

Reflections about Teaching Engineering Graphics: Knowledge and Competencies Management

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Abstract— This article contains some reflections about the experience of the authors after a decade teaching assignments within Engineering Graphics area, like Graphical Expression, Computer-Aided Design, Industrial Drawing, Descriptive Geometry and Technical Drawing, and others related to several Master Programs as Master in Graphical Design. Reflections consider advantages and disadvantages of those traditional experiences regarding to graphical aspects, such as the magisterial Class, practical classes in small groups or working out different tasks and how all of this affects the final results, considering students opinion.

On the other hand of this traditional system is another one based on the learning directed to those students who have ECTS credits, inside the European Educational Higher Space (EEHS) and the experiences in several Universities before entering 2010-2011 season. Knowledge and competencies management are considered within this new system and they be included in the Teacher Guide so that those students who approve the subject acquires specific competences (subject specific knowledge). These competencies coordinated with those specific obligates teachers to develop particular activities, because the detailed knowledge of each is a main condition in order to program competencies briefings with a high detail level. This is not an easy task considering the experiences and opinions of famous professionals specialized in competences issues.

Therefore, new activities should be set up and include new Information and Communication Technologies, such as Internet, search of information, E-learning educational platforms, and a different orientation for individual and group follow up and for seminars and classes in the University environment as well. Sometimes, practical orientation of the lesson should focuses on real cases, on the solution of a real problem. This is more complicated in lessons during the first year when there is a lack of knowledge of other subjects considering that a lesson is not a knowledge “island” in a “sea” of subjects. Nevertheless, besides the difficulties those teachers who have not got that specific training have it becomes a closer challenge and a push to enter the EEHS with a renewed motivation and a different vision about new activities that should be develop.

Keywords- Engineering education; Engineering drawings

I. INTRODUCTION

Knowledge and competencies management [1] within Engineering Graphics subject [2] has been analyzed from different points of view several times, but only a few times it

has been analyzed from transversal competencies related to the design of specific records for its evaluation.

University education considered inside the Europe an Educational Higher Space (EEHS), not only pretends to reach of professional competencies in order to get updated knowledge, technology and specific abilities and be in touch with the real professional world but also to make students acquire knowledge about modern languages, about how to use TICs, how to be creative and keep training constantly, be adaptable to job market, get abilities for teamwork, verbal and written expression and have critical spirit.

According to EEHS one goal of the learning process is the acquiring certain kind of knowledge and developing some transversal competencies according to each one's own academic profile and its correspondent professional profile.

There are basically two kinds of competencies: Specific (technology), related to technical knowledge and Transversal (general), not necessary related to technical knowledge.

Specific competencies are mainly based on the contents of subjects included in the program of the course and that fulfil those requirements described in BOE (Spanish Official Bulletin). Moreover, transversal competencies are generic and should be established in the degree and normally programmed for the subject.

Thus, for designing and evaluating competencies is necessary to know the content of the subject precisely in order to elaborate appropriate records for each one. [3].

II. PRACTICAL APPLICATION

Until a couple of years ago competencies treated in Teacher Guide were basically contents. Since the mandatory implementation of Degrees, as part of the adaptation process to EEHS, Teacher Guide should include activities in order to make students acquire some transversal competences.

As mentioned before, it is not about designing activities to evaluate all that competencies but those considered more appropriate for the subject. Table 1 shows some transversal competencies that can be included in Teacher Guide [3].

As an example, we take a main subject for getting the Engineering Degree in almost all universities, Engineering

Graphics. It has 6 ECTS credits (European Credit Transfer System) and it's also a common subject for several degrees during the first year.

The pilot experience of implantation of ECTS is being applied for some years and Engineering Graphics subject began to be taught 4 years ago. Definitive implantation will not take place until next period (2010-2011), so this experience applied in the University of Jaén, is helpful to get as good Teaching Program.

Particularly, this subject has 6 credits in the ancient system (4'8 ECTS) and its content includes: Descriptive Geometry, Spatial Conception, Normalization and Industrial Design Bases and is taught in one hour of theory and 3 of practice per week.

Main goals of the subject are:

- To develop spatial conception and abstract thinking.
- To manage technical drawing elements and instruments, set up formats, scales and others.
- To dominate normalization and criteria applied to technical drawing and be able to understand and elaborate one.
- To work in group and use Engineering Graphics resources to share technical information.
- To be able to represent pieces and groups of Engineering Applications using representation systems.
- To be able to deduce and apply principles of Industrial Design in technical graphics.

