Work in Progress – Qualitative analysis of the different assessment implementation methods in a School of Engineering. Preliminary Results

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***Abstract* - One of the major challenges of the School of Engineering of Universidad del Norte has been to guarantee an education of quality to its alumni. In the last few years professors from different engineering disciplines have been implementing the Assessment project in the everyday teaching. This project is being implemented by stages. In the first stage, the learning objectives of each engineering program as well as the objectives on each course were reviewed and reformulated, and their outcomes were formulated. In this phase, the alumni profiles were reformulated from the competence approach. In the next stage, a part of the faculty implemented the Assessment in some courses. Nowadays, most professors are implementing Assessment in their courses in an autonomous way concerning tools and teaching methods used. The project has shown a great advance in both qualitative and quantitative aspects. This paper describes, in a qualitative way, the results achieved by some professors during the experience of implementing Assessment in their courses. Different methods of the assessment implementation are presented, and some preliminary conclusions about the usage of the assessment in our School of Engineering are drawn.**

Index Terms - Assessment, Engineering Education, Qualitative Analysis, Outcomes.

INTRODUCTION

The consolidation of a culture of reflection, self-evaluation and the formation given to our students has been one of the most significant achievements in the school of Engineering at Universidad del Norte. In this paper we present the preliminary results of an ongoing assessment process at Universidad del Norte (Barranquilla, Colombia). These results are not conclusive. The process is described in a qualitative way, thus tables presented are samples of the different instruments used by professors to collect and process data to obtain the students performance in learning outcomes. The paper illustrates the way Assessment Project has been contributing to the consolidation of this continuous improvement culture in the teaching-learning process by presenting four cases. These cases are analyzed from the teacher's point of view and the results obtained up to the moment. They are based on interviews and reports. These cases are focused in the description of the implementation of the process and the changes introduced during the process and according to the results obtained by each teacher in their corresponding courses. The results here presented correspond to the second phase of development of the Assessment project per course.

PROJECT STRUCTURING

Assessment, as a core Project of the Division, has been structured in three stages:

- Stage of establishing initial conditions
- Pilot stage
- Consolidation stage

In the first stage, general outlines were established. These outlines were developed by each Engineering program as previous condition to start the project. They included reviewing and adjustment of graduate profiles under the competence approach, reviewing and adjustment of course educational objectives of each course, and formulation, for the first time, of students learning outcomes for each course. Competences are understood as a whole including knowledge, skills, and attitudes applied in a specific situation evidenced through observable and measurable behaviours [1]. In order to formulate outcomes, theories by authors as Bloom [2], Richard Felder [3], Besterfield [4], and the ABET Standard EC2000 [5] were taken into account. Once the outcomes per course were formulated, they were related with course objectives and the competences of the respective Engineering program. TABLE I shows a template to correlate course learning outcomes to their corresponding educational objectives, and these, in turn, to competences of the specific program.

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TABLE I
OUTCOMES VS COMPETENCES

Course Learning Outcomes	Course Educational Objectives	Competences of the Program 1	2	…	m
1					
2					
⋮	⋮	⋮	⋮	⋮	⋮
n					

The above mentioned process was developed in the six Engineering programs. During this stage, collective meetings for discussing and analysing the project were carried out. They permitted to adjust some logistic aspects and to appropriate the assessment as an academic process going beyond outcomes measuring.

To process data, a schema for collecting and processing was established. It was proposed as a model to Division professors in order to be used in a discretional way. The model consists of the information presented on TABLE I, related to the grades obtained by the students of the course, as it can be appreciated in the next tables.

