Stepping Together with Nature of Malang Raya: The Development Environmental Changes E-Book Based on Problem Based Learning (PBL)

Humaimah Nakhlah Rafidah[1], Fida Rachmadiarti[1], Muji Sri Prastiwi[1]

[1]Postgraduate Biology Education, Universitas Negeri Surabaya, Surabaya, Indonesia.

Abstract: The development of teaching materials that are integrated with local wisdom is needed as a teaching tool to support learning using the Merdeka curriculum. To practice some of these skills, teaching materials are needed that support the application of the Merdeka curriculum for learning activities. This research aims to determine the theoretical feasibility of teaching materials in the form of environmental change e-books based on problem based learning integrated with local wisdom in Malang Raya. This research uses the ADDIE model with analysis, design, development, implementation and evaluation stages. Data was obtained from validation results by two biology lecturers and readability tests. The environmental change e-book developed has very valid criteria. The validation results are based on aspects of presentation, content, suitability of problem based learning steps. E-book readability test at level 11 or according to the level of thinking of class X high school students which is categorized as very positive and appropriate. So, it is concluded that the environmental change e-book based on problem based learning integrated with Malang Raya local wisdom is very suitable to be applied in the learning of class X high school students.

Keywords: E-book; Environmental Change; Local Wisdom; Problem Based Learning

Introduction

The Greater Malang area, comprising Batu City, Malang City, and Malang Regency, is characterized by a strong dependence on natural resources, leading to a local wisdom deeply rooted in the environment (Subadyo et al., 2019). The areas dominated by mountains make local people highly dependent on these natural resources, either as a livelihood, tourist attraction, or source of daily life. Therefore, their local wisdom is closely related to understanding and respect for the surrounding natural environment. The local wisdom of Malang Raya is largely motivated by natural conditions and the surrounding environment, where this environment illustrates the close relationship between local communities and the nature around them. One example of local wisdom in the Greater Malang area is the *slametan malam satu suro* and *sesaji* in punden in the Sumber Umbulan Singosari area, *Bersih kali* in Batu, Utilization of Batu Ecological Village, Utilization of Jodipan Colorful Village, Utilization of apple waste TPS and oranges, Earth alms at Wonosari Gardens, Jalanidhi puja ceremony at Balekambang Beach, and many other local wisdom practices.

Local wisdom is part of the community environment that is passed down from generation to generation. Many young people do not know local wisdom or the potential that exists in their area. Therefore, it is important for the younger generation to know more about local wisdom, especially in the area

where they live, not only looking at it from the mystical side but also knowing the logical reasons behind this local wisdom. The problem of diminishing local wisdom can be reduced and prevented by preserving it through formal learning (Mashami et al., 2023). There is some local wisdom that can reduce environmental changes, but there is also some that actually makes the environment polluted, causing problems in everyday life. To integrate local wisdom into science learning, it is necessary to develop a curriculum that includes identifying local wisdom in the environment where students live. This aims to ensure that educational goals can be achieved in accordance with the provisions of the law (Hikmawati et al., 2021).

Problems in everyday life can become the context of problems that are memorable and attract students' interest in exploring them and can be linked to problems that occur in the environment. Currently, the environment, as a place to carry out all life activities, is showing development in an alarming direction. In meeting human needs, humans utilize available natural resources. The increasing number of human needs that must be absolutely fulfilled regardless of the impact on the condition of the biological environment is one of the causes of the increasingly critical condition of the environment. Based on this description, environmental change material is suitable if presented with variations in environmental change phenomena and local wisdom that occur in various regions in Indonesia. There are many problems that occur in the surrounding environment, so environmental change material is very suitable to be taught using a problem-based learning model or what is commonly known as Problem Based Learning (PBL).

Problem Based Learning (PBL) involves the intelligence that exists among people in human groups and regions to identify significant, relevant, and contextual issues. The Problem Based Learning (PBL) learning model is characterized by involving students in solving a problem during the learning process. With this approach, students are expected to be able to develop and discover their own knowledge through a series of scientific activities, such as formulating hypotheses, analyzing problems, providing ideas, and conducting research (Ulhaq et al., 2020). Problem based learning helps students to better connect what they learn with real world problems (Heong et al., 2020). In practice, Problem based learning is used in the education system to reveal real world problems. By using the context of real world problems for learning, students can get ideal learning reduce the occurrence of misconceptions in students (Nurahman & Susantini, 2022).

Ideal learning activities are learning activities that can encourage students' overall creativity and make students active in learning activities and effective in achieving learning goals, all of which must take place in pleasant conditions. Students will more easily be active in learning activities whose material content is contextual. Contextual learning is learning that links teaching material with students' real conditions and encourages students to build relationships between the knowledge they have and its application in their daily lives. To implement contextual learning, learning activities are required that are prepared using good teaching materials.

Learning activities that do not use teaching materials well can ensure that the delivery of material content is not systematic and coherent to students so that ideal learning activities cannot occur. Teachers must be able to hone their thinking skills to be able to innovate in making teaching materials. Therefore, making teaching materials is one of the 4 competencies that teachers must have, namely pedagogical competence. This is a technique for teaching teachers in the classroom to be more effective and efficient and not to deviate the discussion from achievement indicators. Teachers need to prepare teaching materials optimally, but in reality in the field many teachers are not able to understand the techniques for preparing and developing teaching materials, especially in the *Merdeka Belajar* curriculum (Maulida, 2022).

