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EVALUATE THE LEARNING RESULT OF FUNDAMENTAL PHYSIC UNDER CDIO APPROACH

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Summary. CDIO approach, a competency approach, to meet the output standards of integrating knowledge and skills of the engineer training program. Research on CDIO approach in teaching Fundamental Physics will improve the quality of teaching subjects in meeting output standards of training programs. To evaluate the learning results of Fundamental Physics according to CDIO approach, it is necessary to use a combination and variety of forms, methods of evaluations. Rubric is a useful tool in testing and evaluating the competency development.

Key words: CDIO, Rubric, Evaluate on competency, Evaluate on output standard, Fundamental physic.

I. Question

With the goal of university education for engineering students is to meet students' learning requirements so that they become engineers - with technical expertise, social sense, creative mind. The combination of knowledge, skills and attitudes are the core conditions to enhance efficiency and entrepreneurship. The CDIO approach fully meets the requirements of the future engineer by training students to become a comprehensive engineer to understand how to form ideas - Design - Implement - Operate products, processes and engineering systems. In which, teaching methods are considered the key, and changing the evaluation is considered to be the driving force behind the whole teaching process.

Examining and evaluating learning results is an important stage in all teaching models. In the innovation of university towards competency development in general, according to the CDIO approach in particular, there should be a new form of evaluation.

Rubric is an evaluation tool that has been widely used in educational practice in many countries around the world. In this article, we present research on the construction of Rubric to evaluate learning results by CDIO approach in teaching Fundamental Physics for students of engineering major.

II. Research content

2.1. Rubric definition

Since it was introduced and widely used in 1975, many researches in the world and in Vietnam have given the definition of Rubric. Although expressed in different ways, these definitions are consistent from the point of view that Rubric is an evaluation tool to evaluate working results based on predetermined criteria and classified according to the ranks for each criterion.

Beverly Busching (1998) defines Rubric as a guide to evaluate the quality of students' work. It provides the respective evaluation and knowledge for these criterias. Using Rubic as a scoring framework helps teachers determine what to look for, which results represent different levels of knowledge achieved, thereby increasing the consistency of evaluation and clarity of standards[7].

Heidi Goodrich (2000), Rubric expert, defines Rubric as a scoring tool by listing all the criteria for evaluating lessons, assignments or tasks performed by learners and ranking them[2].

According to Dannelle D. Stevens (2010), Rubric is a way of scoring students, describing assignments or tasks in the form of tables [2].

According to TonQuangCuong (2009), Rubric is a detailed systematic description table (by standards, criteria and levels) of results (knowledge, skills, attitudes) that learners should do and need to do in order to achieve the ultimate goal when performing a specific task. The Rubric used in teaching is designed for different evaluation purposes, but are based on the same general principle: comparing and verifying the results achieved with agreed standards and criteria before performing the work [1].

According to Tran Kieu and Nguyen Thi Lan Phuong (2009), Rubric is a complete description of what learners need to prove in order to be ranked as good, fair, average, or weak in the subject requirements [3].

According to Le Thi Ngoc Nhan (2014), Rubric is a tool used to evaluate the learning results of learners represented by the evaluation criteria according to different levels based on the requirements and target of the subject [4].

From the above definitions, we can understand: *Rubric is a detailed, clear, systematic description of the standards, criteria or levels that learners should do or must do to achieve the final goal of learning such as presentations, group work, assignments, tests, etc. in order to receive a corresponding score or assessment*.

Rubric has many ways of presentation, the easiest andmost effective way is presented in the form of a matrix. Rubric is divided into two categories:

- Qualitative / synthetic rubric: provides guidelines that allow the overall evaluation of a particular product or the performance of a task, on the basis of overall performance. This kind of rubric does not go into detail about each specific stage of the job, but it evaluates the performance of the job. The advantage of synthetic Rubric is to help teachers evaluate quickly, but it does not provide much feedback for teachers and students. [2].

- Quantitative / analytical rubric: provides a detailed description of the performance levels for each stage of the task, through which teachers can evaluate the performance of students on each given criteria. In Quantitative Rubric, teacher scores each section then sum it up. A quantitative Rubric matrix has 3 essential features: evaluation criteria, quality rating index and rating scale. This type of rubric has many advantages because it provides continuous detailed information for teachers, students and other stakeholders about the strengths, weaknesses and progress in the learning process of students. Through that, teachers can amend, supplement and draft next plans more flexibly [5].

