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Development of E-LKPD Biotechnology Banana Yoghurt for Person and Product Creativity Students Phase E

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Abstract

This study aims to determine the level of validity and practicality of E-LKPD; the effectiveness of E-LKPD; and the relationship between person and product dimensions of creativity in the experimental class. The research method used is RnD with a 4-D model. The research design used is a quasi-experimental design with a posttest-only design with nonequivalent groups. The study was conducted in one of the schools in Yogyakarta with a small-scale subject of 33 students and a large-scale of 71 students. Data collection techniques used interviews, observations, and questionnaires. The instruments used include questionnaires on learning experiences, materials, media, validation, practitioners, and students; questionnaires on person and product dimensions assessment; and learning implementation. The analysis techniques used are PERMANOVA, Independent Samples T-Test, Mann-Whitney U, and Spearman correlation. Based on the results of the research, the conclusion is E-LKPD has a high-very high level of validity according to experts and the level of practicality of students shows good results. The effectiveness of the product shows a PERMANOVA value of 0.0003 which indicates that there are simultaneous differences in both dimensions in the control and experimental classes; shows a difference in the person dimension with the Mann-Whitney U value and the product dimension of the practicum report with the Independent Samples T-Test value of 0.002; shows a significant relationship of 0.001 with a correlation coefficient of 0.515 which means a strong and positive relationship.

How to Cite

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INTRODUCTION

Every citizen has the right to receive a good and equitable education, as stipulated in Article 31, Paragraph 1 of the UUD 1945 after the amendment. Education is consciously and structured to ensure learning that enables students to develop their potential, as stipulated in UU No. 20 of 2003. Therefore, the development of innovative and creative teaching materials is necessary for the learning process.

Teaching materials are systematically compiled learning materials, whether as a source of information, a tool, or a text, to help students master a specific topic (Waraulia, 2020). Based on structured interviews with biology teachers at the schools studied, it was discovered that the teaching materials frequently used were modules, worksheets (Lembar Kegiatan Peserta Didik/ LKPD), presentation materials (PPT), and textbooks. A questionnaire on student learning experiences revealed that LKPD was rarely used, chosen by 10 out of 33 students. LKPD is a learning tool containing activities and can be used as a guide for students to complete various tasks to achieve curriculum learning objectives (Safitri & Rifa'i, 2023). According to Febriannisa & Ardi (2023), it is known that worksheet (LKPD) can increase the effectiveness of the learning process and solve problems. The LKPD was compiled electronically because, based on an analysis of student learning experiences, 31 out of 33 students used mobile phones more often than other devices. Therefore, the E-LKPD will allow students to focus more on the designed learning.

The E-LKPD was designed to utilize the local banana potential of Yogyakarta, namely the Kebun Plasma Nutfah Pisang Yogyakarta (KPNP). This local potential has not been developed in the form of E-LKPD teaching materials because most journals discussing this potential only focus on banana cultivar varieties or pests that attack bananas. Furthermore, based on student learning experiences, it was found that 28 out of 33 students had never or had little understanding of the KPNP. Structured interviews with biology teachers at the schools studied also revealed that it had never been developed, as contextual information was usually obtained only from YouTube. In fact, according to Anzelina (2023), utilizing local potential can support scientific learning skills, from observing, asking questions, conducting experiments, processing information, drawing conclusions, and communicating results.

Kebun Plasma Nutfah Pisang (KPNP) Yogyakarta is located in Giwangan, Umbulharjo, Yogyakarta, and has been designated a national asset due to its abundance of bananas of various varieties. The KPNP can be used as a learning resource due to its expansive, free, and unlimited nature (Sujawo, 2018). Bananas at the KPNP are propagated through tissue culture, a crucial component of modern biotechnology (Sharman, 2015). Tissue culture is the propagation of plants using cell parts, organs, or tissues, carried out in aseptic media using controlled laminar airflow (Kshisagar, 2023). According to interviews with KPNP officials, the bananas produced are typically used only for making chips or nuggets and have never been processed into yogurt. In fact, according to Rahmawati (2017), consuming yogurt can help people avoid metabolic syndrome, a collection of risk factors, such as central obesity, hypertension, and elevated blood glucose, which increase the risk of diabetes mellitus and cardiovascular disease. This can certainly reduce the number of diabetes mellitus sufferers in Indonesia, because in 2022, Indonesia was ranked first in ASEAN with 41,817 diabetes sufferers (Natalia, 2024) and there was a 70% increase in the age of 12-18 years (Prasetyo, 2024). This is certainly influenced by an unhealthy lifestyle.

Yogurt is a fermented product that utilizes Lactobacillus bulgaricus and Streptococcus thermophilus bacteria that convert lactose in milk into lactic acid through the Embden-Mayerhoff Parnass (EMP) pathway in the glycolysis process. The distinctive and sharp odor of yogurt is the result of the activity of Lactobacillus bulgaricus bacteria that produce other microbial inhibitor substances, in addition, these bacteria also produce hydrogen peroxide (H2O2) and inhibitory compounds (bulgarican) so that the product lasts longer, while the presence of Streptococcus thermophilus bacteria can produce acid and carbon dioxide, in addition, these bacteria also play a role in lowering the pH and also producing a distinctive aroma (Hendarto, 2019). The fermentation process requires several things, including microbes as inoculum, a place to ensure the fermentation process, and a substrate as a medium and source of nutrients (Duda, 2020), therefore bananas from KPNP that contain glucose can be used as a source of glucose and help the yogurt fermentation process. Yogurt was chosen because, according to the TechnoBusiness platform, yogurt consumption reached 9.3 million tons in 2021, as people believe fermented milk is rich in nutrients, thus supporting immunity and digestion (Wisnawa, 2022).

The yogurt production, compiled in the

form of an E-LKPD, is supported by a project-based learning model or Project Based Learning (PjBL). Based on student learning experiences, 28 out of 33 students preferred practical learning because it was enjoyable. This aligns with research by Febriannisa & Ardi (2023), which explains that LKPD using PjBL can facilitate student understanding and interpretation of the topics studied. Project-based learning facilitates students' work independently or in groups and encourages them to produce contextual products appropriate to their abilities (Lestari & Yuwono, 2022). The operational steps of PjBL include starting with the essential questions, designing a plan for the project, creating a schedule, monitoring the students and the progress of the project, assessing the outcome, and evaluating the experiences (Syarif & Susilawati, 2017). The implementation of PjBL can influence student creativity, namely by giving students the freedom to be creative in designing projects, thus generating creative ideas and solutions to the problems they face (Khuzaimah et al., 2024).

