The Development of Project-Based Science Teaching Materials in Building Collaborative Thinking and Acting Skills

Joko Sudarmono*[1], Ujang Rohman[2], Prayogo[3]
[1,2,3]Universitas PGRI Adi Buana Surabaya, Indonesia
E-mail: sudarmonojoko72@gmail.com, ujang_roh64@unipasby.ac.id, prayogo@unipasby.ac.id

Article Info
Article History
Received: 2023-10-12
Revised: 2023-11-23
Published: 2023-12-01

Keywords:
Development of Teaching Materials;
Thinking Skills;
Collaborative Action;
PJBL.

Abstract
Teaching materials are needed to improve the teaching process so that it can make learning easier. The development of project-based learning Science teaching materials aimed to to improve collaborative thinking and action skills at SMK Negeri 1 Sambeng. In this research, the researchers applied the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model reference. This model was structured programmatically with systematic activities in an effort to solve learning problems related to learning media which suit the needs and learning characteristics of students. Based on the results of the development research discussion, the results of the development of project-based science teaching in building collaborative thinking and action skills in class X Vocational Science Science subjects could be utilized and applied. It is hoped that other teaching materials with other subject matter can be developed so that it can improve teaching and learning process.

Artikel Info
Sejarah Artikel
Diterima: 2023-10-12
Direvisi: 2023-11-23
Dipublikasi: 2023-12-01

Kata kunci:
Pengembangan Bahan Ajar;
Keterampilan Berpikir;
Tindakan Kolaboratif;
PJBL.

Abstrak
Bahan ajar diperlukan untuk memperbaiki proses pengajaran sehingga dapat mempermudah pembelajaran. Pengembangan bahan ajar IPA berbasis proyek bertujuan untuk meningkatkan keterampilan berpikir dan bertindak kolaboratif di SMK Negeri 1 Sambeng. Dalam penelitian ini, peneliti menerapkan acuan model ADDIE (Analysis, Design, Development, Implementation, Evaluation). Model ini disusun secara terprogram dengan kegiatan yang sistematis dalam upaya memecahkan masalah pembelajaran yang berkaitan dengan media pembelajaran yang sesuai dengan kebutuhan dan karakteristik pembelajaran siswa. Berdasarkan hasil diskusi penelitian pengembangan, hasil pengembangan pembelajaran IPA berbasis proyek dalam membangun keterampilan berpikir dan bertindak kolaboratif pada mata pelajaran IPA kelas X SMK dapat dimanfaatkan dan diterapkan. Diharapkan bahan ajar lain dengan mata pelajaran lain dapat dikembangkan sehingga dapat meningkatkan proses belajar mengajar.

I. INTRODUCTION

Managing the teaching and learning process is a teacher's systematic effort to make the learning process efficient and effective. Each Education Unit has an obligation to develop the intellectual potential of students to the fullest. This is related to develop the potential of students to become human beings who are knowledgeable, capable, creative, independent, successful, responsible, and democratic. In general, the purpose of education is to facilitate students' talents and develop their abilities. Learning process is the most basic activity in education (Shabiralyani et al., 2015). The achievement of educational goals depends on the learning experiences achived by the students. Teachers play an important role in providing learning experiences to students which needs to be reviewed continuously for the development of processes and learning outcomes in educational units. Therefore, designing and developing learning is an effort to make the learning process more effective and efficient (Gunawan et al., 2017).

Unfortunately, sometimes teacher cannot assist students to achieve learning objectives due to monotonous learning. With variations in learning, it is hoped that students will be able to do it on their own, which will eventually develop all aspects of the individual (Tamrin et al., 2017). Students learn and work according to their interests and abilities, so that it can be useful in developing their potential. Students are required to be able to apply all aspects obtained from the learning process, so that they can become creative individuals. In addition, students will be more successful if they are actively enganged in the classroom and relate their experiences in classes with their life (Baran et al., 2018).

By looking at the conditions mentioned above, it seems that learning development efforts are needed which aim to solve learning problems and improve the quality of learning activities and

conditions. Learning will be easier if it is accompanied by resources in the form of specially designed teaching materials. This is because the teaching materials developed have components that can guide the students to understand the content and achieve learning objectives (Sugiyanto et al., 2021). Teaching materials are very helpful in the learning process, especially during digital learning era like today (Hairani & Amini, 2023).

