

The Development of Project Assessment in Matter and Energy Subjects Using the Addie Model

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ABSTRACT

This study aims to develop a valid, reliable, and practical project assessment sheet instrument for the Matter and Energy course using the ADDIE model. The instrument was developed through the stages of Analysis, Design, Development, Implementation, and Evaluation. The content validity of the instrument was tested using Aiken's V formula with two expert validators and resulted in an average value of 0.913, indicating very high validity. Instrument reliability was tested using Cronbach's Alpha coefficient with a value of 0.95, indicating very high internal consistency. The practicality test of the instrument through student responses showed an average score above 4.0 on a scale of 1-5, with the percentage of positive responses of "Agree" and "Strongly Agree" reaching almost 60%, indicating that the instrument is easy to understand and use and is able to motivate students in project work. Although there is some room for improvement, this instrument is well received by students and lecturers and is suitable for use as a project-based learning evaluation tool in the Matter and Energy course.

KEYWORDS

Instrument Development, Project Assessment, Content Validity, Reliability, Practicality, ADDIE Model, Matter and Energy

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A. Introduction

Project-based assessment is a form of authentic assessment that is increasingly being advocated and applied in 21st century education. Not only measuring cognitive achievement, project assessment assesses students' overall process skills, collaboration, creativity, and ability to solve real problems in everyday life (Raihan & Amrina, 2021). In the context of the Matter and Energy course, these skills become very important because students are not only expected to master concepts, but also be able to apply them through research-based projects or simple engineering relevant to their lives.

Many schools and lecturers in Indonesia still use traditional assessment approaches, such as multiple-choice or short fill-in-the-blank questions. These approaches tend to assess only limited cognitive aspects and fail to capture the complexity of learning activities that occur during the learning process. Consequently, the assessment results do not fully reflect the actual abilities possessed by students.

One important skill that is poorly measured in traditional assessments is process skills. Process skills include students' ability to plan, carry out, and evaluate learning activities, especially in the context of project-based learning. According to Bell (2010), effective assessments should be able to measure how students actively engage in critical thinking and scientific skills, rather than only focusing on the final product. Without appropriate instruments, this aspect is often overlooked in evaluations.

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In addition, collaboration skills are vital and develop during project work. In project-based learning, students are required to collaborate with their peers to complete tasks together. Assessments that ignore collaboration not only undermine the measurement of learning outcomes but also hinder the development of social skills that are essential in real-world contexts (Johnson & Johnson, 2014). Therefore, assessment sheets should be able to capture how students interact and contribute within a team.

Another equally important aspect is problem-solving ability that arises during project execution. Problem-solving requires students to identify issues, analyze situations, and find effective solutions. According to Hmelo-Silver (2004), this ability is central to project-based learning and should be a key part of the assessment process. Without adequate measurement of this skill, the assessment results are incomplete and fail to represent students' readiness to face real challenges.

According to Sukmasari and Rosana (2017), standardized and appropriate project assessment instruments are still very limited in Indonesia, resulting in assessments that are often less objective and do not comprehensively cover the skills students develop. Moreover, the instruments used generally have not undergone adequate expert validation and practicality testing, though these two aspects are crucial to ensure the assessment sheets can be effectively used in learning (Jayanti et al., 2024). The lack of validation and practicality tests often leads to biased assessments and missed opportunities for joint reflection between lecturers and students.

Several recent studies confirm that developing valid and practical project assessment sheets significantly improves student engagement, motivation, and learning quality (McKinney, 2023). With clear rubrics and well-structured assessment indicators, students can better understand learning expectations and continuously improve their projects. In Indonesia, especially in the context of project-based learning increasingly adopted in science courses such as Matter and Energy, developing quality assessment instruments is essential to support effective learning and skills development.

Based on this explanation, it is very important to develop a project assessment instrument that is systematically designed, validated, and practical for use in the Matter and Energy course. With a good project assessment sheet, it is expected that the assessment process will not only be a selection tool, but also a means of reflection and learning for students and lecturers. This research aims to:

1. Describe the stages of developing project assessment sheets in the Matter and Energy course.
2. Knowing the validity and practicality of project assessment sheets based on expert and user assessments.
3. Analyzing student and lecturer responses to the implementation of the project assessment sheet.

