and creativity (Chu *et al*., 2017). One of the four components students must be proficient at is communication skills. To master communication skills, students must also master argumentation skills. Argumentation skills are essential for students to develop thinking and communication skills in daily activities (Wambsganss *et al*., 2020).

In learning biology, argumentation skills are critical to training students to have logical reasoning and rational explanations based on concepts of phenomena encountered in everyday life (Osborne, 2010). However, the reality in the eld shows that the opportunity for students to participate in arguments related to science learning still needs to be completed (Roviati *et al*., 2017). In line with the research by Noer *et al*. (2020), most students'argumentation skills were still at levels 2-3, which means they need to improve.It is because students have yet to be able or cannot use the (rebuttal) indicator correctly but can include (data), (warrant), or (backing) claims that are considered valid by students.

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Based on the explanation above, an alternative solution is needed to improve students' argumentation skills. One is improving the methods or the teachingmaterials used during teaching and learning activities. The results of observations in the field state that teachers are often more dominant in teaching and learning activities using the lecture method. It is in line with Duschl & Osborne (2002) that the teacher's lack of ability to regulate the course of discussion makes discussion activities during classroom learning more dominated by ideas from the teacher. As a result, learning practice these days has yet to be able to initiate students to state their arguments related to their problems. Therefore, a learning process was required by creating a pleasant learning atmosphere and training students' understanding of argumentation.

Another factor that causes low argumentation skills is using learning resources like printed teaching materials from publishers (Student Work Sheet), which are already available in the library. The teaching materials used in schools only present concepts, principles, samples, and practice questions with a discussion (Sujanem *et al*., 2022). In addition, the teaching-learning process during the Covid-19 Pandemic has made the learning process inadequate because the teaching materials needed to be designed to help students learn independently (Puspitasari, 2019). Hence, teachers must be able to innovate and be creative in compiling exciting teaching materials and following advances in science and technology (Yantoro *et al*., 2021). Based on this, practical teaching materials are needed to support independent learning anywhere and anytime by students and can improve argumentation skills. One of them is by using suitable teaching materials, namely e-books.

An E-book is a teaching material in digital form equipped with images, text, and videos that can be read or accessed via electronic devices (Suarez, 2013). According to Jarak & Alwan (2018), current e-books circulated in public are still being developed in pdf format. Hence, e-books must be interactive and easy to access through various devices for future use. One of the devices used to access an e-book is the smartphone, in which the selection is based on the habits of students who arestarting to use electronic media actively. The Kominfo survey (2017) results showed that 79.56% of senior high school students in Indonesia already owned and operated a smartphone (Komunikasi & Indonesia, 2017). In addition, the results of the researcher's observations (2022) also stated that most senior high school students in the Batang area already had smartphones. When e-books and smartphones support learning, the materials could be accessed anytime and anywhere, making their use more effective and efficient (Ali & Mahmoud, 2014).

The development of e-books is adjusted to the essential competencies and the applicable curriculum. In addition, e-books must be arranged systematically and equipped with test questions focusing on the skills to argue against the material being studied and evaluate student learning activities. In their presentation, e-books must also contain the correct theory and explicit material according to the student's cognitive level (Andaresta & Rachmadiarti, 2021). The learning material in the e-book must also be adapted to the actual situation around the learner's environment. The reason is that when facing problems in everyday life, students can solve them by connecting the concepts of the lessons they are studying (Sofyan *et al*., 2019). Therefore, a strategy for e-book development must follow the characteristics and problems in the appropriate social environment, which can later improve students' argumentation skills. One technique that can be used in developing an e-book is known to be based on socio-scientific issues. The results of previous studies by Asi *et al*. (2021) support it, where interactive e-books on peat ecosystem materials that integrate socio-scientific issues are concluded to be effectively helpful in learning science.