Developed teaching materials is systematic, meaning it is arranged sequentially making it easier for students to Study (Setyani et al., 2024). Currently, books are a learning resource that is widely used by students. By flipping the book, students can access as much material as needed to review topics they don't yet understand (Putri et al., 2023). The problem with education in Indonesia that still occurs from the past until now is the lack of teaching and learning materials. This can hinder the learning process. Based on interviews conducted with biology teachers at SMA Negeri 1 Kedungpring, teachers still have difficulty developing teaching materials. So far, teachers have only followed the teaching tools created and distributed by the district MGMP team. Teachers can develop their own teaching materials such as e-books.

Learning can be supported by the use of electronic books or what can be called e-books which can be accessed via the internet and can be used as learning media that utilizes technology according to curriculum demands (Hardiansyah & Sumbawati, 2016). E-books are books in interactive digital form that are more effective and efficient in accessing them. In accordance with research conducted by Tosun (2014) that when using e-books we can minimize the use of paper, besides that the learning is more enjoyable and optimal. E-books are prepared by paying attention to indicators and

learning objectives so that the material can be delivered appropriately and the learning process can run effectively (Paramita et al., 2019). Based on research by Wijayanti & Trimulyono (2019), e-books received a positive response from students, which points to the advantages of e-books, including being able to contain a lot of content, not requiring a place to store, and being able to display images, video and audio that cannot be displayed in printed books. The e-book that is developed must of course be in accordance with the current curriculum in Indonesia. Currently, Indonesia is still implementing the Independent Learning curriculum.

The Independent Learning Curriculum is a curriculum approach that encourages independence for students (Manalu et al., 2022). This independence includes students' freedom to access knowledge from formal and non-formal education. In this curriculum, there are no restrictions on learning methods inside or outside school, and creativity is expected from teachers and students. The emergence of the latest ideas in curriculum development in Indonesia is due to the previous curriculum system where teachers were required to prepare a lot of learning tools such as syllabuses or lesson plans and took quite a long time to prepare them so that the learning process carried out by teachers for students was not optimal and did not provide independence. for students and is considered too monotonous (Fadilah et al., 2020).

Monotonous or one-way learning can be a barrier for students to express their abilities. The application of appropriate learning methods has a significant impact on improving the quality of education (Wahyuni & Yokhebed, 2019). This curriculum also demands creativity from a teacher and students. Teachers need to have professional abilities to plan an effective learning process and in accordance with the learning objectives that have been set (Nafsiyah, 2020). This independent learning curriculum also aims to answer the challenges of education in the era of revolution 4.0.

The era of revolution 4.0 is a sign of the existence of the 21st century, which in the 21st century will be a century of openness or a century of globalization (Fuke et al., 2021). Various technological advances have begun to be implemented in the education sector, such as the use of technology to support more efficient learning, such as distance learning, and so on. This development has a major impact in the realm of education, especially in the context of 21st century learning. In 21st century learning, students are not only required to have expertise in subjects such as mathematics, languages, or science. However, they are also expected to master critical thinking, creativity, communication and collaboration skills.

To practice some of these skills, teaching materials are needed that support the application of the independent curriculum for learning activities. The use of learning media aims to create learning that has meaning for students (Adam, 2021). By using learning media teachers can be helped when delivering lesson material, shorten teaching preparation time, as well as increase learning motivation and reduce misunderstandings that might occur (Suharlan et al., 2023). The hope that is always the goal for teachers is how to ensure that the learning material provided can be mastered by students as a whole (Safitri et al., 2023).

A range of studies have explored the validity of ebooks in different contexts. Agustin & Razi (2023) found that an e-book based on problem-based learning and higher-order thinking skills was a valid learning resource for students and teachers. Chi et al. (2020) proposed a secure and reliable blockchain-based eBook transaction system to address concerns about the validity, ownership, and intellectual property of digital content. Sanford (2013) developed a model of user acceptance of ebooks, identifying factors that predict the propensity to switch from traditional hard copy books to ebooks. Rowberry (2015) delineated the unique properties of ebooks, including their simulation of book trade services and emphasis on user textual manipulation. These studies collectively highlight the potential and challenges of ebooks, and the need for further research to enhance their validity and user acceptance. This study aims to develop a PBL-based e-book that focuses on environmental change by integrating local wisdom in Malang Raya. This e-book is designed to be an interesting and interactive learning resource, which not only provides scientific information but also invites students to be directly involved in environmental conservation efforts. The novelty of this study lies in the integration of the PBL approach with digital technology in the form of an e-book by integrating local wisdom of Malang Raya, which has not been widely applied in the context of environmental education in Indonesia, especially in Malang Raya.

By developing PBL-based books integrated with local wisdom that contain problem-solving content on environmental change material, it can help students to gain meaningful learning. Based on this, this research intends to develop a PBL-based e-book integrated with the local wisdom of Greater Malang on environmental change material.

Method

This research uses a type of development research because it aims to develop teaching materials in the form of e-books based on Problem-Based Learning integrated

with the local wisdom of Malang Raya in environmental change material. The research took place in the Biology Department, Faculty of Mathematics and Natural Sciences, Surabaya State University. The research target of the PBL-based textbook integrated with local wisdom in Malang is environmental change material, which is aimed at class X high school students.

