International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 06 | June -2017 www.irjet.net p-ISSN: 2395-0072

RUBRICS AS AN ALTERNATIVE FOR THE TEACHING OF GEOMETRY AT THE ENGINEERING FACULTY AT THE CATHOLIC UNIVERSITY OF SANTIAGO DE GUAYAQUIL

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Abstract - *As part of the proposal of the design of the course of Geometry for the career of Civil Engineering the author proposes the use of the system of rubrics within the evaluation process. The rubrics are instruments that allow evaluation by defining different criteria, and estimating the student performance according to each one of them. The rubrics are represented by tables that define the levels of qualification for each criterion, and can be global, if they cover comprehensively the subject to be evaluated, or analytical, if they break it down according to different measurement points. Well used, they have the advantage that they are not only used to evaluate the student 's performance but also to know how to improve the interactions between the criteria, as well as the performance of the teacher and the teaching - learning process. The main disadvantage is that they require preparation time, and teacher training for their design and use.*

Key Words: Rubric, learning, Geometry, assessment, model.

1. INTRODUCTION

This document is made as part of a research project aimed at finding a support system for the teaching of Geometry for students of Civil Engineering. One point of interest within the project is the evaluation process in the higher education system. According to the author, the evaluation should serve to improve the teaching - learning process as a whole, and not only to obtain a numerical measurement of the result expected by the students. In this context, the use of rubrics for the evaluation of academic performance is proposed.

2. DEVELOPMENT

A useful tool for student evaluation, which provides the teacher with information that goes beyond the assessment of the level of knowledge reached on a given topic, is the rubric, which is a tool for assessing learning assessment.

Alsina et al. (2013, p.8) point out that "A rubric is an instrument whose main purpose is to share the criteria for performing learning and evaluation tasks with students and among teachers." Gatica-Lara and Uribarren-Berrueta (2012, p. 1) indicate that "they are tables that disclose student performance levels in a given area, with specific performance criteria. They indicate the achievement of the curricular objectives and the expectations of the teachers." Torres, J. and Perero, V. (2010, p. 142) define the rubric as "an evaluation instrument based on a quantitative and / or qualitative scale associated To pre-established criteria that measure the actions of students on the aspects of the task or activity that will be evaluated."

From the definitions given, we can observe the repetition of the following concepts: instrument, evaluation, criteria. A definition that integrates the criteria of the authors mentioned would start by saying that a rubric is an evaluation tool based on criteria. The selection of the evaluation criteria, as well as the way in which these criteria will be evaluated, is the starting point for the use of the rubric as part of a support system in the teaching - learning process of Geometry in Higher Education.

Regarding the evaluation process itself, the RAE points out, among its definitions, that evaluating is "Estimating the knowledge, skills and performance of students" (2016). Gvirtz and Palamidessi, indicate that "an evaluation intends to prove, to verify something relative to the expected qualities of a person or a thing" (2006), and indicate that such evaluation can occur within two models:

- Model 1: assess is to measure learning products to qualify apprentices. Its function is to qualify the student with a grade.
- Model 2: Evaluation is a complex judgment about learners' performance and teaching strategies. It evaluates the student, the action of the teacher, the teaching systems and the curriculum.

In the "Evaluation of students in Higher Education", the Permanent Training Service of the University of Valencia (2007, p.18) points out that evaluation should also involve teaching self-assessment. In this sense, the authors argue that "the time we dedicate to correcting and explaining to a student the reasons and arguments of a judgment about a work, examination or intervention, is teaching", and indicates that there are two types of evaluation: summative evaluation and Formative evaluation. Summative assessment is performed at the end of a period and is intended to "qualify according to the appreciated performance, ie, certify the performance or performance at the end of that period." The formative evaluation is "the issuance of judgments that are carried out throughout a period of teaching and that aim to

inform the student and the teacher about the progressive achievements of the student in order to improve both teaching and learning." (P.19)

The author's position in this document is that the evaluation should be formative, seeking to improve both teaching and learning. Taking the semantic definition, this formative evaluation must also serve to estimate the performance of the students.