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Socio-scientific issues are topics based on scientific and social problems, have a scientific component, and intersect with ethics, politics, economics, and religion (Borgerding & Dagistan, 2018). Learning about socio-scientific issues is suitable because it is believed to improve students' argumentation skills and their ability to distinguish between science-related issues and those not included in science (Han-Tosunoglu & Lederman, 2021). The themes that support socio-scientific issues are extensive, one of which is biology learning material which, according to Paraskeva-Hadjichambi *et al.* (2015), could include discussion on controversial and complex topics and other global issues. Environmental pollution is one of the many biological materials that can beused as a socio-scientific issue. Socio-scientific issues related to environmental pollution are contextualissues that often occur or are encountered in people's daily lives (Herawati *et al*., 2019).

From the explanation above, This study aims to develop and analyze the validity of the e-book on environmental pollution based on socio-scientific issues to improve students' argumentation skills. The e-book designed from this study is expected to be helpful as a learning resource that trains students to improve their argumentation skills.

Research Method

The research employed Research and Development (R&D) design with the ADDIE development model by Sugiyono (2016). The e-book development design used in this research was the ADDIE development model. It comprises five stages: Analysis, Design, Development, Implementation, and Evaluation. However, this research has not reached the development stage (Development/D) This study used a qualitative descriptive analysis with a questionnaire as a validation instrument based on BNSP (*National Education Standards Agency*). Validation questionnaires distributed to validators included material and application/technology validation questionnaires. Material experts assessed the validation test to determine the following elements: feasibility of the content, presentation feasibility, and contextual feasibility, while the validation test assessment by application/technology experts to see the evaluation of the operation of the e-book application and assess the feasibility of content and language feasibility. The validators included two Biology lecturers from the Indonesia University of Education (UPI), one material expert, and one application/technology expert. The data analysis technique used the *Content Validity Ratio* (CVR) (Lawshe, 1975) with the following formula:

$$P = \frac{\sum nx}{\sum ny} x\ 100\%$$

Description:
∑nx = Total score from validator for all aspects
∑ny = Total maximum score of all aspects
P = Presentation of the overall score

The scoring criteria used for the material validation and application/technology validation based on Riduwan (2015) are presented in the following table:

Table 1. Validity Criteria

Validity Criteria	Validity Level
0% - 20%	Invalid
21% - 40%	Not Valid
41% - 60%	Quite Valid
61% - 80%	Valid
81% - 100%	Very Valid

Source: (Riduwan, 2015).

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If the evaluation results reach a percentage of 60%, it is said that the e-book isfeasible and can be further developed.

The e-book development design used in this research was the ADDIE development model. It comprises five stages: Analysis, Design, Development, Implementation, and Evaluation (Sugiyono, 2016). However, this research has only reached the development stage (D), namely the stage to determine the validity of the e-book that has been developed.

