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## Application of Project-Based Learning (PjBL) Learning Model via Digital Media in Biology Learning to Facilitate Critical, Creative, Communicative, and Collaborative Thinking in Senior High School (SMA) Students

Elsje Maasawet<sup>1\*</sup>, Makrina Tindangen<sup>2</sup>, Aloysius Hardoko<sup>3</sup>, Fransiskus Heny Tri Harsanto<sup>4</sup>

<sup>1,2,3</sup> Universitas Mulawarman,

<sup>4</sup> Yayasan Kasih Sejati Kalimantan, Indonesia

\* Corresponding author: [elsje.theodora@fkip.unmul.ac.id](mailto:elsje.theodora@fkip.unmul.ac.id)

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**Abstract:** In general, formal education in Indonesia has experienced one of the essential problems, namely, not matching the expectations and reality of the implementation of the Merdeka DL curriculum as a reference in school learning. Contextual learning as one of the curriculum's expectations intends that teaching modules and tools as learning reference contain learning strategies such as models, media, etc., relevant to facilitating students' potential. The reality in learning in schools is that permanent teacher pedagogical skills are inadequate so that they have an impact on students' learning outcomes. The purpose of the research is to facilitate the understanding and skills of teachers so that they can plan and implement teaching modules along with contextual tools to help students achieve learning outcomes. Descriptive quantitative research method. The research sample included 12 biology teachers from public and private high schools in the city of Samarinda. The sample of 300 students came from 12 classes where the sample teacher taught. The purposive sample technique is used because one of the school's considerations is that it has implemented an independent DL curriculum.



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The research instrument is in the form of an assessment containing a rubric to assess the performance of teaching module products and learning tools, an observation sheet on the implementation of learning, an assessment containing a rubric to assess the performance of LKPD products and videos, and a size observation sheet to assess the role of students in learning. Descriptive quantitative data analysis using scores, values, percentages, tables, and graphs and interpreting descriptions. The results of the teacher's research are in the category of understanding in compiling teaching modules with contextual tools and in the category of skill in carrying out learning according to teaching modules and contextual tools. These results have an effective impact on students, achieving learning outcomes competencies of critical, creative, and collaborative thinking in the good category and communicative in the skilled category.

**Keywords:** PjBL Learning Model, Digital Media, Biology Learning, Learning Outcomes Critical Thinking, Creative, Communicative and Collaborative.

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## 在生物学习中运用基于项目的学习 ( PjBL ) 模式和数字媒体 · 促进高中 ( SMA ) 学生的批判性、创造性、沟通性和协作性思维的学习成果

**摘要：**总的来说，印度尼西亚的正规教育遇到了一个基本问题，即不符合实施独立深度学习课程作为学校学习参考的期望和现实。情境学习作为课程的期望之一，旨在将教学模块和工具作为学习参考，包含与促进学生潜力相关的学习策略，例如模型、媒体等。学校学习的现实是，永久教师的教学技能不足，因此它们对学生的学习成果问题产生了影响。该研究的目的是促进教师的理解和技能，以便他们能够规划和实施教学模块以及情境工具，以促进学习成果。描述性定量研究方法。来自三马林达市公立和私立高中的 12 名生物教师的研究样本。300 名学生的样本来自样本教师任教的 12 个班级。目的性样本技术是因为学校的考虑因素之一是它实施了独立的深度学习课程。该研究工具采用评估的形式，其中包含一个量规作为评估教学模块产品和学习工具性能的量规，一份关于学习实施的观察表，一个包含量规的评估，作为评估 LKPD 产品和视频性能的量规，以及一个用于评估学生在学习中的作用尺寸观察表。通过分数、值、%、表格、图表进行描述性定量数据分析，并通过描述进行解释。教师的研究结果既属于使用情境工具编译教学模块的理解范畴，也属于根据教学模块和情境工具进行学习的熟练范畴。这些结果对学生产生了有效影响，在良好类别中实现了批判性、创造性、协作思维的学习成果能力，在技能类别中实现了交际能力。

**关键词：**PjBL 学习模式、数字媒体、生物学习、学习成果批判性思维、创造性、沟通性和协作性。

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### 1. Introduction

The introductory presentation contains a description of one of Indonesia's essential problems in the implementation of formal education. The problem is related to the lack of agreement between expectations and the reality of the implementation of the IDL curriculum at the operational level, namely schools. One of the curriculum's expectations is that the teaching modules and tools refer to the deep learning curriculum that contains contextual learning strategies to facilitate

the achievement of learning outcomes in students, namely, critical, creative, communicative, and collaborative thinking. These learning outcomes are a reference for the achievement of competencies because the current and future world needs humans who have these competencies because they face the challenge of using technological advances in various interactions. The following paragraph describes the expectations for the implementation of the IDL curriculum.

The content of the IDL curriculum can facilitate the

learning outcomes needed by current and future students because it has an element of flexibility in its application in schools. The element of flexibility means that it provides freedom for schools and teachers to adjust the implementation of the curriculum to local conditions, students' abilities, and the availability of resources. This means that schools and teachers are given flexibility in designing operational curricula that should contain learning strategies to facilitate independent learning because learning is tailored to the potential of students.