In addition, a specific approach is needed to manage learning activities with learning materials, equipment, and time to effectively achieve the predetermined learning objectives. The learning model clarifies procedures, relationships, and the overall state of what is being designed. Therefore, the selection of the model is influenced by the nature of the material to be studied, the skills to be acquired and the abilities of the students. Learning models can also be categorized based on several types according to the desired goals.

In specific, project-based learning model employs projects in everyday life and uses challenging questions, exercises, or problems to master skills that are applied collaboratively in problem solving efforts (Jalinus et al., 2017). The aim of project-based learning is to increase learning motivation, teamwork, and collaboration skills in achieving the high-level academic ability and creativity. In project-based learning students explore, evaluate, interpret, and process other information to produce a variety of different forms of learning (Yuliansyah & Ayu, 2021). This learning model increases student competence holistically, both in terms of attitudes, knowledge, and skills, through a contextual approach that is close to real work in the field (Rahayu & Sukardi, 2020).

Based on the preliminary study, the quality of education at SMKN 1 Sambeng needs to be improved and supplemented. One of problems was that the students lacked the skills to think and act collaboratively. This problem was caused by a number of things, including school management related to unoptimal and unplanned student skill development, and the inadequate infrastructure at school. To overcome this problem, teaching materials which could improve the teaching process were highly required. Therefore, this research aimed to develop Project-Based Learning (Pjbl) Science Teaching Materials to improve collaborative thinking and acting skills at SMK Negeri 1 Sambeng.

II. METHOD

This research used the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model which was also implemented by some previous research (Bukhori et al., 2022; Nadiyah & Faaizah, 2015). The ADDIE model is programmed with systematic actions aimed at solving learning difficulties related to the environment, learning needs of students and student learning characteristics. This model consisted of five stages which included analysis, planning, development, implementation, and evaluation. The ADDIE development research flow in this study is described as follows:

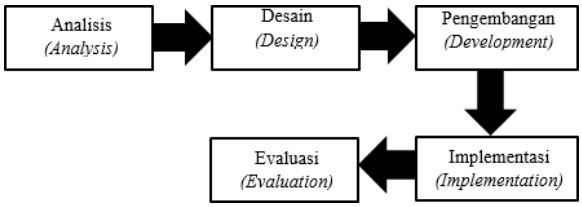

Figure 1. ADDIE development model

Each of the stages is in this research is explain below:

1. Analysis

   Analysis was the first stage in this research. This stage contained initial thoughts in which the researches determined and defined the points of need and goals to be achieved. At this stage, the researchers interviewed Science subject teachers for class X. From the interview, the researchers concluded that there were several problems occurred during in-class learning including inadequate teaching materials. In addition, the teachers commonly used worksheets which caused students to feel bored.

2. Design

   This stage aimed to design the product to be developed. The design form was adjusted to the required product specifications. Several designs which made in this stage included displaying the user interface, making flow-charts, and using case diagrams (illustration of the interaction process between the user and the system).

3. Development

   After getting all the data or information from the interview, the researchers took the initiative to develop interactive teaching materials. In addition, a formative evaluation of material and media validation was carried out by presenters and media experts to find

out whether the media was feasible to be applied or tested in learning so that later suggestions would be obtained to improve teaching materials.

4. Implementation

   At the implementation stage, the researchers began to apply the teaching material to real trials. The implementation of this product aimed at several test subjects, including:

   a) Expert content or subject matter.
   b) Learning media design experts (practitioners).
   c) The 10th grade students of SMK N 1 Sambeng Lamongan.

5. Evaluation

   In the evaluation stage, formative tests were carried out to improve the resulting product. After that, the product was reviewed in the form of product revisions. The product was also tested on material content experts, media experts, and also students. After getting the results, the deficiencies of the products were perceived. Thus, that researchers could revise the shortcomings of the product. This product revision process occurred repeatedly until the the products were feasible for distribution to research targets.