Advantage and disadvantage of using Rubric:

-Advantage:

*For students: Rubric makes the learning of students easier to organize and control because they can visualize the teachers' expectations for themselves. Since then, students can form active learning motives to achieve clearly defined goals; Rubric continuously provides feedback so that students know what they have done well, the shortcomings and need to fix to improve quickly; Rubric helps students to self-test, evaluate and supervise their learning to make them more independent, better aware, more responsible [5];

*For teachers: Rubric helps teachers define clear goals, from which they can plan for more effective teaching; Rubric with clear criteria helps teachers evaluate accurately and fairly the learning results of students and the evaluation becomes easier, more scientific, consistent and convincing; Rubric also provides feedback for teachers to improve teaching quality;

-Limitations: The creation and use of Rubric sometimes makes teachers feel stress and tired; Poor quality Rubric, too high or inappropriate standards will create pressure and form arbitrary frameworks, causing inhibition for students; Rubric forces everyone to look at the problem and come up with solutions in the same way to reach the standards, which will lose students' creative ideas; [1], [5]

Steps to designRubric:

Step 1. Determine the learning goals that students need to meet (knowledge, skills, attitudes);

Step 2. From the learning objectives, teachers outline the output standards that students must understand or demonstrate in the product, in the process of completing learning tasks, characteristics, skills or behaviors that students need as well as the mistakes that students need to avoid;

Step 3. Deploying the output standards according to specific and detailed criteria;

Step 4. Find out the characteristics and descriptive aspects of the criteria. Usually should start at the medium level, followed by the higher and lower description. With the Synthetic Rubric, thoroughly rewrite the descriptions, ranging from good to bad, or vice versa with the defined overall goal. With Rubric Analysis, thoroughly rewrite the descriptions of levels from good to bad with each individual criterion;

Step 5. Review, edit and apply.

2.1 . Design Rubric for teaching Fundamental physics according to CDIO approach

The CDIO approach provides a list of the knowledge, skills and attitudes required to achieve the standards of contemporary technicians through the CDIO Outline. It is formed from the evaluate of practical needs, reviewed by experts in many fields and verified by peer evaluation.[6]

Thus, according to the CDIO approach, it is necessary to assess the achievement level of the standard in both knowledge and skills according to specific criteria, and the Rubric is the right choice to achieve this goal.

Applying the above steps to design Rubric to build an evaluation tool for teaching the Electrical section of Fundamental Physics by CDIO approach.

Step 1. Determine the learning goals in Electricity section (Table 1).

Step 1. Teaching goals in the Electricity section

Goal [1]	**Description [2]**	**Output standard of teaching [3]**	**Competency [4]**
G1	Generalizing basic and modern knowledge about Electricity - General Physics	1.x.y	2
G2	Analyzing, explaining and applying the phenomena of Electricity - Fundamental Physics in life as well as in engineering	2.x.y	3
G3	Conduct self-study, group work, presentation and communicate in an autonomous and effective manner	3.x.y	2

Step 2. From the learning objectives of the Electricity section, applying the CDIO approach, building the subject area to level 3 (Table 2).

Table 2. Output standard of the Electricity section of the Fundamental Physics by CDIO approach to level 4

Output standard [1]	**Description [2]**	**Assign I, T, U [3]**
CLO1	**Knowledge**	
CLO1.1	Generalizing knowledge of Electrostatic field	U
CLO1.2	Generalizing knowledge of Conductors	U
CLO1.3	Generalizing knowledge of Dielectric	U
CLO1.4	Generalizing knowledge of Static magnetic fields	U
CLO1.5	Generalizing knowledge of Electromagnetic induction	U
CLO1.6	Generalizing the knowledge of Electromagnetic fields	U
CLO2	**Skills and personal qualities, occupation**	
CLO2.1	Self-study	U
CLO2.2	Survey through printed and electronic documents	U
CLO2.3	Creative thinking	U
CLO3	**Communication skills: Teamwork and communication**	
CLO3.1	Group activities	U
CLO3.2	Presentation and communication	U
CLO4	**Conceive, design, implement, and operate**	
CLO4.1	The impact of technology on society	T

Step 3. Deploying the output standards according to specific and detailed criteria.