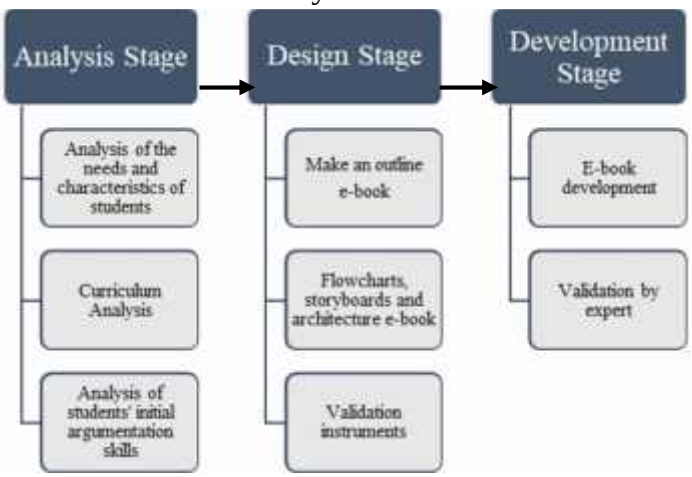

Figure 1. The ADDIE Model

Analysis Stage

The first aspect of the analysis phase is the needs and characteristics analysis. The results obtained from the needs analysis, namely interviews with students about the learning methods teachers often use, 53.33% answered lectures and 33.33% answered questions and answers, and the rest answered discussions. The learning resources used to study environmental pollution material; as many as 66.67% of students answered that the printed teaching materials provided could not assist in independent learning because they only contained short material and evaluation questions. Students saw print teaching materials as less attractive because they needed pictures and were equipped with learning videos and other interesting features. Wibowo & Pratiwi (2018) state that printed teaching materials could be more attractive, varied, and easier to understand, making students feel bored and bored in reading them. That causes a decrease in student interest when using the teaching content provided.

The second aspect is curriculum analysis. In this analysis, information was obtained that high schools in the Batang area used the 2013 curriculum in teaching and learning activities. Based on an analysis of the basic competencies regarding environmental pollution, the material included in the e-book was environmental pollution, types of pollution, types of waste, and ways of managing waste equipped with phenomena related to socio-scientific issues. Materials were prepared by referring to relevant references such as books and discourse from newspapers relevant to socio-scientific issues and journals. Even so, the development of the e-book used the context of the 2013 Curriculum, but the orientation of the e-book was by the Merdeka Curriculum.

In the third aspect, the researcher looked at the student's initial knowledge and argumentation skills regarding environmental pollution by asking questions that included indicators of *Toulmin's Argumentation Pattern* (TAP) argumentation abilities, namely claims, warrants, data, backing, rebuttals, and qualifiers (Magalhães, 2020). The results showed that argumentation skills were dominated at levels 1 and 2, meaning students could only express opinions on claims, warrants, and data indicators. That is supported by the results of

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interviews with teachers that so far, teachers have not known or have just known about socio-scientific issue-based learning, where learning with socio-scientific issues is always related to science concepts and social components so that learning so far carried out by teachers has not opened space for students, in arguing.

Design Stage

According to the ADDIE model, the next stage for e-book development is the design stage. The researchers started to plan and design the e-book according to the results of the previous analysis. The goal is to improve and produce materials to support learning and practicing argumentation skills. The first thing to be done in the design stage was to create an e-book outline. The outline contains a general design of the e-book contents related to discussing environmental pollution materials and the learning objectives.

The outline's contents include the cover section's appearance, introduction, basic competencies, and assessment rubrics. The e-book describes the material, aspects of socio-scientific issues related to environmental pollution, space for socio-scientific issues and discussion about arguments, assignments (observations and practicum), evaluation questions, and answer keys. The closing section contains a bibliography. After determining the outline of the e-book, the process moves on to the flowchart making, storyboard, and e-book architecture. These several stages aim to show the operating flow to facilitate researchers and developers in compiling an e-book on environmental pollution based on socio-scientific issues so that each program flow designed can run harmoniously. When the design phase is complete, the researcher creates an instrument for validation for material experts and application/technology experts. The following is an e-book design based on socio-scientific issues regarding environmental pollution, which is presented in the following picture:

Table 2. Design Characteristics of Environmental Pollution E-Books Based on Socio-scientific Issues

Figure 1. The splash screen is the initial display when users run the application for the first time.

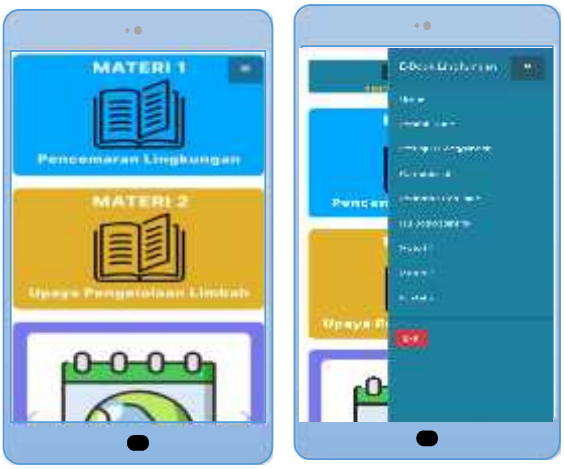

Figure 2. Equipped with a table of contents as a guide for readers to see each content displayed in the e-book.

