Developing Assessment using the TaRL Approach with the PjBL Model on the Topic of Global Warming

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Abstract. This research addresses the limitations of existing physics assessments that primarily focus on outcomes and cognitive abilities, neglecting the need for a deeper understanding of global warming. The study aims to develop assessments using the teaching at the right level (TaRL) approach with a projectbased learning (PjBL) model specifically for global warming. It follows a Research and Development (R&D) methodology using the ADDIE method, comprising analysis, design, development, implementation, and evaluation stages. The developed assessments undergo validation by experts and physics teachers, followed by a limited trial involving 36 tenthgrade students. Questionnaires, observation sheets, and validation sheets are utilized, and data analysis is performed using descriptive qualitative methods with scoring criteria. The findings reveal that the assessments consist of both formative and summative components, covering various aspects such as diagnostic assessments, learning process evaluations, and project assessments. Expert validation confirms the high suitability of the assessment content and components, with an average score of 3.77 from all validators. Consequently, it is concluded that the TaRL approach with the PjBL learning model for global warming assessments is highly suitable for student use.

Keywords: global warming, project based learning, TaRL approach, teaching at the right level

1. Introduction

The education system is a unified subsystem or interconnected components. These components include goals, curriculum, materials, methods, educators, students, facilities, tools, approaches, and anything that supports the system (25). Education must be adaptive and dynamic in responding to changes brought about by various developments in science. This can serve as a foundation for the development of students' lives, leading to the emergence of a self directed curriculum (27). Self directed curriculum is one of the curriculum options that schools can implement. This curriculum is considered capable of addressing learning loss (the decline in knowledge and skills of students due to remote learning) and allows teachers to focus more on essential learning materials (38,39). Consequently, the independent curriculum offers a more adaptive and responsive approach to the changing times, ensuring that students continue to develop holistically (1).

Learning in a self directed curriculum ensures that learning practices are student centered (14). With this self directed curriculum, learning becomes a cycle that starts with mapping competency standards, planning the learning process, and implementing assessments to improve learning so that

students can achieve the expected competencies. Learning with a self directed curriculum is based on five principles: designing learning considering the stages of development and current achievement levels of students based on their learning needs, reflecting diverse characteristics and developments to make learning meaningful and enjoyable; designing and implementing learning to build capacity for lifelong learning; supporting the holistic development of competence and character of students; relevant learning that is designed according to the context, environment, and culture of students, involving parents and the community as partners; and future oriented and sustainable learning (14, 40). The implementation of this self directed curriculum has an interesting aspect, as it allows teachers to be more flexible in teaching according to the abilities of their students, commonly known as teaching at the right level (TaRL) (11, 41). The TaRL approach is a learning approach that does not refer to grade levels but instead focuses on the students' ability levels (24). This makes the TaRL approach different from other approaches, as it provides a solution to the problem of understanding gaps that have occurred in the classroom. By using the TaRL approach, students are grouped based on their developmental stages or according to their similar ability levels (4).

The implementation of the TaRL approach in learning requires an assessment to measure the students' abilities. Assessment is an integral part of the teaching and learning process, serving various purposes, including enhancing the engagement and motivation of students, especially when it involves interactions between teachers, students, and various learning resources (22). Teachers need to consider the effects of assessment and feedback on the motivation and self esteem of students, as well as the importance of active student engagement in their own learning. Classroom assessment is considered a mechanism for determining learning achievement (7). Assessment is highly useful when the assessment goals are clear and well planned to achieve the intended objectives. Assessment should not only focus on learning outcomes but also on the learning process. Students are also involved in self assessment to practice self assessment. To consider educational assessment as a coherent construction, it is important to understand the underlying ideas and how they conceptually relate to each other (30, 35, 42).

Assessment in physics learning is an integral part of the physics education process (6). Efforts to improve the quality of physics education can be pursued through improving the quality of teaching and the assessment system. The quality of learning can be seen from the assessment results. Conversely, a good assessment system encourages teachers to determine appropriate strategies and motivates students to learn better. Currently, all classroom assessments in traditional settings focus on measuring learning after all the material has been presented and are used to classify students and report assessments (10). Currently, assessments in physics learning tend to focus on outcomes and only assess cognitive abilities, without providing room for in depth understanding of global warming issues (12, 43). Many teachers still see assessment as a separate activity conducted at the end of learning, limited to measuring learning outcomes, and not well integrated into the learning process. This results in inconsistency in the assessment process in the classroom, where students are only focused on learning when there are daily tests. Therefore, it is

important to develop a more holistic and integrated assessment approach in physics learning regarding global warming. One approach that can be used is the project based learning model, which has been proven effective in helping students apply the concepts they have learned in real life situations. With this approach, students can concretely understand the impact of global warming and be more motivated to learn about this important environmental issue (36, 44).

