Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

Developing of Teaching Modules with PBL-STEM Model of Photosynthesis Material to Increase Critical Thinking Skills of Grade IV Elementary School Students

Meza Mardita[1*], Sri Haryani[2], Wara Dyah Pita Rengga[3],
[1]Sekolah Pascasarjana ,Universitas Negeri Semarang, Semarang, Indonesia
[2]FMIPA,Universitas Negeri Semarang, Semarang, Indonesia
[3]Fakultas Teknik, Universitas Negeri Semarang, Semarang, Indonesia

Article Info

Article history:

Received: January 06th, 2024
Revised: January 30th, 2024
Accepted: January 12th, 2024

Keywords:

PBL-STEM Model
Photosynthesis
Research and Development
Teaching Module

ABSTRACT

This study aims to develop teaching modules with PBL-STEM models on photosynthesis material. This research is a research and development using the ADDIE (Analysis, Design, Develop, Implementation and Evaluate) development model developed by Raiser and Mollenda in the 1990s. The research and development involved two experts as validators. The data collection technique in this study was a validity questionnaire and a practicality questionnaire. The results of the media validity test on the aspects of cover design and module content design obtained a percentage of 88.4% with a very valid category. While the results of material expert validation which includes aspects of content feasibility, linguistic feasibility, presentation and self-study obtained a percentage of 100% with a very valid category. For the practicality assessment, the teacher and student responses showed that the product developed was very practical with a percentage score of 85.4% and 98.7% respectively. From the results of validity and practicality, it can be concluded that the teaching module with the PBL-STEM model of photosynthesis material can be declared valid and practical and is suitable for testing. This research is expected to help educators in developing teaching modules, especially in science subjects and can be a reference for other researchers.

Corresponding Author:

Meza Mardita
Sekolah Pascasarjana, Universitas Negeri Semarang, Semarang , Indonesia
Email: mezamardita06@students.unnes.ac.id

INTRODUCTION

The 21st century currently provides many opportunities for education to develop faster than in previous periods (Dini et al., 2020). One of the expectations for the education system is to be able to realize students who have critical thinking skills that are able to keep up with the times (Yamin & Syahrir, 2020; Dywan et al., 2020). Critical thinking skills are one of the 21st century skills that really need to be trained because it will make it easier for students to be able to analyze and compile arguments as proof of each decision (Pratiwi & Setyaningtyas, 2020; Wahyunita & Subroto, 2021;

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

Mareti & Hadiyanti, 2021). Therefore, critical thinking skills are a skill that must be possessed by students in stimulating cognitive reasoning and building knowledge in the learning process and are important to be developed early, especially at the elementary school level (Haryani et al., 2021).

However, in fact, in the learning process the teacher only directs students to the ability to memorize material. Students are not directed to understand information related to their daily lives but are only required to memorize and remember information provided by the teacher (Mareti & Hadiyanti, 2021). If students' thinking skills are low, it will have an impact on their learning outcomes. The causes of low critical thinking skills in students are caused by several factors including: (1) students' lack of understanding of the problem; (2) students easily forget the material that has been taught; (3) students are unable to connect concepts with actual circumstances; (4) students lack focus and are easily bored in participating in learning; (5) the learning provided is not contextualized (Simatupang et al., 2020; Benyamin et al., 2021; Fuadi et al., 2020; Widya Sukmana, 2018; Pratiwi et al., 2020; S. Ardianti et al., 2020). Ardianti et al., 2020).

In the learning process, the teacher plays an important role. The role of teachers in learning is to make the knowledge taught to students well received (Yestiani & Zahwa, 2020). Therefore, to improve the quality of education, teachers are required to be able to design an effective and efficient learning system in order to produce graduates with the best titles in accordance with the demands of the times, maximize the use of technology and science in the teaching and learning process so that students will be able to integrate their knowledge and skills (Firdaus & Hamdu, 2020; Subakti et al., 2021; Asrizal et al., 2018)..

One of the things that teachers must prepare in supporting learning is learning tools. In the current Merdeka curriculum, there are several changes such as changing the Learning Implementation Plan to teaching modules (Ardianti & Amalia, 2022). Based on the results of interviews conducted with fourth grade teachers at SDN Kembangarum 01, SDN Kembangarum 02, SDN Kembangarum 03 Semarang, classroom teachers only use teaching modules that have been provided by the school or obtained from the teacher working group forum. The learning models included in the available teaching modules also only include face-to-face models and do not lead to learning models that can improve students' critical thinking skills. In addition, according to teachers, learning activities that can improve student understanding are learning with experiments or students are asked to do experiments independently or in groups when compared to learning with the lecture method or with only media assistance in the form of videos. Therefore, classroom teachers have never developed teaching modules for all subjects including science subjects.

One of the materials taught in grade IV elementary school is photosynthesis. Photosynthesis is a fairly complex science material that contains elements of biology and chemistry in it. According to the teacher, students are quite difficult to understand about photosynthesis material due to the many scientific terms used for the photosynthesis process. In addition, students also find it difficult to understand the concept of the photosynthesis process so that students have misconceptions about photosynthesis.