According to Sit (2016), creativity is a person's thinking that is not limited to summarizing, but rather a person must be able to form a new pattern by combining previously obtained information. The creativity approach is known as the 4P's Model of Creativity. The 4P approach consists of the dimensions of person, process, press, and product. This study focuses on the dimensions of person and product, because if someone can act creatively, the resulting product will also be creative. The indicator aspects of the person dimension are fluency, flexibility, originality, and elaboration, then the indicator aspects of the product dimension are novelty, solution, and detail (Rhodes, 1961; Gruszka & Tang, 2017). The person dimension aspect will be observed using observation techniques and the product dimension aspect will be observed through practicum reports compiled by students. The elements assessed in student practicum reports include the report's identity, related to the experiment title, problem formulation, and experiment objectives. The problem statement, which includes the background, predicted variable effects, and literature citations, is then assessed on the experimental design, which is related to the tools and materials used, as well as the experimental results design. Data analysis, related to the experimental results, data analysis procedures, and relationships between variables, is then assessed. Finally, conclusions and suggestions are assessed, which include experimental conclusions, evaluation, and bibliographic references (Supahar, 2015 with modifications). The person and product dimensions of the practicum report will later be linked to PjBL as a learning model.

Based on the information described above, the researcher is interested in developing an E-LKPD Biotechnology Banana Yogurt for person and product creativity, aimed at students in Phase E. The development of the E-LKPD is structured using the PjBL learning model and is also linked to the local banana potential of the Yogyakarta KPNP (Kebun Plasma Nutfah Pisang/National Banana Farmers Association). This will increase student enthusiasm while learning and provide real-life experiences for students. This will enable students to produce their own products, which, hopefully, can lead to future business opportunities.

METHOD

This research employed Research and Development (RnD), a method for developing products rather than discovering theories, and is related to educational or learning products (Paidi, 2012). The 4-D model developed by S. Thiagarajan, Dorothy S. Semmel, and Melvy I. Semmel encompasses the Define, Design, Develop, and Disseminate stages (Thiagarajan, 1974). The Define stage encompasses front-end analysis, learner analysis, task analysis, concept analysis, and specifying analysis. The Design stage encompasses media selection, format selection, and initial design. The Develop stage encompasses drafting, expert appraisal, and development setting. The Disseminate stage encompasses testing the results to determine the consistency of the developed product (Thiagarajan, 1974; Paidi, 2012).

The research was conducted at a high school in Yogyakarta, with 33 students from class XIG-4 for the small-scale trial and 71 students from class XE-1 and XE-2 for the large-scale trial. The sample was taken using nonprobability purposive sampling, which is a sampling method that does not provide equal opportunities for members of the population, but rather with certain specified criteria (Sugiyono, 2015). The specified criteria were students who had previously received Biotechnology material and the class used had not been subjected to similar research. The research design used was a quasi-experimental design with a posttest-only design with nonequivalent groups. Quasi-experimental design is a pseudo-research by determining experimental and control groups with the aim of determining cause and effect (Abdullah, 2018), while a posttest-only design with nonequivaleny groups is a design that

conducts only a posttest as a post-treatment measurement in unequal groups (Hastjarjo, 2019). The following research design was used:

Table 1. Research Design

Group	Treatment	Posttest
Control Class	X_1	O_1
Experimental Class	X_2	O_2

X_1 : Treatment using general LKPD and the PjBL model

X_2 : Treatment using E-LKPD and the PjBL model

O_1 : Posttest of the control class after learning using general LKPD

O_2 : Posttest of the experimental class after learning using E-LKPD

Data collection techniques used structured interviews, observations, and questionnaires. Structured interviews involve gathering information by preparing questionnaires in advance (Sugiyono, 2015). These interviews were conducted with administrators of the Yogyakarta National Park (KPNP) to determine the potential of local bananas and with biology teachers at schools to determine their experiences teaching biotechnology. Furthermore, non-participant observation is a technique for observing the behavior, symptoms, or work processes of the observed object without participating in the activity (Sugiyono, 2015). This observation was conducted to analyze teacher performance and student characteristics. A questionnaire is a tool containing questions or statements that must be answered by respondents to measure the observed variables (Sugiyono, 2015). The questionnaires were prepared for assessment by subject matter experts, media experts, biology teacher practitioners, students, and observers. The questionnaires used included a student learning experience questionnaire to determine the extent of previous biotechnology learning; a subject matter expert questionnaire to assess content, language, and usability of the creativity dimension; and a media questionnaire to assess the appearance, programming, and language. Validation was used to assess the questionnaire instrument for use in the field. Biology teacher practitioners assessed the product's content, appearance, programming, language, and usability; students assessed the product's content, appearance, programming, language, and usability; the creativity dimension was used to determine the person and product dimensions of the practicum report; and learning implementation was used to determine the biology teacher's implementation of PjBL syntax when practicing this research.

Data analysis techniques for validity and practicality were carried out by material experts, media experts, and biology teacher practitioners using the Aiken V and a Likert scale for assessment options. The Aiken V analysis was used to identify items with low validity so they could be improved (Utami et al., 2024).

$V = (\sum s)/(n\,(c-1))$

V : Aiken Index

s : The score given by the expert minus the lowest score

n : Number of expert

c : Highest assessment score

The results of the Aiken index values are then interpreted according to following Table 2.

Table 2. Interpretation of Aiken Index

Range Score	Interpretation
0.8-1.0	Very High Validity
0.6-0.79	High Validity
0.4-0.59	Fair Validity
0.2-0.39	Low Validity
0.0-0.19	Very Low Validity

(Utami et al., 2024 with modification)

Aiken analysis and the Likert scale were also used to validate the questionnaire instrument for field use. The questionnaire also included a conclusion regarding the E-LKPD, including whether it was unimproved, improved, or unusable. Furthermore, the practicality test, in terms of student readability, used only the Likert scale. The Likert scale used in all questionnaires measures attitudes, opinions, and perspectives on a phenomenon (Sugiyono, 2019). The following is an interpretation of the Likert scale:

Table 3. Interpretation of Likert Scale

Score	Range Score	Interpretation
5	4..20-5.00	Strongly Agree
4	3.40-4.19	Agree
3	2.60-3.39	Somewhat Agree
2	1.80-2.59	Disagree
1	1.00-179	Strongly Disagree

(Sugiyono, 2019)

The measurement results are then calculated using the following formula.

