COMPENTENCE ASSESSMENT OF FINAL YEAR PROJECTS FOR UNDERGRADUATE TELECOMMUNICATION STUDENTS

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Abstract

The value of project-based learning has lead to the inclusion of project development activities in engineering courses, being the Final Year Project (FYP) the most remarkable one. Several approaches have been proposed for assessing and grading FYPs but, among them, rubrics are becoming a standard for such type of assessment. However, due to the different characteristics and orientations of the projects (some are more practically oriented, some more theoretically), and the high amount of different competences to be evaluated (knowledge, working capability, communication skills, etc.), the definition of one unique rubric suitable for the evaluation of all FYPs presented in different degree programs, is a big challenge. In a former work, the educational outcomes expected from the FYP were defined and resulted in a proposal for their assessment. Afterwards, the proposal has been tested during one year within an educational innovation-project at the Universidad Politécnica de Madrid which involved the follow-up of 8 undergraduate telecommunication students elaborating their FYPs. In this publication, our experience will be described, based on the emerging work taking place through the formalisation of the process which consisted in the following steps: i) establishment of a schedule for the whole process (publication of FYPs topics, selection of applying students and their enrolment, assignation of a jury to each FYP, elaboration and follow-up of FYPs, final report submission, oral presentation, etc.); ii) design of rubrics for each of three assessment parts: working process, final report and oral presentation; and iii) follow-up and evaluation of the involved FYPs. Finally, problems that appeared during this experience (e.g. administrative aspects, criticisms and suggestions from the students, tutors and juries involved) are discussed and some modifications in the assessment system will be proposed in order to solve or minimize these problems.

Keywords: competence assessment, rubrics, project-based learning.

1 INTRODUCTION

Project-based learning has become a very effective learning tool that helps students in developing generic skills and higher educational objectives, permits them to apply the knowledge acquired during their university studies and also improves the students' satisfaction [1-4]. For this reasons, Final Year Projects (FYP) have been a standard practice in engineering courses [4] for a long time. However, the educational content and learning outcomes of the FYP have been rarely analysed [1, 5-6]. As a consequence, students are not usually informed on what they are expected to do and this fact impacts negatively on their performance. For instance, some studies indicate that the students have difficulties to develop their projects due to missing guidelines, both on the process itself and on its objectives [6]. A definition of expected learning outcomes in terms of competences has been previously proposed in [5, 7-8].

A second problem is the assessment and grading of FYPs. For this purpose, several approaches have been proposed, and rubrics seem to become a standard for such type of assessment [1, 9]. However, due to the different characteristics and orientations of the projects (some are more practically oriented, some more theoretically), and the high amount of different competences to be evaluated (knowledge, working capability, communication skills, etc.), the definition of one unique rubric suitable for the evaluation of all FYPs presented in different degree programs, is a big challenge. In former publications, rubrics for evaluating three different aspects of FYP (implementation process, final report and oral presentation) were proposed [5, 8]. The aim of the present work is to describe our experience in the practical implementation of such proposals for the development of several FYPs.

In the following section, the context of this study is described, the procedure for development of the FYPs is presented in section 3, the follow up and assessment of FYPs are described and discussed in section 4 and finally concluding remarks are made in section 5.

2 CONTEXT

The present work has been developed during the academic year 2010-11 at the Escuela Universitaria de Ingeniería Técnica de Telecomunicaciones (EUITT) that belongs to the Universidad Politécnica de Madrid (UPM). Once the educational outcomes expected for a FYP were defined and a series of rubrics for its assessment were proposed (see appendix), now, the following step is to test the development and evaluation of some FYPs according to the proposal. During the last years, the group of teachers involved in this work has elaborated the following material, which is available to the students: i) a FYP students' guide providing them with indications on the educational content, administrative procedures, assessment process and formal requirements of the FYP, ii) a virtual space for sharing resources and experiences with their colleagues and supervisors [5]. And finally, iii) templates for all required documents that students should write during the development of their FYP have been created and included as resources on the virtual space used in the UPM. These templates include recommendations about style, appropriate length and contents.

Currently, the regulations about the FYP at the EUITT demand that students should first enrol in the FYP, then apply an offered FYP, the EUITT responsible assign the FYP to the applicants and then the students begin to work. In two months since their enrolment, students should send a project plan and after its approval, the student can do the main work of the FYP which ends with a final report and a final oral examination by a jury formed of three members (the supervisor being always included).