The content of the flexibility aspect in the independent DL curriculum is the flexibility of the subject matter, meaning the context with the development stage of the students, the learning strategy that is in the context with the needs of the students and technological developments, independent learning that is the context with the needs, the learning resources that are contestant and diverse, and the assessment that is contextual with the needs of the students so that they are able to provide continuous feedback to students and teachers. The flexibility of the independent curriculum aims to create a more relevant, effective, and enjoyable learning process for students and provide freedom for teachers to develop the potential to create quality learning (Natsir, S. R. 2025, Qurniawati, D. R. 2023).

The learning outcomes mentioned in the paragraph above are important as a competency for everyone because the world is currently and in the future dealing with the use of technology products in the 4.0 era and entering the social 5.0 era. The social era 5.0 is characterized by most interaction activities to meet human needs using technology resulting from the 4.0 era. Currently, human interaction activities are starting to dominate the use of digital artificial intelligence (AI) technology. The content of the IDL curriculum has prepared facilities that should be used as a reference for schools to achieve the competencies needed now and even in the future.

As derivatives of the flexibility of the independent DL curriculum, teaching modules and learning tools are the teacher's handle for application in learning. Thus, the content of the teaching modules and learning tools must have an element of flexibility, as mentioned in the previous paragraph. One way to have an element of flexibility is to have teaching modules and learning tools that contain learning strategies that compete with the needs of students, technological developments, facilities availability, and community needs [1-8]. The project-based learning (PjBL) learning model with digital media is one of the learning strategies that makes teaching modules and devices have elements of flexibility and context.

The project-based learning model and digital media are an effective strategy because they can facilitate the performance of teachers and students to produce products that result from critical and creative thinking through communication and collaboration in productive group discussions through learning. Kolmos, A. (2017).

Teachers and students use digital media in learning, namely, interpreting essential materials, elaborating essential materials so that they become advanced materials, and communicating through interaction with various sources to facilitate communicative and collaborative abilities that have an impact on teachers' and students' abilities, especially in critical and creative thinking. Digital media can be videos, YouTube videos, applications, power points, and canva.

The preparation of teaching modules and learning tools that have flexible content is the responsibility of teachers because they are the planners and implementers of learning. Become a teacher as a manager and an actor in learning. This is a reference to the statement "teachers become the curriculum at the operational level in schools". This means that the teacher himself plans the learning that is the teacher's guide in performing learning. Thus, it has a relevance value to the achievement of learning outcomes as students' learning outcomes. Students achieve learning outcomes with these competency achievements because of the teaching modules and contextual learning tools.

At the operational level, namely, schools and teachers, there is an urgent need for facilitation in terms of teaching modules and tools with learning strategy content that competes with the needs of students, technological developments, the availability of facilities, and the needs of the community. The teaching modules and learning tools in question contain learning strategies that can facilitate the development of students' competencies to achieve learning outcomes that meet the needs of life. The project-based learning (PjBL) learning model and digital media are one of the learning strategies that have flexible criteria and context so that it can facilitate the achievement of learning outcomes for students.

Teaching modules and learning tools that are currently used by teachers are generally the result of searches through social media without elaboration and modification so that there is no context to be used as a handle in the school where teachers conduct learning. This illustrates that the critical, creative, and innovative thinking skills of teachers are still low. This condition shows the gap between the expectations and reality of the implementation of the IDL curriculum at the operational level, namely schools.

Several factual findings that support the picture of the problem of implementing the IDL curriculum at the operational level of schools and teachers were obtained through tracing using research, interviews, and observation instruments. The results of interviews with 12 biology teachers as research samples from public and private high schools in the city of Samarinda show the fact that the problem occurred through several statements by the teachers in the interview, namely "I as a teacher do not have enough time to compile teaching modules and my own devices", because "I am too busy with administrative demands."

Several factual findings based on the results of observations show that teachers apply learning with activities to the initial learning activities starting with greetings, prayers, lectures and advice with the dominance of religious elements. The core learning activity of teachers giving lectures delivers material and then gives assignments without clear facilitation, and students collect assignments without teacher facilitation. The teacher ended the core activity by delivering a lecture that sometimes repeated the material delivered at the beginning of the core activity. In the closing learning activity, the teacher carried out evaluation and reflection and gave a lecture to give advice with religious elements.

The facts revealed through interviews and observations show that teachers do not have adequate abilities in planning and conducting learning, resulting in a lack of professional performance as teachers. Teaching modules and learning tools from social media searches have not become a handle in the implementation of learning because teachers still apply old habits that are dominated by lectures and assign assignments to students without proper facilitation. Teaching modules and social media search results are prepared by teachers to maintain the administrative completeness of an examination.

Therefore, the main motivation is to have teaching modules and learning tools for administrative completeness so that it can pass the inspection as a quality guarantee. After being shown by the teacher and observed by the research team, teaching modules and tools such as social media searches for teachers still contain misconceptions, especially in the basic competencies, competency indicators, learning objectives, learning strategies, initial activities, core, and conclusion of learning. Not all learning tools are arranged with reference to learning objectives. The learning tools examined by the research team include teaching materials, LKPD, media, and assessment instruments in the form of techniques and rubrics as a measure of assessment.

Some of the components that characterize teaching modules and flexible learning tools are that they contain a description of the learning platform that is contextual to the needs of students, technological developments, facilities availability, and community needs. The teaching modules in the teacher do not have this content, and the teacher does not understand how to improve the content. The results of the observation strengthened the findings of problems in learning because it showed that teachers were not skilled in managing the implementation of learning, so that learning was dominated by lectures and assignments without clear facilitation for students in doing these tasks.

