

Analysis of Assessment Tools on Engineering Degrees

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Abstract

This work presents an analysis that has been done about the assessment tools used by the professors of the Universitat Politècnica de Catalunya to assess the generic competencies introduced in the Bachelor's Degrees in Engineering.

In order to realize this study has been elaborated a survey which has been done anonymously to a sample of the most receptive professors with the educational innovation of the own university. In total there were 80 professors who answered the cited survey, of whom the 26% resulted to be members of the evaluation innovation group (<https://www.upc.edu/rima/grups/grapa>) the own university, GRAPA. This percentage represents a 47% of the total GRAPA membership, so from the most sensible professors with the evaluation matter in the university, closely the half has answered.

The variables analysis realized using the statistical program SPSS v19 shows that for practically the 49% of the surveyed the rubrics are the most utilized tools to assess the generic competencies integrated with the specific ones, and of those the 60% use them frequently or always. The most evaluated generic competencies have been the teamwork (28%), problem solving (26%), effective oral and written communication (24%) and autonomous learning (13%) all of them very recognized competencies for the engineering profession.

Two dimensional crosstabs analysis with SPSS v19 show that there is a significant correlation (Asymp. Sig. 0,001) between the type of used tool and the assessed competencies. However, any significant correlation has not been found between the type of assessment tool used and the type of subject, typology of evaluation (formative or summative), feedback frequency given to the students or satisfaction degree of the students so none of those variables have influence on the kind of used assessment tool. In addition, the results also indicate that there are not significant differences between the GRAPA's professorship and the remain of the surveyed.

Keywords: competencies; assessment tools; engineering degree

1. Introduction

In general, after the incorporation of Spanish universities in the European Higher Education Area (EHEA), the main professor's preoccupation is the acquisition of generic (or transversal) together with specific competencies integrated in the student's curriculum. In engineering studies, the major problem might not be found in the integration of generic competencies in the subjects, because they are considered in most of the docent activities, but in the gradual incorporation all along the studies and its assessment.

Universities have chosen different options going from the assessment of generic competencies independently from specific ones, so each subject has two associated qualifications, to a single qualification including both competencies. In the Universitat Politècnica de Catalunya, (UPC-Barcelona Tech, (<http://www.upc.edu/>)) both options can be found, as each university center has chosen the one considered more convenient.

In order to bring some teacher's support when facing this challenge, the (Education Science Institute (ICE) of the UPC-Barcelona Tech (<http://www.upc.edu/ice/>)) created in 2007 a series of educative innovation groups, enclosed in the RIMA [1] Project. The Grup d'Avaluació de la Pràctica Acadèmica, GRAPA, (<https://www.upc.edu/rima/grups/grapa>) is one of these groups. Its main goal is to give support in the generic competencies assessment through all the degrees given by the university, mostly engineering degrees. In order to achieve this objective, the group has cooperated with the ICE in the elaboration of subject evaluations support material [2] and in the organization of professor's formation courses. These courses were given by group members or by experts in the field, coming from the main university and even from other universities. In addition, annual dissemination sessions were organized in order to share experiences related to the educative innovation [3]. Additionally, the group has published several articles showing various experiences related with the competencies assessment in subjects that can be used as "good practice" models [4-7].

The last GRAPA activities were oriented to the elaboration and management of assessment tools that should permit the assessment of the generic competencies in an integrated way with the once specific from each subject. These tools are meant to encourage the students to participate in the assessment tasks. In order to encourage the self and peer-assessment it is necessary to clearly define assessment tools with a well specified criteria and exigency levels. If an objective evaluation is desired it is also necessary to use the most coherent methodology and strategy with the competence to be integrated and/or assessed.

The main objective of this article is to do a quantitative analysis (using the statistical program SPSS v19) of the utilization of the different types of assessment tools by the teachers following some variables (such as being member of the GRAPA group, generic competencies to assess, type of session, number of students, course, satisfaction survey.....). In order to achieve this goal an anonymous survey was done so to have a teacher representative sample.