The low critical thinking skills of students, especially at the elementary school level, require improvements to the learning process so that it can run effectively, is easy to understand and involves students actively. One solution to solving problems regarding critical thinking skills and student learning outcomes is to test various learning models until the teacher finds a learning model that is deemed suitable for use in learning (Pratiwi et al., 2020). The PBL learning model is one example of a learning model which in its implementation is related to the indicators of critical thinking skills assessment. According to Zhao et al (2020) the definition of PBL learning model is

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

a student-centered pedagogy in which each student is allocated into groups, then each group is given a task or challenge that reflects a situation that is relevant to their environment. Meanwhile (Graaff, 2003) defines the PBL model as a concept in attributes, especially student-centered learning, which takes place in groups of a small scope with the teacher acting as a facilitator and organized around the problem.

The PBL model can be integrated with the science, technology, engineering, and mathematics (STEM) approach (Putri et al, 2020). The purpose of STEM education is to increase students' understanding of learning materials and so that students are able to apply this knowledge to solve the problems they face by developing higher order thinking skills, preparing for 21st century human resource needs, and developing competencies in the STEM field (Mu'minah, 2021; Sutaphan & Yuenyong, 2019).

Based on the background of the problems described above, this study will develop modules with the PBL-STEM model on photosynthesis material. The developed teaching module is expected to be used as a reference in the development of teaching modules for the learning process, especially at SDN Kembangarum 02 Semarang in science subjects or other subjects.

LITERATURE REVIEW

Teaching Module

The current independent curriculum has four principles that have been transformed into new policy directions, one of which is the use of lesson plans. Unlike the previous curriculum, where lesson plans were prepared following the general format. However, the independent curriculum gives teachers the freedom to freely choose, create, use and develop the format of the lesson plan itself while still paying attention to the three core components in making lesson plans, namely learning objectives, learning activities, and assessment. The lesson plans in the independent curriculum are known as teaching modules (Maulinda, 2022). A teaching module is a learning tool based on the curriculum and applied for the purpose of achieving predetermined competency standards (Maulinda, 2022).

The main role of the teaching module is to support teachers to design learning activities. In addition, teaching modules play an important role in helping educators to design their learning (Dini et al., 2020). If the design of learning activities in teaching modules is developed based on 21st century skills, then these activities will have the potential to be applied in the learning process. In a teaching module, students will play more roles in the learning process. While the teacher only acts as a facilitator in a learning process.

PBL-STEM Model

PBL is one of the learning models that connects learning with problems in everyday life. In learning using the PBL model, students learn by experience to solve problems related to the real world. The problems in PBL are related to STEM (Parno et al., 2019). STEM is an interdisciplinary approach formed by connecting Science, Technology, Engineering and Mathematics and aims to develop students' creativity in solve a real-life problem (Tezer et al., 2021; Monsang & Srikoon, 2021; Öztürk & Özdemir, 2020; Changpetch & Seechaliao, 2019; Baharin et al., 2018). In applying the PBL-STEM model in learning, students are challenged critically, creatively and innovatively to solve real-world problems through collaborative teamwork (Parno et al., 2020).

According to Safitri et al (2021), the application of the PBL-STEM model is able to foster student creativity through a problem-solving process that is integrated with four STEM disciplines, namely science, technology, engineering and mathematics. The results of research conducted by

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

Parenta et al (2022) show that the PBL-STEM model is effectively used to improve students' critical thinking skills. The use of the PBL-STEM model not only focuses on content but also incorporates problem solving skills and inquiry instructions (Aulia et al., 2021).

The syntax of learning steps with the PBL-STEM model is the first syntax of student orientation to the problem, the second syntax organizes students on problems to learn. In the first and second syntax train students to explain scientific phenomena. In the third syntax, namely guiding the investigation. Students conduct experiments to explore the problems that have been given. The third syntax trains students to evaluate and design scientific investigations, interpret scientific evidence and data. The fourth syntax presents the results of the work, where students produce and make presentations about the products or data results that have been obtained during the experiment. The fourth syntax trains students to evaluate and design scientific investigations. And the fifth syntax is analyzing and evaluating the problem-solving process associated with the STEM approach. The fifth syntax trains students to interpret scientific evidence and data (Parno et al., 2022).

Photosynthesis Material

The Merdeka curriculum at the primary school level, there are several differences in terms of subjects, one of which is the merging of science and social studies into one into IPAS (Natural and Social Sciences) (Sosilowati, 2022). One of the materials in the IPAS subject in elementary school is photosynthesis. Some of the concepts discussed in photosynthesis material are the concept of substances needed in the photosynthesis process in green plants, the concept of the photosynthesis process, the concept of substances produced from the photosynthesis process and the concept of green plants getting food from the photosynthesis process (Laksana, 2016).

Photosynthesis material in elementary school there are several misconceptions that occur in students, namely on several concepts such as: (1) the concept of photosynthesis in the materials needed; (2) the concept of photosynthesis that requires light; (3) the concept of photosynthesis in the products produced; (4) the concept of photosynthesis in the place where it occurs; and (5) the concept of photosynthesis at the time it occurs (Sari & Amini, 2020). To overcome the misconceptions in photosynthesis material, learning activities using the PBL-STEM model can be used as one of the solutions to these problems. Where learning activities using the PBL-STEM model students will learn directly outside the classroom and close to nature. From these activities students will form concepts on the photosynthesis material independently by carrying out activities related to photosynthesis material.