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Figure 3. In this feature, the argumentation skills of students will be seen. This feature supports improving argumentation skills through the identification and description of issues taken from the study of articles and current news sources on socio-scientific issues on environmental pollution by considering various aspects such as social, economic, and environmental aspects which are equipped with questions that refer to the indicators of argumentation skills from *Toulmin's Argumentation Pattern* (TAP).

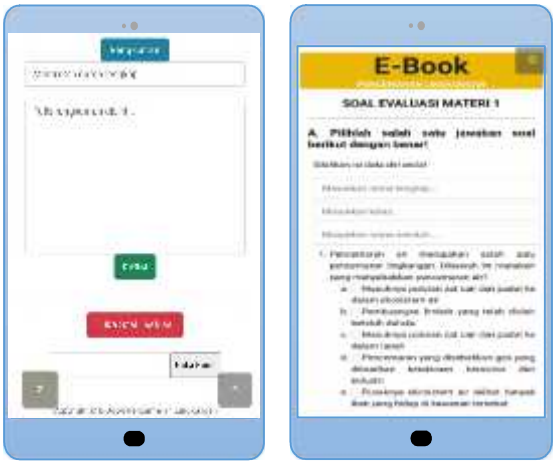

Figure 4. Left: Summary column to summarize all the material that students have understood. Right: Practice questions as a form of evaluation in improving students' understanding of the concepts.

Figure 5. Design of pages for observation and practicum activities relevant to environmental pollution issues.

Development Stage

The development stage is the third stage in the ADDIE model. In this stage, the e-book designed according to the design would be produced as an initial product. The application developed was electronic media with the help of Android Studio programming. It consists of environmental pollution material with socio-scientific issues and space for students to train their argumentation skills. The e-book application must be tested for validity by experts to see its feasibility. The e-book application developed must be declared valid and feasible by these experts before being implemented in classroom learning. Experts validating this e-book include material experts and application/technology experts. In the validation process, the study used the instruments prepared in the previous stage.

Results and Discussion

The Material Expert Validation Assessment

A Biology Education Lecturer from the Indonesia University of *Education* assessed the validation test as the material expert. This assessment aims to determine aspects of content feasibility, presentation feasibility, and contextual feasibility. The results of the validation in detail for each assessment indicator (Figure 2.) is as follows:

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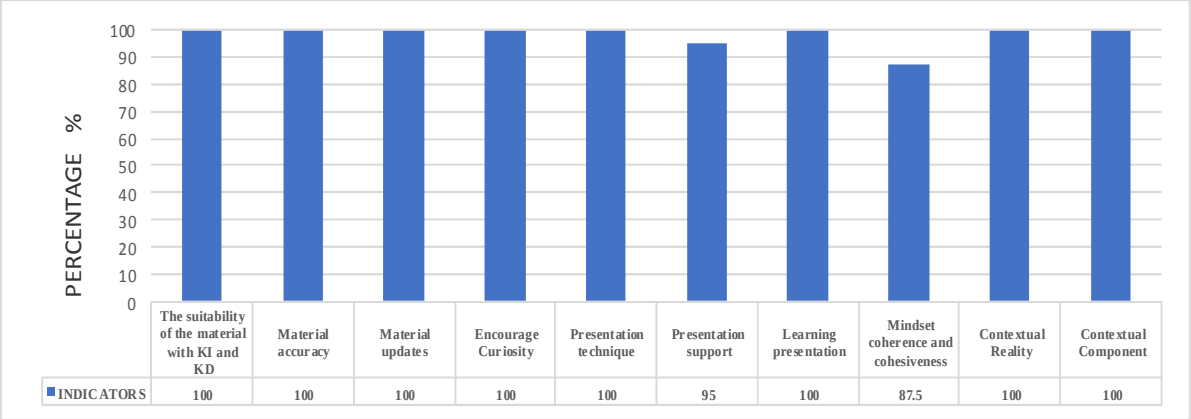