Practicality = Total Score/Number of Statement/Questions Items

The practicality test in terms of readability was conducted by students on a small scale. The creativity dimension data analysis techniques used PERMANOVA, Independent Sample T-Test/ Mann-Whitney U, and Spearman Correlation. The assessment scale was the same as before, using a Likert scale. PERMANOVA, like MANOVA, is useful for simultaneously analyzing all variables used, with H_0 indicating no simultaneous difference and H_1 indicating a simultaneous difference. The decision is made if the significance level is <0.05, then H_0 is rejected and H_1 is accepted (Muhid, 2019). Furthermore, the Independent Sample T-Test and Mann-Whitney U are useful for determining whether there are differences between each variable used, with H0 indicating no difference in the person/product dimension and H_1 indicating a difference in the person/product dimension. The decision is made if the significance level is <0.05, then H0 is rejected
Learnner Analysis
This stage was carried out to determine the characteristics of students during the previous Biotechnology learning. This stage was carried out by distributing Google accepted (Muhid, 2019). Spearman correlation is an analytical technique to determine whether or not there is a relationship between variables used in the experimental class (Budiwanto, 2017), with H_0 indicating no relationship and H_1 indicating a relationship. The decision is made if the significance level is <0.05, then H_0 is rejected and H_1 is accepted (Muhid, 2019). The level of variable correlation can be seen in the correlation coefficient with the following interpretation.

Table 4. Correlation Coefficient Interpretation

r Score	Interpretation
0.01-0.19	No Relationship
0.20-0.299	Weak Relationship
0.30-0.39	Medium/Fair Relationship
0.30-0.69	Strong Relationship
> 0.70	Very Strong Relationship

(Syahputra & Mulya, 2022)

All data analysis techniques to determine effectiveness or relationships are always used for data that is not normal and not homogeneous, either in one or both variables. Data is considered abnormal and not homogeneous if the significance level is <0.05 (Muhid, 2019).

RESULT AND DISCUSSION

The results of RnD research with the 4-D model need to go through several stages, including

1. Define

Define is the initial stage with the following activities:

a. Front-end analysis

This initial step involved structured interviews to assess educator performance and identify future needs. It was discovered that student worksheets (LKPD) were rarely used, and that the biotechnology most frequently used by students was making tempeh, tape, and cheese, while yogurt was not yet available.

The next step was a structured interview with the KPNP (National Teachers' Association). It was discovered that the use of KPNP for teaching materials had not been previously developed. It was also discovered that banana propagation at KPNP is the result of tissue culture, a modern biotechnology. Furthermore, the products produced are usually nuggets or chips, while processing yogurt into yogurt has not yet been implemented.

b. Learnner Analysis

This stage was carried out to determine the characteristics of students during the previous Biotechnology learning. This stage was carried out by distributing Google Forms to classes X and XI. Based on the analysis of learning experiences, it was found that 97% of students felt that Biotechnology was a fun subject if there was a lot of practice. Conventional Biotechnology products that they often made were making tape (75.8%) and tempeh (72.7%). Furthermore, 84.8% of them did not know/read about visiting KPNP, therefore the researcher felt the need to develop conventional Biotechnology practicums by making yogurt as the output so that students could get a different experience from before.

c. Task Analysis

This stage is a task analysis that identifies the scope of material with adjustments to the Independent Curriculum. The material obtained from the Yogyakarta KPNP can be incorporated into the Biotechnology material and given to Phase E students in grade X, beginning the second semester.

d. Concept Analysis

This stage is carried out by analyzing the task on the material concept according to the topic raised. Based on the Decree of the Education Standards, Curriculum, and Assessment Agency of the Ministry of Education, Culture, Research,

and Technology Number 032/H/KR/2024, it is known that the elaboration of Learning Outcomes (LO) or Capaian Pembelajaran (CP) for phase E, specifically Biotechnology material, is "At the end of phase E, students have the ability to understand Biotechnology, so that students can be responsive and can play an active role in solving problems on global issues as an effort to achieve sustainable development goals (Sustainable Development Goals/SDGs)". This Learning Outcome requires students to be able to understand, however, because the learning is designed using PjBL, the cognitive level increases to analyzing (C4), evaluating (C5), and creating (C6) as a form of application to solve global issues. Before the learning begins, the Biology teacher who teaches first provides an explanation so that students are surprised before the implementation of the practicum later.

e. Specifiying Analysis

This stage is to analyze the instruction by formulating learning objectives. The learning objectives in the developed E-LKPD include students being able to define the meaning of biotechnology, students being able to understand the differences between modern and conventional biotechnology in the Kebun Plasma Nutfah (KPNP) of Yogyakarta City, students being able to design and create yogurt creatively by utilizing bananas from the KPNP of Yogyakarta City. Students are expected to be able to compile a scientific report in the form of a practicum report and present the results in front of the class.

2. Design

The Design Stage includes several stages, including.

a. Media Selection

This stage is the determination of the form of media according to the needs of educators and students, namely compiling E-LKPD to add to students' learning experiences.

b. Format Selection

This stage is carried out by analyzing the selection of media formats to determine the composition and design of E-LKPD that are adjusted to the PjBL syntax. The specifications of the learning activities are, namely Let's Ask!, Let's Do It!, and Evaluate!. Let's Ask!, includes the syntax Start With Essential Questions, then Let's Do It!, includes Design a Plan for The Project, Create a Schedule, Monitor The Students and The Progress of The Project, and Assess The Outcome, while in the Evaluation Let's! activity, includes Evaluate The Experiences.