2. Methodology

As previously indicated, the main objective of this paper was to know the utilization of the assessment tools by the professorship to integrate and assess generic competencies while the subject of the new Engineering degree is being imparted (Bachelor's Degrees in Engineering) in the Universitat Politècnica de Catalunya (UPC-Barcelona Tech). In addition it was pretended to relate the type of used tool with the assessed generic competencies and with some other variable of interest as the kind of session, students number, given feedback, students participation as well as satisfaction degree.

To accomplish this, it was realized a survey where were formulated questions having in account the indicators related with the quality principles that must have a good practical in assessment [7, 8] like they are the tool specification and the used methodology, the feedback time, the student participation, the typology of the evaluation (formative and summative) and the final analysis of the activity in order to fulfill with the process of continued improvement [9-13].

The questions were joined in different categories, all of them with compulsory and closed answer and relative to just one subject, the one most relevant for the tools used, to do easier the following analysis. The first question was to indicate if they were or were not from the GRAPA group and the first group of questions was formulated in order to describe the subject type and the competencies to assess. For it they were asked to select one option from a list. For the kind of session the list was: expositive,

problems, laboratories, projects, software computers, seminars, others; for the number of students per classroom: less than 10, from 10 to 20, from 20 to 30, from 30 to 40, from 40 to 50, from 50 to 60 and more than 60; for the impartation semester (until 8^o semester) and the specification about if the studies were Degree or Master. Related to the evaluated generic competencies they had to choose just one, the one that they consider the most representative, to do easier the following analysis. It was shown a list composed for the seven compulsory competencies own of the UPC: enterprising and innovation, sustainability and social commitment, foreign language (English), effective oral and written communication, teamwork, effective use of information resources and autonomous learning, plus the problem solving one [14], in addition there was the option to mark another if the one they was evaluating there was not in the list.

The second group of questions was designed to identify the kind or kinds of assessment tools and the degree of use. To avoid differing interpretations, it was defined as an assessment tool an real and physic tool that let define the quality level of the evidences collected from student in order to value the learning. There were defined and specified three types: checklist, assessment scales and rubrics plus the mixed tools (mix of different tools), from which were shown examples to classify [15, 16]. For quantifying the degree of utilization it was done questions with four options for the answer where it was possible to differentiate between the utilization was always (4), frequently (3), sometimes (2) or never (1).

A third group of issues, also with four answer option, was designed to identify the kind and degree of the strategy usage of utilized evaluation. These were classified in three types: observation, interviews and evidences analysis or delivered productions by the students and the usage degree between 4 (always) and 1 (not much) or never.

In addition were planned some questions to figure out the participation degree of the professorship and the students in the evaluation as well as to know if it was given a feedback to the students and the feedback period. For the participation degree it was distinguished between 1 (minor) and 4 (higher) and for the feedback time it was distinguished between less than a week or more.

They were also asked about the evaluation typology, distinguishing between four closed answers: a) summative along the all process; b) formative during the process and finally summative; c) distributed between formative and summative along the process but the summative weight is more important; d) distributed between formative and summative during the process but the formative weight is more important. On last were planned questions to figure out the satisfaction degree, in a scale from 1 (minor) to 4 (higher) for the professorship and students related with the assessment tools usage.

The questionnaire was designed by means of formulary Google Drive which was validated firstly for some GRAPA group members all along a couple of weeks to avoid conceptual or informatics mistakes. The sample selection to send the questionnaire was done by means of two routes or itineraries to propose currently immersed professorship in the utilization of participative and innovative methodologies and so with a higher probability to find professorship that had been using tools to value the generic competencies which must obtain the students that are coursing the new degrees. One route was the own GRAPA group (45 members) and the other was by means of the collaboration of the Education Science Institute (ICE-UPC), to send the survey to their distribution list. On the mail text it was explained the objective of the cited survey as well as the sending group, the questionnaire was anonymous and it was left open during a period of a month.