Figure 2. Graph Of Material Validation Results by Experts

The assessment results on the content, presentation, and contextual feasibility of the developed e-book have very valid, with a total percentage of 98.38%. In the aspect of feasibility, the content consists of 4 assessment indicators. All assessment indicators get a very valid score in percentage since the material compiled in the e-book is by KI and KD and follows the applicable curriculum. The developed e-book has excellent accuracy in concepts and definitions, data and facts, pictures, and illustrations. According to Rafidah & Rachmadiarti (2022), e-books with accurate material concepts accurate, facts, examples, and explanations in the material do not cause different interpretations of meaning when applied to students. Therefore, students can use e-books for their independent study since it will not cause them any misconceptions.

The up-to-date material contained in the e-book also got a good percentage because the content of the e-book was adapted to the latest developments in biological science, especially on environmental pollution material. In its development, the material was equipped with socio-scientific issues and examples of recent cases regarding environmental pollution that are directly related to the problem that students in the surrounding environment often face. Therefore, e-books can stimulate curiosity and develop the ability of users to formulate hypotheses, ask questions and find solutions to these problems (Triana & Sulistiyowati, 2020). In addition, the material presented is completed with supplemental pictures and videos to make it easier for students to learn, according to the opinion of Yalçintas Sezgin & Ulus (2017), which states that teaching materials supported by images, videos, and links provide much information to help students understand the material.

The next was the aspect of presentation feasibility which includes four assessment indicators. The e-book scored perfectly in the presentation techniques and support indicators, which was very valid. It is because the e-book consists of all the necessary elements: the front page or main menu, introductory words, table of contents, and essential competencies, and the content section contains material discussion topics focusing on environmental pollution, the subject of water pollution, the subject of soil pollution, the subject of air pollution, and the subject of management waste, a summary, and bibliography in the closing section. The sequence of concepts proposed in this e-book is appropriate and systematically arranged, making it easier for students to study the e-book. In line with the opinion of Sadjati (2019), e-books that are presented systematically can provide convenience to students when they master the subject matter.

The e-book developed in this study was also equipped with evaluation questions and answer keys. It aims to facilitate students to know the extent of their understanding in studying environmental pollution material. The e-book also included practice questions to

hone students' argumentation skills. The questions were taken from relevant sources, such as news discourse or journals related to socio-scientific real-life actual issues around students. These questions were also designed based on *Toulmin's Argumentation Pattern* (TAP) argumentation skills indicator.

The e-book also contains observation and practicum activities for individual and group activities. These activities could be carried out by students outside and inside the classroom. The goal is to help students actively discuss to prove or experience the concepts they have learned for themselves. Besides, by providing these features, the e-book can be a source for students to train their creative, problem-solving, and critical thinking skills. It is because the mentioned skills before are also part of the argumentation skills (Hendri & Anwar, 2019).

These features also correlate to contextual feasibility, which gets a perfect percentage. It is because the e-book presents the material by citing and using actual issues around the students' environment. The content presented in the e-book met the construct requirements since it includes socio-scientific issues as the materials and practice questions that can drill students' argumentation skills. The validation results from material experts also prove the suitability of the e-book content with the dependent variable in the study. The results of the validation can be seen in the following table:

Table 3. Aspects of Compatibility of E-Book Content with Argumentation Skills

Argumentation Indicator	E-book materials	Compatibility	
		Yes	No
Claim	Soil Pollution	✓	-
Ground			
Warrant	Liquid Waste Management	✓	-
Backing			
Qualifier	Gas Waste Management	✓	-
Rebuttal			