METHOD

This research was conducted at Kembangarum 02 public elementary school in Semarang City. This research is a research and development (R&D). The R&D method can be said to be a scientific way to research, design, produce and test the validity of the products produced (Anarli et al., 2023; Fitra et al., 2023; Nurzayyana et al., 2021; Sugiyono, 2015). This research adopted the ADDIE development model (Analyze, Design, Develop, Implementation, and Evaluation) (Hidayat et al., 2021). This ADDIE model is a model developed by Reiser and Mollenda in the 1990s (Sari, 2017).

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

This ADDIE development model has one of its functions as a guide in developing an effective training program tool and infrastructure.

The development systematics of this ADDIE model are Analyze, Design, Development, Implementation, and Evaluation (Evaluation or feedback) (Sari, 2017). The final result of this research is a teaching module product with PBL-STEM model of photosynthesis material. Teaching modules with PBL-STEM models are developed using the Canva application and Microsoft Word software. The data collection instruments in this study consisted of observation sheets, namely initial interviews and questionnaires, namely product validity and practicality questionnaires to test the feasibility of the products developed.

The type of data obtained from product development in this study is qualitative data obtained from suggestions and comments given by expert validators and practitioners. Furthermore, quantitative data is obtained based on the assessment scores given by expert validators and practitioners based on validity and practicality questionnaires which are then analyzed according to predetermined assessment criteria so as to obtain the validity and practicality of the products developed.

The data analysis technique used is descriptive qualitative analysis which is used to analyze data in the form of suggestions and comments that have been given by media expert validators and material experts and practitioners, then the product is revised according to the suggestions and comments from validators and practitioners. Meanwhile, descriptive quantitative data analysis techniques are used to analyze data obtained from scores from validity questionnaires and product practicality. To determine the category in decision making includes module validation with a Likert scale, strongly agree = 4, agree = 3, less agree = 2, and disagree = 1. To find out the average score obtained from expert validators, it is calculated using the following formula:

$$\text{Average} = \frac{total\ score}{the\ sum\ of\ all\ data\ scores}\ x\ 100\%$$

The percentage of validity criteria and practicality assessment criteria are presented in tables 1 and 2 below.

Table 1. Validity Assessment Criteria

Interval Average Score (%)	Category
81,25< x ≤ 100	Very Valid
62,5 < x ≤ 81,25	Valid
43,75 < x ≤ 62,5	Invalid
25 < x ≤ 43,75	Very Valid

Table 2. Practicality Assessment Criteria

Interval Average Score (%)	Category
84 < x ≤ 100	Very Practical
68< x ≤ 84	Practical
52 < x ≤ 68	Enough Practical
36 < x ≤ 52	Less Practical
20 < x ≤ 36	Not Very Practical

RESULTS

This research is a development research that has been carried out so as to produce products in the form of teaching modules with PBL-STEM models in IPAS class IV elementary school subjects. The focus of the material on the teaching materials developed is photosynthesis material for grade

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

IV SDN Kembangarum 02 Semarang city. The results of this study examined: (1) the development of teaching modules and (2) the feasibility of teaching modules. The purpose of this study was to produce products in the form of teaching modules with PBL-STEM models of photosynthesis material in grade IV elementary schools. The development stage with the ADDIE model is passed with several stages as follows:

Analysis Stage

In the first stage, the needs analysis stage was carried out by conducting interviews with fourth grade teachers at SDN Kembangarum 01, SDN Kembangarum 02, and SDN Kembangarum 03 Semarang city. From the results of this interview, then used as a reference in the development of teaching modules with PBL-STEM models. Based on the interviews that have been conducted with homeroom teachers IV, the results obtained that the teacher in the learning process has not developed independently teaching modules that will be used in the learning process, but only depends on teaching modules that have been provided by the school or obtained from the teachers' working group forum. In addition, according to teachers, learning methods that can improve student understanding are learning with experiments or experiments that are directly carried out by students either individually or in groups when compared to learning with the lecture method or with only media assistance in the form of videos. Therefore, it can be concluded that classroom teachers have never developed teaching modules independently by adjusting to students' abilities, especially in science subjects.

Design Stage

The next stage is the planning stage which is a follow-up to the analysis. At the teaching module design stage, a prototype design is needed to assist in making teaching modules. The main components in making teaching modules with the PBL-STEM model include: Cover, introductory part, core part and closing part. The teaching module developed discusses photosynthesis material tailored to learning outcomes and learning objectives.

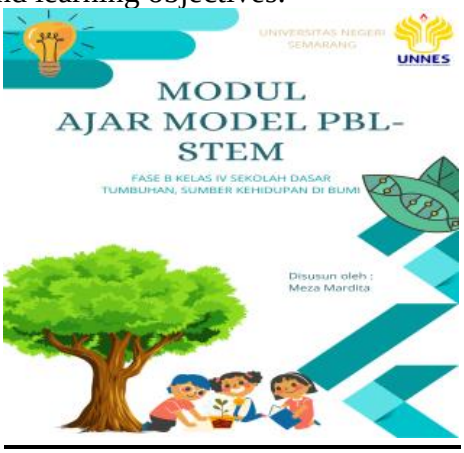


Figure 1. Initial design of teaching module

Development Stage

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

After the design stage, the development stage is carried out, namely realizing the design that has been made before. At this stage, there are several things that need to be done, among others:

Making Teaching Modules

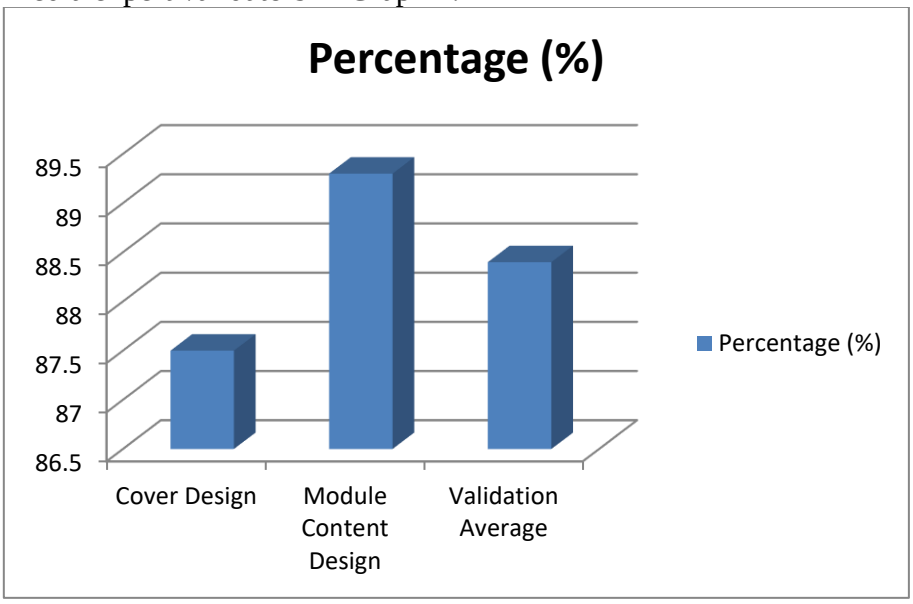
The teaching module that has been designed in the form of a prototype then continues at the manufacturing and development stage. Making this teaching module uses the Canva application and Microsoft Word software. The teaching module developed consists of several components, namely: learning steps using the PBL-STEM model, student worksheets (LKS), teaching materials, learning media and evaluation tools for photosynthesis material in grade IV elementary school.

Product Feasibility Validation

The product that has been developed is then validated by two experts, namely media experts and material experts to determine the feasibility of the teaching module that has been developed.

Media Expert Validation

The media expert validator for this developed product is one expert. The validation carried out by media experts is related to the appearance of the teaching module. Media experts conduct an assessment by providing comments and suggestions related to the media and to improve and perfect the teaching modules that have been developed. The following presents the results of media validation by media expert validators in Graph 1.



Graph 1. Media Expert Validation Results

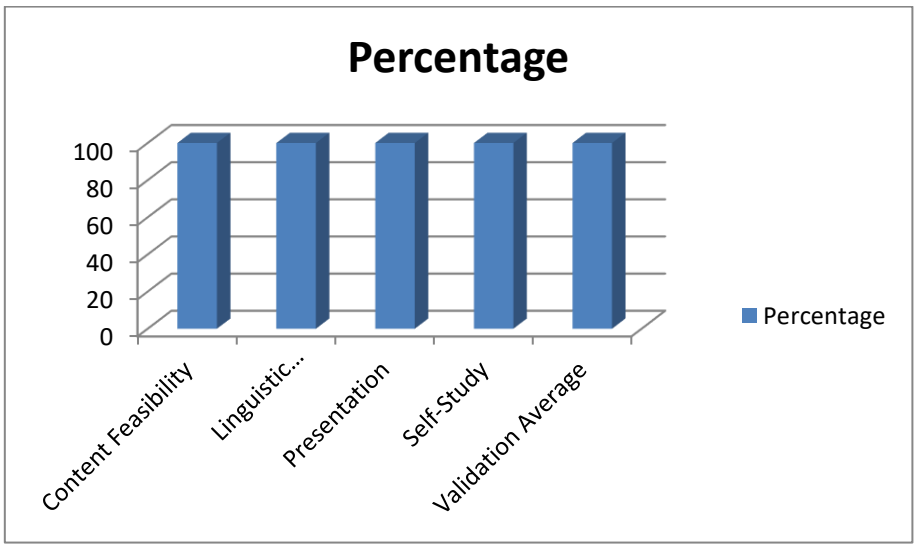
Based on the results of the assessment by the media expert validator contained in graph 1, it can be concluded that the teaching module with the PBL-STEM model is included in the very valid category with an average percentage score of 88.4%. Furthermore, the teaching module was revised according to the suggestions and comments from the media expert.

Material Expert Validation

Material validation conducted by material experts includes several aspects, namely content feasibility indicators, language indicators, presentation indicators and self-learning indicators. The

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

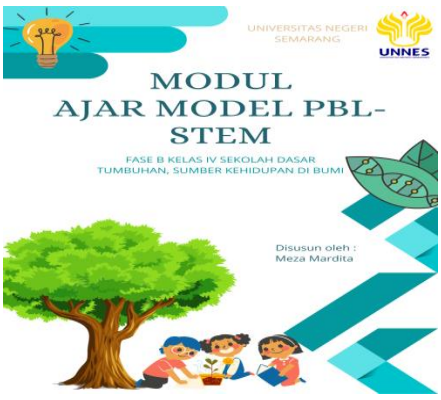
following are presented the results of media validation by media expert validators in Graph 2 below.