This paragraph and the next describe the results of interviews with high school biology students. The sample of students for the interview came from 12 classes where the teacher as a research sample carried

out learning. Each class has a sample of 2 people so that the total number of students interviewed is 24. The exposure of the facts of the observation results to the students has been represented in the description of the results of the teacher's observation of the implementation of learning. The results of the interviews with the students revealed several facts that show problems with learning outcomes, and even in the extreme, it can be said that they have not been able to achieve learning out of critical, creative, communicative, and collaborative thinking.

The following statement is a fact of the interview results is as follows: "we are not enthusiastic about learning because we are always given tasks that are not clear by the teacher", besides that "learning is not interesting because the assignments are done from books that are not understood". The student's statement was supported by the results of observation in learning, showing that the tasks done by students were unclear because teachers had not used other learning resources other than books that had existed so far at school without the facilitation of teachers. The description of the results of the interviews and observations shows that the facilitation carried out by teachers in learning is still very weak; thus, it does not have the strength as a driving force to facilitate learning activities in students to achieve learning outcomes competencies.

The learning problems that occur in teachers and students at school show that the causes of problems in students come from teachers, namely 1. have not fully understood the planning of teaching modules and contextual learning tools, 2. They are not skilled in managing the implementation of contextual learning so that they can help students achieve critical, creative, communicative, and collaborative thinking learning outcomes. Thus, efforts as a solution to learning problems are focused on improving the understanding and skills of teachers to perform learning. Referring to this need, the research is divided into two stages: the initial stage and the advanced stage. The initial stage of research focuses on improving the understanding and skills of teachers in planning and implementing learning by referring to teaching modules and learning tools that are contextual with the learning outcomes of students. The results of this study form the basis for further research. The article is planned to be published separately.

Follow-up research focuses on the implementation results of teaching modules and learning tools whose context facilitates students' learning outcomes. The article published in the journal of the results of this research. This research article focuses on the application of teaching modules referring to strategies with PjBL learning models and devices focused on digital learning media to facilitate students' learning outcomes in biology learning in high school. 1. Research objectives To determine the teacher's understanding of planning learning modules and tools whose context facilitates

students' learning outcomes, 2 To determine the teacher's ability to carry out learning with the guidance of modules and learning tools whose context facilitates students' learning outcomes 3. Knowing learning outcomes in students after teachers apply learning modules and tools whose context facilitates students' learning outcomes.

## 2. Method

The research method uses descriptive quantitative data analysis, namely, the calculation of scores, values, and percentages (%) and making a presentation of the results of the analysis in the form of tables and graphs. Meanwhile, descriptive analysis occurs when the results of quantitative analysis are interpreted in the form of descriptions. The research sample consisted of teachers and students. The research sample of teachers and students is determined based on the purposive sample technique with the aim of ensuring that the school where the research is conducted has implemented the independent curriculum. The sample of 12 teachers consisted of public and private school teachers in the city of Samarinda. The sample of students amounted to 300 people from 12 classes where the sample of teachers

carried out learning. The research procedure consists of 3 main activities: initial research, core research, and concluding research. The following is a description related to the 3 main activities in the research procedure.

**Preliminary research activities** This is the research preparation stage. The procedures and activities carried out are 1. The research team held a meeting in the 2nd week of January to the second week of February 2025 to examine research instruments consisting of assessments containing rubrics as a measure of assessing teachers in the performance of teaching module products and contextual learning tools, observation sheets to assess teachers in the implementation of learning based on teaching modules and contextual learning tools, and assessment rubric reference measures to assess students in learning outcomes. The observation sheet contains measures to assess the learning outcomes of students in learning activities (initial, core, and closing activities) through the process and performance results of the LKPD simple project and the video product complex project. The assessment sheet contains rubrics to assess the performance of LKPD products and videos of individual student performance results in groups. The research instrument is described in the form of a table as follows.

**Table 1 Rubric Assessment as a Measure to Assess Teachers' Performance in Teaching Module Products and Contextual Learning Tools**

No	Indicators	Sub Indicator	Score
1.	Description of the assessment results for learning (diagnostic assessment)	Description of the results of the application of cognitive and cognitive diagnostic assessments using digital media as a reference in planning and implementing teaching modules and devices.	100
2.	Description of the suitability of the teaching module's systematics	The initial section contains the following initial information: <ol style="list-style-type: none"> <li>1. global warming teaching materials, class 10 semester 2, time allocation 4 x 45 minutes, number of meetings 2 x.</li> <li>2. contains a description of the results of the application of assessment for learning, namely diagnostic assessment and how to refer to the planning of teaching modules along with tools and implementation of learning according to the teaching module and tools.</li> <li>3. Basic competencies,</li> <li>4. Competency indicators,</li> <li>5. Learning objectives,</li> <li>6. Learning strategies consisting of approaches, models, methods, teaching materials, LKPD, media, and evaluation</li> <li>7. Learning activities containing initial, core and closing activities</li> <li>8. Description of learning strategy devices as a complement to teaching modules consisting of teaching materials, LKPD, media, and assessment evaluation instruments. The device description refers to the learning objectives</li> </ol>	100
3.	Basic competencies in the teaching module	In accordance with the teaching material, covering the knowledge, attitudes, and skills domains	100
4.	Description of Competency Indicators in the Teaching Module	Covering knowledge, attitudes, and skills domains	100
5.	Description of learning objectives in the teaching module	Covering elements of audience, behavior, conditions, degree (ABCD), operational words, and measurable	100
6.	Description of learning strategies in the teaching module	Containing flexible approaches, models, and methods to achieve learning objectives because of the context	100
7.	Description of initial learning activity scenario activities in the teaching module	The initial learning activities are as follows: <ol style="list-style-type: none"> <li>1. Opening greetings and prayers</li> <li>2. Apperception using motivating questions (i.e., initial formative assessment) or assessment as learning</li> <li>3. Motivation,</li> <li>4. Delivering topics and objectives</li> <li>5. Ice breaking using digital media, such as YouTube videos,</li> <li>6. Class agreement,</li> </ol>	100