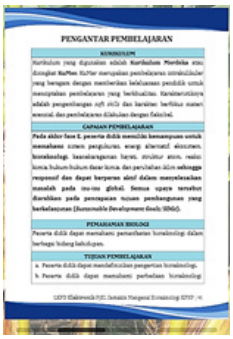
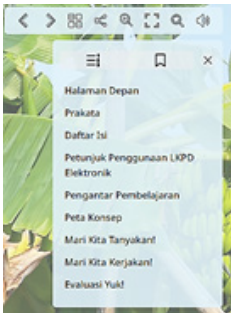
c. Initial Design

This stage is the initial design stage, analyzing the sections of the E-LKPD that have been prepared. The following is an explanation of each section of the E-LKPD:

3. Develop

Table 5. E-LKPD Section

E-LKPD Overview	Information	E-LKPD Overview	Information
	1 The front page contains information about the book, including the title, the intended class, and the author of the LKPD.		2 Foreword, contains the author's gratitude, an explanation of most of the contents of the E- LKPD, and the author's hopes.
	3 Table of contents, containing the sections of the E-LKPD along with their page numbers.		4 Instructions for using the E-LKPD, containing steps to help readers understand the contents of the E- LKPD, while also encouraging readers to undertake the prepared projects.

E-LKPD Overview	Information	E-LKPD Overview	Information
	5 Introduction to learning, containing the curriculum used, CP, TP, and the Pancasila student profile.		6 Concept map, containing a chart of the material and application of Biotechnology at the Yogyakarta KPNP.
	7 Learning Activities, including "Let's Ask!".		8 Learning Activities, including "Let's Do!"
	9 Learning Activities, including "Let's Evaluate!"		10 Initial Display of the LKPD Link
 	11 E-LKPD Navigation Button		

This stage is product trial stage, including:

a. Drafting

Drafting involves creating a framework that was designed in the Design stage by creating a visual prototype (Table 5). This draft was created using Microsoft Word 2010, which was then entered into the Heyzine application to create a flipbook.

b. Expert Appraisal

This stage is an assessment conducted by subject matter experts, media experts, and biology teacher practitioners. Subject matter and media experts also validated the questionnaire before its use in the field. The following are the results of the questionnaire instrument validation:

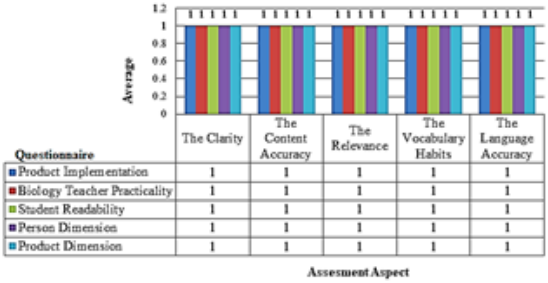


Figure 1. Questionnaire Instrument Validation Chart

It is known that all aspects have a very high level of validity with an Aiken index of 1 by both material and media experts, as shown in Table 2. The clarity aspect was assessed as very valid in all questionnaires. The content accuracy aspect was also assessed as very valid in all questionnaires. Next, the relevance aspect was assessed as very valid in all five questionnaires. Then, the aspects of vocabulary habits and language accuracy were also assessed as very valid in all five questionnaires. The following expert assessment of the material obtained the following results.

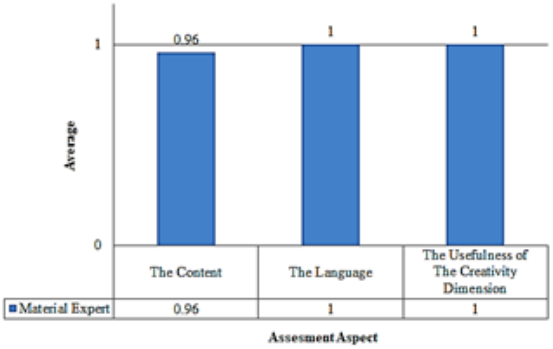


Figure 2. Graph of LKPD Assessment Results by Material Experts

It is known that the assessment aspects of content, language, and usefulness of the creativity dimension received an Aiken index with a very high level of validity according to Table 2. The first revision provided by the material expert, included the addition of an explanation regarding KPNP with diabetes, the vitamin and mineral content of bananas, and the addition of an explanation of tissue culture. The revision was improved according to the suggestions given. Then the second revision was the addition of follow-up activities after the explanation of tissue culture. This revision was also followed up by adding practice questions directed at Google Form after the tissue culture video. Furthermore, the media expert's assessment obtained the following results.

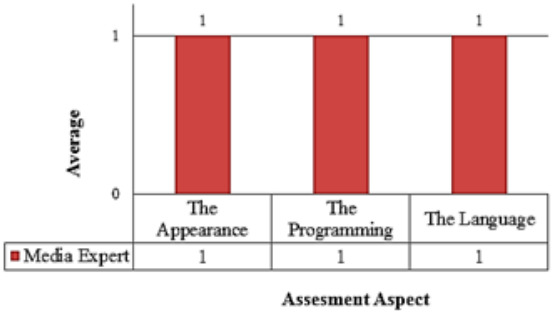


Figure 3. Graph of LKPD Assessment Results by Media Experts

It is known that the appearance, programming, and language aspects received a score of 1 with a very high level of validity according to Table 2. The first revision given was in the form of increasing the cognitive level that was not only up to understanding, so it needed to be adjusted to the CP. This revision could not be fully followed up because the CP set by the government did reach the understanding stage, but a higher cognitive level was also added as a form of adjustment to the E-LKPD PjBL. The second revision given was related to the products produced not only yogurt. This revision could not be followed up due to time and cost constraints. The final assessment is the Biology Teacher Practitioner Assessment. The following are the results.