TABLE II
PROPOSED TEMPLATE FOR TABULATING LEARNING OUTCOMES

Weight	Partial 1	Student 1	2	…	m	Average
x %	Question 1					
y %	Question 2					
⋮	⋮	⋮	⋮	⋮	⋮	⋮
n %	Question n					
100%	Grade					

TABLE III
PROPOSED TEMPLATE FOR TABULATING LEARNING OUTCOMES

Outcome	Student 1	2	…	m	Outcome Description
1					
2					
⋮	⋮	⋮	⋮	⋮	⋮
n					
Grade					

In the second stage, an agenda was established whose initial coverage was of two years, which began in the first semester 2005. In this year (first year of this stage), full time professors (tenure) carried out the assessment in one of the courses they were teaching. Most of them used the model of data supplied and others worked with the proposed model adapted. When each semester ended, collective meetings by department were carried out in order to evaluate globally the developed work and improvement actions were proposed in each course to be performed next semester. Among the activities proposed, it is worth to highlight the beginning of the development of an informatics system supporting data processing and results analysis. In 2006, tenure professors carried out the assessment in two courses. While some of them used improved versions of the data model proposed, others used the same 2005 model. In the same way, the software developed was tested. In this stage, though the project focused on the individual assessment of each course, important results became evident, which have generated new adjustments and reformulations both academically and logistically. The Division considers 2007 as a transition step of the Project towards its establishment as the red line of the program of permanent improvement and assuring formation quality of engineering students. In this stage, assessment is required to be carried out by knowledge areas in each program and shared areas with other Engineering programs. It will begin with area subchains. Starting from the second stage results, the third stage will be developed (estimated year, 2008) in which assessment will be developed by program aiming at articulating and evaluating complete knowledge areas, and inter and intra-disciplinary chains. In this stage, the project is expected to be consolidated and articulated to the academic daily life, becoming its axis.

EVOLUTION IN ASSESSMENT IMPLEMENTATION

To observe assessment evolution, some cases are presented which show how the process has evolved since the Project began (first semester, 2005) until now (first semester, 2007). The cases presented show different advance stages in the project and the most significant results obtained at the moment of writing this paper. The process is described qualitatively and figures show specific examples of the way professors collect and process data of the student performance.

Case 1

- Department: Systems Engineer
- Course: Data Base
- Professor Degree: Magister in Systems and Computing Engineer

The assessment for this course is being developed since 1st semester 2006 up to the current semester, with an interruption in the second semester 2006. The professor based on data model proposed, designed and constructed a database in MS Access, which allowed obtaining statistical information on certain particular aspects relevant for the analysis. In the second semester, he did not apply the assessment as such, but continued improving the database. A report of the database is shown on FIGURE I, in which the numerical performance of each subject outcome per student is observed (obtained through the individual grades of students per item of each evaluation), and Figure II shows the global performance of students at the end of the course.

Course	Data Base				
Group	1				
Average	idOutcome				
idStudent	1	2	3	4	Total
768882946	3.0	3.4	1.4	0.3	2.0
164735063	1.6	4.1	3.5	2.8	3.0
504429813	1.7	0.3	0.8	1.3	1.0
87665373	4.7	3.1	1.9	0.5	2.5
958373973	2.3	0.6	2.6	2.2	1.9
802347571	4.2	4.6	2.9	4.1	4.0
916212707	4.3	2.7	4.4	4.9	4.1
641019757	0.9	0.0	1.5	2.8	1.3
55452720	3.9	1.8	4.5	4.8	3.7
Total	3.0	2.3	2.6	2.6	