The Application/Technology Expert Validation Assessment

A Biology Education Lecturer from the Indonesia University of Education performed the validation test assessment by an application/technology expert. This assessment aims to see the evaluation of the operation of the e-book application and assess the feasibility of the content and language feasibility. The results of the validation are detailed for each indicator (Figure 3.) is as follows:

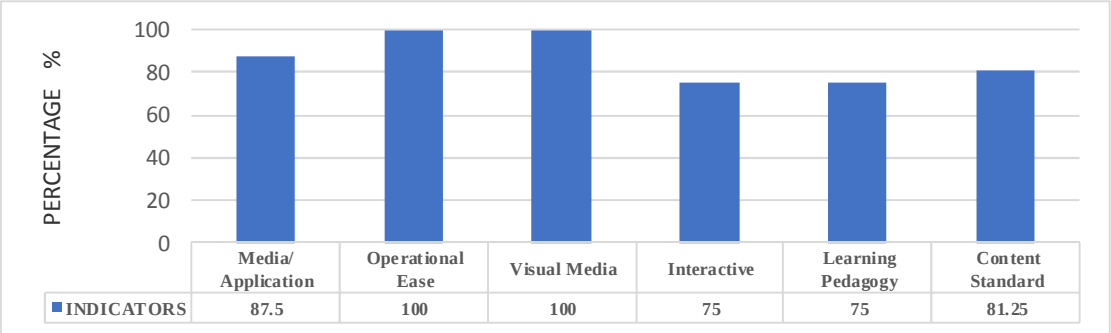

Figure 3. Graph of E-Book Evaluation Results

The validation results by application/technology experts showed that the evaluation of the e-book was qualified as a very valid product with a total percentage of 85.94%. When regarded from each component aspect, the aspect that gets the highest score was the aspect of operational ease and visual media, with a value of 100%. In comparison, the lowest score was

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75%, which includes the interactive aspect and learning pedagogy. As for the media/applications aspect, it got a value of 87.5%, and for the standard content, of 81.25%. As a result, the average percentage of the evaluation was 75.00% - 100%. Riduwan (2015) stated that the average feasibility score of teaching materials should be between 60 - 80%. Hence, it showed that the e-book developed in this study could be declared valid and appropriate for use as a learning resource.

Next, the e-book evaluation questionnaire assessed by application/technology experts had six assessment aspects: Media/Applications, Ease of Operation, Visual Media, Interactive, Learning Pedagogy, and content standards. The media/application aspect includes four indicators: profitability, installation, smooth operation, and documentation (instructions for use). Probability and installation get a good score of 3 of the four indicators. In contrast, the indicators for smooth operation and documentation (instructions for use) get an excellent rating with a score of 4. E-books with good portability and smooth operation can make it easier for students to access and use e-books anytime. Because they can install e-books through the Android operating system, and e-book software products can be easily transferred to other domains (Supriyono, 2019). In line with Kukulska-Hulme (2012), the portability of learning resources would allow students to learn without being limited by place and time.

The smooth operation and instructions in the e-book can facilitate students in learning independently inside and outside the classroom. The research results conducted by Ghofur (2015) concluded that practical e-books could be operated smoothly and independently by students because there are operating instructions at the beginning of the developed e-book. This aspect is related to the ease of operation aspect, which has a consistency indicator with an excellent score, which has score of 4. Thus, the e-book can be qualified as consistent since the navigation position, navigation buttons, and button shape are consistent and have the same color and function on each screen.