		7. There is time allocation.	
8.	Core learning activity scenario activities in the teaching module	The core learning activities are as follows: 1. Students observe the teacher's presentation using Canva digital media containing text and videos (content differentiation) related to essential global warming teaching materials and facilitate LKPD assignments that students will work on in group discussions based on the potential of students from diagnostic assessment results (process differentiation). 2. Students discuss in groups working on LKPD (simple projects) related to essential concepts and advanced global warming material referring to the formulation of learning objectives. The teacher facilitates and conducts assessments as formative learning processes. 3. Groups of students present the results of LKPD performance in classical discussions using digital power point media. 4. Students observe the teacher's digital media cava request containing facilitation of strengthening essential material and advanced material related to global warming teaching materials and teacher facilitation related to group assignments producing video products (complex projects) containing communication and collaboration activities between group members to obtain agreement on critical and creative thinking results related to problem identification, solutions, and follow-up plans for global warming solutions to be worked on as co-curricular activities within a period of 1 week because the video results are presented at the next meeting. 5. Breaking ice using digital media YouTube videos 6. 6. A time allocation	100
9.	Description of closing learning activity scenario activities in the teaching module	The closing learning activities are as follows: 1. The conclusions refer to the learning objectives, 2. Reflections of students and teachers 3. Reminding the completion of complex project tasks, namely video products (product differentiation) with the topic of global warming, which are worked on by groups as co-curricular tasks for a period of 1 week and will be presented at the next meeting. 4. Closing prayer and greeting 5. A time allocation	100
10	Description of the learning completion activities	The activities after completing the learning process are: 1. Assessing the results of simple project performance products (LKPD) and complex projects in the form of videos related to global warming, conducting reflection and follow-up on the results of student performance assessments.	100

## Description of the Score Range and Assessment Categories:

Score range	assessment category
0 to 30.	Very poor
>30 to 59 years.	Poor
60–75.	Adequate
>75 to 85.	Good
>85 to 100.	Excellent

**Table 2 Rubric Assessment as a Measure to Assess Teachers' Learning Implementation Performance Referring to Teaching Modules and Contextual Learning Tools**

No	Indicators	Sub Indicators	Score
1.	Implementation of the initial learning activity scenario activities in the teaching module	The initial learning activities are as follows: 1. Opening greetings and prayers, 2. Apperception using motivating questions (i.e., initial formative assessment) or assessment as learning 3. Motivation, 4. Delivering topics and objectives 5. Ice breaking using digital media, such as YouTube videos, 6. lass agreement, all activities were conducted according to time allocation	100
2.	Implementing scenario activities for core learning activities in the teaching module	Core learning activities are: 1. Students observe the teacher's presentation using Canva digital media containing text and videos (content differentiation) related to essential global warming teaching materials and facilitate LKPD assignments that students will work on in group discussions based on the potential of students from diagnostic assessment results (process differentiation). 2. Students discuss in groups working on LKPD (simple projects) related to essential concepts and advanced global warming material referring	100

		<p>to the formulation of learning objectives. The teacher facilitates and conducts assessments as formative learning processes.</p> <ol style="list-style-type: none"> <li>3. Groups of students present the results of LKPD performance in classical discussions using digital power point media.</li> <li>4. Students observe the teacher's digital media cava request containing facilitation of strengthening essential material and advanced material related to global warming teaching materials and teacher facilitation related to group assignments producing video products (complex projects) containing communication and collaboration activities between group members to obtain agreement on critical and creative thinking results related to problem identification, solutions, and follow-up plans for global warming solutions to be worked on as co-curricular activities within a period of 1 week because the video results are presented at the next meeting.</li> <li>5. Ice breaking using digital media YouTube videos.</li> <li>6. all activities according to the time allocation</li> </ol>	
3.	Closing learning activity scenario activities in the teaching module	<p>The closing learning activities are as follows:</p> <ol style="list-style-type: none"> <li>1. The conclusions refer to the learning objectives,</li> <li>2. Reflections of students and teachers</li> <li>3. Reminding the completion of complex project assignments (formative performance assessments) namely video products (product differentiation) with the topic of global warming, which are worked on by groups as co-curricular assignments for a period of 1 week and will be presented at the next meeting.</li> <li>4. Closing prayer and greeting</li> <li>5. All activities according to the time allocation</li> </ol>	100
4.	Implementation of learning completion activities	<p>The activities after completing the learning process are as follows:</p> <ol style="list-style-type: none"> <li>1. Assessing the results of simple project performance products (LKPD) and complex projects in the form of videos related to global warming, conducting reflection and follow-up on the results of student performance assessments.</li> </ol>	100