FIGURE I
OUTCOMES PER STUDENT AND COURSE

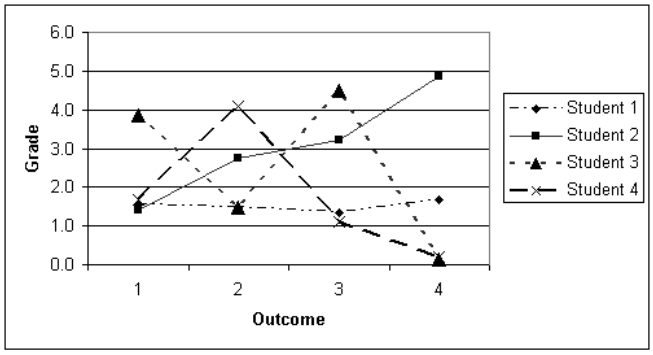

FIGURE II
LEARNING OUTCOME PERFORMANCE PER STUDENT

With the information obtained, the professor has identified low performance outcomes, has developed diverse teaching and evaluation activities to improve student performance in such outcomes, and at the present semester, he is planning the course by reformulating the objectives, fixing the learning outcomes and adjusting the content sequencing. Although the professor has the necessary information to carry out detailed individual follow up to students, he has not yet done it because, according to him, the course is in a first learning stage in which he continues revising and adjusting the database and improving the course planning, which has been possible through the analysis of obtained results in previous semesters. One of the improvements the professor has proposed is to obtain information about the learning outcome performance evaluation per student in each academic semester, in order to carry out the individual follow up to students.

Case 2

- Department: Mechanical Engineer
- Course: Thermodynamics
- Professor Degree: Ph. D. in Mechanical Engineering

The assessment for this course is being developed since 2nd semester 2004 (on his own as a result of his participation in the Workshop: "Excellence in Engineering Education, Fayetteville, Ark., 2004) up to the current semester. The model used is a simplified version of the one proposed, because it does not assign weights to each learning outcome in each type of evaluation. Basically, the professor has focused on measuring the outcomes of each evaluation, giving feedback to students in real time according to results, and doing teaching activities oriented to achieve a satisfactory outcome performance level. One of the final reports at the end of the course is shown below. In it, the global numerical performance of outcomes by type of evaluation is presented.

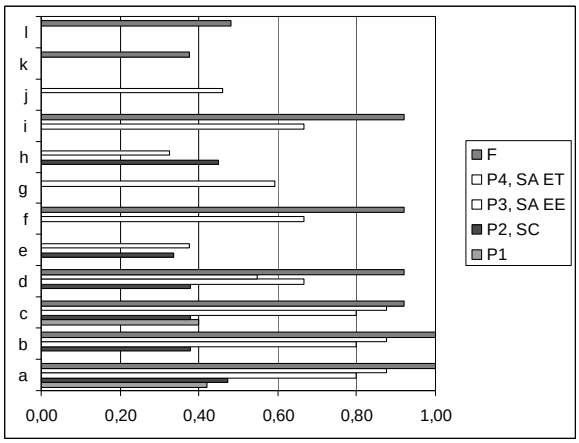

FIGURE III
GLOBAL PERFORMANCE OF OUTCOMES BY EVALUATION TYPE

Since the second semester 2006, the professor has been adjusting the process. The general principle is the same as that of 2004, but he has adopted the originally proposed model (see TABLE I, TABLE II and TABLE III) in order to carry out a more detailed analysis both at individual and group level.

Case 3:

- Department: Industrial Engineer
- Course: Operations Research
- Professor Degree: Magister in Industrial Engineering

The assessment for this course is being developed since 1st semester 2005 up to the current semester. In the first semester, the professor worked with a variation of the proposed model which consisted of assigning performance levels to the learning outcomes in each evaluation item. FIGURE IV shows the handled tabulation.