The obtained results in the survey were treated by the statistical program SPSS v19 where were analyzed the obtained variables using frequencies of descriptive statistic to define the percentages of the variables utilization. There was used two dimensional crosstabs analysis with SPSS to analyze crossings of variables which had interest for the study. With the analysis of the signification degree (Asymp. Sig) and Chi-Square it was possible to verify the correlation of the analyzed variables where the signification degree is lower than 0,05, what involve the rejection of void hypothesis and that the correlations are not of the luck. The Chi-Square high value associated to a signification lower than 0,05 involve the existence of significative intercorrelations.

3. Main Results i Discussion

The number of received answers was in total 80, of which 21 corresponded to GRAPA group (26,3% of the surveyed and 47% of the total GRAPA membership). The survey just was answered by professorship that use evaluation tools in some of the subjects which impart.

The variable analysis showed that the 48,8% of the surveyed professors uses rubrics as assessment tool, followed by the use of mix tool (mix of different tools) with a 22,5%. In the Figure 1 it is possible to appreciate the utilization of the different kinds of tools.

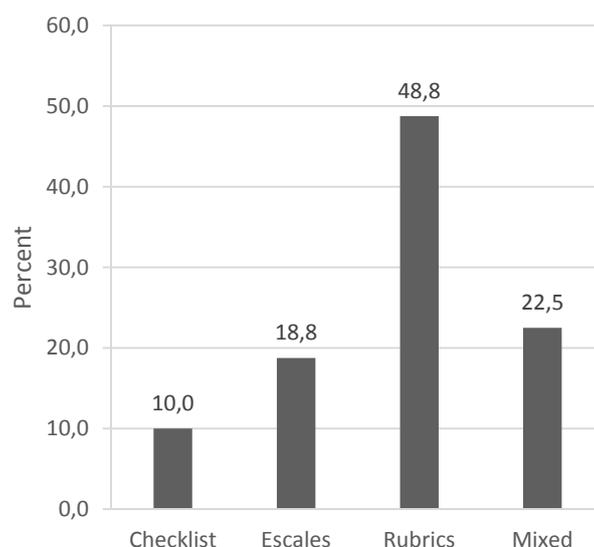


Figure 1. Use of the different assessment tools.

In addition the results related to the frequency of the usage showed that the 57,5% of the surveyed who use rubrics uses them between with frequency and always (see Figure 2) and just a 15% never.

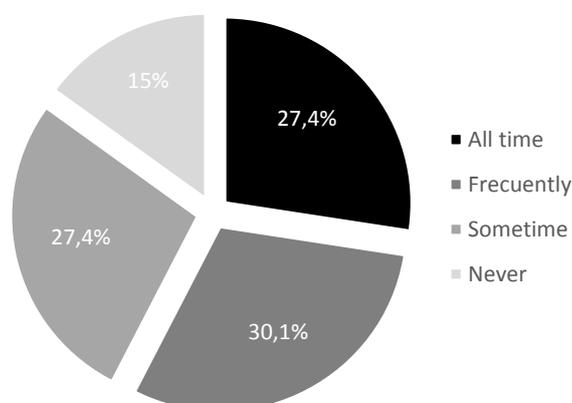


Figure 2: Frequency use of the rubrics between the surveyed.

About the rubrics they were also asked if they were holistic or analytic type and the results showed that the 42% use the mix type, it means a mix of both.

The results of the variables analysis showed that none specific kind of session in which assessment tools are used stands out, due to the frequency percentage were quite similar: projects (26,3%), laboratory (21,3%), expositive lectures (20%) and problems (17,5%).

The analysis with crosstabs showed that there aren't significant correlation between the kind of session and the kind of tool, so this means that the use of the tool type don't depends on the session type, important aspect due to involve that in any session whatever the type it's possible to use assessment tools. In the figure 3 is shown the relation between the tool kind and the session kind and it is possible to appreciate how the rubrics are in general the most used tool as it was mentioned and in addition that in particular is the most used tool in the projects sessions.