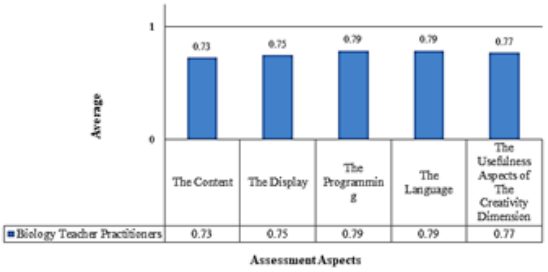


Figure 4. Graph of LKPD Assessment Results by Biology Teachers

It is known that the content, display, programming, language, and usefulness aspects of the creativity dimension received an Aiken index value in the range of 0.73-0.79 with a high level of validity interpretation. In the content aspect, the Aiken index value was 0.73 with a high level of validity, then in the display aspect, the Aiken index value was 0.75 with a high level of validity, the programming aspect received an Aiken index value of 0.79 with a high level of validity, the language aspect received an Aiken index value of

0.79 with a high level of validity, and last aspect was the usefulness of the creativity dimension which received an Aiken index value of 0.77 with a high level of validity. The revisions given came from second Biology practitioner, who requested to improve the bottom margin of page 4 of the E-LKPD and replace the screenshot of the tissue culture video to better represent tissue culture. The revision was followed up by providing space so that the margins were widened and replacing the screenshot to better represent tissue culture.

c. Development Testing

This stage is a small-scale testing phase for students to determine whether the developed E-LKPD produces consistent and effective results. The following are the average assessment results from 33 small-scale students:

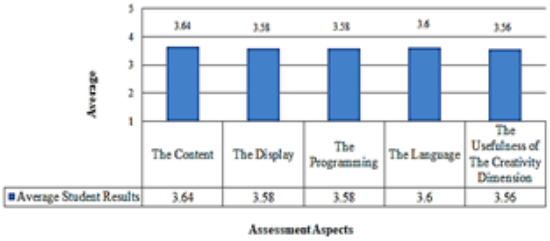


Figure 5. Graph of LKPD Assessment Results by Students

4. Disseminate

The Disseminate stage is the stage of distributing the E-LKPD using a quasi-experimental design with a posttest-only design with nonequivalent groups. At this stage, an assessment of the creativity dimensions is carried out using PERMANOVA, Independent Samples T-Test/Mann-Whitney, and Spearman Correlation. However, descriptive statistical tests are conducted first. The following are descriptive statistics for each class and dimension.

Table 6. Descriptive Statistics of Data

Person Dimension

1. Control Class

Information	Case Number	Statistic
Mean	-	65.19
Median	-	66.70
Variances	-	220.195
Highest Score	20	91.10
	23	89.60
Lowest Score	2	26.70
	35	40.70

2. Experimental Class

Information	Case Number	Statistic
Mean	-	80.45
Median	-	82.25
Variances	-	234.191
Highest Score	51	97.80
	46	97.00
Lowest Score	61	25.20
	44	29.60

Product Dimension

1. Control Class

Information	Case Number	Statistic
Mean	-	75.54
Median	-	74.80
Variances	-	91.368
Highest Score	23	89.80
	13	88.70
Lowest Score	9	55.80
	8	55.80

2. Experimental Class

Information	Case Number	Statistic
Mean	-	81.69
Median	-	82.00
Variances	-	41.789
Highest Score	47	91.70
	42	91.20
Lowest Score	44	61.30
	67	71.50

The statistical data above is used to determine the results of normality and homogeneity tests. The following are the results of the normality test using IBM SPSS Statistics 22.

Table 7. Normality Test Results

Class	Kolmogorov-Smirnov		
	Statistics	df	Sig.
Person Dimension			
Control XE1	0.097	35	0.200
Experiment XE2	0.190	36	0.002
Product Dimension			
Control XE1	0.115	35	0.200
Experiment XE2	0.112	36	0.198

The number of data used is 71 students, so the normality test used is the Kolmogorov-Smir-

nov. Based on the results in the table, it is known that the significance level in all dimensions, except the person dimension of the experimental class is normally distributed, because the significance value is > 0.05, while the significance of the person dimension of the experimental class with a value of 0.002 < 0.05, so the data is categorized as abnormal. This abnormal data occurs because there is an abnormal distribution of data, resulting in a sharp slope or skew. The lowest and highest values in the person dimension experimental class are too different from Median value, thus making data abnormal. Next, test the homogeneity of the data by looking at the table below.

Table 8. Levene's Test Homogeneity Results

	F	df1	df2	Sig.
Person Dimension	0.926	1	69	0.339
Product Dimension	6.749	1	69	0.011

Based on the homogeneity test results above, the homogeneity of the person dimension is 0.339 > 0.05, thus concluding that the data vary homogeneously. Meanwhile, the product dimension has a value of 0.011 < 0.05, thus concluding that the data do not vary homogeneously. The product dimension data are not homogeneous because the variance values in Table 6 between the control class (91.368) and the experimental class (41.789) differ significantly from the variance values for the person dimension in the control class (220.195) and the experimental class (234.191).

The first analytical study examined the effectiveness of creativity in the person and product dimensions simultaneously in both classes. The analysis technique used was PERMANOVA, not MANOVA, due to the non-normal and non-homogeneous distribution of data as explained previously. The following table shows the results of the PERMANOVA test using PAST software:

Table 9. PERMANOVA Results

Results	Value
Permutation N	9999
Total su of squares	0.527
Witin-group sum of squares	0.4373
F	14.15
p (same)	0.0003

Based on the table above, it is known that 9999 permutations or randomizations yielded a p-value of 0.0003. A p-value of 0.0003 <0.05, therefore, the decision taken is to reject H0 and accept H1. Therefore, the conclusion of the first hypothesis is that there is a simultaneous difference between the creativity dimensions of the person and product of the practicum reports that use PjBL-based E-LKPD and those that do not use PjBL-based E-LKPD.

The analysis of creativity using MANOVA analysis to obtain normal and homogeneous has also been studied by Fiteriani et al. (2021) who in their research wanted to determine the effect of the PjBL learning model with a STEM approach in improving creative problem-solving abilities and metacognitive skills in physics learning. The problem-solving ability value of the experimental class was 0.39, while the control class was 0.30. The metacognitive skill value of the experimental class was 0.30, whereas the control class had a value of 0.20. The PjBL learning model with a STEM approach was more effective in improving problem-solving and metacognitive abilities with an effect size value of 0.72 for problem-solving and 0.73 for metacognitive. Based on the results of the MANOVA test, creative problem-solving abilities and metacognitive abilities had a significance value of 0.000 < 0.05, indicating that the implementation of the PjBL learning model with a STEM approach has a significant effect on students' creative problem-solving abilities and metacognitive abilities. Creative problem-solving variables are related to the aspects of fluency and flexibility in the person dimension and solutions in the product dimension, while metacognitive variables are a learning process that starts from planning, monitoring, and evaluation skills that are closely related to creative problem-solving.

The second analytical study after recognizing the simultaneous differences through the PERMANOVA test examined the effectiveness of the creativity dimension of the person in both classes. The analysis technique used was Mann-Whitney U test because there was non-normal distribution of data in the experimental class. The following table shows the results of Mann-Whitney U test using IBM SPSS Statistics 22.