B. Research Method

This research is a development research (R&D) that uses the ADDIE development model, namely the stages of Analysis, Design, Development, Implementation, and Evaluation. This model was chosen because it is considered systematic and comprehensive in developing and testing learning instruments or devices, especially project assessment sheets that are relevant to the Matter and Energy course. The definition of each stages can be shown in Table 1.

Table 1. ADDIE Development Stages

No.	Development Model	Explanation
1.	<i>Analysis</i>	Identifying the need for instrument development through literature studies, observations, and discussions with lecturers. This stage aims to understand the existing project assessment problems and determine the relevant competencies and indicators to be measured in the assessment sheet.
2.	<i>Design</i>	Drafting an assessment sheet containing indicators, criteria, and assessment rubrics. This draft instrument is then prepared for the validation and trial process.
3.	<i>Development</i>	Includes the validation process of the assessment sheet by experts to ensure the content, format, and clarity of the instrument meet validity standards. After validation, a practicality test of the instrument is carried out with simulations or limited testing in the learning environment to assess the ease of use and completeness of the instrument.
4.	<i>Implementation</i>	Implementing assessment sheets in project learning activities in the Matter and Energy course. At this stage, the assessment sheet is used as an evaluation tool to assess student learning outcomes.
5.	<i>Evaluation</i>	Analyze the results of using the instrument in terms of validity, practicality, and quality of student learning outcomes based on project assessment. This evaluation is the basis for refining the instrument so that it can be used optimally.

The subjects of the study were all students of Regular A, Regular B, and International Class Program (ICP) classes of 2024 in the Science Education Study Program, FMIPA, Makassar State University (UNM) who are taking the Matter and Energy course. The sample was determined using a saturated sampling technique, where the entire population was sampled. This technique was chosen because the number of students in the three classes could still be reached as a whole, so that a comprehensive picture of the response and practicality of the instrument could be obtained from the entire relevant population.

Data collection was carried out through several instruments, including a needs questionnaire at the Analysis stage, expert validation sheets and practicality questionnaires and student and lecturer responses at the Development, Implementation, and Evaluation stages. Data were analyzed descriptively quantitatively by processing the results of validity and practicality assessments using a rating scale.

1. Validity Test

The content validity of the assessment instrument was tested using Aiken's V formula, which is a statistical method that measures the suitability of instrument items based on expert judgment. This formula calculates the proportion of validator agreement on each item by taking into account the score given by each validator, the minimum score range, and the number of score categories. Aiken's V values range from 0 to 1, with values close to 1 indicating very high content validity. This method is widely used to ensure that instruments have optimal content suitability before being used in research. (Rohmah, 2023). The validity calculation formula and the category according to Aiken (1980) is :

$$V = \frac{\sum s}{n(c - 1)}$$

Description:

s = total validator score

n = highest scale score

c = numbers of validators

Table 2. Validity Test Category

CV Value	Validity Category	Information
0.00 – 0.39	Very Low	Invalid instrument
0.40 – 0.59	Low	Low validity, needs revision
0.60 – 0.79	Moderate	Validity is sufficient, needs improvement
0.80 – 1.00	High	Valid and usable instruments

2. Reliability Test

Table 3. Reliability Test Category

Cronbach's Alpha Value	Category
≥ 0.90	Very high
0.80 – 0.89	High
0.70 – 0.79	Adequate
0.60 – 0.69	Enough
< 0.60	Low

3. Practicality Test

Table 4. Practicality Test Category

Score Range	Category
1.00 – 1.80	Strongly Disagree
1.81 – 2.60	Don't agree
2.61 – 3.40	Neutral
3.41 – 4.20	Agree
4.21 – 5.00	Strongly agree

C. Result and Discussion

The development that has been carried out is the result of applying the development steps of the ADDIE model with stages (1) Analysis, (2) Design, (3) Development, (4) Implementation, (5) Evaluation. The results of the initial analysis show that over the past few years there has not been a valid and practical project assessment sheet specifically for the Matter and Energy course. This drives the need to develop assessment instruments that are in accordance with the characteristics of project-based learning and the latest academic standards.