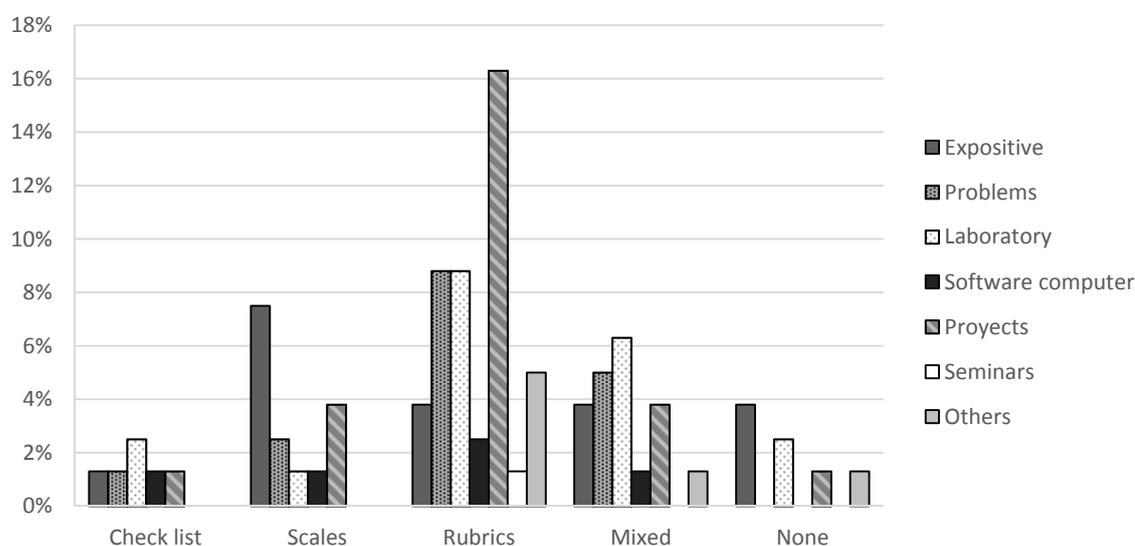


Figure 3: Relation between the type of tool and the type of session where they are used.

Respect to the number of students in the classroom resulted that a 32% of the surveyed have been using evaluations tools in sessions with more than 60 students and a 22% in sessions between 20 and 30 students. This result confirms that not always are been doing innovations in reduced groups of students like it is usually thought but also in numerous groups. The subjects where the surveyed are using tools are semester ones and from Degree (91,2%). This last result is logical so the degree subjects are in general semesterly in the UPC. The crosstabs highlights that there aren't significant correlation between the tool type and the students number, this together with the previously shown results highlight that nor the session type nor the students number have an influence in the type of evaluation tool used, expected result due to they shouldn't have dependence. In the Figure 4 it is shown the relation between the kind of tool and the students number and it confirm that in numerous groups is where are used more assessment tools with the rubrics as the most used.