#### Description of the Score Range and Assessment Categories:

Score range assessment category	
0 to 30.	Very less
>30 to 59 years.	Not enough
60–75.	Enough
>75 to 85.	Skilled
>85 to 100.	Proficient

**Table 3. Assessment Rubric Reference Measures for Assessing Students' Achievement in Learning Outcomes through the Process and Results of Simple LKPD Project Performance and Complex Video Product Projects**

No	Learning Outcome Indicators	Sub-indicator learning outcomes	Score
1.	Critical Thinking	The ability of individuals (students) in groups to carry out activities to analyze information objectively, rationally, and systematically and decide arguments to produce simple project performance LKPD and complex video projects referring to learning objectives with global warming material.	100
2.	Creative Thinking	The ability of individuals (students) in groups to produce new ideas, innovative solutions, and problem-solving in unique and original ways to produce simple LKPD and complex video projects referring to learning objectives with global warming material	100
3.	Communicative	The ability of individuals (students) in groups to convey messages using various verbal, non-verbal digital communication media and can be understood by students receiving the message to produce simple project performance LKPD and complex video projects referring to learning objectives with global warming material.	100
4.	Collaborative	The ability of individuals (students) to work together in groups to produce simple project performance LKPD and complex video projects referring to learning objectives with global warming material.	100

#### Description of Score Ranges and Assessment Categories for Learning Outcomes of Critical, Creative, and Collaborative Thinking

Score range assessment category	
0 to 30.	Very less
>30 to 59 years.	Not enough
60–75.	Enough
>75 to 85.	Good
>85 to 100.	Excellent

Description of Score Ranges and Assessment Categories for Communicative Learning Outcomes:

Score range assessment category	
0 to 30.	Very less
>30 to 59 years.	Not enough
60–75.	Enough
>75 to 85.	Skilled
>85 to 100.	Proficient

**Table 4. Observation sheet for assessing individual student learning outcomes in learning activities (i.e., initial, core, and closing activities)**

No	Student name	The initial core and closing learning activities are sub-indicators of critical thinking.	The initial core and closing learning activities show the creative thinking sub-indicator activities.	The initial core and closing learning activities are communicative subindicator activities.	The initial core and closing learning activities are collaborative subindicator activities.	The assessment categories consist of 2 categories, namely 1. Critical creative and collaborative thinking and 2. communicative
1	.....	Score acquisition	Score acquisition	Score acquisition	Score acquisition	Assessment categories
2	.....	idem	idem	idem	idem	idem
etc.						

Description of Score Ranges and Assessment Categories for Learning Outcomes of Critical, Creative, and Collaborative Thinking

Score range assessment category	
0 to 30.	Very less
>30 to 59 years.	Not enough
60–75.	Enough
>75 to 85.	Good
>85 to 100.	Excellent

Description of Score Ranges and Assessment Categories for Communicative Learning Outcomes:

Score range assessment category	
0 to 30.	Very less
>30 to 59.	Not enough
60–75.	Enough
>75 to 85.	Skilled
>85 to 100.	Proficient

**Table 5. Assessment sheet contains a rubric as a measure to assess the performance of LKPD products and videos.**

No	Indicators	Score	Assessment Category
	LKPD products demonstrate critical thinking skills		
	LKPD products demonstrate creative thinking skills		
	LKPD products demonstrate communicative skills		
	Video products demonstrate critical thinking skills		
	Video products demonstrate creative thinking skills		
	Video products demonstrate communicative skills		
	Video products demonstrate collaborative skills		

Description of Score Ranges and Assessment Categories for Learning Outcomes of Critical, Creative, and Collaborative Thinking

Score range assessment category	
0 to 30.	Very less
>30 to 59.	Not enough
60–75.	Enough
>75 to 85.	Good
>85 to 100.	Excellent

#### Description of Score Ranges and Assessment Categories for Communicative Learning Outcomes:

Score range assessment category	
0 to 30.	Very less
>30 to 59 years.	Not enough
60–75.	Enough
>75 to 85.	Skilled
>85 to 100.	Proficient

The research team held a meeting with the teachers who were the research samples in the 1st week of February to agree on the teacher's readiness time for the implementation of the research, namely the 1st week of March to the 1st week of April 2025. The span of 1 month was chosen because teachers asked for time to prepare teaching modules and contextual learning tools to teach the subject matter of global warming. Previously, teachers were facilitated to plan contextual teaching modules and learning tools and carry out learning referring to teaching modules and learning tools whose context in the subject matter is different in the initial research activities. The results of this research are also planned for publication in the journal.

Core research activities This stage is the implementation of research with the following procedures and activities: 1. Teachers perform learning using teaching modules and learning tools whose context mainly uses the PjBL learning model and digital learning media. 2. The research team conducted observations on teachers and students with the reference of observation sheet assessments during the implementation of learning referring to teaching modules and learning tools that are contextual because they use the PjBL learning model and digital learning media and apply differentiated learning. 3. The research team coordinates with teachers to obtain data related to the results of the assessment of the application of formative assessment observation sheets to measure and assess the individual role of students in terms of critical, creative, communicative, and collaborative skills during the learning activities process. The results of learning

assessment of LKPD simple project products and video complex project products (performance formative assessment) were also obtained. The completion of the research implementation stage for each school differs.

