Meta-assessment of student’s renewable energy projects

D Nasrudin¹,²*, A Setiawan³, and D Rusdiana⁴
¹Program Studi S3 Pendidikan IPA, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No.229, Bandung, Indonesia
²Program Studi Pendidikan Fisika, UIN Sunan Gunung Djati Bandung, Jl.AH. Nasution 105, Bandung, Indonesia
³Departemen Pendidikan Teknik Mesin, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No.229, Bandung, Indonesia,
⁴Departemen Pendidikan Fisika, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung, Indonesia

*Corresponding author’s e-mail: dindin.nasrudin@upi.edu

Abstract. The success of students in doing projects is determined through assessment. Lecturers make rubrics by the assignments given to students. Are arranged tasks and rubrics able to measure what is being measured? This paper aims to uncover the results of a meta-assessment of student projects on renewable energy. The method used is a systematic meta-analysis that is confirmed by self-evaluation, peer reviewers, and expert opinions on lesson plans, implementation, and evaluation. The results showed that the lesson plan that had been prepared was good, only needed improvement in the teaching materials. At the implementation stage, field monitoring and a daily journal are required. While in the evaluation aspect, the rubric that is used is still not enough to express all the categories and abilities displayed by students. Muti-method assessment is needed to measure student competencies and skills that are more holistic.

1. Introduction
There are three essential elements in a learning process, namely planning, implementation, and assessment [1,2]. These three crucial elements are often called the learning trilogy. In the context of lectures on Higher Education, lesson plans have the leading role in planning efforts. Lesson plans serve as a guide to a lecturer in bringing learning in class or the field. To determine the effectiveness of the implementation of learning and its impact on student learning outcomes, an assessment is carried out both in the process and learning outcomes [3,4,5]. Assessments at all stage of this learning assessment are called meta-assessments.

In the world of education, meta-assessment can use to improve the quality of learning. Meta-assessment is used to assess the constructive learning paradigm [6] and project-based systems engineering lectures [7]. Previous research shows that students that receive and practice meta-assessment training give higher scores of assignments than students that do not receive training [8].

Meta-Assessment has been carried out at the tertiary level. More than 50 colleges in America currently evaluate program assessments using several types of meta-assessments [9]. The application of meta-assessment is widely used to assess the effectiveness of an institution's program [10, 11] and the administration's assessment of the institution [12]. Meta-assessment is also used to assess programs
such as the Online Certification Exam System [13], Online Reference Services [14], and Online Research Guides [15]. The importance of meta-assessment in tertiary assessment has been well documented. However, until now, there is still little research that shows evidence of the validity of specific meta-assessment processes [16]. This paper aims to describe the results of the meta-assessment on the assessment of student projects in renewable energy physics courses.

2. Methodology

The study uses a systematic meta-analysis (meta-assessment) method of three stages of learning, namely the development of learning plans, implementation, and evaluation. In practice, methodologically, the application of meta-assessment combines quantitative and qualitative approaches to create a portrait of learning achieved [17]. In the context of higher education, the meta-assessment needs to start with an analysis of the current assessment model [18] and continue with an improvement program and involve evaluating the overall quality of the assessment process itself [19]. By assessing each component of the assessment cycle, an institution can guide its program towards better practice [9]. Table 1 below shows the assessment activities for the three stages.

| Assessment at the planning | Assessment at the implementation | Assessment at the evaluation |
|---------------------------|---------------------------------|-----------------------------|
| Assessment of lesson plan | Assessment of learning syntax implementation | Assessment of student project results |
| Assessment of learning materials | Assessment of the effectiveness of using learning material | Assessment of the effectiveness of assessment instruments |

Assessment at each stage will be carried out by the lecturer concerned (self-assessment), coworkers (peer assessment), and expert assistance by portions and needs. In the planning stage, the evaluation is carried out by reviewers and experts. The assessment focused on the adequacy of the lesson plan component and the presence or absence of teaching material and its appropriateness. The lesson plans assessment standard refers to previous research [20].