Table 9. Mann-Whitney U Results Person Dimensions

	Person Dimension	Product Dimension
Mann-Whitney U	225.500	391.000
Wilcoxon W	855.500	1021.000
Z	-4.654	-2.749
Asymp. Sig. (2-tailed)	0.000	0.006

Based on the table above, the Asymp. Sig. (2-tailed) value for the person dimension is 0.000

< 0.05, so the decision taken is to reject H0 and accept H1. Therefore, the second hypothesis is drawn that there is a difference in the creativity ability of the person dimension between students who use PjBL-based E-LKPD and those who do not use PjBL-based e-worksheets. This difference in ability is indicated by a significant difference in the mean (mean) of the person dimension in the control and experimental classes (Table 7). The mean value of the person dimension for the control class is 65.19 and the average for the experimental class is 80.45. The person dimension value for the experimental class that uses PjBL-based E-LKPD is higher than the control class, indicating that the aspects of fluency, flexibility, and elaboration are better in experimental class.

The results obtained are also in line with other studies, namely the results of research by Suwarno et al. (2020), which explains that the effect of the PjBL model assisted by Science Worksheets on creativity and learning outcomes shows a significant difference between the control class and the experimental class. Aspects assessed in the creativity dimension in the study include fluency, flexibility, originality, and elaboration with the highest value in the experimental class, namely group I, namely 96.67% (good category) and the lowest value in group III, namely 60% (sufficient category). This shows that the application of PjBL assisted by Science Worksheets can foster creativity when designing products and produce relevant answers in making products. This study is also in line with research by Husna et al. (2023) which states that project-based learning with the theme of Biotechnology can help improve more contextual creative thinking skills, so that students can easily remember them.

The third analytical study after identifying simultaneous differences through the PERMANOVA test is regarding the effectiveness of creativity in the product dimension in both classes. The analysis technique used was the Independent Samples T-Test because all the data were normally distributed, although there was non-homogeneous data in the product dimension, but the results of the T-Test used were equal variances not assumed. The following table shows the results of the Independent Samples T-Test using IBM SPSS Statistics 22. Based on the table above, it is known that the Sig. (2-tailed) value of the Equal variances not assumed product dimension is 0.002 < 0.05, so the conclusion is that H0 is rejected and H1 is accepted, then the third hypothesis is that there is a difference in the creativity ability of the product dimension of the practicum report in students who use PjBL-based E-LKPD and those who do not use PjBL-based E-LKPD. The difference in the creativity ability of the product dimension of the practicum report can be seen from the average value (Mean) of the experimental class which is higher than the control class. The value of the experimental class is 81.69 and the control class is 75.54. This value shows that the experimental class is better at compiling practicum reports. This is evident from the experimental class being able to write identities, problem statements, experimental designs, and data analysis better than the control class, and experimental class students are also better at making conclusions and suggestions than the control class.

Table 10. Independent Samples T-Test Results for Product Dimensions

	T-Test		
	t	**df**	**Sig. (2-tailed)**
Person Dimension			
Equal variances assumed	-4.260	69	0.000
Equal variances not assumed	-4.262	69.000	0.000
Product Dimension			
Equal variances assumed	-3.183	69	0.002
Equal variances not assumed	-3.166	59.526	0.002

The results of the students' practicum report products are summarized in the following table.

Based on the table above, it is known that the experimental class's creative products are

Table 11. Practical Report Results

Group	**Title of The Practical Report**	
	Control Class	**Experiment Class**
1	The Effect of Differences in the Use of Cow's Milk and Soy Milk in Making Banana Yogurt	The Effect of Adding Blueberries to Banana Yogurt with the Help of KPNP Bananas to Enhance Flavor

Group	Title of The Practical Report	
	Control Class	**Experiment Class**
2	Developing Banana Yogurt from Plain Milk and Javanese Sugar as a Healthy Drink Alternative	Bannery Yogurt (Banana and Strawberry) with Honey to Determine Consumer Preference Level
3	Banana and Honey-Based Yogurt Innovation: A Healthy and Natural Alternative	Analysis of the Effect of Adding Chocolate and Oats on the Flavor of Banana Yogurt with the Help of KPNP Bananas
4	Application of the Fermentation Process in Making Nutritious Banana and Dragon Fruit Yogurt	Making Banana Extract-Based Yogurt with Mango Extract and Nata de Coco to Add Texture and Flavor to Yogurt
5	Making Banana Coconut Yogurt as a Fermented Processed Product with High Nutritional Content	Comparison Between the Use of Palm Sugar and Granulated Sugar in Making Banana Yogurt
6	Application of Fermentation Technology in Making Banana and Mango Yogurt as an Effort to Reduce Diabetes	The Effect of Adding Dates to Banana Yogurt as an Alternative Drink to Prevent Heart Disease

more creative or show differences compared to the control class. This is seen from the types of yogurt developed which are more varied and complex. In the experimental class, students dared to take three ingredients at once to combine, in addition, the experimental class was also creative in composing report titles in naming the products they made. Generally speaking, the experimental class also raised issues other than Diabetes, namely the benefits of yogurt for the treatment of cancer, eyes, skin, heart, digestion, and IBD/intestinal inflammation, although there was one group that continued to use the Diabetes issue. The issues raised were very different from the control class, which mostly still raised Diabetes without taking the initiative to explore the benefits of the products that students made. The different report results from the control and experimental classes are the result of the successful steps and instructions from the E-LKPD that were developed. The electronic worksheets (LKPD) were prepared with detailed and clear explanations, making it easier for students to understand the assessment criteria requested by the teacher. In contrast, in the control class, where the LKPD was only given a general outline of the assessment steps and criteria, students lacked a clear understanding of what they needed to do.

These results are in line with Luzywati's (2018) research, which explains that work implementation is directly proportional to the products produced by students, meaning that detailed and clear work implementation will produce more organized and clear products. The activity steps in the E-LKPD are designed using the PjBL learning syntax starting from designing, making, to presenting the results of the practicum report, which are explained in detail. This is in line with Hindun and Husamah's (2019) research, which explains that the implementation of STAD-PjBL from design planning to project presentation can show an increase in product creativity. In addition, this research is also in line with Chiang & Lee (2016), who explain that project-based learning can not only increase learning motivation but also facilitate students' problem-solving abilities. Problem-solving is one aspect of the product creativity dimension, namely, solutions or problem-solving.