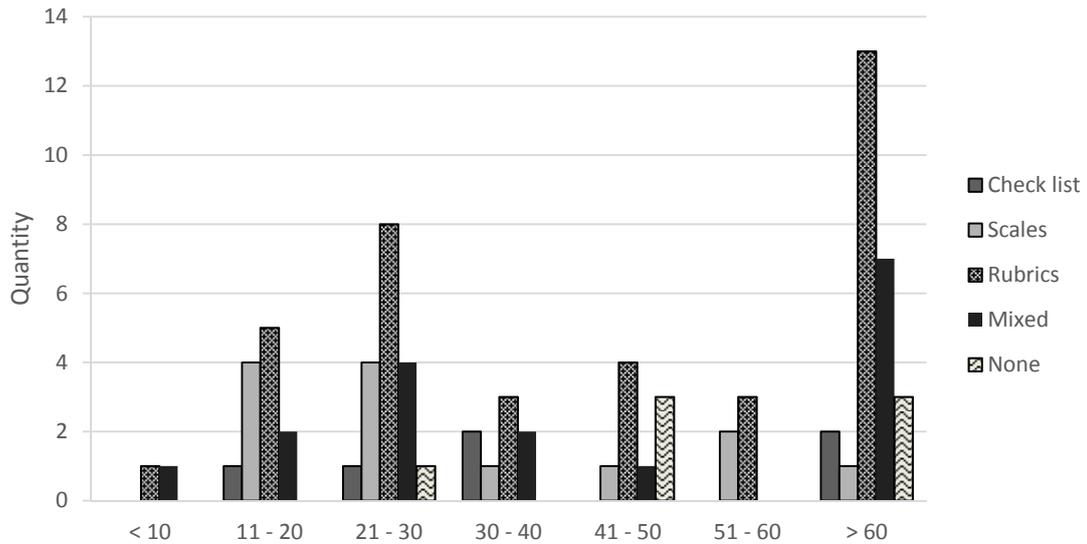


Figure 4. Relation between the type of tool and the students' number in the classroom.

In relation to the course imparted in the subject the analysis of variables showed that there aren't any highlights, despite of that the higher frequency was the first semester with a 24,7% followed by the fourth semester with a 17,8%. So it was also manifested that since the initial time of the studies have been integrating and valuing generic competencies in the subjects favoring the gradual process of acquisition of these ones.

When analyzed the assessed competencies, the variables analysis resulted that the 90,4% of the surveyed evaluate in an integrated way the specific competencies (the related with the knowledge) and generic (the global ones common at all Degrees). Even more the four most assessed generic competencies were: teamwork (28,2%), problems solving (25,6%), effective oral and written communication (24,4%) and autonomous learning (12,8%). Those results confirm that have been introducing in the UPC the required competencies to the future professions as engineers, that it was one of the lack detected on the study plans to extinct, in addition between those four there are three of the mandatory own of the UPC. The crosstabs show that to evaluate the autonomous learning is preferred to use assessment scales while that for the rest of the competencies is preferred the rubrics as it's possible to appreciate in the following Figure 5.

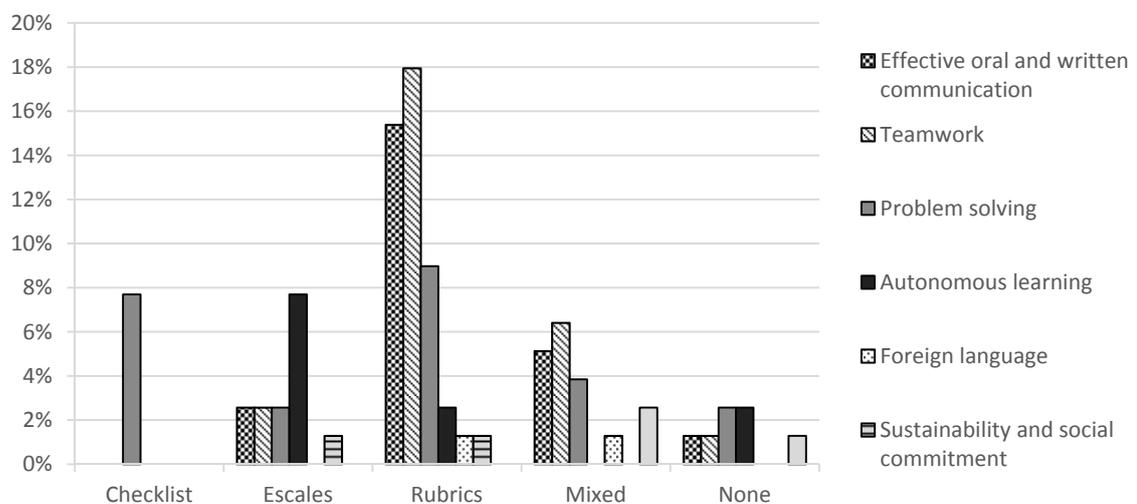


Figure 5. Relation between the assessment tool type and assessed generic competencies.