The research design refers to the development research design from Dick et al. (1996), namely the ADDIE model with analysis, design, development, implementation and evaluation stages. The analysis stage consists of several stages, namely problem analysis, student analysis, and task analysis. The design stages carried out include designing a systematic e-book plan, determining the e-book format, and creating an e-book draft. Next is the development stage which consists of developing draft 1, validation of draft 1 which is carried out by media expert lecturers and material expert lecturers, and then draft 2 is obtained from the validation results. The next stage is implementation as seen from the e-book readability test. The final stage is evaluation. The stages of the ADDIE model in this research can be explained in the figure 1.
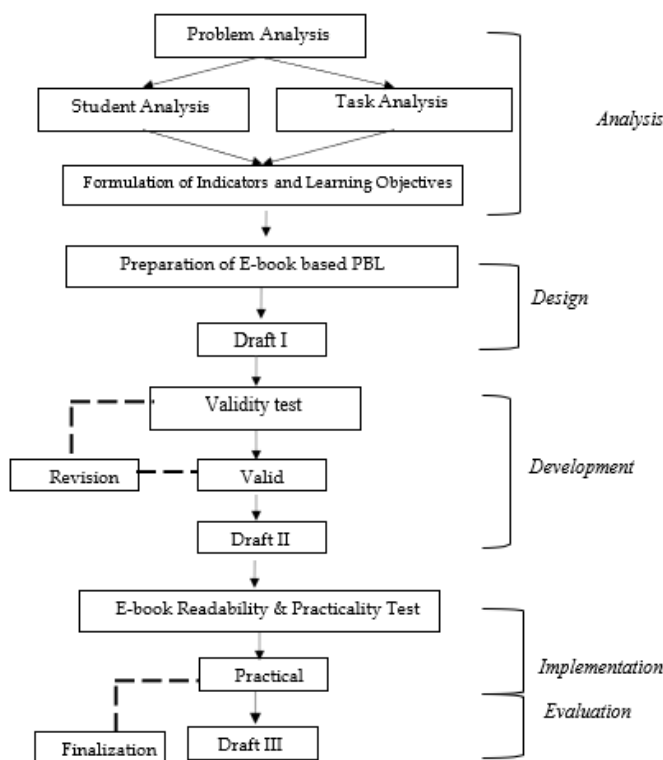

Figure 1. Stages of the ADDIE Development Model adapted from Dick et al. (1996)

The instrument used to measure the suitability of e-books is the teaching material validation instrument. The Problem Based Learning component is an additional component in accordance with the characteristics of Problem Based Learning. The validation sheet for this textbook is then assessed by validators, namely an education expert lecturer and a lecturer who is an expert on postgraduate material in Biology Education, Surabaya State University. The validator assessment results were analyzed descriptively using an e-book feasibility presentation. Values are obtained from Likert Scale calculations which are presented in Table 1.

Table 1. Likert Scale Criteria

Scale value	Evaluation
1	Not good
2	Pretty good
3	Good
4	Very good

The results of validity calculations are used to determine the feasibility of PBL-based e-modules, which are then calculated using the following formula 1.

$$\text{Average Score} = \frac{\sum \text{Scores for each criterion for all validators}}{\sum \text{validators}} \quad (1)$$

After the average score is obtained, to calculate the average criteria score, the following formula is used.

$$\text{P validation score (\%)} = \frac{\sum \text{Score obtained}}{\sum \text{Maximum score}} \times 100\% \quad (2)$$

The calculation results obtained are then classified into 4 validity criteria which can be seen in Table 2. An e-book is said to be valid if it gets a score $\geq 61\%$.

Table 2. E-book Eligibility Criteria Based on Validation Results

Percentage (%)	Criteria
0-20	Very invalid
21-40	Invalid
41-60	Fairly valid
61-80	Valid
81-100	Very valid

The e-book readability sheet was used to determine the level of practicality of the PBL-based e-book, integrated with the local wisdom of Malang, the environmental change material being developed. Data collection techniques using the readability test method were used to determine the readability level of the e-book that had been developed. The readability method is carried out by selecting readings at the beginning, middle and end of the e-book totaling 100 words and then counting the number of sentences and syllables.

The data from the readability test results obtained through the e-book readability test sheet were analyzed using a quantitative descriptive method using formulations and interpreted on the Fry Graph. One hundred words of discourse are taken, then the calculation results of the number of sentences and the number of syllables is multiplied by 0.6. The final results are converted into Fry Charts. Upper secondary education level is at 10-12. E-book readability is said to be practical if it is at level 10-12.

Results and Discussion

The research that has been carried out has resulted in a product in the form of an environmental change e-book based on problem based learning integrated with the local wisdom of Malang Raya. From the results of the researcher's analysis, it is known that class X students at SMA Negeri 1 Kedungpring need electronic teaching materials to support their learning process. At the analysis stage, problem analysis, student needs analysis, task analysis, concept analysis, and learning objective analysis have been carried out to determine the initial problems and needs needed so that the teaching material development process can be used and achieve development goals. It is necessary to renew the learning atmosphere in an interesting way, such as changing the learning model which can improve critical thinking and problem solving skills (Suharlan et al., 2023).

The design stage carried out includes designing a systematic e-book plan, determining the e-book format, which is then continued with creating an e-book draft. The e-book developed contains several topics, namely environmental damage, environmental pollution and waste. The e-book developed contains several parts, namely the introduction, contents and closing. The arrangement of the material sequence and structure of an open book is based on the logic of the field of study being discussed focusing on content (Nge et al., 2024).

The next stage is the e-book development stage. The following is a display of an e-book on environmental change based on problem-based learning integrated with local wisdom in Malang Raya (Table 3).