		O. 1		O. 2		O. 3		O. 4		O. 5					O. 6						O. 7	
No.	Name	Yogel	R1	Sol opt	R2	Mult	R3	2nd sol	R4	b	c	d	R5		b	c	d	R6			a	R7
1	Avendaño Merced	1	1	0	0	1	1	0	0	0	0	0	0		0	0	0	0			0	0
2	Báez Edgardo	1	1	1	1	1	1	1	1	0	0	0	0		0	0	0	0			1	1
3	Barrera Kelly	1	1	0	0	1	1	0	0	0	1	1	2		0	0	0	0			0	0
4	Barreto Karina Bea	1	1	1	1	1	1	1	1	1	1	0	2		0	0	0	0			1	1
5	Berruecos Ramiro	1	1	1	1	1	1	1	1	0	0	1	1		0	0	0	0			0	0
6	Camargo Manuel	1	1	1	1	1	1	1	1	0	0	0	0		0	0	0	0			0	0
7	Cotes Juan Pablo	1	1	1	1	1	1	1	1	0	1	1	2		0	1	0	1			0	0
8	De La Ossa Olmos	1	1	0	0	1	1	0	0	0	0	1	1		0	0	1	1			0	0
21	Rico Ana Maria	1	1	0	0	1	1	0	0	1	0	0	1		0	0	0	0			1	1
22	Sánchez Rodrigo	1	1	1	1	1	1	1	1	0	0	0	0		0	0	0	0			0	0
23	Sarmiento Alvaro	1	1	1	1	1	1	1	1	0	0	0	0		0	0	0	0			0	0
24	Valdivieso Viviana	1	1	1	1	1	1	1	1	0	1	1	2		0	1	1	2			0	0
25	Vengoechea Maur	1	1	0	0	1	1	1	1	0	1	0	1		0	1	0	1			0	0
26	Zúñiga Marco	1	1	1	1	1	1	1	1	0	0	0	0		0	0	0	0			0	0
		Number	%	Number	%	Number	%	Number	%	Number	%				Number	%					Number	%
	N1	0	0,00	12	46,15	3	11,54	9	34,62	11	42,31				17	65,38					22	84,62
	N2	26	100,00	14	53,85	23	88,46	17	65,38	7	26,92				7	26,92					4	15,38
	N3	NA		NA		NA		NA		8	30,77				2	7,69					NA	
	N4	NA		NA		NA		NA		0	0,00				0	0,00					NA	
		26	100	26	100	26	100	26	100	26	100				26	100					26	100

FIGURE IV
PERFORMANCE LEVELS OF OUTCOMES

The model was used in the next semester when more evaluation moments were established, and more emphasis was put in the teaching of low performance outcomes in previous semester. From 2006, the model changed the measure of outcome performance into grades obtained by students and the weights of them were associated to the evaluation moment. According to the professor, this allowed her obtaining better quality information. In a similar way, a qualitative scale was established for measuring, which is showed on FIGURE V.

Results								
		Outcome	Average	Minimum	Maximum	Deviation	Qualitative Valuation	0,9 Excellent
	1	Defining problem variables	77,25%	25,14%	100,00%	20,49%	Good	0,8 Very Good
	2	Defining objective function	67,47%	25,14%	100,00%	22,33%	Acceptable	0,7 Good
	3	Defining restrictions	67,37%	31,16%	96,00%	20,89%	Acceptable	0,6 Acceptable
Linear Programming	4	Understanding and defining non-negativity	93,13%	56,00%	100,00%	10,59%	Excellent	0,5 Insuficiente
Graphic Method	5	Defining feasible region	93,75%	33,33%	100,00%	15,70%	Excellent	Muy Insuficiente
	6	Finding the optimal solution	58,33%	0,00%	100,00%	41,48%	Insufficient	
Sensitivity Analysis	12	Ability to find new solutions with variations in problem parameters.	55,44%	31,06%	92,94%	17,02%	Insufficient	
Application of transport technique	21	Selection and application of a transport initial solution method.	80,26%	50,00%	90,00%	13,47%	Very Good	
	22	Capacity to find an optimal solution to transport method.	61,31%	30,00%	80,00%	15,73%	Acceptable	
Application of assignation technique	23	Capacity to find an optimal solution by the assignation method.	39,58%	0,00%	100,00%	20,41%	Very Insufficient	
	24	Recognizing the fundamental concepts of integer programming					Non assessed	
Integer Programming	25	Capacity to identify and develop the process that allows finding integer optimal solutions.					Non assessed	
	29	Decision taking facing information	59,00%	38,33%	85,78%	14,03%	Insufficient	
	30	Use of computer tools	91,75%	0,00%	100,00%	22,40%	Excellent	
General	31	Identify special solutions	61,25%	0,00%	100,00%	22,75%	Acceptable	

FIGURE V
QUALITATIVE PERFORMANCE OF OUTCOMES

The information obtained during project implementation semesters has allowed the professor to develop more pertinent and didactic evaluations adjusted to outcomes performance. Similarly, outcomes have been reformulated and course activities have been adjusted according to results. In present semester, the professor is redesigning the model aiming at measuring outcome performance according to their evolution in the semester and the kind of evaluation applied.