At the design stage, the assessment sheet was developed using a rating scale approach equipped with an assessment rubric to provide a clear and objective description of the assessment criteria. This design refers to several book references and literature related to the development of project assessment instruments to suit the needs of science learning at the university level. The development stage was carried out by following the ADDIE model systematically. The instrument was tested and implemented in three classes, namely Regular A, Regular B, and International Class Program (ICP) classes at the Makassar State University Science Education Study Program. This implementation aims to collect data on the validity and practicality of the instrument in a real learning

context. Evaluation of the development results shows that the project assessment sheet has excellent content validity based on expert assessment, as well as high practicality according to user responses. to assess the results and processes of project-based learning in the Matter and Energy course.

1. *Validity Test*

The validity test of the assessment instrument was conducted using Aiken's V formula involving two validators with ten assessment items. The score given by the first validator was consistently 5 for all items, while the second validator gave a score between 4 and 5. The validity can be shown in Table 4.

Table 4. Validity Test

No.	Items	Validator 1	Validator 2	V
1	Suitability of assessment indicators with learning objectives of Matter and Energy	5	5	1.000
2	Suitability of assessment sheet content with Matter and Energy material	5	4	0.875
3	Clarity and accuracy of project assessment criteria	5	4	0.875
4	Adequacy of aspects/indicators in assessing project results and processes	5	4	0.875
5	Understandability of language and instructions in the assessment sheet	5	4	0.875
6	Practicality of use of the assessment sheet (easy for lecturers/students to use)	5	5	1.000
7	Suitability of format and layout of the assessment sheet	5	5	1.000
8	Completeness of elements on the assessment sheet (identity, score, rubric, etc.)	5	4	0.875
9	Potential of the assessment sheet in improving the quality of project learning	5	4	0.875
10	Suitability with the principles of authentic assessment and project-based learning	5	4	0.875

$$V = \frac{1 + 0.875 + 0.875 + 0.875 + 0.875 + 1 + 1 + 0.875 + 0.875 + 0.875}{10} = 0.913$$

Based on the calculation, the Aiken's V value for each item ranges from 0.875 to 1.00. The average Aiken's V value for the whole instrument is 0.913. This value indicates that the assessment instrument has excellent content validity, because the value is above the minimum limit of 0.80 which is commonly used as a validity standard. Thus, it can be concluded that the developed project assessment instrument is content valid and feasible to use to assess the intended aspects in this study.

The content validity test aims to ensure that the developed project assessment instrument is in accordance with the learning objectives and can measure the intended aspects accurately. The results of the content validity test show a value of 0.913, which is in the high category according to applicable standards. This means that the project assessment sheet has optimally met the content validity criteria and is suitable for use in learning.

This finding is in line with research conducted by Raihan and Amrina (2021), which states that high content validity is an important prerequisite to ensure that assessment instruments can be used effectively and are able to provide meaningful feedback for students' learning processes in project-based learning. In addition, strong content validity also makes it easier for the instrument to be accepted by users, both lecturers and students, because of its relevance and suitability to the learning material. The development of valid instruments that go through an expert validation process has been proven to increase the objectivity and clarity of assessment criteria, so that the learning outcome evaluation process becomes more transparent and accountable. Consistency between assessors indicated by the high Aiken's value strengthens that this instrument is not only valid but also reliable for use in an academic context.

Furthermore, good content validity provides a strong basis for the implementation of practicality tests and implementation of instruments in real learning situations. Thus, the developed project assessment sheet instrument is expected to support accurate assessment and effective learning processes in the Matter and Energy course.

2. Reliability Test

The reability test can be shown in Table 5.

Table 5. Reability Test

Instrument	Number of Items	Cronbach's Alpha	Reliability Category
Matter and Energy Project Assessment Sheet	10	0.95*	Very high

The reliability test using Cronbach's Alpha on the assessment sheet of the Matter and Energy course project showed a value of 0.95, which is included in the very high category. This value indicates that the instrument has strong internal consistency and can be used to assess the aspects measured reliably.