Graph 2. Material Expert Validation Results

Based on Graph 2 above, it shows that the average assessment of teaching module material validation shows a percentage of 100% which is included in the very valid category. From the results of the assessment given by the material expert, it can be concluded that the teaching module with the PBL-STEM model developed is feasible and clear. The language used is easy to understand and in accordance with the understanding of grade IV elementary school students.

Product validation has been carried out by two expert validators, namely media experts and material experts. The results of suggestions and improvements from both expert validators can be seen in the following figure:



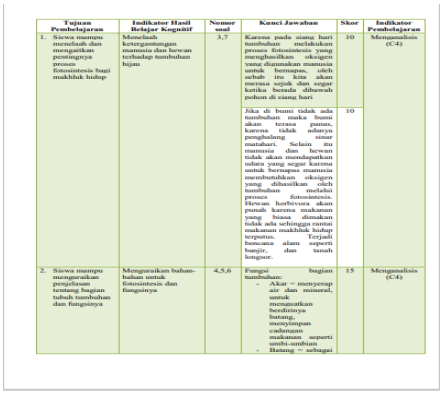
Before Revision

After Revision

Figure 2. Cover Revision View

The results of the development of teaching modules with the PBL-STEM model can be seen in the following figure:

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)



Tujuan Pembelajaran	Indikator Hasil Belajar Kognitif	Nomor soal	Kunci Jawaban	Skor	Indikator Pembelajaran
1. Siswa mampu menelaah dan mengartikan pentingnya proses fotosintesis bagi makhluk hidup	Menelaah ketergantungan manusia dan hewan terhadap tumbuhan hijau	3,7	Karena pada siang hari tumbuhan melakukan proses fotosintesis yang menghasilkan oksigen yang digunakan manusia untuk bernapas, oleh sebab itu kita akan merasa sejuk dan segar ketika berada dibawah pohon di siang hari	10	Menganalisis (C4)
			Jika di bumi tidak ada tumbuhan maka bumi akan terasa panas, karena tidak adanya penghalang sinar matahari. Selain itu manusia dan hewan tidak akan mendapatkan udara yang segar karena tidak ada tanaman yang menghasilkan oksigen yang dihasilkan oleh tumbuhan melalui proses fotosintesis. Hewan herbivora akan punah karena makanan yang biasa dimakan tidak ada sehingga rantai makanan makhluk hidup terputus. Terjadi bencana alam seperti banjir, dan tanah longsor.	10	
2. Siswa mampu menguraikan penjelasan tentang bagian tubuh tumbuhan dan fungsinya	Menguraikan bahan-bahan untuk fotosintesis dan fungsinya	4,5,6	Fungsi bagian tumbuhan: - Akar = menyerap air dan mineral, untuk mentransfer nya, menyimpan cadangan makanan seperti umbi-umbian - Batang = sebagai	15	Menganalisis (C4)

Figure 3. Display of Learning Activity Steps

Figure 4. One of the Teaching Material Display

Implementation Stage

After the validity test is carried out on the developed product, and it is declared feasible to be tested, the next stage is the implementation stage. At the implementation stage, the products that have been developed are applied after revision. Teaching modules with PBL-STEM models that have been developed are implemented in class IV elementary schools in real terms. However, before the teaching module is implemented in a large group, the author first conducts a small group trial (limited trial) by looking at the response of the fourth grade teacher and student responses after the product is tested on the learning. The limited trial consisted of two fourth grade teachers and 6 fourth grade students of Kembangarum 02 public elementary school.

In the implementation of the limited trial, the author conducted teaching and learning activities as usual guided by the teaching module with the PBL-STEM model that had been developed. For some students' misconceptions about photosynthesis material based on the results of teacher interviews at the initial observation of the study, here are some solutions that can be done by teachers to support smooth learning with teaching modules with PBL-STEM models, among others: 1) Misconceptions on terms in photosynthesis material. Teachers can introduce new terms related to photosynthesis material and provide teaching materials that have been provided in the teaching module so that students can more easily understand each photosynthesis process; 2) misconceptions in the photosynthesis process. Teachers can carry out the learning process in

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

accordance with the learning steps that have been arranged in the teaching module, so that students can understand how the photosynthesis process takes place; and 3) misconceptions on the results of photosynthesis. Teachers can direct students to learn independently and conduct experiments based on student worksheets contained in the teaching module so that students can directly observe the results of the simple photosynthesis process.

After the learning process was completed, at the end of the trial, teachers and students were given a practicality questionnaire. The purpose of this questionnaire is to see the responses of teachers and students to learning using teaching modules with the PBL-STEM model that has been developed.

The teacher response trial was conducted on two fourth grade teachers of SDN Kembangarum 02 named Mrs. Siswi Handayani, S.Pd. SD and Mrs. Meila Nisa Hidayah, S.Pd. The aspects assessed include presented in 11 question items. For the student response trial, it was conducted in a small group of 6 fourth grade students of Kembangarum 02 public elementary school. The aspects assessed are presented in 13 questions. The following presents the results of the practicality of teacher and student responses in table 5.