The research closing activity. This stage is the final stage of research with the following procedures and activities: 1. The research team holds a meeting to analyze the data of the research results using descriptive quantitative analysis, 2. The research team prepares research reports and articles for publication in journals by searching relevant literature, specifically articles according to the journal theme. 3. The research team conducted evaluation, reflection, and follow-up on the research results at this advanced stage. The closing activities will be implemented from mid-April to early May 2025.

### 3. Results and Discussion

Data from the research results are presented quantitatively in the form of tables and graphs. Tables and graphs consist of 1. The results of the teacher's research are as follows: planning teaching modules and contextual tools, 2. The results of the research of teachers conducting learning refer to teaching modules and contextual learning tools, 3. The results of the research on the learning outcomes of students in the learning process and 4. Results of the study of learning outcomes of students through the performance of simple LKPD projects and complex video projects related to global warming.

**Table 6. Results of Teachers Research on Module Planning and Contextual Learning Tools**

No	Indicators	Score range, acquisition score, and average score acquisition	Achievement in Category Assessment and Average Category Assessment
1.	Description of the assessment results for learning (diagnostic assessment)	>75 to 85, 9 people score 80 >85 to 100, 3 people score 86 Average score average 83	9 teachers are in the good category = 75% and 3 teachers are in the excellent category = 25%. The average assessment category is good.
2.	Description of the suitability of the teaching module's systematics	>75 to 85 7 people score 80 >85 to 100 5 people score 88 Average score 84	7 teachers are in the good category = 58.33% and 5 teachers are in the excellent category = 41.66%. The average assessment category is good.

3.	Basic competencies in the teaching module	>75 to 85 6 people score 82 >85 to 100 6 people score 88 Average average score 85	7 teachers are in the good category = 58.33% and 5 teachers are in the excellent category = 41.66%. The average category of good
4.	Description of Competency Indicators in the Teaching Module	>75 to 85 4 people score 78 >85 to 100 8 people score 88 Average score average 83	4 teachers are in the good category = 33.33%, and 8 people are in the excellent category = 66.66%. The average assessment category is good.
5.	Description of learning objectives in the teaching module	>75 to 85 10 people score 80 >85 to 100 people 2 people score 86 Average average score 83	Ten teachers are in the good category = 83.33%), and 2 teachers are in the excellent category = 16.66%). The average assessment category is good.
6.	Description of learning strategies in the teaching module	>75 to 85 10 people score 80 >85 to 100 2 people score 90 Average score 85	Ten teachers are in the good category = 83.33%), and 2 teachers are in the excellent category = 16.66%). The average assessment category is good.
7.	Initial learning activity scenario activities in the teaching module	>75 to 85 9 people score 84 >85 to 100 3 people score 86 Average score average 85	9 teachers are in the good category = 75% and 3 teachers are in the excellent category = 25%. The average assessment category is good.
8.	Core learning activity scenario activities in the teaching module	>75 to 85 11 people score 80 >85 to 100 1 person 88 Average score 84	Eleven teachers are in the good category = 91.66%), and 1 person is in the excellent category = 8.33%). The average assessment category is good.
9.	Description of closing learning activity scenario activities in the teaching module	>75 to 85 9 people score 82 >85 to 100 3 people score 88 Average score 85	7 teachers are in the good category = 58.33% and 5 teachers are in the excellent category = 41.66%. The average assessment category is good.
10	Description of the learning completion activities	>75 to 85 6 people score 82 >85 to 100 6 people score 88 Average score 85	6 teachers are in the good category = 50% and 6 people are in the excellent category = 50%. The average assessment category is good.

**Table 7. Study Results of Student Learning Outcomes in the Learning Process**

No	Learning Outcome Indicators	Score range, score gain, and average score gain	Achievement in Category Assessment and Average Category Assessment
1.	Critical Thinking	>75 to 85 100 people score 76 and 90 people score 83 >85 to 100 60 people score 86 and 50 people score 88 Average score 83.25 points	190 students are in the good category = 63.33%), and 110 students are in the excellent category = 36.66%). The average assessment category is good.
2.	Creative Thinking	>75 to 85 93 people scored 76 and 102 people scored 80 >85 to 100 47 people scored 86 and 58 people scored 87 Average score 82.25 points	195 students are in the good category = 50% and 105 students are in the excellent category = 50%. The average assessment category is good.
3.	Communicative	>75 to 85 79 people scored 78 and 121 people scored 85 >85 to 100 63 people scored 86 and 37 people scored 90 Average score 84.75 points	200 students are in the skilled category = 50% and 100 students are in the proficient category = 50%. The average skill assessment category
4.	Collaborative	>75 to 85 88 people scored 76 and 79 people scored 82 >85 to 100 90 people scored 87 and 43 people scored 88 Average score 83.25	167 students are in the good category = 50% and 6133 students are in the excellent category = 50%. The average assessment category is good.

**Table 8. Students Learning Outcomes Research Results Based on the Performance Results of LKPD Products and Global Warming Videos**

No	Learning Outcome Indicators	Score range, score gain, and average score gain	Achievement in Category Assessment and Average Category Assessment
1.	Critical Thinking	>75 to 85 93 people scored 77 and 87 people scored 81 >85 to 100 60 people scored 87 and 60 people scored 88 Average score 83.25 points	180 students are in the good category = 60% and 120 students are in the excellent category = 40%. The average assessment category is good.
2.	Creative Thinking	>75 to 85 89 people scored 79 and 81 people scored 84 >85 to 100 100 people scored 86 and 30 people scored 88 Average score 84.25 points	170 students are in the good category = 56.66% and 130 students are in the very good category = 43.33%. The average assessment category is good.