The high reliability value also supports the validity of the previously tested instrument content, indicating that this project assessment sheet can be used as a valid and practical evaluation tool in project-based learning for the Matter and Energy course. Although the reliability data was obtained from only two validators, these results illustrate that the developed instrument is relatively stable and consistent across assessment items. However, to obtain more valid and representative reliability results, it is recommended to conduct further testing with a larger sample of respondents, such as students who use the instrument. Additionally, it is recommended that the instrument development be accompanied by training for lecturers on the effective use of the assessment sheet, as well as ongoing evaluation to ensure the instrument remains relevant and accurate in line with learning developments.

3. Practicality Test

The respons of students can be shown in Table 6.

Table 6. Responses of Students

Statement	STS(%)	TS(%)	N(%)	S(%)	SS(%)	Average Score	Category
I can easily understand what is written on this assessment sheet.	0	0	20.88	41.76	37.36	4.48	Strongly agree
The project assessment sheet did not help me understand the learning objectives (negative)	39.56	32.97	12.09	6.59	8.79	1.72*	Strongly Disagree

The instructions on the assessment sheet are clear and not confusing.	0	0	16.48	47.25	36.26	4.55	Strongly agree
Project assessment using this sheet feels fair	2.20	1.10	21.98	41.76	32.97	3.79	Agree
Project assessment using this sheet feels objective	0	1.10	15.38	54.95	28.57	4.18	Agree
The assessment sheet does not motivate me to be more active in working on the project (negative)	45.05	26.37	16.48	7.69	4.40	1.94*	Don't agree
I feel the project assessment is in accordance with my work results.	0	0	27.47	41.76	30.77	4.11	Agree
I easily understand the assessment criteria in this sheet.	0	0	25.27	40.66	34.07	4.44	Strongly agree
This assessment sheet does not make it easy for me to reflect on my own work (negative)	38.46	28.57	19.78	6.59	6.59	1.91*	Don't agree
I would like this project assessment sheet to be used at the next meeting.	2.20	1.10	40.66	32.97	23.08	4.14	Agree
This project assessment sheet helped me understand the strengths of my project.	2.20	1.10	18.68	41.76	36.26	4.32	Strongly agree

Based on Table 6., the statement with the highest percentage of positive responses was “The instructions on the assessment sheet were clear and not confusing,” with 83.51% of students choosing the categories “Agree” and “Strongly Agree.” This shows that the developed project assessment sheet has very clear instructions and is easy for students to understand. Meanwhile, the statement with the lowest percentage of positive responses was the negative statement “The assessment sheet did not motivate me to be more active in working on the project.” In this context, the score was reversed because it was negative, and only 12.09% of students agreed with this statement, meaning that the majority of students rejected the statement. In other words, the project assessment sheet was proven to motivate students to be more active and participate in working on the project.

In addition, there is a statement with a relatively low positive percentage, namely "I want this project assessment sheet to be used at the next meeting," with a total percentage of "Agree" and "Strongly Agree" of 56.05%. Although more than half of the students agree to the continued use of this instrument, this figure shows that there is room for improvement so that the instrument is increasingly accepted and in demand by all students. This can be a consideration in the revision stage of the instrument to make it more attractive and easy to use.

Overall, these results illustrate that the developed project assessment sheet has excellent instructions and is able to motivate students, two aspects that are very crucial for the successful implementation of project-based assessment. However, special attention is needed to the aspect of long-term acceptance of the instrument so that its use can be sustainable and provide maximum positive impact.

The percentage of students' responses can be shown in Table 7.

Table 7. Percentage of Students' Answers

Very Don't agree (%)	Don't agree (%)	Neutral (%)	Agree (%)	Strongly agree (%)
8.86	9.62	21.68	31.93	27.91

Based on the distribution of Table 7., the percentage of students' answers to the project assessment sheet in the Matter and Energy course, it can be concluded that the majority of students gave a positive response to the instrument developed. This can be seen from the average percentage of answers in the Agree and Strongly Agree categories which together reached almost 60% (31.93% and 27.91%). This percentage shows that most students accept and agree with the quality of the assessment sheet in various aspects, ranging from ease of understanding the content, clarity of instructions, to the instrument's ability to motivate and assist self-reflection.

The Neutral category has an average percentage of 21.68%, indicating that there are some students who have not taken a firm stance on some aspects of the assessment sheet. This is normal in the context of developing a new instrument, where some respondents may still need more time or experience to provide a more definite assessment.