TABLE I. TRANSVERSAL COMPETENCES

Nº	Transversal Competence
1	Planning and managing time
2	Verbal and written Communication
3	Using TIC
4	Managing Information (search, selection and integration)
5	Solving problems
6	Taking decisions
7	Critical thinking
8	Teamwork
9	Abilities for personal relations
10	Consciousness of ethical values
11	Ability to put knowledge in practice
12	Autonomic Learning
13	Ability to adapt to new situations
14	Creativity and innovation
15	Responsibility
16	Selfconfidence
17	Initiative and enterprising spirit

The experience of programming a Teacher Guide mentioned above has been applied in developing and evaluating (from 1 to 10) different activities as following:

- Practical final exam: max 7 points
- Constant evaluation of practices: max 1 point
- Doing and presenting mandatory group work: max 0.5 points
- Doing and extra exercise of increasing difficulty: max 0.5 points.
- Assistance to group tutorials, journeys, seminars: max 0.5 points.
- Related information search through Internet: max 0.5 points.

As described before, exam has a quote of 70% of the final qualification and the rest 30% are activities in and outside the class.

Competences in Table 1 are related to each activity as following:

- Practical Final Exam (1-5-7-11).
- Constant Evaluation of practices (1-4-5-11-12-15-16).
- Doing and presenting mandatory group work (1-2-3-4-5-6-8-9-10-11-15-17).
- Doing and extra exercise of increasing difficulty (1-4-5-7-11-12-15-16).
- Assistance to group tutorials, journeys, seminars (2-6-9-10-13-15).
- Related Information search through internet (1-3-4-6-13-15).

But designing activities in order to get certain competencies is not always easy and depends on the nature of the subject. We honestly think this series of activities reinforce an important amount of transversal competences explained before.

There are other examples of transversal competences much more detailed [3] that include 4 items as following:

1. **Competence Nomination**
2. **Definition of the Competence:** Definition, description, competences needed to develop this one and other competences developed from this one.
3. **Develop of the Competence:** Training activities used to develop it.
4. **Evaluation of the Competence:** Concrete and simple items used for the evaluation and its process, such as observation, interrogation or performance; evaluation instruments related to process; and bibliography.

Nevertheless, from a practical point of view it is better to develop a work report as following that includes the development of activities in a specific teaching week. Although only a practical session along a week is explained as

an example of autonomous work report, it should be applied during all weeks along 4 months.

3rd Week from October 19th to October 23rd 2009:
DIEDRIC SYSTEM I

Transversal Competences:

- Ability for putting knowledge into practice.
- Information management (search, selection and integration)

Specific Competences:

- To train for the correct representation of notable elements (dot, straight line, plane) and related position between each other in the Diedric System.

Objective:

- To dominate criteria and norms of Diedric System (Representation System) applied to Technical Draw.
- Search Basic and complementary bibliographical information.

Content:

- 2nd Theme. Diedric System
 - Chapter 1: Notable elements. Representation.
 - Chapter 2 : Relative position between notable elements.

Development activity:

- Description: Elaboration of 4 exercises practice.
- Tiempo: 3 hours.
- Resources, bibliography and spaces:

Resources needed are Euclidian tools (set square and triangle, millimeter ruler, compass, triangle, angle carrier, 2H hardness pencil and eraser as well). Besides, it is also required the PDF document containing the exercises for the practice and locate it in the file platform of the university of Jaen.

Basic and complementary bibliography is listed in the Teacher Guide of the subject.

Practices will take place in room 31, building A4 in Las Lagunillas Campus, provided with projector, board and drawing tables.

Evaluation Criteria:

- Presential assistance to practice.
- Clean and draw.
- Correct result.

Nevertheless, one of the most complicated parts is how to evaluate learning process. Besides teacher evaluation other evaluation tools should be established, such as self evaluation, equal evaluation and co-evaluation between teacher and student.

There are several technology [4, 5] that evaluate the learning of facts and issues such as opinion polls, conceptual maps, self evaluation and equal evaluation or the learning of procedures (control lists, estimative scales and polls); and the learning of attitudes, such as analysis of speech and productions.

Proposed evaluation tools could be improved for sure in order to get more clarity in the process, but the diversity of evaluation tools and the lack of time make it hard to find a valid result.

III. FINAL REFLECTIONS

We can list following final conclusions:

1. Designing activities in order to get certain competences is not easy and depends on the nature of the subject.
2. Designing specific and developed report for transversal competences is complicated at the very beginning due to a lack in teacher training. They are prepared in their professional area but in most cases they do not know the pedagogic basements and other issues related to teaching innovation.
3. Recommending teacher training in activities about learning evaluation considering that the output of that process can improve the results seriously. Besides, making the student participate in the evaluation of its own learning process make it possible to detect weak points and reinforce the strong ones.
4. Establishing a national net of Teacher Guide that include recommendations about how to elaborate this text because although each professor can freely program the subject, the mix of experiences from other professors from many Spanish Universities, is a more rich source to consult.

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