Global warming is one of the topics in physics learning in phase E or equivalent to grade X in high schools. Global warming is a crucial environmental issue that requires serious attention. Global warming is a global environmental problem that is increasing concerns worldwide (28). According to the report by the Intergovernmental Panel on Climate Change (IPCC) in 2018, climate change has caused many negative impacts, such as rising sea levels, increasing surface temperatures, and an increase in the frequency and severity of natural disasters (13). In facing this complex problem, effective and differentiated learning is needed to enhance students' understanding of global warming and its impacts. The project based learning model has been proven effective in helping students apply the concepts they have learned in real life situations. In this way, students can concretely understand the impact of global warming and be more motivated to learn (16). The implementation of Project Based Learning in the learning process is crucial to improve students' critical thinking skills and foster independence in learning (3). As a constructivist approach, Project Based Learning provides learning in real world problem situations for students, leading to the development of lasting knowledge. Project assessment is an evaluation activity of a task that needs to be completed within a specific period or timeframe. Project assessment can be used to assess understanding, application skills, research skills, and students' ability to provide clear information on their investigations in specific subjects (5, 29, 45).

In this regard, the development of assessment using the TaRL approach with the PjBL model on the topic of global warming can help enhance students' understanding of this complex environmental issue by providing diverse learning experiences that meet their needs. In TaRL based learning, students receive tailored learning materials based on their abilities, and in PjBL, students participate in projects that are relevant to real life situations based on their interests or needs (2). The development of assessment using the TaRL approach and PjBL model on the topic of global warming can help improve students' skills and knowledge in understanding complex environmental issues and enhance their participation in solving these problems. This development can help students think critically in active problem solving and be part of the solution to increasing global issues like global warming.

2. Method

This study is a research and development (R&D) (33). According to Riduwan, "Educational research and development is a process used to develop and validate educational products, or it can be explained as educational research and development is a process used to develop and validate educational products" (26). As for the method used, it is ADDIE with 5 stages: analysis, design, development, implementation, and evaluation (34). ADDIE is a systematic and structured framework

for organizing a series of research, design, and development activities (Rusdi, 2018). The assessment that has been developed was validated by experts and physics teachers. After the assessment validation, it was implemented as a limited trial on 36 10thgrade students at SMA Negeri 13 Surabaya. The instruments used were questionnaires, observation sheets, and validation sheets. The analysis of the questionnaire, observation, and validation results was conducted using qualitative descriptive analysis based on score criteria.

3. Result and Discussion

The assessment design is divided into two aspects, namely formative assessment and summative assessment. In this development, formative assessment includes diagnostic tests on learning styles and initial capabilities of students conducted before the learning process begins. Furthermore, assessment of the learning process and attitudes is conducted during the learning process, while assessment of worksheets, self assessment, peer assessment, assessment of student works, and quizzes are conducted at the end of the learning process.

a. The Assessment Development Utilizes the TaRL Approach with the PjBL Model

The implementation of Teaching at The Right Level (TaRL) is a learning approach that focuses on the individual learner's level of achievement or ability (8). This approach does not rely on grade levels but rather tailors the learning experience to match the learner's level of achievement, ability, and needs in order to reach the desired learning outcomes. TaRL is an implementation that aligns with the philosophy of Ki Hadjar Dewantara Education (20). By considering achievement levels, ability, and learner needs as a basis for instructional design, every effort is made to center the learning process around the learner. The goal of teaching using this approach is to strengthen numeracy and literacy skills in learners, as well as knowledge in the subject matter being taught (14). Learners are not bound by grade levels but are grouped based on developmental phases or similar ability levels. Each phase or level has specific learning outcomes that need to be achieved. The learning process for learners is organized based on these learning outcomes, while also taking into account their characteristics, potential, and needs (21). The attainment of learning outcomes is determined through ongoing evaluation. Learners who have not yet achieved the learning outcomes in their respective phase will receive guidance from educators to help them reach their learning goals (32).