The rubric, in this context, should specify the criteria necessary to evaluate the performance of the student, and also find the shortcomings of the student and the curricula, the teacher and the teaching process, so that learning can improve.

Torres and Perera coincide with Gatica-Lara and Uribarren-Berrueta, pointing out that there are two types of rubrics: global rubrics and analytical rubrics. The authors point out that global, comprehensive or holistic rubrics assess learning or competence from a global view, without determining the components of the process or topic evaluated, while the analytical rubrics focus on specific areas of learning and break down their components to obtain a total grade.

Goodrich (2005, p. 2) points out that a rubric is instructional if it is "co-created with students, delivered, used to facilitate peer review and self-assessment and teacher feedback, and only then used to grade." In this sense, a rubric, whether analytical or comprehensive, must be designed to meet other learning requirements first, before being used in the evaluation itself. Gatica-Lara and Uribarren-Berrueta (2013) present examples of comprehensive and analytical rubrics, which are shown in Tables 1 and 2.

Table 1: Example of comprehensive rubric

Scale	Description
5	Full understanding of the problem is evident. Includes all the elements required in the activity.
4	Understanding of the problem is evident. It includes a high percentage of the elements required in the activity.
3	Partial understanding of the problem is evident. It includes some elements required in the activity
2	The evidence indicates little understanding of the problem. Does not include the elements required in the activity.
1	The activity was not understood
0	Nothing was done

Source: Gattica-Lara y Uribarren-Berrueta (2013).

Table 2: Example of analytical rubric

Criteria	Level			
	4. Excellent	**3. Satisfactory**	**2. Improvable**	**1. Inappropriate**
Supports used in the presentation on the subject. Sources of biomedical information	The student uses different resources that strengthen the presentation of the subject	He/she uses few resources that strengthen the presentation of the subject	He/she uses one or two resources but the presentation of the subject is deficient	He/she does not use additional resources in presenting the subject
Understanding of the subject. Sources of biomedical information	He/she answers precisely all the questions proposed from the subject	He/she answers with precision the majority of the questions proposed from the subject	He/she answers accurately some questions on the subject	He/she does not answer the questions proposed from the subject
Mastery of biomedical information search strategies	He/she demonstrates mastery of search strategies	He/she demonstrates a satisfactory level of proficiency in search strategies	He/she demonstrates mastery of some search strategies	He/she does not dominate search strategies

Source: Gattica-Lara and Uribarren-Berrueta (2013).

In either case, it should be clear what are the learning objectives and the criteria to be evaluated. And as in any evaluation, determine the weight of each criterion. Goodrich points out the following advantages of an instructional rubric: it helps students to understand the goal of an assignment, helps the teacher to provide feedback, in an individualized manner and in an acceptable time, and even though it does not correspond to the grade, it also allows students to generate a self-assessment and a peer evaluation, which makes them aware of their areas of failure. As for the disadvantages, the authors of the tables presented indicate

that rubrics require time in their elaboration and that the teacher training for its design and use is necessary.

3. RESULTS

The proposal of this document is that, since Geometry is an initial subject, the rubric can be used in two moments during the course:

- Intermediate, to assess the evaluation of continuous learning throughout the course
- Final, to assess the evaluation of general course learning

For the realization of these rubrics some components are needed:

- Academic: the contents of the geometry program (intermediate and final moment)

- Spatial visualization of the student at the beginning of the course. The author proposes the Van Hiele model, as cited by Crowley (1987) for being commonly used in the course of Geometry.

- Use on the part of the students of the computer support available to them, mainly new information and communication technologies, ICT.

There is also an initial moment, when the student enters the course, and there is no material to evaluate. The author's position is that at the beginning of the course should be used a support instrument, similar to a rubric of a comprehensive type, referring only to academic performance. The results of this instrument can serve the teacher to know which are the subjects of the course on which should be focused at the beginning in order to facilitate the success of the learning. A proposal is presented in Table 3.