Table 3. E-book display

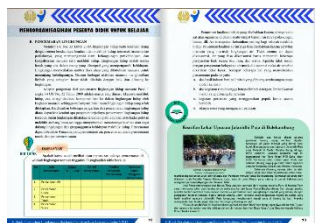| Appearance	Information
	The front cover of the e-book has an attractive design. Taking pictures of environmental pollution that occurs in the Malang Raya area illustrates the material discussed in the e-book, namely environmental damage, environmental pollution and waste that occurs.
	The foreword is given to explain the author's opening sentence and thanksgiving.
	The table of contents and list of images are provided as an overview or outline to the reader regarding the main discussion contained in the E-book.

Appearance	Information
	An introduction to the local wisdom of Malang Raya and Problem Based Learning so that readers know what local wisdom is contained in the e-book and the steps for learning using the PBL model.
	E-book which was developed contains various features, namely Bio News, Bio Mini Lab, Think Zone, Biosol, and Bio Local Wisdom. Learning outcomes, Learning Objectives, and Learning Objective Indicators are included in the e-book so that learning activities become more focused
	A concept map is provided to find out the topics discussed in the e-book.
	The first topic about environmental damage contains orientation to environmental damage problems, explanations related to environmental damage, and activities to overcome environmental damage problems. At the end there are reflection activities and formative assessments.
	The second topic about environmental pollution contains orientation to environmental pollution problems, explanations related to environmental pollution, and activities to overcome environmental pollution problems. At the end there are reflection activities and formative assessments.
	The third topic about waste contains orientation to waste-related problems, explanations regarding waste, and activities to deal with waste in the surrounding environment. At the end there are reflection activities and formative assessments.
	At the end of the content section there is a summary of all the material and also a comprehension test which contains 15 AKM-based questions.

Appearance	Information
	Bibliography as a reference for writing e-books. The glossary contains an alphabetical list of terms along with the definition of each term.
	The back cover page is attractively designed in such a way that it matches the front cover of the e-book.

The problem based learning developed is supported by several features. This feature helps students to enhance their learning experience. Some of the features available include Bio News, Bio Mini Lab, Think Zone, Biosol, and Bio Local Wisdom. A description of these features can be seen in Table 4.

E-book can increase interaction between teachers and students and help the learning process which must be carried out remotely. Learning that utilizes local wisdom, especially in science lessons, can facilitate students' understanding because they can directly observe based on their surroundings (Setianingrum et al., 2023). Apart from that, e-books can also contain various interesting features such as image, video and link features, where these features will support students to understand the subject matter more deeply (Muhammad et al., 2015). The integrated e-book of Malang Raya local wisdom based on Problem Based Learning that has been developed can be used as teaching material that provides contextual learning experiences. For example, the bio local wisdom feature contains information about local wisdom and as a means for students to get to know local wisdom around their area. Instructional materials in the context of learning are one of the essential components because they are what will be analyzed, studied, and mastered by the students (Ramdoniati et al., 2018). This e-book has been validated by two validators, namely a validator from a material expert lecturer and a validator from a media expert lecturer. Where the validation instrument contains e-book components, namely presentation, content and language.

E-book has been revised several times and has been reviewed to find out the shortcomings of the e-book both in terms of material and design before being validated. The final result of this e-book has received several comments and suggestions from validators, for example several incorrect writing formatting errors. Apart from that, to differentiate the syntax of problem based learning from the title of the topic you want to train on, it should be designed differently.

Based on the results of the research that has been carried out, validation is used to determine the theoretical feasibility of the e-book that has been developed. The validator assessment results were analyzed descriptively using an e-book feasibility presentation through Likert scale calculations with a value range of 1-4. Where a value of 1 is described as not good, a value of 2 is described as quite good, a value of 3 is described as good, and a value of 4 is described as very good. Several aspects that were validated include aspects of appropriateness of presentation, aspects of content validity, aspects of language validity, and aspects of PBL syntax achievability. The following are the results of the validation of the E-book integrated with local wisdom of Malang Raya based on Problem Based Learning seen from the aspect of feasibility of presentation which can be seen in Table 5.

Table 4. Features in the environmental pollution sub-material e-book

Feature	Information
Bio News	Contains the latest news related to environmental changes occurring in the Greater Malang area.
Bio Mini Lab	Contains practical activities through collaboration in groups with problem based learning stages.

Feature	Information
Bio Think	Contains tools that aim to measure students' level of critical thinking skills.
Biosol	Contains comprehension test questions as a means of measuring students' understanding.
ThinkZone	Contains tools that aim to measure students' understanding.
Bio Local Wisdom	Contains local wisdom information and as a means of measuring students' level of critical thinking skills.

Table 5. The results of the E-book validation are seen from the aspect of feasibility of presentation

Aspects of Presentation Feasibility Assessment	Validation Result Score		Average Score
	V1	V2	
E-book Display Quality	4	3.50	3.75
Quality of E-book Use	4	3.75	3.87
Layout Quality	4	3.25	3.62
Image Quality	4	3.33	3.66
Average Score of Validation Results for Feasibility of Presentation Aspects			3.72
Validity Score (%)			93%
Interpretation of Validity Scores			Very Valid

The appropriateness of the presentation of an e-book refers to how well the e-book meets the needs and expectations of readers. Several aspects that are assessed in the appropriateness of presentation include the quality of the e-book display, the quality of the use of the e-book, the quality of the layout, and the quality of the images. The PBL-based environmental change e-book developed is easy to access. E-books can be accessed both via mobile devices and PCs via a link https://humaimahnr.github.io/materi/index.html. The appearance of the e-book is made as attractive as possible by adding images, links to access information, and colorful designs so that readers don't get bored.