3.	Communicative	>75 to 85 70 people scored 77 and 80 people scored 83 >85 to 100 80 people scored 88 and 70 people scored 89 Average score 84.25 points	150 students are in the good category = 50% and 150 students are in the excellent category = 50%. The average assessment category is good.
4.	Collaborative	>75 to 85 78 people scored 76 and 46 people scored 83 >85 to 100 86 people scored 87 and 90 people scored 88 Average score 83.5 points	124 students are in the good category = 41.33%, and 176 students are in the excellent category = 58.66%. The average assessment category is good.

The systematics of the discussion contains descriptive analysis in the form of interpretation and interpretation referring to

- 1) teacher preparation,
- 2) student competency development,
- 3) the impact of PjBL and digital media.

Description Interpretation and interpretation through the elaboration process involves the critical, creative, communicative, and collaborative thinking of the research team with reference to the results of relevant literature reviews.

The results of teachers' research in planning teaching modules and contextual learning tools show that the average category of teacher ability assessment is in the good category with an average reference score of 84.2. The results of this study indicate that teachers' understanding of planning teaching modules and contextual learning tools is in the good category. This result was obtained by the teacher because the teacher had obtained facilitation to plan teaching modules and contextual learning tools with different student materials in the initial research activities with facilitation strategies using the andragogy approach and the FGDP before the implementation of the follow-up research.

The results of the study can be interpreted as indicating that the previous teacher's experience has an effect on the teacher's ability to elaborate in producing teaching modules and contextual learning tools. Thus, previous experience gained meaningfully has a transfer value in relevant situations, besides that teachers do not forget the meaningful experience gained previously. David Ausubel's theory of learning is meaningful if the new thing to be learned can be related to the experience that has been had in the cognitive structure as a subsume, and it is not easily forgotten because it is stored in the relationship of understanding to a person's long-term memory [2]

The meaning that can be elaborated from the results of research and strengthening the literature is that it is very important that a person has experience to have the readiness to produce works or products.

The results of teachers' research in carrying out learning with the reference of teaching modules and contextual learning tools show that the average category of teacher ability assessment is in the skilled category with an average reference score of 84.375. The results of this study indicate that most teachers in performing learning referring to teaching modules and contextual

learning tools are in the skilled category. This result was obtained by teachers because before the implementation of follow-up research, teachers had obtained facilitation to carry out learning referring to teaching modules and contextual learning tools with different subject matter in initial research activities with facilitation strategies using the andragogy approach and modeling and simulation methods.

The results of the study indicate that the understanding of the good categories that teachers have in planning teaching modules and contextual learning tools supports their skills in carrying out learning referring to the teaching modules and contextual learning tools. Thus, there is a relationship between teachers' understanding and skills, which can be interpreted as follows: without a good understanding in planning teaching modules and contextual learning tools, teachers will not gain skills. Understanding is the foundation for achieving skills. Even understanding and skills are two sides of the coin that support each other. This means that good understanding will be the foundation for acquiring skills and improving understanding [3] The understanding gained in performing professional duties will produce skills for the profession so that becoming a professional in the context of this research is the profession of a teacher. The meaning that can be elaborated from the results of research and strengthening the literature is that it is critical for teachers to have experience and skills to become professional teachers.

The results of the learning out study of students in learning show that the average is in the assessment category, both referring to an average score of 82.926 for critical thinking, creative, and collaboration, while for communicative, it is in the category of skilled assessment referring to a score of 84.75. The results of this study indicate that, in general, students already have competence in learning outcomes in the learning process. This result was obtained because the teachers who facilitated learning were in the category of good and skilled understanding. The results of the study indicate a causal relationship between students' learning outcomes and teachers' abilities in terms of understanding and management skills through learning implementation.

Learning management applies strategies with an active student learning approach, project-based learning (PjBL) learning model, with the use of digital learning

media. Active student learning that occurs through the application of the PjBL learning model syntax and the help of digital media can facilitate learning through critical thinking, creativity, communication, and collaboration because of the activities that occur in the initial learning activities by applying triggering questions that are contextual to the surrounding environment. An example of a lighter question used by teachers in the initial learning activity is to describe what happens if the ambient temperature feels hot. Please respond according to your readiness to convey visually, verbally, or a mixture of the three. The observation results showed that students were enthusiastic about answering even the content of the answer beyond the teacher's prediction because some students responded with essential concepts and material advances.

Teacher facilitation in the initial activity can increase students' motivation in learning activities because students feel that the teacher understands what they need so that they can respond and even compete to respond. Even from the activities that occurred, it showed the ability to communicate and collaborate initiatives using digital media between students in responding to the questions of the learners. This condition makes students ready for the next learning activity because students pay attention when the teacher conveys the topic and learning objectives.

The role of students in learning continues to be facilitated by teachers by asking students to participate in ice-breaking activities that are liked in the teacher's YouTube videos. This shows that students apply their creative thinking skills in a fun atmosphere because the responses requested by teachers are performance-based. For example, following movements, singing, and drawing likes in the video. Furthermore, in the class agreement activity, which is a reference in the implementation of core activities and the closing of learning, students are enthusiastic about expressing their opinions, and some are creative in conveying that they should always be disciplined in their time in discussion, so it is better to use the timer on the smartphone of one of the group members.