In the limited trial implementation, learners are initially grouped according to their ability levels and provided with instruction tailored to their respective levels. The instruction is delivered for one hour each day, aligned with their ability levels. Research findings show that by using achievement or ability levels as a basis for instructional design, educators are able to better develop learners. Instruction is customized to meet the needs and abilities of learners, which proves to be more effective for the learners themselves. The stages for implementing the TaRL approach are divided into three: Assessment, Planning, and Instruction (20). Assessment is the first stage that needs to be conducted in implementing the TaRL approach. In order to create learner centered

instruction, a diagnostic assessment is necessary. This assessment aims to gain a deeper understanding of the learners (23). Through diagnostic assessment, educators can learn many things about the learners, such as their potential, characteristics, needs, developmental stages, learning outcomes, and learning styles. After obtaining initial data from the diagnostic assessment, the next stage is planning. Educators use the data to plan instruction that aligns with the characteristics and achievement levels of the learners (17). This planning also involves grouping learners at the same level. By developing instruction that matches the learners' achievement levels or abilities, learners are placed at the center of the learning process, in accordance with Ki Hadjar Dewantara's philosophy (Maulana, 2014). During the learning process, regular assessments are conducted to monitor learners' understanding, needs, and progress. These periodic assessments can be conducted as formative assessments. Meanwhile, to assess the attainment of learning objectives at the end of a learning period, summative assessments are conducted.

The development of formative assessments includes assessing the learning process and attitudes during instruction. Meanwhile, assessments at the end of instruction include assessing the learners' worksheets and their works, as well as using the PjBL model, teacher and learner reflections (self assessment), peer assessment, and quizzes (formative). The timing of the assessments aligns with the implementation schedule. The combination of formative and summative assessments in educational development allows teachers to understand and respond to the individual needs of learners throughout the learning process (37). Formative assessments help learners improve their understanding continuously, while summative assessments provide an overall picture of learners' achievements (15). These two types of assessments work synergistically to enhance the quality of education and instruction. The following is a link to the assessment that has been developed (https://s.uad.id/pengembanganasesmenTaRLPjBL)

b. The Validity of Assessment Instruments

Before instructional modules and assessment instruments are used for classroom learning, validation activities are crucial. According to Daryanto (9), validation is the process of testing the suitability of modules with the targeted competencies. If the content of the instructional modules and assessment instruments align with the intended learning outcomes, they can be considered valid. However, if the validation results indicate invalidity, revisions are needed until the modules reach a valid category. Validation is conducted by consulting experts who have expertise in the relevant competencies (31). Content experts assess the appropriateness of the content, while media experts evaluate the graphic design (19). Teacher validation assesses the suitability of the presentation and the feasibility of using the instructional modules and assessment instruments in teaching and learning. Table 1 presents the validation results from content experts and physics teachers.

Table 1. Validation Result by Physics Experts and Teachers

Validator	Average	Description
Subject matter expert	3,75	Highly feasible
Media expert	3,80	Highly feasible
Physics teacher	3,75	Highly feasible

The validation conducted by content experts to assess the content validity obtained an average score of 3.75, which meets the criteria for high suitability. The validation results for assessing the completeness of the components obtained an average score of 3.80, meeting the criteria for high suitability. The validation results from educational practitioners, specifically physics teachers, to assess the suitability of the presentation obtained an average score of 3.75, meeting the criteria for high suitability. Based on the average validation results from all validators, which is 3.77, it can be concluded that the development of assessment using the TaRL approach with the PjBL instructional model for the topic of global warming is highly suitable for students.

After revising based on the suggestions and feedback from all validators, a product that can be implemented in learning is produced. The instructional modules and assessment instruments are then subjected to a limited trial or small scale testing to determine the effectiveness of the developed assessment. The limited trial is conducted at SMA Negeri 13 Surabaya with a total of 36 students. The purpose of this trial is to determine whether the use of the TaRL approach with the PjBL instructional model, supplemented with diverse assessment instruments, will assist students in achieving the predetermined learning objectives.

c. Limited Trial

After conducting the limited trial of developing assessment using the TaRL approach with the PjBL model on the topic of global warming, reflection and follow up actions were carried out based on the obtained results. The TaRL approach, which places students at the appropriate level of learning based on their understanding, has proven to be very useful in identifying students' initial understanding of global warming through diagnostic tests (20). By understanding the students' level of understanding, teachers can design learning experiences that meet their individual needs, avoiding boredom or confusion and ensuring their active engagement in the learning process. Furthermore, the use of the PjBL model has also succeeded in increasing student engagement by providing relevant and challenging project tasks related to global warming. In PjBL, students are given the opportunity to actively learn through exploration, collaboration, and real world problem solving (18). They are presented with challenges or projects that require the application of knowledge about global warming in real world contexts. In this study, they were asked to create eco bricks as an effort to reduce global warming in their environment. Through this project, students not only gain a deeper understanding of global warming but also develop critical thinking, collaboration, communication, and problem solving skills that are highly valuable in their daily lives (28).