The visual media aspect includes three indicators: text, text color alignment with the background, and illustrations (pictures). Based on the overall assessment results on the three indicators, the e-book obtained an excellent score of 4. The e-book's contents display not only text but also contain pictures, videos, and interactive links that connect directly to the internet. The hyperlink allows students to access material through YouTube videos and discussion exercises, making the content discussed in the e-book more entertaining and inclusive (Rosyidah & Rahayu, 2022). Moreover, using images and videos in e-books can increase students' interest in learning and make it easier to understand their learning material. The interactive aspect gets a score of 3, which is good. Interactive e-books facilitate students to play an active role in teaching and learning activities (Rosida *et al*., 2017).

The pedagogic aspect of learning consists of three indicators: the alignment of illustrations with descriptions, learning emphasis, and evaluation. Of the three indicators, the e-book is categorized as good with one indicator with a score of 3, one indicator qualified as good with a score of 2, and one indicator got an outstanding category with a score of 4. However, in this aspect, it is necessary to revise the emphasis on learning by submitting requests to students to carry out productive activities. Therefore, the e-book developed is about evaluation and observation or practicum activities. According to Febriarti & Rahayu (2022), the presence of features that support students in doing observations or practicums can encourage them to observe and analyze so that students can present and conclude the previous practicum results. Observation and practicum activities can also facilitate students to improve their creative thinking skills in finding material concepts and increase students' understanding of what they are learning.

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Aspects of standard content include three indicators: accuracy, the images' appropriateness, conformity with the applicable curriculum, and learning objectives. Of the three indicators, two met the reasonable requirements with a score of 3, and one completed the perfect requirements with a score of 4. Based on the evaluation results, the e-book developed was by the applicable curriculum, the essential competencies, and the learning objectives to be achieved. However, some additional materials must be more relevant to competency standards and basic competencies, so repairs are made. As a tool for evaluating learning outcomes, an important thing in developing an e-book is selecting material according to the indicators, basic competencies, and learning objectives to be achieved and formulated in the syllabus (Aisyah *et al*., 2020). The material in the e-book is precisely on target study and can help the learning process run effectively and optimally.

The application/technology expert also assessed the content and language feasibility aspects. As for the results of the validation in detail, each assessment indicator (Figure 4.) is as follows:

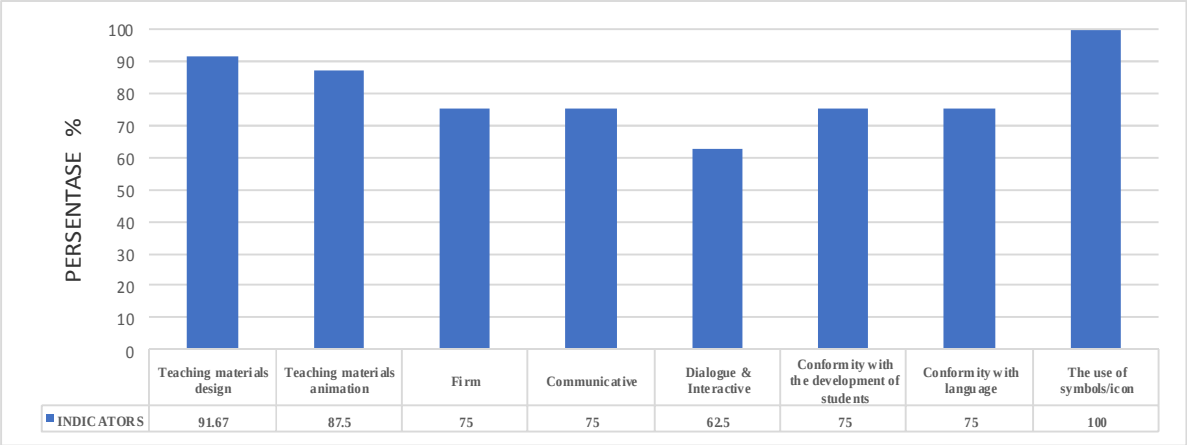

Figure 4. Graph Of Application Validation Results by Technological Experts

Based on the table showed that the assessment result of the content and the language aspect of the developed e-book qualified as valid, with a total percentage of 81.58%. The content feasibility aspect was very valid since the teaching material design indicator reached 91.67%, and the teaching material animation indicator achieved a score of 87.5%. Regarding feasibility, the content includes writing between paragraphs distinctly separated, the spacing between lines of standard text composition, and the text layout is also proportional. The use of letter variations was also reasonable because they were adapted to the display on the smartphone screen. The presentation of content, illustrations, images, and videos were also adjusted to the contents of the material e-book.