Table 3: Proposal of an assessment instrument – Initial moment

Scale	Description
4	He/she has exceptional knowledge about Basic Mathematics taught at school.
3	His/her knowledge about Basic Mathematics is very good.
2	His/her knowledge about Basic Mathematics is acceptable.
2	He/she brings a lot of Basic Mathematics failures from school.
1	His/her initial level is deficient and will not allow him/her to continue with the course.

Table 4: Example of analytical rubric – Intermediate and final moment

Criteria	Level				
	4. Excellent	3. Very good	2. Good	1. Regular	0. Deficient
Understanding the content of the course	His/her knowledge is widely demonstrated in problem solving and in his/her theoretical knowledge.	He/she solves problems by demonstrating clear theoretical knowledge. However, answers are not accurate.	His/her lack of theoretical knowledge is evident in the imprecision of his/her answers. However, he/she seeks to find a way towards a solution.	He/she does not find ways to solve the problems raised. Scarcely handles theoretical information	His/her theoretical knowledge and practical application are absent
Visualization (Van Hiele model)	Rigor	Deduction	Informal deduction	Analysis	Visualization (básic level)
Use of ICT as support to the best performance of the course	He/she masters the ICT that allow him/her to take full advantage of the course	He/she knows some ICT and tries to use them in the course	He/she is learning some ICT and uses the one he/she knows in the best manner	He/she knows few ICT and does not know how to use them in the course.	He/she does not know ICT

For the following levels, it is proposed to evaluate the criteria indicated, according to the rubric shown in Table 4. This rubric can be useful to the following actors:

Student: allows him/her to know the faults in each of the criteria.

Teacher: allows him/her to locate student failures, according to the different criteria, and at the same time, to generate a possible correlation between said failures.

Educational institution: Applying rubrics according to the different contents of the course, allows identifying areas with major deficiencies, which could be due to the structure of the program, or to the teacher.

4. DISCUSSION

Since rubrics are an evaluation tool that measure across diverse criteria, the accuracy with which these criteria are

defined and the grades for each are important. This definition has to be based on the learning objectives of the academic program, and in turn, these must be detached from the object of the course. Thus, the usefulness of the rubric does not only depend on a good work done by the teacher, but also depends on the structure of the subject in which they will be used.

Here, it is important the interaction of the teacher with the educational institution, for the elaboration of the document that will be used with the student. In this interaction, the student must also participate. This way, the student will be enabled to know, in advance, which are the criteria that will be part of the final evaluation. This goes beyond the knowledge of the thematic units. In the particular case of Geometry, it is beneficial to know the type of spatial thinking with which the student initiates higher education. There are scales for the measurement of this thought, which are not the reason for the present study. Also, by their nature, ICT present a learning tool for the student, which can provide a better understanding of the object of study. The ability to use these ICTs is also of interest for evaluation.

5. CONCLUSIONS

In the case of Geometry, for the design of the rubrics it is important to generate a link with the content prior to the course, that is, the subjects of higher education. The first concern at the time of design is to identify the points of contact between the Basic Mathematics of the high school and Geometry. The author's position is that these subjects should be evaluated in a global way, since it is knowledge not provided by the institution or the teacher that applies the initial rubric, and because in addition, it should be used only as a tool of assessment of the diagnostic evaluation, which cannot serve for a final grade.

The initial rubric should allow the teacher to know in a global way the level of knowledge of Basic Mathematics with which the student arrives at the course of Geometry. From there, the teacher can give a new direction to the course, so that the learning process is facilitated. For the rubrics corresponding to the intermediate and final moments, it must first be clear on which are the thematic units to be evaluated. The rubrics should answer the following questions:

- Which are the thematic units that generate the greatest learning difficulty
- How the level of visualization affects the understanding of the subject
- How is it possible to move from one level to the next, in each criterion
- How the criteria may complement / affect each other

By answering these questions, the rubric becomes not only a tool for assessing the learning evaluation but also a support element for the improvement of the whole teaching of the subject.

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