Apart from the feasibility aspect of presentation, e-books are also validated from the aspect of content validity. The following are the results of the validation of the E-book integrated with local wisdom of Malang Raya based on Problem Based Learning seen from the aspect of content validity which can be seen in Table 6.

Table 6. The results of the E-book validation are seen from the aspect of content validity

Aspects of Presentation Feasibility Assessment	Validation Result Score		Average Score
	V1	V2	
Concept quality	4	4	4
Quality of Concept Conformity with the Independent Curriculum	4	4	4
Recency and Contextual Concepts	4	4	4
Activities in the E-book Facilitate the Problem Solving Process	4	4	4
E-book systematics	4	3.31	3.65
Average Score of Content Validity Aspect Validation Results			3.91
Validity Score (%)			97%
Interpretation of Validity Scores			Very Valid

Content validity in e-books refers to the validity and reliability of the information presented in the e-book content. It includes a number of factors that must be considered to ensure that the e-book content is trustworthy and conforms to established standards. Several aspects assessed for content validity are the quality of the concept, the quality of the concept's suitability to the independent curriculum, the up-to-datedness and contextuality of the concept, the activities in the e-book facilitating the problem solving process, and the systematicity of the e-book. The PBL-based environmental change e-book that was developed has a concept that is arranged systematically referring to learning outcomes in accordance with the decision of the head of the standards, curriculum and educational assessment body of the Ministry of Education, Culture, Research and Technology number 008/h/kr/2022 concerning learning outcomes in early childhood education, basic education levels, and secondary education levels in the independent curriculum, environmental change material is taught in phase E, namely class X. E-books also facilitate the problem solving process, this is applied to the bio mini lab feature. Where in this feature students are oriented to

problems in the environment and then carry out activities aimed at solving these problems.

Apart from aspects of suitability of presentation and content validity, e-books are also validated from the aspect of language validity. The following are the results of the validation of the integrated E-book of Malang Raya local wisdom based on Problem Based Learning seen from the aspect of language validity which can be seen in Table 7.

Table 7. The results of the E-book validation are seen from the aspect of language validity

Aspects of presentation feasibility Assessment	Validation result score		Average score
	V1	V2	
Use of Language	4	4	4
Language structure	4	3.66	3.83
Use of Terms and Sentences	4	3.33	3.66
Average Score of Validation Results for Language Validity Aspects			3.83
Validity score (%)			95%
Interpretation of Validity Scores			Very Valid

The validity of language in e-books refers to the correctness, accuracy and clarity of language use in e-book content. It covers several aspects that need to be considered to ensure that the language used conforms to established standards and allows readers to understand well. By ensuring the validity of the language, e-books can provide a more enjoyable and effective reading experience for readers, as well as increasing the credibility and professionalism of the content delivered. Several aspects assessed in language validity are language use, language structure, use of terms and sentences. The PBL-based environmental change e-book was developed using standard language in accordance with PUEBI (General Guidelines for Indonesian Spelling).

Table 8. The results of the E-book validation are seen from the aspectsachievement of PBL syntax

Aspects of Presentation Feasibility Assessment	Validation Result Score		Average Score
	V1	V2	
Conformity of Activities in E-books with PBL Syntax	3.20	4	3.60
Average Score of Aspect Validation Results Syntax Achievement PBL			3.60
Validity Score (%)			90%
Interpretation of Validity Scores			Very Valid

Apart from aspects of appropriateness of presentation, content validity and language validity of e-books are also validated in terms of aspects achievement of PBL syntax. The following are the results of the validation of the E-book integrated with local wisdom of Malang Raya based on Problem Based Learning, seen from the aspects achievement of PBL syntaxcan be seen in Table 8.

Achievement of PBL syntax-books refer to PBL syntax, namely orienting students to problems, organizing students to learn, guiding individual/group experiences, developing and presenting work results, analyzing and evaluating the problem solving process. Each topic developed in this environmental change e-book uses the five PBL syntaxes in a coherent manner starting from problem orientation to the evaluation process. A recapitulation of the validation results of the PBL-based environmental change e-book developed can be seen in Table 9.

Table 9. Results of e-book validation by material expert lecturers and media expert lecturers

Aspect	Validation Result Score %		Average %	Category
	V1	V2		
Feasibility of presentation	100	86.43	93	Very valid
Content validity	100	96.55	97	Very valid
Language validity	100	91.58	95	Very valid
Achievement of PBL syntax	80	100	90	Very valid

Based on the validation that has been carried out, the results are very valid for all aspects. Based on the analysis of the display quality of the e-book, it can be categorized as very feasible. This is because e-books have a very attractive design with a colorful appearance and lots of pictures. The selected e-book cover with a design of environmental pollution in the Greater Malang area illustrates the learning material topics discussed in this e-book. Also supported by the choice of color composition that is not monotonous and the presence of sound to indicate page movement makes this e-book very interesting to use. The environmental change e-book also has features such as images, videos and hyperlinks, for example the bio news, bio local wisdom, bio mini lab, bio think and biosol features which make it easier for students to understand the material. Advantages of teaching materials like this which combine material presented with images, videos and hyperlinks are that they can be accessed and effective for students because a lot of information can be obtained.