Due to the EUITT regulations for the FYP development, the students where assigned to the FYP proposed by some of the authors of the present study and then they were informed about the goals of this work: the development of FYP following the students' guide and the evaluation of their FYP following the competence-based assessment system described in [5] (see appendix for definition of competences, proposed rubrics and weights). After this information was given, a group of 8 students voluntarily participated in this experience. The EUITT regulations demand that the presentation of the FYP is the last academic work of the students, i.e., the students must have passed all the courses of their grades prior to the presentation of the FYP.

3 THE PROCEDURE FOR DEVELOPMENT OF THE FYP

In order to guide and facilitate the work of the students and the supervisors, a schedule for the development of the FYP has been proposed and followed along this experience. This schedule includes the three main phases described in the following:

3.1 Initial phase: project planning (2-4 weeks)

During this phase, students and supervisors should maintain a constant communication for establishing the goals of the FYP and to organize the work. Meetings between students and supervisor (possibly in groups if more students work on similar topics) are necessary during this phase. The supervisor should:

- Introduce the subject of the FYP.
- Check if the student has acquired the necessary knowledge to start with the assigned work.
- Point out the first steps of the work.
- Detail the specific objectives of the FYP.
- Give basic orientation about bibliographical search.
- Review the bibliography founded the students.

On the other hand, students' tasks during this phase are:

- Review or study the necessary topics to develop the FYP
- Search for information about their topic.

- Obtain and study (after supervision) the basic bibliography.
- Write down an abstract of the meetings they have with their supervisor.
- Write a project plan describing the main tasks and a temporal planning.

As a milestone of this phase, a project plan has to be written, which includes a brief description of the problem, states the main goals of the FYP, explains the proposed methodology to solve the problem, gives a brief description of the tasks to be developed, presents a temporal planning of the main tasks, the necessary resources (specifying if they are available or not), a budget (if applicable) and basic bibliography.

3.2 Main phase: working out the problem (2 months)

During the second phase of the work, the student should find a solution to the proposed problem: a design, algorithm, software, prototype, etc. The supervisor should check that the proposed solution is accomplishable and guide the student for the implementation of such solution. A regular communication (via e-mail, virtual space, personal meetings…) between student and supervisor is convenient during this phase. The students' tasks for this phase should be (at least):

- Pose a solution of the given problem and check if it satisfies or not all the initial objectives.
- Write a resume of the meetings they have with their supervisor.
- Write a scheme of the final report.

This phase should finish with a report about the work done. It could be in form of a short oral or written presentation to the supervisor and/or their colleagues, containing a brief description of the state of the art, a description of the developed solution and initial tests of that solution, a detailed temporal planning of the work done and a sketch for the future work (Gantt diagrams or similar could be included). Then, the supervisor should write a report about the project execution.

3.3 Last phase: final tests, final report and oral presentation (3 months)

During this phase, the supervisor should check that the implemented solution works as expected and that the FYP plan is carried out. Then, the final report should be reviewed, checking out that all regulations are met, that the supplied templates have been used and that all other requisites specified in the students' guide are kept). The students' tasks will be (at least):

- Refine the proposed solution in order to satisfy all (or almost all) the stated requirements.
- Finish the work to fulfil the specific FYP objectives.
- Write the final report following the supplied templates and the recommendations given in the students' guide.
- Prepare and make the final presentation.

As a result of this final phase, the work must be concluded with the final presentation and assessed by the supervisor. The final report and presentation are also assessed independently by the members of the jury.

4 FOLLOW UP AND ASSESSMENT OF THE FYPS

4.1 Follow up of the FYPs

All students that wanted to develop their FYP during the academic year 2010-11 at the EUITT had to register by July 2010. The offered FYPs were published during the last two weeks of September 2010, and the students applied and were assigned for a specific FYP during the first week of October. Those students that applied for the FYPs offered by the authors of the present work were called for a first informative meeting on October 7th, 2010. On that meeting, this group of students was informed about the goals of this educational innovation project: to follow-up the development of their FYP and to evaluate it with a competence–based assessment system. A total of 8 students agreed to participate in the project. Additionally, 3 students that were previously enrolled in the FYP with some of the authors accepted to finish their FYP and to be assessed applying the system described in this work.

During the first week of November 2010, the 8 students sent their written project plans to the virtual space and during the following week they made an oral presentation of such plans. All the involved supervisors and students attended to that presentation.