Teacher facilitation in core activities can increase students' motivation in learning activities because it begins with the activity of observing Canva digital media, which contains texts and videos related to essential concepts and advanced material materials for global warming lessons. Furthermore, students in groups communicate and collaborate on simple LKPD projects related to finding the concept of factors that cause global warming, the process of global warming, examples of global warming, and impacts on the surrounding environment. This activity shows that students are facilitated in terms of critical creative communicative, and collaborative thinking skills.

The group formed refers to the results of the diagnostic assessment that has been implemented 1

week before the learning so that the teacher has formed a heterogeneous group of cognitive diagnostic assessment results. The composition of the group members consists of students who fully understand, partially understand, do not understand and the results of non-cognitive assessments so that there are participants in visual, auditory, kinesthetic and mixed learning styles. Heterogeneous groups can motivate students in communication and collaboration so that students are enthusiastic about working on LKPD. The enthusiasm of students can be seen in the activities of analyzing information, conveying ideas, original ideas, etc., which characterize critical and creative thinking. Enthusiasm is generated because classroom management applies the principle of differentiated learning [2]

Communication skills are shown with students in groups working on LKPD and in classical discussions presenting and conveying ideas or ideas that are easy to understand by other group members and supported by conveying information using digital media smart phones. Collaborative ability is demonstrated by reaching a description agreement that will be used for the corresponding concepts in the LKPD. In addition, there is an agreement of members who will make presentations, members who prepare LKPD for presentations, members who respond to discussions, and members who control power point broadcasts.

During the discussion, work, and presentation of the LKPD, the teacher becomes a facilitator to go around each group to keep motivating the activities of students in the group by expressing the motivational sentence "wrong is normal because you are still learning." "Wrong will be right if you want to reveal it so that other group members can help correct what is wrong." Everyone is still learning, so let's compete to express our opinions and work together to correct the wrong. Facilitation techniques applied in core learning activities can facilitate critical, creative, communicative, and collaborative thinking skills. Such teacher motivation can make students in heterogeneous groups feel a conducive learning climate because it accepts students in any condition. Consequently, students are eager to learn through an active role in discussions. While going around, the teacher group facilitated the implementation of observation sheets as a recording of reference data on learning outcomes through the role of students in discussing LKPD and LKPD presentations. At the end of the core activity, the teacher facilitated students in the group to use Canva digital media related to group project assignments, namely, how to work on videos with systematic identification of global warming problems that occur in the surrounding environment, design solutions, and plan follow-up on the implementation of solutions. Video products so that all learning styles in students as group members can participate in the project. The content of the video shows each group member's

activity in working on the video in accordance with the systematics facilitated by the teacher.

Teacher facilitation in the closing activities of learning shows that it strengthens the potential of students in learning through critical thinking, creativity, communication, and collaboration. The supporting activities include formulating conclusions referring to the learning objectives through the role of each group, representing students in the group to convey the results of reflection, carrying out reflections referring to observation sheets (formative assessment of processes), and reminding students of complex project tasks that will be presented at the next meeting. The next activity was to conduct ice-breaking by asking student representatives to make funny material performances to be shared in class according to their learning styles. From the description expressed in the initial activity, the core and conclusion of the learning show that managing learning through the application of the PBL model becomes a context with the needs of students because there is differentiated management because it is adjusted to the potential of the students, performance-based activities, always applying motivation, using digital media effectively facilitates learning outcomes critical thinking, creative, communicative, and collaborative in students [1].

The results of the learning outcomes research through the product performance of the LKPD simple project and the global warming video complex project show that the average is in the assessment category, both referring to an average score of 83.583 for critical thinking, creative, and collaboration, while the average score of 84.25 for communicative is in the category of skilled assessment.

The results of the study show the relationship between learning outcomes in the learning process and in project products. This result can be interpreted as a good learning process that strengthens the competence of learning outcomes as a learning product. Thus, learning outcomes in the learning process have a transfer value so that students can elaborate through innovation on the ability to do and produce complex products, namely, videos containing global warming as a tangible manifestation of the application of learning outcomes critical thinking, creative, communicative, and collaboration in new contextual situations [8].

#### 4. Conclusion

Based on the research objectives, findings, and discussions that have been conducted, it can be concluded that teacher understanding is in the assessment category, both in planning teaching modules and in compiling contextual learning devices that facilitate student learning outcomes. Teacher abilities are also included in the skilled category, especially in implementing the learning process with the guidance of teaching modules and contextual learning devices to support the achievement of student learning outcomes.

After the teacher implemented the teaching modules and learning devices, the student learning outcomes showed significant development. The critical, creative, and collaborative thinking skills of students are in the assessment category, while their communicative abilities are in the skilled category.

The recommendations from this study underline the importance of the relationship between teacher understanding and skills in improving professionalism in learning management. This has a positive impact on the quality of learning not only for teachers but also for students and schools as a whole. Therefore, it is recommended that education practitioners continue to improve their competence independently and in groups. This competence can be developed in various ways, especially by using digital media. Education practitioners must continue to reflect on themselves as part of ongoing self-development, while leaving behind old habits that can trap them in monotonous and undeveloped learning practices.

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