When analyzed the related results with the utilized strategies, it was found that when the strategy of evaluation is the observation a 46% use it between with frequency and always and just a 15% confirm that never use it, while that if the used strategy is the interview, the results are very different due to a 43% don't use it never and just a 22% use it between with frequency and always. To the analysis strategy case of evidences delivered by students, the results put on evidence that a 98% of the surveyed use this strategy, of which a 72,5% use it always. So it seems that this last strategy is the most used and in addition it's also corroborate that the rubrics are the most used tools when is this the used strategy like it's possible to see in the Figure 6.

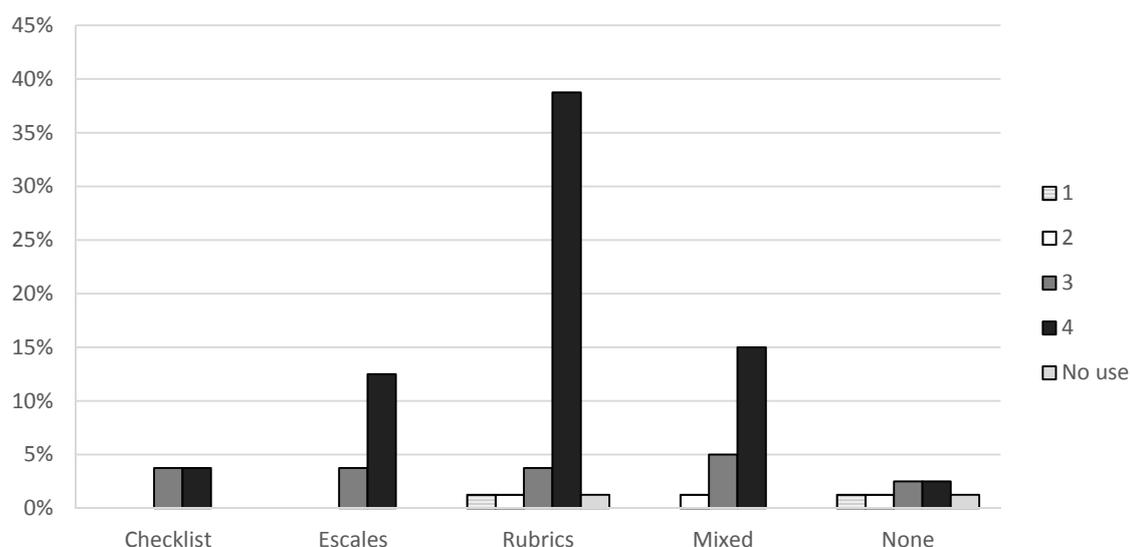


Figure 6. Use of tools when the used strategy is the evidences analysis (1 minor and 4 higher).

Related to the evaluation typology the analysis of variables resulted that the 43,8% of the surveyed confirm that is a summative and formative type during all the process with a higher weight of the formative part. It has to be stand out this aspect, due to this is the most significant difference about the assessment in the new Degree study plans, because the traditional assessment without doubt can be considered as more summative (qualificative) than formative, and just a 13.8% of the surveyed confirm that realize summative only, what is a logical situation due to the professorship who the survey was directed is the most motivated to the methodological innovation. The crosstabs showed that there aren't any significant correlations between the tool type and the evaluation typology.

Another aspect analyzed was the student participation on the assessment, differentiator aspect of the new degrees where the students go from to be a passive agent to an active one and the results of the variables analysis were satisfactory due to a 55% of the surveyed confirm that between with frequency and always the students participate in the evaluation and just a 21,3% confirm that never participated.