General comments about this meeting were:

- The objectives of the FYP should have been more explicit than those presented.
- The starting point of the FYP (what is done and what not, which resources are available and which will be available during the development of the FYP, etc…) and the context (the FYP is the initial part, the continuation, the final part of a research project of the supervisor …) of the FYP should have been more clearly stated.
- Two supervisors considered that, generally speaking, the presented objectives were too ambitious for FYP. This fact could affect negatively in their grading if such objectives were not achieved at the end of the FYP.
- All the students presented very detailed Gantt diagrams of their planned work. This also could affect negatively in their grading if the work was not developed as planned. The supervisors recommended that the temporal planning should be more flexible than that presented.
- Most of the works were planned to be developed from November 2010 to March 2011 and two of them were planned to be developed from March to June 2011. However, all the works were to be presented from July to November 2011 due to the EUITT regulations about FYPs.
- Students considered that this presentation helped them to understand the specific objectives of the proposed FYPs and to organize their future work. However they felt that they were being examined in this presentation.

Out of the eight new FYP students, four made their FYP final report and oral presentation on July 2011, one is expected to present his FYP on October 2011, and the last three students did not satisfy the requirements to present it in time (they have failed in at least one course). The three students that had initiated their FYP previously to this work, wrote their final report following the recommendations given in the students' guide and presented their FYP in February 2011 (two students) and in July 2011 (one student).

4.2 Assessment of the FYPs

Supervisors and assigned members of the jury generally agreed that the proposed competence-based-assessment rubrics are difficult to apply due to following reasons:

- The rubrics include a brief description of what is intended to evaluate for each competence but there is no description of possible ranks and their values. Finally it was agreed to mark each evaluated competence in a 0 to 10 scale and highlight some aspects of the rubric in order to emphasize what is considered as highly relevant (see tables 2-4 in the appendix).
- Although there is a precise definition of each competence, the rubrics for evaluating a given competence include many aspects, some of them are clearly applicable for a given FYP but others may not. For example, the rubric for evaluating in which grade the competence C-I (analyzing and synthesizing) was achieved in the final report, includes four different aspects to evaluate, which leads to the problem that a final report could be excellent in one of this aspects but poor in others (see table 3 in the appendix).
- Some assessors consider that there are competences which are not applicable to some types of FYP. For example, competence C-XI (analysing the social context) was hardly understood by more than half of assessors and several members of the juries consider that competence C-III (making research) was generally not necessary for undergraduate FYP. It was decided that if some competence was not given a mark, then this competence was not considered for the evaluation.

Besides all these difficulties, the members of the juries made an effort to evaluate all or almost all the competences.

The final issue is to assign a single mark and a grade to each FYP which resumes all the obtained marks. A first step in this sense was to use the competence relevance and weights elaborated in a previous work [5] (see table 5 in the appendix). However it was considered that the seven marks

(supervisor evaluation of the implementation process, members of the jury evaluations of the final report and oral presentation) should also be weighted. In this sense the authors have followed a two-stage procedure inspired by [10]:

- As a first step, each author has ordered the seven marks by their relevance for FYPs.
- Secondly, a weight has been assigned to each evaluation relative to the following one in the ordered list. After that, a simple set of linear equations has allowed to convert these weights to a set summing 100%.

These two steps have been taken independently by each author, without knowing the proposals of the rest. Averaging the resulting weights results in the list of relative relevance of evaluations included in Table 1.

TABLE 1. RELATIVE RELEVANCE AND WEIGHTS OF MEMBERS OF THE JURY EVALUATIONS

Rank	Competence	Weight
1st	Supervisor evaluation of the implementation process	23%
2nd	President of the jury evaluation of final report	15%
3rd	Secretary of the jury evaluation of final report	14%
4th	Supervisor evaluation of final report	14%
5th	President of the jury evaluation of oral presentation	12%
6th	Secretary of the jury evaluation of oral presentation	12%
7th	Supervisor evaluation of oral presentation	10%

It should be noted that there was unanimous agreement that the supervisor evaluation of the implementation process was the most relevant evaluation.

Due to the fact that there are up to 55 marks that lead to one single final mark and grade for the FYP, it could result quite difficult for an excellent FYP to obtain an outstanding grade with any weighted average of those 55 marks. For this reason it is proposed to normalize the weighted average to a 120 points scale and assign the following grades: over 100: outstanding (may be with distinction, to be considered by the jury); from 85 to 99: outstanding; from 65 to 84: very good; from 50 to 64: sufficient; lower than 50: fail.

Following this process, 3 of the students that presented their FYP obtained “outstanding with distinction” grade, 2 students obtained “outstanding” grade and 2 students obtained “very good” grade.

It is worth noting that the mean length of the final report was considerably reduced to 80±30 pages compared to 120±40 for the last ten FYP previously supervised by the authors. This could be a consequence of following the recommendations of the students’ guide and which includes limiting the extension of the final report. A reason to include the recommendation to write brief reports is to help the juries to appropriately evaluate the FYP.