In the achievement aspect, PBL syntax gets an average percentage of 90%, this is because the problem

orientation given does not focus on just one problem so that the problems presented are less visible. Learning uses Problem Based Learning (PBL), utilizing intelligence from individuals, groups and the environment to solve problems that are meaningful, relevant and contextual (Octavianis & Ranu, 2019). The context of problems that can be presented is problems that are open, unstructured and general in nature so that it is intended that students will be more challenged to express opinions and formulate solutions to problems.

The implementation of e-books is seen from the e-book readability test. The readability test results are seen by counting the number of sentences and the number of syllables, then multiplying them by 0.6 out of 100 words at the beginning, middle and end of the e-book, then the results are converted to a fry graph. This figure of 0.6 is the result of a comparison between the number of syllables in English and Indonesian, with a ratio of 6 to 10. This means that around 6 syllables in English are equivalent to around 10 syllables in Indonesian. The following is a recapitulation table of the e-book readability test results, which can be seen in Table 10.

Table 9. Recapitulation Table of Readability Test Results

Reading samples	Page	Number of sentences	Number of syllables x 0.6	Levels
Text 1 (initial part)	1	5	163.2	12
Text 2 (middle part)	26	7	159	10
Text 3 (final part)	45	4	160.2	12
Average amount		5.3	160.8	11

The results of calculating the number of sentences and syllables that have been averaged are then converted into the fry graph presented in Figure 2. Based on the results in Figure 2, it can be concluded that the readability of the environmental change e-book based on problem-based learning integrated with local wisdom in Malang Raya which was developed is appropriate and in accordance with the level of thinking of class X high school students. The PBL model is utilized in learning by presenting students with real-world problems, then students are given the opportunity to actively participate in finding solutions through group discussions (Putri et al., 2023). There are several factors that can influence the readability level of a discourse, namely the number of sentences in the discourse, the number of syllables in the discourse, and the grammar used. To prepare teaching materials so that students are able to understand the content of the reading well and correctly, reading specs are needed that match the readability level and the students' level of thinking. The use of language, sentence structure and word choice must be appropriate so that it is easily understood by students, and the use of language must be adjusted to the student's level of maturity (Umbaryati, 2016).
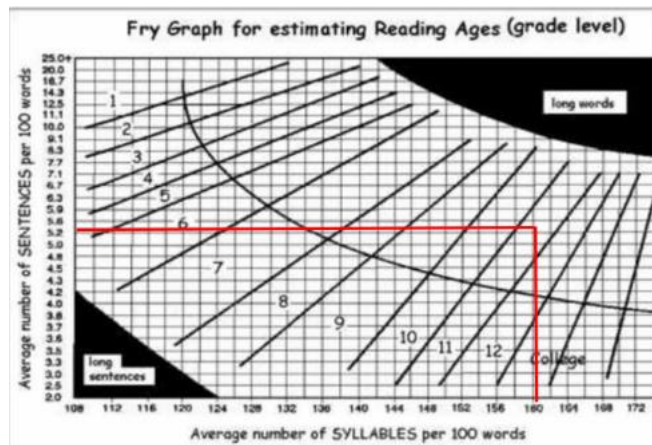

Figure 2. Readability Conversion Results on Fry Charts

Eye movements, letters, spaces, lines, columns and line length affect the readability of each student so that there are differences in the readability results for each student (Tarasov et al., 2015). The level obtained is expected to be in accordance with the class level and students' ability to understand reading with the fry graph. The higher the readability level of a discourse, the easier it is to understand, and conversely, the lower the readability level, the more difficult it is to understand. This shows that discourse with a low readability level is not suitable to be presented at the target level (Nuryani, 2017).

Based on the results of the development of teaching materials in the form of an e-book on environmental change based on problem-based learning integrated with local wisdom in Malang, data was obtained in the form of e-book descriptions, theoretical feasibility of e-books as seen from the results of validity through aspects of presentation, content and language, as well as empirical feasibility e-books are seen from the readability test. E-books can be called feasible if they meet the requirements, namely theoretically feasible and empirically feasible (Ristanti & Rachmadiarti, 2018).

Based on all the descriptions of the data analysis results obtained, the development of an environmental change e-book based on problem-based learning integrated with local wisdom in Malang Raya has been declared theoretically feasible and empirically feasible from the readability test results.

Conclusion

E-book Environmental change based on problem based learning integrated with local wisdom in Malang Raya was stated to be very feasible theoretically and

empirically. Judging from the validation scores obtained in the very valid and theoretically feasible category. The readability of the e-book is at level 11 or in accordance with the level of thinking of class X high school students which is categorized as very positive and appropriate. So, it is concluded that the environmental change e-book based on problem based learning integrated with Malang Raya local wisdom is very suitable to be applied in the learning of class X high school students.