Another quality indicator in the assessment is the period to give feedback to the students and the results are very satisfactory due to the 84,6% of the surveyed do it in less than a week. In addition the 84% of the surveyed professorship confirm that is between satisfied and very satisfied with the assessment tools utilization and more than a 51% give surveys to their students to figure out the satisfaction degree in relation with the assessment tools and the results show that the 90,2% of the surveyed students are between satisfied and very satisfied with the used assessment tools in their subject. In the Figure 7 it is

possible to appreciate the results about the satisfaction degree of the professorship and the students where it is possible to see that in both cases the addition of options 3 and 4 prevail, representing 4 the highest level of satisfaction.

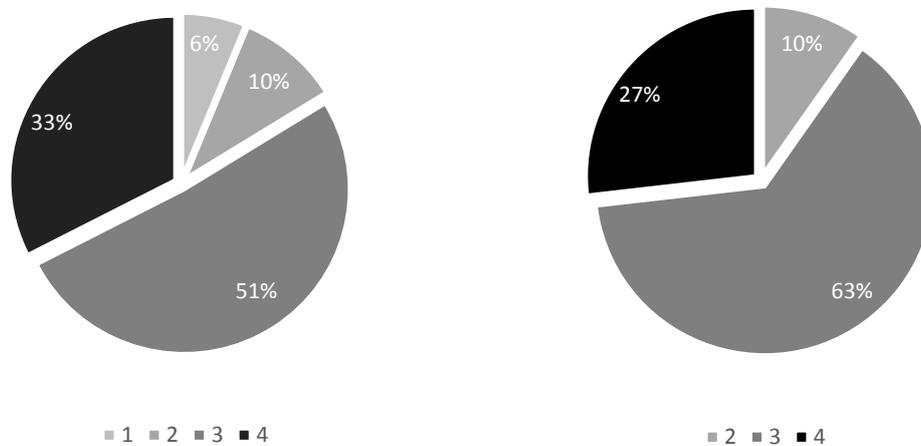


Figure 7. Right: Student satisfaction degree. Left: Professorship satisfaction degree related to the assessment tools utilization (1 minor, 4 higher)

The crosstabs showed that there aren't any significant correlation between the tool type and the satisfaction degree of professorship or students so both collective are satisfied with any the used tool.

Finally were used the crosstabs to compare if there were significant differences between the answers of professorship from GRAPA group and the other professorship but it results not to be significative. This can be due to in general all the professorship who use assessment tools had assisted to formation courses organized by the group what can do possible a state of general uniformity in the use.

Conclusions and future issues

The main conclusion of this analysis has been that the rubric has resulted the most utilized assessment tool between the UPC's professorship that answered the survey, with a use of 48,8% in front of the rest of the tools (checklist and scales) used between with frequency and always in a 57% of the cases. The rubrics are the tools which ease integrate and assess in an objective way the generic competencies very relevant for the future professional engineers, as teamwork and effective oral and written communication, that even more has resulted to be the generic competencies own by UPC more assessed between the surveyed. In addition it has been possible appreciate that there is a significant correlation between the tool type use and the assessed competence, being the autonomous learning the only competence evaluated using scales instead of the rubrics as for the rest of the investigated. Another important conclusion extracted from the study is that the assessment tool utilization has been independent of the number of students per classroom and the session type where they are used. In addition 84% of the surveyed give feedback in a period lower than a week and both professorship and students satisfaction degree is very high.

As future work are planned two studies, the first one is related with the own university and consist in compare the tools utilization between the different Bachelor's Degrees in Engineering imparted in the UPC and analyze the existence of some significant correlation between the type of tool and Degree. The second study, more ambitious, consist on the elaboration of a new survey, much more specific, to figure

out the assessment tools utilization in other Spanish Universities, where there imparted Engineering Degrees, related to the generic competencies and compare with the obtained results in the UPC.