Meanwhile, for language eligibility, the e-book was qualified as valid as it scored 75% on the following indicators: rm, communicative, conformity to the development of students, and conformity to language. The material in the e-book must use simple and communicative language to be appropriately understood and studied independently by students. In addition, the language used in the e-book is adjusted to the age level of the learners to make it easier for them to operate the e-book. Generally, senior high school students are aged between 16 and 18 years. According to Piaget, students at this level can think logically, so the language level is much more abstract and complicated (Suryaman, 2012). Students can interpret, develop hypotheses, and draw conclusions (Budiningsih, 2012).

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In this aspect, the highest percentage value is the indicator of using symbols/icons, which is 100%. E-books with symbols/icons make it easy for students to use them. The symbols/icons included in the e-book comprise the start icon on the main page of the e-book, the home icon on the table of contents page, and the exit icon to return to the main page. In contrast, the lowest percentage is dialogue and interaction at 62.5%. E-book development focused on presenting material with dialogue and interactive design. The dialogue presented in the e-book contains communicative text, which can give a communication experience between the user and the e-book engagingly. While being interactive means the e-book includes color pictures, videos, and evaluation questions that can be seen directly in the answers. However, in the e-book developed in this study, an error occurred in the answer key, so improvement or revision must be made.

The application of the development of an E-book on environmental pollution based on socio-scientific issues as Biology course material in high schools was unique because it has yet to be tested more broadly and is still in the development stage. The novelty of the e-book that was being developed lies in the feature section, which facilitates students in practicing to develop argumentation skills. The e-book feature contains the latest articles or discourses that discuss a problem regarding environmental issues, accompanied by several questions to train students in presenting arguments. The teacher could directly read the students who have submitted their answers, so the teacher could find out students who actively practice. In addition, the material contained in the e-book does not only include the concept of environmental pollution. However, it is complemented by examples of current issues from relevant sources, such as the latest research and discourse, to support explanations of environmental pollution material.

The conceptual implication of this research is that environmental pollution e-books based on socio-scientific issues can facilitate students in developing argumentation skills, especially regarding environmental issues or issues surrounding them. Meanwhile, for practical implications, e-books that can be accessed via smartphones can be used as an alternative or innovation as one of Biology learning resources that makes it easier for students to learn independently and streamlines the delivery time of material in classroom learning activities for teachers.

Conclusion

The results of this study conclude that an *e-book* on environmental pollution based on Socio-scientific Issues to improve students' argumentation skills is stated to be included in the very valid category. It can be seen based on the results of the validation by the material expert. The score was 98.38%, with a very feasible/valid category. In comparison, the application/technology expert for application evaluation scored 85.94%, and the validation value for the feasibility of content and language got a value of 81.58% with a very decent/valid category. Based on the assessment results of the two validators, the *e-book* on environmental pollution based on socio-scientific issues was declared valid and suitable for use in the learning process.

Recommendation

Based on the research results above, the researchers recommend developing an environmental pollution e-book based on socio-scientific issues for teachers and students. Developing this e-book can facilitate teachers' efforts to improve students' argumentation skills. During learning activities, the teacher can innovate and be responsive to technological developments to create engaging and more meaningful learning. Meanwhile, e-books are recommended for students

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to develop argumentation skills by practicing exercises on argumentation skills on environmental issues independently so that they are accustomed to being trained to present arguments both in learning activities and in everyday life.

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