The data obtained in this research were in the form of qualitative and quantitative data. The qualitative data were analyzed by systematically compiling in the form of sentences or words, categories regarding objects, so that general conclusions were obtained. This technique was carried out by collecting and classifying information in the form of input and suggestions for improvement and comments in the assessment instrument sheet or questionnaire. The results of the analysis were then used to revise the product being developed. On the other hand, the quantitative data were analyzed in the form of percentage descriptive. The following formula was used:

$$P = \frac{\sum x}{N} \; x \; 100\%, \quad NA = \frac{\sum P}{n}$$

Description:
P = Score Percentage
NA = Final Value
$\sum x$ = Total Score
N = Maximum score
n = number of questions

Then, the results were used as assessment qualification criteria based on as shown in the following table:

Table 1. Questionnaire assessment guidelines

Options	Scores
Strongly agree/Very good	5
Agree/Good	4
Undecided/Sufficient	3
Disagree/Poor	2
Strongly disagree/Very poor	1

Table 2. Expert Validity Category

Achieved Score (100%)	Qualifications	Categories
81% -100%	Strongly agree/Very good	Very feasible/no need to revise
61% - 80%	Agree/Good	Feasible/Partial revision
41% - 60%	Undecided/Sufficient	Less feasible/needs revision
21% - 40%	Disagree/Poor	Infeasible/full revision
< 20%	Strongly disagree/Very poor	Very infeasible /total revision

III. RESULT AND DISCUSSION

This chapter presents several media development activities that have been adapted to the procedures and steps of ADDIE development, and data and results have been obtained from the development of project-based learning media products or science teaching materials in building collaborative thinking and acting skills at SMK Negeri 1 Sambeng. The elaboration is presented in each stage.

1. Analysis

   Through interviews with students and several Science subject teachers, it is known that they still used conventional media and textbook, so it is possible that they could not promote students to think critically and work collaboratively in accordance with the needs of science learning. The observed students were in class X SMK Negeri 1 Sambeng with an age range between 16-17 years. Science teaching materials were equipped with practice questions, reflections, practices, and projects as learning media which clould attract students' attention. This teaching media adapted to the latest curriculum set by the government, namely Kurikulum Merdeka.

2. Design

Designing project-based science teaching materials in building collaborative thinking and action skills at SMK Negeri 1 Sambeng used A4 size with a space scale of 1.15; font size 12pt, and font Time New Roman.

3. Development

At this stage it is the realization of the media design that was designed at the previous stage.

4. Implementation

At the implementation stage, a product trial was to see if the media was acceptable or not. In this study, the trial was conducted in class X with a total of 30 students. Product acceptance refers to the practicality and effectiveness of the product after use.

5. Evaluation

The evaluation stage was conducted in several ways.

a) Validity/Feasibility Test

All products produced before being tested first need to be tested for validity by experts and practitioners. The validity test was to see the feasibility of science teaching materials, namely Living Things and their Environment both in terms of material and product design.

b) Practicality Test

The practicality test could be seen from the responses of the teachers and 10th grade students of SMK Negeri 1 Sambeng. The responses of teachers and students to learning media were known based on the analysis of data obtained from questionnaires or assessment instruments filled out by teachers and students after using teaching-based materials.

c) Content Expert Test Results

Validation or content expert test was intended to obtain data for revision. The data was in the form of content feasibility assessments, comments, and suggestions on the content or material presented in the teaching materials. The data were collected by using a questionnaire containing questions about the content and components of the teaching materials given to the content experts. From the activities, aspects of content feasibility, presentation feasibility, and language feasibility for project-based science teaching materials in building collaborative thinking and action skills, it obtained a percentage of 90.24%. From the results of the percentages converted into a table of validity level criteria, the project-based science teaching material in building collaborative thinking and action skills was classified as valid and declared very feasible for use in learning.