References

Adam, A. (2021). Penggunaan Media Pembelajaran Berbasis Visual Terhadap Hasil Belajar Bahasa Indonesia Siswa SMP. *Jurnal Riset Pendidikan Dasar*, *4*(1), 57. https://doi.org/10.26618/jrpd.v4i1.4820

Agustin, S., & Razi, P. (2023). Validity of E-Book Based on Problem-Based Learning with Higher Order Thinking Skills Oriented for Senior High School. *Journal of Physics: Conference Series*, *2582*(1). https://doi.org/10.1088/1742-6596/2582/1/012066

Chi, J., Lee, J., Kim, N., Choi, J., & Park, S. (2020). Secure and Reliable Blockchain-Based eBook Transaction System for Self-Published eBook Trading. *PLoS ONE*, *15*(2). https://doi.org/10.1371/journal.pone.0228418

Dick, W. (1996). The Dick and Carey Model: Will It Survive the Decade?. *ETR&D*, 44, 55–63. https://doi.org/10.1007/BF02300425

Fadilah, R., Parinduri, S. A., Syaimi, K. U., & Suharyanto, A. (2020). Islamic Guidance and Counseling to Overcome the Study Difficulty of Junior High School Students in SMP IT Nurul Azizi Medan (Case Study of Students experiencing Anxiety). *International Journal of Psychosocial Rehabilitation*, *24*(Special Issue 1), 1154–1160. https://doi.org/10.37200/ijpr/v24sp1/pr201262

Fuke, Y., Iwasaki, T., Sasazuka, M., & Yamamoto, Y. (2021). First Record of Freshwater Shrimp Neocaridina denticulata (Crustacea: Decapoda: Atyidae) from Fukue-Jima Island, Goto Islands, Japan. *CANCER*, *30*, 63–71. Retrieved from https://www.jstage.jst.go.jp/article/cancer/30/0/30_63/_pdf

Hardiansyah, D., & Sumbawati, M. S. (2016). Pengembangan Media Flash Flipbook dalam Pembelajaran Perakitan Komputer untuk Meningkatkan Hasil Belajar Siswa Kelas X TKJ SMK Negeri 7 Surabaya. *Jurnal IT-Edu*, *1*(2), 5–11. Retrieved from https://ejournal.unesa.ac.id/index.php/it-edu/article/view/17420

Heong, Y. M., Sharberi, S. N. M., Bakar, N. A., Chin, K. B., & Mohamad, M. M. (2020). Pembangunan Modul Triz Secara Pencantasan untuk Pembelajaran Berasaskan Masalah. *Online Journal for TVET Practitioners*, *5*(2), 12–19. https://doi.org/10.30880/ojtp.2020.05.02.002

Hikmawati, H., Suma, K., & Subagia, I. W. (2021). Problem Analysis of Science Learning Based on Local Wisdom: Causes and Solutions. *Jurnal Penelitian Pendidikan IPA*, *7*(SpecialIssue), 46–55. https://doi.org/10.29303/jppipa.v7ispecialissue.1021

Manalu, J. B., Sitohang, P., Heriwati, N., & Turnip, H. (2022). Prosiding Pendidikan Dasar Pengembangan Perangkat Pembelajaran Kurikulum Merdeka Belajar. *Mahesa Centre Research*, *1*(1), 80–86. https://doi.org/10.34007/ppd.v1i1.174

Mashami, R. A., Suryati, S., Harisanti, B. M., & Khery, Y. (2023). Identification of Local Wisdom of The Sasak Tribe In Chemistry Learning as an Effort to Strengthen Student Character. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 337–345. https://doi.org/10.29303/jppipa.v9i1.2434

Maulida, U. (2022). Pengembangan Modul Ajar Berbasis Kurikulum Merdeka. *Tarbawi: Jurnal Pemikiran dan Pendidikan Islam*, *5*(2), 130–138. https://doi.org/10.51476/tarbawi.v5i2.392

Muhammad, M., Rahadian, D., & Safitri, E. R. (2015). Penggunaan Digital Book Berbasis Android untuk Meningkatkan Motivasi dan Keterampilan Membaca pada Pelajaran Bahasa Arab. *PEDAGOGIA: Jurnal Ilmu Pendidikan*, 170–182.

https://doi.org/10.17509/pedagogia.v15i2.8094

Nafsiyah, F. (2020). Pengembangan Booklet Keanekaragaman Lepidoptera Subordo Rhopalocera di Kawasan Cagar Alam Pagerwunung Darupono Kendal sebagai Sumber Belajar Biologi pada Materi Keanekaragaman Hayati di Madrasah Aliyah. *Bioeduca: Journal of Biology Education*, 2, 1–8. https://doi.org/10.21580/bioeduca.v2i1.5994

Nge, S. T. M., Ballo, A., Sabuna, A. C., Rupidara, A. D. N., & Ch, A. (2024). The Development of Reference Book from Medicinal Plant Exploration Results in Rote Tengah Sub-district, Rote Ndao District. *Jurnal Penelitan Pendidikan IPA*, 10(5), 2473–2479. https://doi.org/10.29303/jppipa.v10i5.7083

Nurahman, A. A., & Susantini, E. (2022). Analysis and Remediation of Student Misconceptions Using P2OC2R-Based Learning Model on Fungi Materials in Senior High School. *Journal of Biology Education*, 11(2), 220–231. https://doi.org/10.15294/jbe.v11i2.56477

Nuryani, N. (2017). Tingkat Keterbacaan Soal Wacana Ujian Nasional (UN) Tingkat SMA Mata Pelajaran Bahasa Indonesia Tahun Pelajaran 2013/2014. *KEMBARA: Jurnal Keilmuan Bahasa, Sastra, dan Pengajarannya*, 2(1), 57. https://doi.org/10.22219/kembara.vol2.no1.57-66

Octavianis, R., & Ranu, M. E. (2019). Pengembangan Buku Ajar Berbasis Problem Based Learning (PBL) pada Mata Pelajaran Otomatisasi Tata Kelola Kepegawaian Kelas XII OTKP di SMKN Mojoagung. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, 07(01), 1–6. Retrieved from https://ejournal.unesa.ac.id/index.php/JPAPUNESA/article/view/28520