Table 5. Practicality Results of Teacher and Student Responses

Practicality Results	Average Practicality Score	Category
Teacher Practicality	85,4%	Very Practical
Student Practicality	98,7%	Very Practical

Based on the results of the practicality test of student responses to learning activities using teaching modules with the PBL-STEM model obtained a percentage of 98.7% with a very practical category. So, it can be concluded that learning using teaching modules with the PBL-STEM model of photosynthesis material can be followed easily by students in class IV elementary school.

DISCUSSION

Product development carried out by researchers is in accordance with product design and the results of initial observations on the potential and problems that exist in the field. The potential and problems obtained based on the needs analysis process are curriculum analysis, learning analysis and teaching module analysis. Needs analysis was conducted through interviews with fourth grade teachers in three schools in one cluster, namely SDN Kembangarum 01, SDN Kembangarum 02 and SDN Kembangarum 03 Semarang City. Based on the results of the interviews that have been conducted which are then used as a foundation by researchers in the development of teaching modules with the PBL-STEM Model. The development of teaching modules is in line with the needs of teachers who have to change learning tools from lesson plans to teaching modules in accordance with the independent curriculum that applies in the school.

After analyzing the needs, then proceed to the product design and development stage, namely the teaching module with the PBL-STEM model of photosynthesis material. The components contained in the teaching module developed include: (1) steps for using teaching modules for teachers and students; (2) learning steps that use the syntax of the PBL-STEM model; (3) teaching materials; (4) learning media; (5) student worksheets; (6) evaluation questions to measure students' critical thinking skills. The teaching module was developed using the canva application and Microsoft word software.

Journal Of Teaching And Learning In Elementary Education
Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

The product that has been developed is then tested for feasibility by two experts, namely media experts and material experts. Assessment by media experts and material experts has several aspects of indicators, namely cover design, module content design, content feasibility, linguistic feasibility, presentation and independent learning. Each expert validator provides an assessment of the feasibility of teaching modules with the PBL-STEM model that has been developed. Based on the results of the assessment by the media expert validator, the overall average percentage was 88.40% with a very valid category and the material expert validator obtained an average percentage of 100% with a very valid category. Although the teaching module with the PBL-STEM model is declared valid, there are still some suggestions and comments which are then revised or improved so that the product developed becomes better.

The innovations in the development of this product from the research conducted by Adiwiguna (2019) are in the learning steps that use the PBL model integrated with the STEM approach in its learning activities. The development of teaching modules with PBL-STEM models can provide new experiences for students and teachers which emphasize the use of PBL models integrated with STEM in the learning process. After going through each stage of the research, teaching modules with PBL-STEM models are considered capable of providing new and enjoyable experiences for students so that they can improve student learning outcomes. The characteristics of the teaching module with the PBL-STEM model that has been developed include: a) The learning model used is the Problem Based Learning model which is integrated with the STEM approach; b) contains steps of learning activities with PBL-STEM syntax; c) Learning activities that focus on students (student-centered; d) learning steps are arranged, directing students to utilize the environment as a learning resource and e) pouring stimulus to develop critical thinking skills.

CONCLUSION

Based on the results and discussion of this study, the final product is a teaching module with PBL-STEM model and it can be concluded that the teaching module with PBL-STEM model of photosynthesis material is feasible and can be used in the learning process with suggestions and comments from expert validators and based on teacher and student responses. This can be seen from the results of the media and material feasibility test by expert validators with an average of 88.4% and 100% respectively with a very valid category. The development of teaching modules is said to be valid because it has met the assessment criteria. At the implementation stage, the teaching module with the PBL-STEM model in small groups obtained practicality results from teachers and students. Based on the results of the practicality assessment, the teacher obtained an assessment with a percentage of 85.4% with very feasible criteria. As for the student assessment after the learning process with the PBL-STEM model obtained a percentage of 98.7% with very practical criteria.

The implication of this research is that through this development research, it is hoped that it can add insight into the learning theory of IPAS, especially on photosynthesis material. The development of teaching modules with the PBL-STEM model can be used as a guide for teachers in developing teaching modules for other materials that can be adapted to the PBL-STEM learning model. After the implementation of this study, teachers are expected to be able to develop teaching modules independently by adding new innovations to teaching modules developed with PBL-STEM models or other learning models.

Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

Suggestions for further research are expected to pay more attention to the limitations in the development and technical planning and implementation process of the products developed. Teaching modules with the PBL-STEM model can be used as a reference in developing teaching modules in further research, especially in IPAS subjects.

REFERENCES

Adiwiguna, P. S., Dantes, N., & Gunamantha, I. M. (2019). Pengaruh Model Problem Based Learning (PBL) Berorientasi Stem terhadap Kemampuan Berpikir Kritis dan Literasi Sains Siswa Kelas V Sd di Gugus I Gusti Ketut Pudja. Jurnal Pendidikan Dasar Indonesia, 3(2), 94–103

Anarli, A., Hermita, N., & Putra, Z. H., (2023). Pengembangan Media Interaktif Articulate Storyline Berbasis Kontekstual pada Materi Ekosistem Kelas V Sekolah Dasar. *Tunjuk Ajar: Jurnal Penelitian Ilmu Pendidikan, 6*(1), 15 - 29.