Step 4. DesignRubric (Table 4,5,6 and 7)

+ Evaluate output standards CLO2.1 (Rubric 1), self-study of students with the provided materials, based on completing study sheets and online multiple choice tests each week. The result is the average of the weekly scores (Table 3).

Table 3. Rubric 1 evaluate CLO2.1

Output standard	**LV1**	**LV2**	**LV3**	**LV4**
CLO2.1.1 Develop a self-study plan	The self-study plan has not been completed and has many limitations	A self-study plan was developed, but important details were missing	The planned construction lacks some details	Develop a full and thoughtful self-study plan
Score	0,25	0,5	0,75	1,0
CLO2.1.2 Implement the self-study plan	Implementation of the plan but not sure about the content and time	Performing the guaranteed plan on time but the content still has flaws	Implementation of the plan in terms of time and content but still has flaws	Perform the plan well, guarantee both content and time
Score	0,25	0,5	0,75	1,0

+ Evaluate output standard CLO2.2 (Rubric 2), survey skills through printed documents and electronic documents based on the content of the essay or theoretical project product (Table 4).

Table4. Rubric 2 evaluate CLO2.2

Output standard	**LV1**	**LV2**	**LV3**	**LV4**
CLO2.2.1 Identify and detect problems	Detect some problems but need suggestions	Detect the problem, but still not sufficient	Detect the problem but has small flaws	Detect and determine the problem need to be solved
Score	0,25	0,5	0,75	1,0
CLO2.2.2 Estimation and qualitative analysis	Identify relevant information to solve the problem, but need suggestions	Identification of relevant information to solve the problem but also have irrelevant information	Identify relevant information to solve the problem	Identify which information is relevant and useful to solve the problem
Score	0,25	0,5	0,75	1,0
CLO2.2.3 Propose a solution (propose a problem-solving strategy)	Cannot come up with a solution to solve the problem,still needs teacher support	Proposing a solution to the problem	Proposing, evaluating problem solving plan	Proposing, evaluating and selecting problem solving plans
Score	0,25	0,5	0,75	1,0
CLO2.2.4 Implementation of solutions and conclusions	Not implemented according to the proposed plan	Follow the proposed plan, but there are still some points that have not been implemented as planned	Follow the proposed plan	Fully implement the proposed plan, have the appropriate adjustment
Score	0,25	0,5	0,75	1,0

+ Evaluateoutput standard CLO2.3 (Rubric 3), Creative thinking skills based on an essay test consisting of two questions (Question 1. State and explain a concept. Question 2. Summarize 1 knowledge content of 1 lesson or 1 chapter by diagram) (Table 5).

Table 5. Rubric 3 evaluate CLO2.3

Output standard	**LV1**	**LV2**	**LV3**	**LV4**
CLO2.3.1 Give a hypothesis that need to be examined	The hypotheses that need to be examined have not been stated yet, still need suggestion	Can give a hypotheses but still have errors	Can give a hypotheses but still have small errors	Can give a fully hypotheses that need to be examined
Score	0,25	0,5	0,75	1,0
CLO2.3.2 Survey through documents	Still have mistakes in using documents	Still have mistakes in managing documents	Regularly use the documents	Manage all documents efficiently and responsibly
Score	0,25	0,5	0,75	1,0

+ Evaluateoutput standard CLO2.4 (Rubric 4), Group activities skills are based on the project monitoring book and teamwork peer evaluation sheets (Table 6).

Table 6. Rubric 4 evaluate CLO2.4

Output standard	**LV1**	**LV2**	**LV3**	**LV4**
CLO2.4.1 Time management	Didn't complete the assigned task on time	Completed the task, but there were still small flaws	Often complete tasks on time	Complete work on time
Score	0,25	0,5	0,75	1,0
CLO2.4.2 Learning altitude	Not paying attention to listening, exchanging the opinions with members, not giving personal opinions	Sometimes not paying attention to listening, exchanging the opinions with members, not giving personal opinions	Often pay attention to listening, carefully exchange the opinions with members, giving personal opinions	Pay attention to listening, carefully exchange the opinions with members, give personal opinions
Score	0,25	0,5	0,75	1,0

+ Evaluate output standard CLO3.1 (Rubric 5, 6), presentation and communication skills based on project reports. (Board 7, 8).