Input, suggestions, and comments from content experts regarding this teaching material are as follows:

1) The teaching materials developed were suitable for use with revisions.
2) Teaching materials needed to be fairly revised.

d) Design Expert Test Results

Based on input from material content experts, the teaching materials in the form of Draft I development was revised. The revised results of Draft I resulted in a development Draft II. Draft II was submitted to learning design experts to provide feedback and assessment. The data were collected by using a questionnaire. From the activities, aspects of graphic feasibility, and visual engineering feasibility, the percentage was 90.23%. From the results of the percentages converted into a table of validity level criteria, the teaching material was classified as valid and declared very feasible for use in learning. Based on the results of the questionnaire, learning design experts provided the following suggestions:

1) In order for the teaching materials to be more interesting and clearly useful, the colors, layout harmony could clarify functions need to be revised.
2) It is recommended that the format of the book title be corrected and it is not suitable when compared to the author's name as well as the dimensions of the book.

e) Peer Test Results

From this kind of test, it was expected that colleagues could provide input the practicality of the teaching materials. The data were collected by using questionnaire. From the teacher/ eer assessment activities, a percentage of 87.86% was obtained. From the results of the percentages converted into a table of validity level criteria, the media were classified as valid and declared very feasible for use in learning. Based on the results of the questionnaire, learning colleagues provided the following suggestions:

1) Teaching materials developed could be used as a guide for students.
2) The questions contained teaching materials capable of inviting students to think more critically
3) Examples of projects in teaching materials could encourage students to work collaboratively.
4) This teaching material needed improvement related to the color of the letters which was rather difficult to read.
5) The questions and assignments on teaching materials were in accordance with the material.

f) Individual Trials Results

The individual trial used three class X students of SMK Negeri 1 Sambeng as respondents. In individual trials, the main focus was whether the physical appearance of teaching materials was interesting or not. The outline of the content at the beginning of the chapter helped to understand the content of the material. The level of clarity of instructions, font size, type, color used in the teaching materials was easy to read. Additionally, the objectives, exposure to material, suitability of images, and examples of learning materials were considered clear. The assignments, exercises, materials, and summary at the end of the chapter were considered clear. Finally, the order in which the material was presented in each chapter was also clear. In conclusion, the individual test assessment result was 80.89%. After being converted with a validity level table, it showed that the teaching materials were good.

g) Small Group Test Results

This small group trial consisted of six 10th grade students of SMK Negeri 1 Sambeng. The data were gathered from a questionnaire. The results indicated that the overall percentage was 76.22%, so that the teaching materials were in good qualifications and the media was said to be good for use in learning.

h) Large Group Test Results

The students who were used as respondents for the field trial were 30 10th grade students of SMK Negeri 1 Sambeng. In the large group trial, the researches intended to know the physical appearance data of the teaching materials; whether they were attractive or not. The outline of the content at the beginning of the chapter helped to understand the content of the material. The level of clarity of instructions, font size, type, color used in the teaching materials was easy to read. The objectives, exposure to material, suitability of images and examples of learning materials were considered clear. The assignments, exercises, materials, and the summary at the end of the chapter were considered clear.

The results showed that the assessment questionnaire for large group trials of teaching materials in field trials was 86.36%. After being converted with a validity level table, it showed that the teaching materials were in good criteria. The criteria obtained during the field trials were the same as those obtained during the individual trials and also the small group trials.

i) Overall Test Results

Questionnaire result data from the overall trial starting from material expert reviews to field trials can be presented in the table below:

Table 3. The Overal Test Results

Types of Test	Subjects	Mean of Percentage	Validity Criteria
Content Test	1 person, the head of Science teacher's association	90.24%	Very good
Design Test	1 person, a lecturer of UNIPA Surabaya	90.32%	Very good
Peer Test	2 Science subject teachers of SMKN 1 Sambeng	87.86%	Very good
Individual Test	3 students of SMKN 1 Sambeng	80.89%	Good
Smal Group Test	6 students of SMKN 1 Sambeng	76.22%	Good
Large Group Test	24 students of SMKN1 Sambeng	85.32%	Very good
Mean		85.32%	Very good

IV. CONCLUSION AND SUGGESTION

A. Conclusion

This development has produced a learning media in the form of project-based science

teaching materials. With the ADDIE model, this teaching material is very suitable for use at vocational high schools' level learning.