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References

1. N. Salán, M. Martínez, A. Adam, I. Darnell, E. Portet and I Torra, RIMA, Research and innovation in learning methodologies, a dynamic tool of the ICE-UPC. *Proc. 37th SEFI Annual Conference*, Rotterdam (2009), 14 January 2012, <http://www.sefi.be/wp-content/abstracts2009/Martinez.pdf>. Accessed 15 March 2013.
2. Monográfico: La evaluación en el marco del Espacio Europeo de Evaluación (EEES), http://www.upc.edu/ice/innovacio-docent/publicacions_ice/monografics-ice Accessed 15 March 2013.
3. Jornada de innovació docente RIMA- 2010, ISBN: 978-84-7653-485-4. <http://upcommons.upc.edu/revistes/handle/2099/9336> Accessed 15 March 2013
4. B. Amante, M. Martinez, A. Cadenato, I.Gallego and N.Salan, Applied Scientific Method' in the Laboratory, *International Journal of Ingeniering Education, Sciences*. 27(3),2011, pp.559-570
5. M. Martinez, A. Cadenato and B. Amante. Evidencias e instrumentos para la evaluación del aprendizaje por competencias, *EVALtrends 2011; Congreso Internacional: Evaluar para aprender en la Universidad, Experiencias Innovadoras en el aprendizaje a través de la evaluación*, Bubok Publishing S.L. Cádiz, Spain , 2011, pp 98-113, <http://evaltrends.uca.es/index.php/publicaciones.html>, Accessed 15 March 2013
6. M. Martínez, B. Amante and A. Cadenato, A. Competency assessment in Engineering courses at the Universitat Politècnica de Catalunya in Spain. *World Transactions on Engineering and Technology Education*, 10 (1), 2012, pp. 46-52.
7. M Martinez, B. Amante, A. Cadenato and I. Gallego, I. Assessment tasks: center of the learning process. *Procedia Social and Behavioral Sciences*. 46, 2012, pp.624-628.
8. G. Gibbs, *Condiciones para una evaluación continuada favorecedora del aprendizaje*. Octaedro, Barcelona, (2009)
9. D. Nicol, *Principles of good assessment and feedback: Theory and practice*. REAP [on line]. International Online Conference on Assessment Design for Learner Responsibility (2007), 23 December 2011, http://litt.strath.ac.uk/REAP/public/Papers/Principles_of_good_assessment_and_feedback.pdf, Accessed March 2013.
10. D. Boud, and Associates, *Assessment 2020: Seven propositions for assessment reform in higher education* [online] 2010.Sydney: Australian Learning and Teaching Council. http://www.iml.uts.edu.au/assessment-futures/Assessment-2020_propositions_final.pdf. Accessed 15 March 2013
11. P. Canto del, I. Gallego, J. M. López, E. Medina, F. Mochón, J. Mora, A. Reyes, E. Rodríguez, E. Salami, E. Santamaría, and M.Valero, Follow-up and feedback processes in the EHEA. *Journal of Technology and Science Education*.1, 1, 12-22 (2011). ISSN: 2013-6374. DOI:10.3926/jotse.2011.14.

12. V.M. López (coord.). *Evaluación Formativa y Compartida en Educación Superior: Propuestas, técnicas, instrumentos y experiencias*. Narcea, Madrid (2009)
13. V.M. López Pastor, Best practices in academic assessment in higher education: A Case in formative and shared assessment. *Journal of Technology and Science Education*. 1, 2, 25-39 (2011). ISSN: 2013-6374; DOI: 10.3926/jotse.2011.20.
14. I. Torra, I. Corral, M. Martínez, I. Gallego, E. Portet, M. Pérez, Proceso de integración y evaluación de competencias genéricas en la Universitat Politècnica de Catalunya. *Red U: revista de docencia universitaria*. 8-1, pp. 201-224. (2010). Disponible en Internet en: <<http://redaberta.usc.es/redu/index.php/REDU/article/view/154>>
15. A. Blanco, *Las rúbricas: un instrumento útil para la evaluación de competencias*. In: L. Prieto, (coord.) *La enseñanza universitaria centrada en el aprendizaje*. Barcelona, Octaedro, 17 (2008).
16. G. Rodríguez and S. Ibarra, *E-evaluación orientada al e-aprendizaje estratégico en Educación Superior*, Narcea, Madrid, (2011)

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