Table 7. Rubric 5 evaluate CLO3.1

Output standard	**LV1**	**LV2**	**LV3**	**LV4**
CLO3.1.1 Tasks and team work procedure	Participated but the implement of work was not effective	Participated but the implement of work was low effective	Fully participated, work hard	Fully participated, work hard,achieve high results
Score	0,25	0,5	0,75	1,0
CLO3.1.2 Planning and making solutions for problems	Have not given the solution for problems, still need suggestion	Can give solutions to problems but there are some unrelated problems	Can give solutions to problems but has small flaws	Can give sufficient and effective solutions to problems
Score	0,25	0,5	0,75	1,0
CLO3.1.3 Team work	Not respect the other members' opinions and not cooperate to give a general opinion	Often respects the other members' opinions but not cooperate to give a general opinion	Often respect the opinions of other members and cooperate to give a general opinion	Respect the opinions of other members and cooperate to give a general opinion
Score	0,25	0,5	0,75	1,0

Table8. Rubric 7evaluate CLO3.2

Output standard	**LV1**	**LV2**	**LV3**	**LV4**
CLO3.2.1 Prepare the presentation with media support	Content is not selective, information has not been quoted, layout is reasonable, images, sound illustrations are satisfactory	Content is selective but still spread, information has been quoted but not sufficient, layout has some flaws, images, sound illustrations are satisfactory	Content is selective, information has been quoted but not sufficient, layout has some flaws, images, sound illustrations are satisfactory	Content is selective, information has been quoted, layout is reasonable, images, sound illustrations are satisfactory
Score	0,25	0,5	0,75	1,0

CLO3.2.2 Communication	The voice is monotone, incoherent, confused, not appealing, can answer a few questions.	Language expression still stumbles on some passages,not appealing to listeners, can answer some questions from other groups.	Expressing language fluently, attracting listeners, suitable with contents presented, can answer some questions from other groups	Expressing language fluently, attracting listeners, appropriate gestures and flexibly in accordance with the content, can answer questions from other groups
Score	0,25	0,5	0,75	1,0

+ Evaluateoutput standard CLO4.1 (Rubric 6), The skill of explaining the impact of engineering on the environment through the technical applications of the studied knowledge based on the results of answering the question “Proposing solutions to use electrostatic machines safely and effectively"in implementing project tasks. (Table 9).

*Table9*Rubric 7 evaluate CLO4.1

Output standard	**LV1**	**LV2**	**LV3**	**LV4**
CLO4.1.1 Understand the goals of knowledge	Not clearly understanding the goal of knowledge, still need suggestion	Clearly understanding the goals of knowledge, still has some minor flaws	Clearly understanding the goals of knowledge	Fully understanding the goals of knowledge in a small amount of time
Score	0,25	0,5	0,75	1,0
CLO4.1.2 Establish goals of knowledge	Not yet established the goals of knowledge, still need suggestion	Can establish the goals of knowledge but still have flaws	Can establish the goals of knowledge but still have minor flaws	Can fully establish the goals of knowledge
Score	0,25	0,5	0,75	1,0

Table 10. Rubric 8 evaluate CLO4.2

Output standard	**LV1**	**LV2**	**LV3**	**LV4**
CLO4.2.1 Implementation of the proposed projects	The project is implemented but the data organization is not good and not creative	The project is implemented but the data organization is not creative, the visual still have some flaws in	The project is implemented, the content and visual are good	The project is implemented, the data organization is good, the visual is creative
Score	0,25	0,5	0,75	1,0
CLO4.2.2 Explain the technical impact of the project through the technical applications of the learned knowledge	The technical impact of the project cannot be explained or only partially explained	The technical impact of the project can be explained but not sufficient	Can explain the technical impact of the project	Can fully explain the technical impact of the project through technical applications

With the 8 Rubric built above, it ensures the evaluate of 6 output standard (CLO) of skills in Fundamental Physics subject according to CDIO approach. Each skill is evaluated on a scale of 10, which is very convenient for teachers to summarize and evaluate.

III. Conclusion

Teaching with CDIO approach is active learning and integrating both knowledge and skills. The Rubric is built by describing the necessary manifestations and the ways to be performed in order for students to achieve the subject's standard, so that students know what to do to achieve the goal of the subject, make their learning

become more active and effective. Rubric-based evaluation of learning results makes the evaluation more transparent, accurate and easier.

The above Rubric is not only suitable for Fundamental Physics module, with CDIO approach, but it is also suitable with orientation of competency development in teaching.

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