The results of the eligibility of teaching materials based on the validation results from the Material Expert that the level of validity shows the final value of 90.24%. The media expert's assessment shows a percentage value of 90.23%, meaning that the product was stated to be very suitable for use as a medium for learning science. The results of the practicality test based on the assessment responses from teachers/colleagues indicate a percentage of 87.86%. The results of student responses carried out through three stages, namely individual, small-scale, and large-scale tests indicate a percentage of 80.89%, 76.22%, and 86.36%, or an average of 81.16% which can be concluded to have a very good response. Based on the results of the data acquisition, it shows that project-based science teaching in building collaborative thinking and action skills is very well used in learning and means that the media is practical and appropriate to use.

B. Suggestion

Based on the results of the development of project-based science teaching in building collaborative thinking and action skills in class x vocational science science subjects, it is hoped that teachers can make use of this teaching materials specially to develop students' collaborative thinking and acting skills. Additionally, other researchers can develop teaching materials with other subject matter so that it can solve other learning problems.

REFERENCES

Baran, M., Maskan, A., & Yasar, S. (2018). Learning Physics through Project-Based Learning Game Techniques. *International Journal of Instruction*, *11*(2). https://files.eric.ed.gov/fulltext/EJ1175029.pdf

Bukhori, H. A., Widyatmoko, T., & Ting, H. L. (2022). ADDIE method for implementation of virtual reality in online course using model project-based learning. *Jurnal Inovasi Pembelajaran*, *8*(1). https://ejournal.umm.ac.id/index.php/jinop/article/view/18905/10989

Gunawan, G., Sahidu, H., Harjono, A., & Suranti, N. M. Y. (2017). THE EFFECT OF PROJECT BASED LEARNING WITH VIRTUAL MEDIA ASSISTANCE ON STUDENT'S CREATIVITY IN PHYSICS. *Cakrawala Pendidikan*, *XXXVI* (2). https://journal.uny.ac.id/index.php/cp/article/view/13514/pdf

Hairani, S., & Amini, R. (2023). Development of Integrated Thematic Teaching Materials Based on Creative Problem Solving Assisted by Kvisoft Flipbook Maker Pro in the Third Grade of Elementary School. *AL-ISHLAH: Jurnal Pendidikan*, *15*(2). https://doi.org/10.35445/alishlah.v15i2.2864

Jalinus, N., Nabawi, R. A., & Mardin, A. (2017). The Seven Steps of Project Based Learning Model to Enhance Productive Competences of Vocational Students. *Advances in Social Science, Education and Humanities Research*, *102*. https://doi.org/10.2991/ictvt-17.2017.43

Nadiyah, R. S., & Faaizah, S. (2015). The Development of Online Project Based Collaborative Learning using ADDIE Model. *Procedia - Social and Behavioral Sciences*, *195*.

Rahayu, I., & Sukardi, S. (2020). The Development Of E-Modules Project Based Learning for Students of Computer and Basic Networks at Vocational School. *Journal OfEducation Technology*, *4*(4). https://ejournal.undiksha.ac.id/index.php/JET/article/view/29230/16853

Shabiralyani, G., Hasan, K. S., Hamad, N., & Iqbal, N. (2015). Impact of Visual Aids in Enhancing the Learning Process Case Research: District Dera Ghazi Khan. *Journal of Education and Practice*, *6*(19).

Sugiyanto, S., Maryani, E., & Ruhimat, M. (2021). Development of social teaching materials based on geography literacy for increasing, critical, and creative thinking skills. *Earth and Environmental Science*, *683*. https://doi.org/10.1088/1755-1315/683/1/012042

Tamrin, M., Azkiya, H., & Sari, S. G. (2017). Problems Faced by the Teacher in Maximizing the Use of Learning Media in Padang. *AL-TA'LIM JOURNAL*, *24*(1). http://journal.tarbiyahiainib.ac.id/index.php/attalim/article/view/262/228

Yuliansyah, A., & Ayu, M. (2021). THE IMPLEMENTATION OF PROJECT-BASED ASSIGNMENT IN ONLINE LEARNING DURING COVID-19. *Journal of English Language Teaching and Learning (JELTL)*, *2*(1). http://jim.teknokrat.ac.id/index.php/english-language-teaching/index