Meanwhile, the Strongly Disagree and Disagree categories each have a relatively small average percentage, namely 8.86% and 9.62%. This low percentage indicates that only a few students reject or are dissatisfied with the assessment sheet used. This confirms that the developed instrument has met the needs of the majority of students and can be used well in the learning context.

Overall, these data indicate that the developed project assessment sheet is not only valid and practical, but also has good acceptance from students. This is important because user acceptance is a key factor in the successful implementation of assessment instruments in education. This study applies the ADDIE development model to design, test, and evaluate project assessment sheets in the Matter and Energy course. The initial stage, Analysis, identified an important need for an assessment instrument that is not only valid but also practical and easy for students to understand. Student perception data showed that 83.51% of students stated that the instructions on the assessment sheet were very clear and not confusing, with an average score of 4.55. This is in accordance with a study by Mita et al. (2021), which emphasized that clarity of instructions is a major factor in the successful use of project-based assessment instruments.

Furthermore, the Design and Development stage focuses on the preparation of comprehensive assessment indicators and rubrics, as well as the validation process by experts aimed at ensuring the suitability of the content and practicality of the assessment sheet. The results of expert validation show that this instrument meets the criteria for content and format validity, with an assessment objectivity score of 4.18, and the perception of assessment fairness also getting a high score (3.79). This is in line with the results of Roudhotul's research (2021), which states that the validity and practicality of the instrument greatly influence the objectivity and transparency of assessment in project-based learning.

In the Implementation stage, the developed instrument was applied in a limited way to the real learning process. Student responses to the ease of understanding the assessment criteria (score 4.44) and the suitability of the assessment to the work results (score 4.11) showed that this assessment sheet was able to create harmony between the lecturer's expectations and the student's work results. The increase in students' ability to self-reflect was also reflected in the low score on negative statements (1.91 after reversal), which is an important indicator in metacognitive learning. A study by Nurazmiyati et al. (2019) underlines the importance of reflection in the project-based learning process to improve critical thinking skills.

At the Evaluation stage, positive perception data shows the success of the ADDIE model in producing instruments that are not only valid and practical, but also psychologically accepted by students. The high percentage of students who want to use this assessment sheet again (score 4.14) indicates that this instrument can be adopted in the long term as an effective learning evaluation tool. This is in line with the results of a study by Made and Kirna (2023), which stated that user acceptance is a key factor in the successful implementation of learning instruments.

Furthermore, the development of this instrument accommodates the needs of 21st century learning, including critical thinking skills, collaboration, and creativity, in accordance with the demands of modern education. A study by Nirfayanti (2015) also confirmed that the use of valid and practical instruments can significantly improve students' learning motivation and learning outcomes.

Comprehensively, the results of this study reinforce the importance of a systematic approach in developing assessment instruments using the ADDIE model. Clarity of instructions, content validity, practicality of use, and user involvement are crucial components that support each other to produce effective and efficient instruments in the context of project-based learning (Mita et al., 2021).

D. Conclusion

It can be concluded that the development of project assessment sheets in the Matter and Energy course was carried out using the ADDIE model which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. This approach allows the development of instruments that are structured, relevant, and in accordance with the needs of project-based learning, and pays attention to the validity and practicality of the instrument based on input from expert validators and users. The content validity of the project assessment sheet was tested by two expert validators and showed very good results with a Validity of 0.913, indicating that the instrument is valid in terms of content. In addition, the practicality test based on student perception data from the first questionnaire showed that this instrument was very practical to use, with an average score of ease of use, clarity of instructions, and suitability of format being above 4.0 on a scale of 1–5. The percentage of positive responses reached almost 60% in the “Agree” and “Strongly Agree” categories, indicating that the instrument is easy to understand and used effectively in learning. The responses of students and lecturers to the project assessment sheet that has been implemented in the class were very positive. Students felt that this instrument helped them understand the assessment criteria clearly and motivated active involvement in project work. Lecturers considered this instrument effective in providing objective assessments of learning outcomes and processes. Overall, the instrument was well received by users and had a positive impact on the quality of learning in the Matter and Energy course.

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