5 CONCLUSIONS

The main conclusions obtained from the present work are:

- The students’ guide and the templates created for the project plan and for the final report help the students to organize them and to write the documents they have to present during the development of their FYP (at least the project plan, the final report and the slides for the oral presentation). As a result of these, a reduction of the mean length of the final reports is observed.
- From the point of view of the juries, the proposed rubrics are too general, and contain competences that not always apply.
- The rubrics for each competence seem to contain too much information. They must be re-written by in subdividing the different aspects of each competence and marking rules for each aspect have to be included.

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APPENDIX

The competences directly related to FYP defined in our previous work [5] are as follows:

C-I. Competence for analysing and synthesizing: capacity for compiling, comprehending, interpreting and evaluating information and data relative to a technological problem in such a way that its main aspects can be easily identified.

C-II. Competence for applying knowledge to practice: capacity for solving specific problems making use of the specific knowledge of the correspondent technology and conceiving, if needed, new systems or devices that help achieving the objectives and requirements of the undertaken problem.

C-III. Competence for making research: capacity for generating new knowledge from hypothesis and data making use of the scientific method.

C-IV. Competence for scientific and rational analysis: attitude for systematically analysing reality from a rational scientific point of view, which is characterised by the appropriate use of theories and models, the production of coherent interpretations of facts, the critical analysis and the forming of personal opinions and judgements.

C-V. Competence for dealing with the basic knowledge of the technological area: familiarity with the basic concepts of the correspondent knowledge and technological area and capacity to increase the personal knowledge through autonomous study.

C-VI. Competence for managing information: capacity for finding information in bibliographies, distinguishing between primary and secondary bibliographic sources, making good use of libraries and locating information on the World Wide Web assessing its reliability.

C-VII. Competence for performing basic tasks with computers: capacity for creating and storing information in several formats, for complying with norms relative to those formats, for communicating making use of computer networking, for using on-line resources, for registering experimental data in electronic format and for using software specific to the correspondent knowledge area.

C-VIII. Competence for language communication: capacity for elaborating written texts and oral dissertations following orthographic and grammatical rules, with a coherent ordering of ideas and arguments and with different levels of detail; having good fluency in a second language, at least in reading comprehension.

C-IX. Competence for inter-personal relations: capacity for listening others' opinions and views, for using verbal and non-verbal codes, for working in a team and, if necessary, leading it, for presenting proposals and projects, for debating, for conducting interviews, for generating interactive environments, for interacting with people coming from diverse social and cultural contexts.

C-X. Competence for task managing: capacity for organising time, for setting priorities, for working under pressure, for complying with compromises in results and time.

C-XI. Competence for analysing the social context: consciousness of the existence and the origin of social conditions, restrictions, beliefs and usages and capacity for assessing the social and ethical impact of technological projects.

Tables 2 to 5 reproduce the rubrics used in the assessment process and the weights used for obtaining a final mark [5].

TABLE 2. RUBRIC FOR THE EVALUATION OF THE IMPLEMENTATION PROCESS

Competence	Mark
C-I Analyzing and synthesizing: The **student has understood** the proposed problem and all its conditions and circumstances. He or she **has been autonomous** in critically searching, gathering and processing information. He or she **has succeeded in relating the problem to others** previously approached.	
C-II Applying knowledge to practice: The student **has been autonomous** in applying scientific knowledge and he or she **has proposed well founded hypothesis and methods**. Changes in methods and objectives have been well reasoned. **Required time and equipment resources have been defined** beforehand.	
C-III Making research: The student has shown ability **to approach problems** at different levels of abstraction, **to design experiments, to process data** using appropriate statistical and mathematical tools, **to handle specific instrumentation and to interpret results**.	
C-IV Scientific and rational analysis: The student **has identified all the different parts of the problem**. He or she has presented and **defended arguments** in discussions with the supervisor and with other students. He or she **has decided based on objective criteria** and has used multidisciplinary knowledge when needed.	
C-V Basic knowledge of the technological area: The student has shown **to be competent in dealing with procedures and concepts** of his or her knowledge area and also in **handling specific instrumentation**. He or she has been **autonomous** in looking for information that helped in solving his or her doubts.	
C-VI Managing information: The student has been autonomous in gathering and selecting information. He or she **has resorted to several sources of information** and has been able to assess the reliability of each one. He or she has made use of on-line resources provided by the university.	
C-VII Performing basic tasks with computers: The student **is skilled in managing diverse data and document formats**, he or she has usually accessed to network resources and services and **has appropriately used data processing software and also software specific** to his or her knowledge area.	
C-IX Inter-personal relations: The student **has regularly attended to meetings** with the supervisor and has been able both to discuss and defend his or her approaches and to rectify them when needed. He or she has shared ideas with colleagues and, if required, he or she has participated in joint projects and coordinated part of the work.	
C-X Task managing: The student **has written a project plan**, kept a log book of the project activities, **respected foreseen deadlines** and activities and **adjusted the plan** when needed.	
C-XI Analyzing the social context: The student has evaluated results bearing in mind their applicability. He or she **has included ethical and social issues** in the context analysis.	