The final analysis examined the relationship between the person and product dimensions in the class using the PjBL-based E-LKPD. The analysis technique used was Spearman's correlation, due to the non-normal and non-homogeneous nature of the data. The following table shows the results of the Spearman correlation test using IBM SPSS Statistics 22:

Table 12. Spearman Correlation Results

Spearman's rho		**Person XE1**	**Product XE2**
Person XE1	Correlation Coefficient	1.000	0.515
	Sig. (2-tailed)		0.001
	N	36	36
Product XE2	Correlation Coefficient	0.515	1.000
	Sig. (2-tailed)	0.001	
	N	36	36

Based on the table above, it is known that the Sig. (2-tailed) value is 0.001 < 0.05, so the

conclusion is that H0 is rejected and H1 is accepted, so the fourth hypothesis is that there is a significant relationship between person dimension creativity and practicum report products in classes that use E-LKPD. The level of this significant relationship can be seen through the correlation coefficient value in the table of 0.515. Based on Table 4 Spearman's correlation, this value is included in a strong relationship because it is in the range of 0.40-0.69. The correlation coefficient value is positive, so it can be seen that when the person dimension variable increases, it will also be accompanied by an increase in the product dimension. The results of the Spearman correlation relationship between the person and product dimensions show a strong and mutually influential relationship. This strong relationship is thanks to the E-LKPD that was developed. This is in accordance with the advantages of PjBL-based E-LKPD according to Syarif and Susilawati (2017), who explained that PjBL-based E- LKPD can increase learning motivation, problem-solving skills, make students more active, increase collaboration, improve the ability to process information sources, provide new experiences in accordance with the real world, encourage communication skills, and create a more enjoyable learning atmosphere. The results of this study are also in line with the research of Khastini et al. (2018), who conducted t-test, correlation, and regression research on creativity and entrepreneurial values. The creativity measured was the person and product dimensions. Aspects observed in the person dimension were fluency, flexibility, originality, and elaboration, while aspects observed in the product dimension included novelty, solutions, and detailed elaboration. The results of both dimensions in the control and experimental classes showed that the experimental class had a better level of creativity than the control class.

The results of effectiveness and correlation relationships show positive results. These results cannot be separated from the implementation of learning that has been carried out by Biology teachers when leading learning in both control and experimental classes. All PjBL syntax can be implemented well according to three observers, only because the class used was not in the first and last hours, the opening and closing activities, especially the prayer section, were not implemented. This study's limitations were limited to the person and product dimensions, so it is hoped that future researchers can examine other dimensions of creativity, namely the Process and Press dimensions.

CONCLUSION

Based on the results of the research that has been carried out, the level of PjBL-based E-LKPD on banana yogurt biotechnology material shows a high to very high level of validity according to competent experts in their fields; the level of practicality of PjBL-based E-LKPD on banana yogurt biotechnology material in terms of student readability shows good results; PjBL-based E-LKPD on banana yogurt biotechnology material shows simultaneous differences in both dimensions in classes that use E-LKPD or not with a PERMANOVA p-value of 0.0003 which is supported by differences in the person dimension with an Asymp. (2-tailed) Mann-Whitney U value of 0.000 and in the product dimension of the practicum report with a Sig. (2-tailed) Independent Samples T-Test value of 0.002; the relationship between the creativity of the person dimension and the product of the practicum report using PjBL-based E-LKPD shows a relationship with Sig. The 2-tailed value was 0.001 and the correlation coefficient was 0.515, indicating a strong and positive relationship. Therefore, when the person dimension increases, an increase in the product dimension of the practicum report will follow.

This research is necessary to provide researchers with a more detailed understanding of creativity values in the person and product dimensions. Hopefully, the developed E-LKPD can provide teaching material references for other teachers, broaden students' knowledge, and provide insights for future researchers. Suggestions for further product development include: Hopefully, other researchers can examine other dimensions of creativity, namely the Process and Press dimensions. The developed product can be used in other schools, and can be developed into a more interactive application.

REFERENCES

Abdullah. (2018). *Berbagai Metodologi dalam Penelitian Pendidikan dan Manajemen.* Gowa: Gunadarma Ilmu.

Anzelina, D. E. (2023). Potensi kearifan lokal sumatera selatan sebagai basis media pembelajaran kontekstual biologi SMA. *Journal of Nusantara Education*, 2(2), 53-63. https://doi.org/10.57176/jn.v2i2.51.

Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi (2024). Nomor 032/H/KR/2024 tentang Capaian Pembelajaran Pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah

Pada Kurikulum Merdeka.

Budiwanto, S. (2017). *Metode Statistika untuk Mengolah Data Keolahragaan*. Malang: UM Press.

Chiang, C. L., & Lee, H. (2016). The Effect of Project-based Learning on Learning Motivation and Problem-Solving Ability of Vocational High School Students. *International Journal of Information and Education Technology,* 6(9), 709-712. http://dx.doi.org/10.7763/IJIET.2016.V6.779.

Duda, H. J., et al. (2020). *Bioteknologi Berbasis Proyek*. Pontianak: Program Studi Pendidikan Fisika IKIP PGRI Pontianak.

Febriannisa, D., & Ardi. (2023). Meta-Analisis Pengembangan Lembar Kerja Peserta Didik Berbasis Project Based Learning (PjBL). *Jurnal Pendidikan Tambusai,* 7(2), 14825-14831.

Fiteriani, I., et al. (2021). Project-Based Learning Through STEM Approach: Is it Effective to Improve Students' Creative Problem-Solving Ability and Metacognitive Skills in Physics Learning?. *Journal of Phisics: Conference Series*, 1796(1), 1-13. http://dx.doi.org/10.1088/1742-6596/1796/1/012058.

Gruszka, A., & Tang, M. (2017). The 4P's Creativity Model and Its Application in Different Fields. Handbook of The Management of Creativity and Innovation: *Theory and Practice*, 51-71. https://doi.org/10.1142/9789813141889_0003.

Hastjarjo, T. D. (2019). Rancangan eksperimen-kuasi. *Buletin psikologi*, 27(2), 187-203. https://doi.org/10.22146/buletinpsikologi.38619.