3. Result and Discussion

3.1 Assessment at the planning

The first meta-assessment was conducted at the stage of preparing lesson plans and developing learning materials. Table 2 below shows the results of the assessment at the planning stage.

| Assessor | Lesson Plan | Learning Materials |
|----------|-------------|--------------------|
| Reviewer | 147, good   | Yes, Teaching materials are made more varied |
| Expert   | 145, good   | Yes, Teaching materials are arranged based on goals and needs |

In general, the assessment of reviewers and experts on learning renewable energy-based projects can be said to be good. It is essential to assess the lesson plan because of its vital role and function. Errors in making lesson plans result from the poor quality of the implementation stage. Lesson plans are an essential part of the learning process [21,22,23]. Given the importance of learning to plan, the components of a learning plan must be as detailed and comprehensive as possible.

Regarding the teaching materials used, reviewers and experts propose teaching materials that are compiled by themselves according to needs. Teaching materials were also asked to use the latest approaches and media, including accommodating learning styles in the digital age. Current physics teaching materials can be presented using the help of a smartphone [24]. The development of physics teaching materials in the future must consider the feedback given by students [25].
3.2 Assessment at the implementation
Table 3 below shows the results of the assessment at the learning implementation stage. In the implementation phase, the assessment is focused on the implementation of Project-Based Learning (PjBL) syntax.

| Syntax of PjBL                | Self assessment                                      | Observer (peer assessment) |
|-------------------------------|------------------------------------------------------|---------------------------|
| start with the essential      | Implemented; there are some students who find it    | Good enough, special assistance is needed for groups who find it difficult |
| question                      | difficult to formulate problems                      |                           |
| design a plan for the project | Well done, there is one group that is having difficulty | It must be ensured that the group agrees on the project to be made |
| create a schedule             | Well done                                             | Each group has determined the project topic and activity agenda |
| monitor the students           | Monitoring is carried out by contacting the group     | Occasionally lecturers must go to the field to see firsthand what students are doing |
| and the progress of the project| leader to check project progress                      |                           |
| assess the outcome            | All groups successfully carried out the project       | The resulting projects are different. Are the assessments various? |
| evaluate the experience       | The processes and products of the projects are        | There must be a daily journal |
|                               | carried out in accordance with the learning         | from each group to report on the activities carried out |
|                               | objectives                                           |                           |

Table 3 shows the results of the assessment at the learning implementation stage. The assessment is focused on the implementation of Project-Based Learning (PjBL) syntax. Based on table 3, several issues must be considered about the implementation of the PjBL in the field: (1) group differences, (2) field monitoring, and (3) the importance of daily journals. Besides having to follow the standard-setting [26], the implementation of PjBL in the field requires positive feelings from the lecturer [27]. Some suggestions from reviewers and experts become invaluable input for the application of future learning.

3.3 Assessment at the evaluation
During the evaluation phase, two things were reported. Namely, the assessment is given by the lecturer to the projects undertaken by students and the expert assessment of the instruments used by lecturers in assessing student projects. Table 4 is the assessment given by the lecturer to students.

| Group | Product Score | Report Score | Presentation Score |
|-------|---------------|--------------|--------------------|
| A     | 82            | 85           | 80                 |
| B     | 84            | 88           | 85                 |
| C     | 75            | 80           | 84                 |
| D     | 88            | 86           | 85                 |
| E     | 78            | 80           | 82                 |

Table 4 shows the scores obtained by each group for each aspect of the assessment based on the rubric that was made. Despite using detailed analytic rubrics, the final score obtained does not adequately describe competence. Skills and attitudes possessed by each member in each group. Based on the suggestions from reviewers and experts, to get a complete skills profile, the assessment of student projects is not only assessed on the product aspect, but also with the process. Therefore a multi-method assessment is needed.

4. Conclusion
Continuous meta-assessment is an effort to assess an educational program that has a long-term impact [28]. One reason is because the meta-assessment goes beyond routine discussion about valuation [29] but is part of continuous improvement [30]. The meta-assessment can find out at what stage the problem occurred: planning, implementation or evaluation. At the planning stage, the results of the...
meta-analysis show the importance of detailed lesson plans and the suitability of teaching materials. In the implementation phase, the results of the meta-analysis show the importance of instruments for monitoring projects in the field. While at the evaluation stage, further development in assigning tasks and rubrics for project-based learning is needed by using several assessments that can measure students’ competencies and skills holistically.

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