Ardianti, S., Sulisworo, D., Pramudya, Y., & Raharjo, W. (2020). The Impact of the Use of STEM Education Approach on the Blended Learning to Improve Student ' s Critical Thinking Skills. 8, 24–32. https://doi.org/10.13189/ujer.2020.081503

Asrizal, A., Amran, A., Ananda, A., & Festiyed, F. (2018). Effectiveness of Adaptive Contextual Learning Model of Integrated Science by Integrating Digital Age Literacy on Grade VIII Students. IOP Conference Series: Materials Science and Engineering, 335(1). https://doi.org/10.1088/1757-899X/335/1/012067

Baharin, N., Kamarudin, N., & Manaf, U. K. A. (2018). Integrating STEM Education Approach in Enhancing Higher Order Thinking Skills. International Journal of Academic Research in Business and Social Sciences, 8(7), 810–821. https://doi.org/10.6007/ijarbss/v8-i7/4421

Benyamin, B., Qohar, A., & Sulandra, I. M. (2021). Analisis Kemampuan Berpikir Kritis Siswa SMA Kelas X Dalam Memecahkan Masalah SPLTV. Jurnal Cendekia : Jurnal Pendidikan Matematika, 5(2), 909–922. https://doi.org/10.31004/cendekia.v5i2.574

Changpetch, S., & Seechaliao, T. (2019). The Propose of an Instructional Model Based on STEM Education Approach for Enhancing the Information and Communication Technology Skills for Elementary Students in Thailand. International Education Studies, 13(1), 69. https://doi.org/10.5539/ies.v13n1p69

Dini, F., Nesri, P., Kristanto, Y. D., & Sanata, U. (2020). Pengembangan Modul Ajar Berbantuan Teknologi untuk Mengembangkan Kecakapan Abad 21 Siswa. Aksioma, 9(3), 480–492.

Dywan, A. A., Airlanda, G. S., Kristen, U., Wacana, S., & Tengah, J. (2020). Efektivitas Model Pembelajaran Project Based Learning Berbasis Stem Dan Tidak Berbasis Stem Terhadap Keterampilan Berpikir Kritis Siswa. 4(2), 344–354.

Fitra, A., Miranti, F., Rahmayani, R., & Putra, Z. H. (2023). Pengembangan media pembelajaran interaktif berbantuan Microsoft PowerPoint pada materi ciri-ciri dan pertumbuhan makhluk hidup untuk siswa sekolah dasar. *Indonesian Journal of Science, Technology, Engineering, Art, and Mathematics Education, 1*(2), 61 - 71.

Firdaus, S., & Hamdu, G. (2020). Pengembangan Mobile Learning Video Pembelajaran Berbasis STEM (Science, Technology, Engineering And Mathematics) Di Sekolah Dasar. JINOTEP (Jurnal Inovasi Dan Teknologi Pembelajaran): Kajian Dan Riset Dalam Teknologi Pembelajaran, 7(2), 66–75. https://doi.org/10.17977/um031v7i22020p066

Fuadi, H., Robbia, A. Z., Jamaluddin, J., & Jufri, A. W. (2020). Analisis Faktor Penyebab Rendahnya Kemampuan Literasi Sains Peserta Didik. Jurnal Ilmiah Profesi Pendidikan, 5(2), 108–116. https://doi.org/10.29303/jipp.v5i2.122

Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

Graaff, E. D. E. (2003). Characteristics of Problem-Based Learning *. 19(5).

Haryani, S., Prasetya, A.T., Dewi,S.H., & Fadillah, A. (2022). Penyusunan Bahan Ajar SMK Terintegrasi Konteks Kejuruan pada Pembelajaran Kimia. Jurnal Inovasi Pendidikan Kimia, 16(2), 131–137. https://doi.org/10.15294/jipk.v16i2.31633

Hidayat, F., Rahayu, C., Barat, K. B., Nizar, M., Coblong, K., & Bandung, K. (2021). Model ADDIE (Analysis , Design , Development , Implementation And Evaluation) Dalam Pembelajaran Pendidikan Agama Islam Addie (Analysis , Design , Development , Implementation And Evaluation) Model In Islamic Education Learning. 28–37.

Mareti, J. W., & Hadiyanti, A. H. D. (2021). Model Problem Based Learning Untuk Meningkatkan Kemampuan Berpikir Kritis dan Hasil Belajar IPA Siswa. Jurnal Elementaria Edukasia, 4(1), 31–41. https://doi.org/10.31949/jee.v4i1.3047

Maulinda, U. (2022). Pengembangan Modul Ajar Berbasis Kurikulum Merdeka. Tarbawi, 5(2), 130–138.

Monsang, P., & Srikoon, S. (2021). Meta-Analysis of STEM Education Approach effected on Student' Creative thinking skills in Thailand. Journal of Physics: Conference Series, 1835(1). https://doi.org/10.1088/1742-6596/1835/1/012085

Mu'minah, I. H. (2021). Studi Literatur: Pembelajaran Abad-21 Melalui Pendekatan Steam (Science, Technology, Engineering, Art, and Mathematics) dalam Menyongsong Era Society 5.0. Prosiding Seminar Nasional Pendidikan, 3, 584–594.