Case 4

- Department: Civil Engineer
- Course: Hydrology
- Professor Degree: Magister in Civil Engineering

The assessment for this course is being developed since 1st semester 2005 up to the current semester. The professor used the model proposed during the year 2005. In the first semester 2006, he adjusted the model to obtain results from the outcomes of evaluation types (individual or in groups) as can be observed on TABLE IV and TABLE V. In the second semester 2006 the professor was willing to test the model and therefore, he eliminated weights in the outcome, type of evaluation and he added the date of each evaluation. Parallel to assessment the professor developed an Excel application which allows a friendlier and more efficient data management during 2005 and 2006. A report of the excel application can be observed in FIGURE IV. The implementation of Assessment during these two years has allowed the professor to formulate the outcomes, adjust their number and improve his teaching process by concentrating in the core contents of the course and in developed in better formulated evaluations. According to the professor's opinion, students registering for the next semester are the most benefited by posterior implementation of the Assessment.

Based on the results obtained during previous semesters the professor is developing a model in Access based on the originally proposed model, which has been considered both the most complete and complex. Additionally, the model will manage dates for each evaluation item, types of evaluation (individual or in groups), multiple courses and professors and students' follow up through different courses. TABLE IV and TABLE V shows the proposed template (TABLE II and TABLE III) filled in by a professor, who has introduced some changes in the format.

TABLE IV
OUTCOME RESULT FOR EACH EVALUATION ITEM AND GROUP PART A

		1	2	…	26	Average
25%	P1-A	3.5	3.8		3.5	3.6
25%	P1-B	4.3	4.4		4.4	4.4
30	P1-C	3.2	3.4		3.3	3.3
20%	P1-D	3.8	4.0		4.0	3.9
100%	Partial 1	3.7	3.9		3.8	3.8

TABLE V
OUTCOME RESULT FOR EACH EVALUATION ITEM AND GROUP PART B

	Average	Outcomes	Weight in outcome	Evaluation type
P1-A	3.6	Outcome 1	25%	Individual
P1-B	4.4	Outcome 1	25%	Individual
P1-C	3.3	Outcome 3	30	Individual
P1-D	3.9	Outcome 2	20%	Individual
Partial 1	3.8		100%	

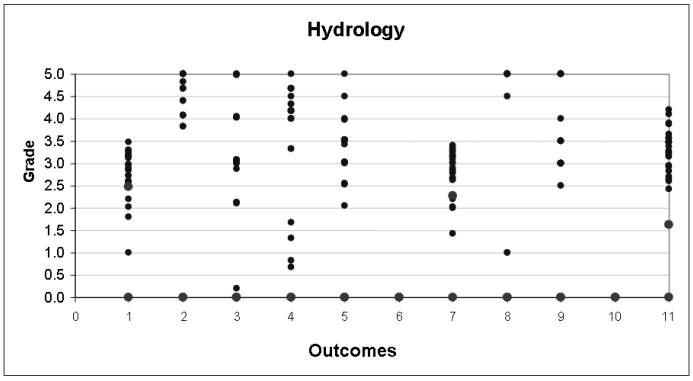

FIGURE IV
FINAL PERFORMANCE FOR EACH ITEM PER STUDENT

CONCLUSIONS

Since 2005 professors in our division have been implementing the Assessment Project at their own pace. Results become evident in the process of improvement of teaching and learning, even though there is still need of articulating the assessment for each course in order to configure the complete program and professors who are still in the process of appropriation of the process while others

have show significant advance in qualitative and quantitative terms. Among the aspects to be highlighted, recognized by some authors [6]-[12], as key elements in Engineering Teaching, are feedback given to students in real time, the clear identification of the core elements of the curriculum, improvement of evaluations, the use of active pedagogical teaching, measuring of the teaching learning process, the determination of the advance in achieving individual and group outcomes and the process of permanent reflection on the meaning of learning and studying engineering.

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