TABLE 3. RUBRIC FOR THE EVALUATION OF THE ORAL PRESENTATION

Competence	Mark
C-IV Scientific and rational analysis: The student **has presented his or her work in a well structured way**. He or she **has adequately justified his or her decisions, proposals and answers**.	
C-V Basic knowledge of the technological area: The student **has shown good knowledge of the subject** in which the project is framed. He or she has used specific vocabulary properly and avoided superficial analyses.	
C-VII Performing basic tasks with computers: The student **has adequately used supporting software for the presentation**, shown well elaborated graphs and, if needed, performed software demonstrations.	
C-VIII Language communication: The structure of the presentation has been appropriate. Repetitions and ambiguities have been avoided. **The language has been clear and concise** and using appropriate vocabulary and register. The presentation length has been adapted to its contents.	
C-IX Inter-personal relations: The student **has succeeded in maintaining the attention of the audience. He or she has answered all questions** without avoiding any and recognized own mistakes. His or her position in the room and speech loudness and speed have also been appropriate. Reading has been avoided.	
C-XI Analyzing the social context: The student **has spoken about the social context and relevance of the work**. Topics and superficial approaches in analyzing ethical issues have been avoided. He or she has shown sensitivity towards the social impact of the project.	

TABLE 4. RUBRIC FOR THE EVALUATION OF THE FINAL REPORT

Competence	Mark
C-I Analyzing and synthesizing: Problem description and analysis are based on a sufficiently wide up-to-date specialized bibliography. The literature review has clearly synthesized contents, it is well structured and it includes a judicious analysis of the bibliography while avoiding plagiarism. The hypothesis and/or design criteria are clearly linked to the review of the state of the art. Data collected during the project have been adequately organized and analyzed and they provide a clear foundation for the conclusions.	
C-II Applying knowledge to practice: **Project hypothesis and objectives are clearly stated**, well founded on theoretical knowledge and realistic. Project **objectives are original and result from a personal contribution** of the student. The proposed methodology is coherent with the objectives, it is clearly explained and justified and it leads to the reported results.	
C-III Making research: Unsolved issues have been identified and corresponding hypothesis have been stated. Experiments and results have been adequately carried out and collected in order to confirm or reject such hypothesis. **Data analysis has been unbiased and it clearly supports the conclusions**. **Findings and conclusions have been discussed and contrasted to previous results** present in literature.	
C-IV Scientific and rational analysis: **The contents of the final a report are well organized**. The approach to the project is systematic. **Statements and interpretations are correctly reasoned or founded in adequate bibliography**.	
C-V Basic knowledge of the technological area: **Project implementation has involved knowledge related to the university course**, and part of it has required autonomous study by the student. **Conceptual errors have been avoided** and, if needed, specific instrumentation has been correctly used and its specifications and using requirements have been reported.	
C-VI Managing information: **The final report includes a list of references**. All references have been **cited in the text**. Reference format is as specified. Sources of all copied material have been cited.	
C-VII Performing basic tasks with computers: **The format specifications of the document have been respected**. Usage of styles and formats is coherent throughout the whole document. Appropriate software has been used for generation of graphics and data processing.	
C-VIII Language communication: **The structure of the report is correct**. Headings and content are coherent. Both repetitions and ambiguities are avoided. *The text is clear and concise*. **The length of the final report is adequate** for its contents and **it does not contain either syntactic, orthographic or semantic errors**. The bibliography is multilingual.	
C-XI Analyzing the social context: **The project context is mentioned and described**. Both practical and ethical consequences of the project have been considered.	

TABLE 5. RELATIVE RELEVANCE AND WEIGHTS OF COMPETENCES

Rank	Competence	Weight
1st	C-V Dealing with the basic knowledge of the technological area	15%
2nd	C-II Applying knowledge to practice	14%
3rd	C-I Analysing and synthesizing	13%
4th	C-VI Managing information	11%
5th	C-X Task managing	9%
6th	C-IV Scientific and rational analysis	9%
7th	C-VIII Language communication	8%
8th	C-IX Inter-personal relations	7%
9th	C-VII Performing basic tasks with computers	6%
10th	C-III Making research	4%
11th	C-XI Analysing the social context	4%