Nurzayyana, A., Putra, Z. H., & Hermita, N. (2021). Designing a Math Picture Book to Stimulate Primary School Students' Understanding of Properties of 2-D Shapes. *Journal of Teaching and Learning in Elementary Education*, *4*(2) 164 - 179. http://dx.doi.org/10.33578/jtlee.v4i2.7892

Öztürk, F., & Özdemir, D. (2020). The Effect of STEM Education Approach in Science Teaching: Photosynthesis Experiment Example. Journal of Computer and Education Research. https://doi.org/10.18009/jcer.698445

Parenta, Y., Masykuri, M., & Saputro, S. (2022). Literature Study: Application of PBL-STEM on Simple Machine Topic to Improve Critical Thinking Skills. Jurnal Penelitian Pendidikan IPA, 8(2), 674–680. https://doi.org/10.29303/jppipa.v8i2.1181

Parno, P., Yuliati, L., Hermanto, F. M., & Ali, M. (2020). A Case Study on Comparison of High School Studentsâ€™ Scientific Literacy Competencies Domain in Physics with Different Methods: Pbl-Stem Education, Pbl, and Conventional Learning. Jurnal Pendidikan IPA Indonesia, 9(2), 159-168.

Parno, P., Yuliati, L., & Ni'mah, B. Q. A. (2019, February). The influence of PBL-STEM on students' problem-solving skills in the topic of optical instruments. In *Journal of Physics: Conference Series* (Vol. 1171, p. 012013). IOP Publishing.

Pratiwi, E. T., & Setyaningtyas, E. W. (2020). Kemampuan Berpikir Kritis Siswa Melalui Model Pembelajaran Problem Based Learning dan Model Pembelajaran Project Based Learning. Jurnal Basicedu, 4(2), 379–388. https://doi.org/10.31004/basicedu.v4i2.362

Pratiwi, E. T., Setyaningtyas, E. W., & Setyaningtyas, E. W. (2020). Jurnal basicedu. 4(2), 379–388.

Safitri, R., Haryanto, H., & Harizon, H. (2021). Development of PBL-STEM-based E-LKPD to improve students' science literacy skills on reaction rate materials. Jurnal Pendidikan Kimia, 13(2), 113–129. https://doi.org/10.24114/jpkim.v13i2.26980

Sari, F. B., Amini, R., & Mudjiran, M. (2020). Lembar Kerja Peserta Didik Berbasis Model Integrated di Sekolah Dasar. *Jurnal Basicedu, 6*(3), 1194 - 1200.

Vol. 7, No.1, February 2024, pp. 134 – 147
DOI: http://dx.doi.org/10.33578/jtlee.v7i1.8075
ISSN : 2615-4528 (Print) 2622-3023 (Online)

Simatupang, H., Sianturi, A., & Alwardah, N. (2020). Pengembangan Lkpd Berbasis Pendekatan Science, Technology, Engineering, and Mathematics (Stem) Untuk Menumbuhkan Keterampilanberpikir Kritis Siswa. Jurnal Pelita Pendidikan, 7(4), 170–177. https://doi.org/10.24114/jpp.v7i4.16727

Subakti, D. P., Marzal, J., & Hsb, M. H. E. (2021). Pengembangan E-LKPD Berkarakteristik Budaya Jambi Menggunakan Model Discovery Learning Berbasis STEM Untuk Meningkatkan Kemampuan Berpikir Kreatif Matematis. 05(02), 1249–1264.

Sugiyono. (2015). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D.* Bandung : ALFABETA.

Sutaphan, S., & Yuenyong, C. (2019). STEM Education Teaching approach: Inquiry from the Context Based. Journal of Physics: Conference Series, 1340(1). https://doi.org/10.1088/1742-6596/1340/1/012003

Tezer, M., Orekhovskaya, N. A., Shaleeva, E. F., Knyazeva, S. A., & Krokhina, J. A. (2021). The Effectiveness of STEM Education Applied with a Distance Education Approach. International Journal of Emerging Technologies in Learning, 16(19), 180–192. https://doi.org/10.3991/ijet.v16i19.26061

Wahyunita, I., & Subroto, W. T. (2021). Efektivitas model pembelajaran blended learning dengan pendekatan STEM dalam upaya meningkatkan kemampuan berfikir kritis peserta didik. Edukatif : Jurnal Ilmu Pendidikan Volume, 3(3), 1010–1021. https://edukatif.org/index.php/edukatif/index%0AEfektivitas

Sukmana, R. W. (2017). Pendekatan science, technology, engineering and mathematics (stem) sebagai alternatif dalam mengembangkan minat belajar peserta didik sekolah dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *2*(2), 189-197.

Yamin, M., & Syahrir, S. (2020). Pembangunan Pendidikan Merdeka Belajar (Telaah Metode Pembelajaran). Jurnal Ilmiah Mandala Education, 6(1), 126–136. https://doi.org/10.58258/jime.v6i1.1121

Yestiani, D. K., & Zahwa, N. (2020). Peran Guru dalam Pembelajaran pada Siswa Sekolah Dasar. Fondatia, 4(1), 41–47. https://doi.org/10.36088/fondatia.v4i1.515

Zhao, W., He, L., Deng, W., Zhu, J., Su, A., & Zhang, Y. (2020). The effectiveness of the combined problem-based learning (PBL) and case- based learning (CBL) teaching method in the clinical practical teaching of thyroid disease. 1–10.