As a follow up to this trial, there are several strategies and improvements to be implemented. First, we will enrich the learning materials with engaging multimedia resources, actual case studies,

and relevant real life examples of global warming. This will help strengthen students' understanding and stimulate their interest in environmental issues. Additionally, we will apply differentiation strategies in teaching to address the varying levels of student understanding. The TaRL approach allows us to tailor the learning experiences based on individual students' needs, enabling them to achieve significant goals and feel valued in the learning process (8,50). Formative evaluation will also be integrated into the learning process to provide continuous feedback to students. Teachers will provide constructive feedback regarding students' understanding, acknowledge their achievements, and help them identify areas for improvement. With this feedback, students can become more aware and responsible for their developing understanding of global warming.

Furthermore, facilitating collaboration among different subject teachers, such as science, mathematics, and language, will be encouraged to integrate the understanding of global warming across various learning contexts (47,48). For example, science teachers can collaborate with mathematics teachers to analyze data related to global warming, or language teachers can teach writing skills through research projects on the impacts of global warming. This collaboration will provide holistic and comprehensive learning experiences for students, connecting their knowledge across different subjects (46,49). Through these follow up actions, the researchers hope to enhance the effectiveness of the TaRL approach with the PjBL model in teaching global warming to students. It is expected that students can gain deeper understanding, relevant skills, and a caring attitude toward environmental issues, enabling them to become environmentally conscious individuals who take action in preserving the environment.

d. Learning Analysis and Student Response

The revised product is used for a limited trial, where students are asked to fill out a learning questionnaire and student response form. The questionnaire results are used to assess the feasibility of the implemented teaching and assessment methods when applied to 36 students in class X1 at SMA Negeri 13 Surabaya. The results of the student response questionnaire reflection are presented in Table 2.

Table 2. Student Response Questionnaire

Indicator	Reflection Results
Implementation of formative assessment	a) From the questionnaire results, the majority of participants have an understanding of formative assessment concepts with varying levels of comprehension. This indicates a basic understanding of formative assessment, but efforts are still needed to improve overall understanding. b) Most participants feel that formative assessment has greatly helped them understand their learning progress. This suggests that the implementation of formative assessment has significantly contributed to monitoring and improving participants' understanding of the learning material. c) The questionnaire participants indicate that the Teaching at the Right Level approach has a significant influence on their understanding of the material. This demonstrates that this approach is effective in helping participants achieve better understanding by considering their individual abilities and needs. d) Participants perceive that formative assessment greatly assists in improving their

Indicator	Reflection Results
	abilities in the classroom. This indicates that through the implementation of formative assessment, participants can identify areas for improvement and take appropriate actions to enhance their learning achievement. e) Many participants feel an increase in learning motivation through the implementation of formative assessment. This indicates that continuous monitoring and feedback provided through formative assessment can motivate participants to continuously improve their understanding and learning achievements.
Implementation of summative assessment	a) The questionnaire participants show varying levels of understanding regarding the concept of summative assessment. This indicates the need to provide clarification and a deeper understanding of summative assessment to the participants. b) Most questionnaire participants feel that summative assessment is very helpful in evaluating their overall understanding. This indicates that summative assessment has provided a clear picture of participants' learning achievements over a specific period of time. c) Many participants perceive that summative assessment helps them identify weaknesses or difficulties in their learning. This indicates that summative assessment can serve as a tool to identify areas for improvement and provide direction for further learning development. d) The questionnaire participants provide diverse assessments regarding the effectiveness of summative assessment in measuring learning objectives' achievement. This indicates the need for further evaluation and improvement of the methods and instruments used in summative assessment. e) Some participants experience pressure or stress when facing summative assessment. This indicates the need for a more sensitive approach in managing summative assessment and providing adequate support and guidance to participants to help them cope with the pressure.

4. Conclusion

From the research results, it can be concluded that: (1) The assessment instruments developed consist of formative assessment and summative assessment. Formative assessment is divided into three types: assessment for learning, which includes diagnostic assessment of learning styles and students' initial abilities, assessment of learning, which includes attitude assessment and process assessment, and assessment as learning, which includes assessment of learning materials, teacher and student reflections (self assessment), peer assessment, assessment of works, and quizzes (formative). Summative assessment includes summative assessment conducted at the end of the material. (2) Validation conducted by subject matter experts to determine the adequacy of the content obtained an average score of 3.75, which meets the criteria of high suitability. The validation results by experts to assess the completeness of the components yielded an average score of 3.80, which meets the criteria of high suitability. The validation conducted by education practitioners, specifically physics teachers, to assess the suitability of the presentation yielded an average score of 3.75, which meets the criteria of high suitability. From these various validation results, the average validation score from all validators is 3.77, therefore it can be concluded that the development of assessment using the TaRL approach with the PjBL instructional model on the topic of global warming has met the criteria of high suitability for use by students.

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