Hendarto, D. R., et al. (2019). Mekanisme Biokimiawi dan Optimalisasi Lactobacillus bulgaricus dan Streptococcus thermophilus dalam Pengelolaan Yoghurt Berkualitas. *Jurnal Sains Dasar,* 8(1), 13-19. http://dx.doi.org/10.21831/jsd.v8i1.24261.

Hindun, I., & Husamah. (2019). Implementasi STAD-PjBL untuk Meningkatkan Kreativitas Produk Mahasiswa Calon Guru Biologi. *JINoP (Jurnal Inovasi Pembelajaran*, 5(2), 139-154. https://doi.org/10.22219/jinop.v5i2.9969.

Husna, A., et al. (2023). Correlation Analysis of Biotechnology Theme Project-Based Learning with Students Creative Thinking Skills at The Junior High School. *BIO-INOVED: Jurnal Biologi-Inovasi Pendidikan,* 5(3), 341-347. http://dx.doi.org/10.20527/bino.v5i3.16925.

Kemendiknas RI. (2003). Undang-undang Republik Indonesia Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional.

Khastini, R. O., et al. (2018). Developing Creativity and Entrepreneurial Values in High School Student through Project Based Learning Model on Biotechnology. *EDUSAINS*, 10(2), 185-196. http://dx.doi.org/10.15408/es.v10i2.7303.

Khuzaimah, U., et al. (2025). Pengaruh Model Pembelajaran PjBL (Project Based Learning) Terhadap Kemampuan Berpikir Kreatif Siswa SMA Pada Pembelajaran Biologi. *Jurnal Edukasi Biologi*, 10(2), 166-176. http://dx.doi.org/10.21831/edubio.v10i2.21611.

Kshisagar, A.B., et al. (2023). *Plant Cell and Tissue Culture Practice Manual*. Ghati: Romaan Publications House.

Lestari, S., & Yuwono, A.A. (2022). *Choaching untuk Meningkatkan Kemampuan Guru dalam Menerapkan Pembelajaran Berbasis Proyek (Project Based Learning)*. Jawa Timur: Kun Fayakun.

Luzyawati, L. (2018). Hubungan Antara Keterampilan Kerja Ilmiah Siswa dengan Kualitas Produk Hasil Praktikum Mol Kulit Pisang. *Jurnal Pendidikan Sains Indonesia*, 6(1), 1-8. https://jurnal.usk.ac.id/JPSI/article/view/10625.

Muhid, A. (2019). *Analisis Statistik 5 Langkah Praktik Analisis Statistik dengan SPSS for Windows.* Surabaya: Zifatama Jawara.

Paidi. (2012). *Metodologi Penelitian Pendidikan Biologi*. Yogyakarta: UNY Press.

Rahmawati, F. C., et al. (2017). Pengaruh Yoghurt Sinbiotik Pisang Terhadap Kadar Glukosa dan Insulin Tikus Sindrom Metabolik. *Jurnal Gizi Klinik Indonesia,* 14(1), 10-18. https://doi.org/10.22146/ijcn.19379.

Rhodes, M. (1961). An Analysis of Creativity. *The Phi Delta Kappan*, 42(7), 305–310. http://www.jstor.org/stable/20342603.

Safitri, T. A., & Rifa'i, M.N. (2023). Analisis Penggunaan Lembar Kerja Peserta Didik (LKPD) pada Pembelajaran IPS Terhadap Hasil Belajar di MTs Al-Ikhlas Pemetung Basuki, *HARMONY*, 8(1), 63-68. https://doi.org/10.15294/harmony.v8i1.62028.

Sharman, G.K. (2015). General Techniques of Plant Tissue Culture. India: Mewar University Press.

Sit, M., et al. (2016). *Pengembangan Kreativitas Anak Usia Dini Teori dan Praktik.* Medan: Perdana Publishing.

Sugiyono. (2019). *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D.* Bandung: Alfabeta.

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

Sujawo, Fitta U.S, & Tristanti. (2018). *Pengelolaan Sumber Belajar Masyarakat.* Yogyakarta: UNY Press.

Supahar. (2015). Pengembangan Instrumen Penilaian Kinerja Penyusunan Laporan Praktikum Fisika SMP Berbasis Inkuiri. *Jurnal Pendidikan Matematika dan Sains (JPSM)*, 3(1), 23-29. https://journal.uny.ac.id/index.php/jpms/article/view/7232.

Suwarno, S., et al. (2020). Project-Based Learning Model Assisted by Worksheet: Its's Effect on Students' Creativity and Learning Outcomes. *JPBI (Jurnal Pendidikan Biologi Indonesia),* 6(1), 113-122. http://dx.doi.org/10.22219/jpbi.v6i1.10619.

Syahputra, B. P., & Mulya, A. (2022). Analisis korelasi rank spearman & regresi linear nilai indeks stabilitas atmosfer dan suhu puncak awan citra satelit himawari-8 ir (studi kasus banjir Pekanbaru 22 april 2021). *Prosiding: Konferensi*

Nasional Matematika dan IPA Universitas PGRI Banyuwangi, 2(1), 293-300. https://ejournal.unibabwi.ac.id/index.php/knmipa/article/view/1755.

Syarif, M., & Susilawati, E. (2017). *Modul Pengembangan Keprofesian Berkelanjutan Biologi SMA Terintegrasi Penguatan Pendidikan Karakter Kelompok Kompetensi D.* Jakarta: Pusat Pengembangan dan Pemberdayaan Pendidik dan Tenaga Kependidikan Ilmu Pengetahuan Alam.

Thiagarajan, S., et al. (1974). *Intructional Development for Training Teachers of Exeptional Children A Sourcebook*. Minnesota: University of Minnesota Press.

Undang-Undang Dasar 1945 Pasal 31 Ayat 1-5 tentang Hak Warga Negara Indonesia.

Utami, L., et al. (2024). Analisis Indeks Aiken untuk Mengetahui Validitas Isi Instrumen Scinetific Habbits of Mind. *Journal of Research and Education Chemistry*, 6(1), 59-59. https://doi.org/10.25299/jrec.2024.vol6(1).17430.

Waraulia, A. M. (2020). *Bahan Ajar: Teori dan Prosedur Penyusunan.* Jawa Timur: UNIPMA Press.