Paramita, R., Panjaitan, R. G. P., & Ariyati, E. (2019). Pengembangan Booklet Hasil Inventarisasi Tumbuhan Obat sebagai Media Pembelajaran pada Materi Manfaat Keanekaragaman Hayati. *Jurnal IPA & Pembelajaran IPA*, 2(2), 83–88. https://doi.org/10.24815/jipi.v2i2.12389

Putri, M. E., Ahda, Y., Anhar, A., & Putri, D. H. (2023). Effect of Problem-Based Learning Models and Prior Knowledge toward Critical Thinking Skills on Human Digestive and Circulatory System. *Jurnal Penelitian Pendidikan IPA*, 9(5), 3905–3914. https://doi.org/10.29303/jppipa.v9i5.3697

Ramdoniati, N., Muntari, M., & Hadisaputra, S. (2018). Pengembangan Bahan Ajar Kimia Berbasis Problem Based Learning untuk Meningkatkan Keterampilan Metakognisi. *Jurnal Penelitian Pendidikan IPA*, 5(1). https://doi.org/10.29303/jppipa.v5i1.148

Ristanti, A. D., & Rachmadiarti, F. (2018). Kelayakan Buku Ajar Berbasis Etnosains pada Materi Pencemaran Lingkungan untuk Melatihkan Berpikir Kritis Siswa SMP. *E-Jurnal Pensa*, 06(02), 151–155. Retrieved from https://ejournal.unesa.ac.id/index.php/pensa/article/view/23573

Rowberry, S. P. (2015). Ebookness. *Convergence*, 23(3), 289–305. https://doi.org/10.1177/1354856515592509

Safitri, R., Hadi, S., & Widiasih, W. (2023). Effect of the Problem Based Learning Model on the Students Motivation and Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 9(9), 7310–7316. https://doi.org/10.29303/jppipa.v9i9.4772

Sanford, C. (2013). An Artifact Switching Model for User Acceptance of eBooks. *Journal of Organizational and End User Computing*, 25(2), 19–40. https://doi.org/10.4018/joeuc.2013040102

Setianingrum, D. A., Matahari, D. B., Jumadi, J., & Wilujeng, I. (2023). Development of Science e-Book Containing Gamelan's Local Wisdom Based on STEAM-POE to Facilitate Students' Love of Local Culture. *Jurnal Penelitian Pendidikan IPA*, 9(6), 4791–4800. https://doi.org/10.29303/jppipa.v9i6.3760

Setyani, U., Nugroho, I. R., Jumadi, J., Suyanta, S., & Wilujeng, I. (2024). Development of the PjBL Model Science E-Book to Improve Creative Thinking Skills of Middle School Students. *Jurnal Penelitian Pendidikan IPA*, 10(3), 1032–1038. https://doi.org/10.29303/jppipa.v10i3.6303

Subadyo, A. T., Tutuko, P., & Jati, R. M. B. (2019). Implementation Analysis of Green City Concept in Malang - Indonesia. *International Review for Spatial Planning and Sustainable Development*, 7(2), 36–52. https://doi.org/10.14246/irspsd.7.2_36

Suharlan, L. S., Arsyad, M., & Palloan, P. (2023). Influence of Problem Based Learning and Self Directed Learning Models on Students' Problem Solving Abilities. *Jurnal Penelitian Pendidikan IPA*, 9(12), 11386–11393. https://doi.org/10.29303/jppipa.v9i12.4730

Tarasov, D. A., Sergeev, A. P., & Filimonov, V. V. (2015). Legibility of Textbooks: A Literature Review. *Procedia - Social and Behavioral Sciences*, 174, 1300–1308. https://doi.org/10.1016/j.sbspro.2015.01.751

Tosun, N. (2014). A study on Reading Printed Books or E-Books: Reasons for Student-Teachers Preferences. *Turkish Online Journal of Educational Technology*, 13(1), 21–28. Retrieved from http://www.tojet.net/volumes/v13i1.pdf

Ulhaq, R., Huda, I., & Rahmatan, H. (2020). Pengaruh

Model Pembelajaran Problem Based Learning dengan Modul Kontruktivisme Radikal Terhadap Hasil Belajar Peserta Didik. *Jurnal IPA & Pembelajaran IPA*, 4(2), 244–252. https://doi.org/10 .24815/jipi.v4i2.17874

Umbaryati, U. (2016). Pentingnya LKPD pada Pendekatan Scientific Pembelajaran Matematika. *PRISMA, Prosiding Seminar Nasional Matematika*, 217–225. Retrieved from https://journal.unnes.ac. id/sju/prisma/article/view/21473

Wahyuni, E. S., & Yokhebed, Y. (2019). Deskripsi Media Pembelajaran yang Digunakan Guru Biologi SMA Negeri di Kota Pontianak. *Jurnal Pendidikan Informatika dan Sains*, 8(1), 32. https://doi.org/10. 31571/saintek.v8i1.1105

Wijayanti, T. E., & Trimulyono, G. (2019). Pengembangan Flipbook Berbasis Multiple Intelligence pada Materi Substansi Genetika untuk Melatihkan Keterampilan Berpikir Kritis Siswa Kelas XII SMA. *Bioedu: Berkala Ilmiah Pendidikan Biologi*, 8(2), 253–259. Retrieved from https://ejournal.unesa.ac.id/index.php/bioedu/ article/view/28796