APPLICATION OF THE COMPETENCES IN GEOMETRY IN THE MASTER THESIS PROJECT (MUGIE) OF BUILDING ENGINEERING. THREE CASE STUDIES

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Abstract

This communication presents how the competences acquired in the Descriptive Geometry course go deeper into the Master Thesis Project (MTP). This supposes a teaching challenge, because Descriptive Geometry is taught in the first course of the Degree in Building in Higher Technical School in Building Engineering, University of Seville. In addition, the Degree does not offer linkage between Geometry and the rest of the teaching imparted in the last years.

We will expose the importance of recovering the foundations of geometry with the help of new technologies and applying them to new challenges that may appear on the professional and research horizon of the student of Building Engineering.

We will explain how these competences have been extrapolated to three specific research projects. We will also comment on the methodologies used to achieve these objectives both in the classroom work and in the tutorial action. Finally, we will show partial conclusions together with a plan to improve the results obtained. We will present three MTPs, as case studies, which have obtained good results.

Keywords: Innovation, technology, research projects, Master Thesis Project.

1 INTRODUCTION

There is a common belief that the knowledge and skills offered in higher academic levels are more specific and, therefore, more likely to become a research work. This is the reason why the MTPs appear next to subjects contained in the higher courses of the Degree.

We differ from that point of view. Subjects such as Geometry -developed in the first course- have a fruitful field of research related, in turn, with new technologies: CAD-CAM systems, software of simulation based at graphic and geometric mechanism, digital fabrication, etc. Many of these contents are not taken into consideration -precisely by its novelty- in any subjects studied in the whole grade.

In that sense, we propose several actions to stimulate research in Geometry and produce a transfer of knowledge from researchers to MTP’s students. Firstly, it would be important for the Higher Technical School of Building Engineering of Seville, the creation of strategies so that the students know the entire offer at research work, specifically the research competences offered by geometry and its variants.

Relating to the work with the students, we propose to develop creativity, as a tool to find new challenges and new relationships between knowledge in Geometry and the different fields of research in Building Engineering. From the point of view of tutorial action, we propose a guided learning process, according to Professor Mihály Csíkszentmihályí, clear goals, immediate feedback, challenges commensurate with skills, etc., to promote into the student “intrinsic motivation” during the development of the research [1].

2 METHODOLOGY

2.1 Teaching and Research objectives

The MTP aims to develop an original research work that meets scientific criteria [2]. Our challenge as teachers is to recover the fundamentals of Descriptive Geometry, which were studied in the first year, and apply them to a research project.

This involves a challenge from the theoretical point of view. It supposes delve more deeply into the very foundations used in the first courses. This also means making progress in controlling graphical
tools. These tools come from the hand of new technologies. Likewise, a study of the state of art is required in issues related to Geometry and Building in order to know the new needs of the profession. The challenge of research involves taking these premises to a specific field of Building Engineering, within a scope (academic forums) where such investigations take place.

2.2 Problems in the MTP teaching structure during previous courses

As a starting point, we consider normal the lack of knowledge that the students have about the fields which may be appropriate to carry out a research work. Due to this fact, it is necessary to consider the student's own lack of experience in scientific methodology and the unawareness about how to carry out a project of this nature. All this complexity encourages students to look for projects already defined, with a pre-established research structures. The goals and objectives of the projects are not really chosen by students, but they decide to carry them out for the sake of greater security and safety.

This structure of thought determines considerably the course of the research project itself. The student, in the long run, will feel that he must meet the teacher's expectations instead of his own, since the true goals of the student were repressed or never really taken seriously.

As a consequence, we observe that many of the research works in the Mastercourse are limited to the teacher's criteria and objectives. The experience of the students during the investigation is imbued with a certain sense of "loss of time". Attention and effort have been employed in meeting the goals and objectives of another person (the teacher) rather than the student's own. We have numerous testimonies that indicate that this "waste of time" feeling most often manifests in students who have scored brilliantly in comparison to those students who decided to do mediocre jobs from the beginning. They feel more satisfaction with a worse mark, but it was achieved with very little effort.

In this type of pedagogical approach, which derives from proposing extrinsic motivations, the time and energy invested in the project are only justifiable in the key of the relation between effort and the reward obtained. In contrast, we propose a methodology based on intrinsic motivation [3].

2.3 The construction of the research project

We raise a teaching challenge based on the studies of Professor Mihály Csikszentmihályi. The idea is fundamentally the empowerment of the student, which will result in "intrinsic motivation". The student himself sets his or her own objectives and research goals. The reward of the work will be related to having satisfied the own goals and personal objectives. Mihaly defines the satisfaction feeling that occurs during this optimal experience as "state of flow". Likewise, creativity will be enhanced as a transversal skill that allows relating personal knowledge and skills with the new challenges encountered [4].

These premises taken to the teaching environment mean that the role of the teacher is transformed. The teacher stops being a "corrector" to become a "catalyst". That is why the teacher must be an observer and a connoisseur of the different processes to reach the "state of flow" in research.

2.4 Training actions in the classroom

First, it is necessary to remember the basic research questions, data-taking techniques, the reference management, etc. The professor presents different research works carried out in other Universities and Centers. The opportunities that our local environment could offer regarding new ideas become particularly important.

Likewise, the teacher will focus on resuming our already acquired abilities, namely the capacities in Descriptive Geometry, handling of digital instruments, software, etc. Creativity is also fostered as the ability to relate capabilities to opportunities, defining the field of research.

Finally, the student proposes a line of improvement of geometry, which can be understood both at the theoretical level or instrumental level. This concludes that the student undertakes to manage his self-learning in a specific CAD or Software program where he can develop the issues related to his research.
2.5 Tutorial action

Once the student has chosen the project, the tutorial action will focus on providing the student with a "feeling of control" over the actions. Like other "flow" activities, research work, according to Mihaly's premises, has clear goals, immediate feedback, rules and challenges. This causes one to be involved in the work, to concentrate and to get lost in it. Any system that does not have that structure requires a greater effort to become something that can be enjoyed.

It is important to produce an intrinsic motivation in the student, to get him involved in the very action of research. The major source of student distraction during the research is the anxiety to keep his or her own image high. As Mihaly says, self-awareness is the most common source of distraction. The person involved in a task instead of worrying about how he is doing it, how he looks like from the outside is totally committed to his goals. This is manifested in the excessive worry for both the final qualifications and the oral presentation of the research project.

It is proposed to work the oral presentation of the research project as an intrinsic goal. It should be conceived not as a threat to be defended, but as an opportunity that the student should freely choose to support and strengthen his goals.

3 RESULTS

3.1 Research results

Below we present the projects of three students that we have chosen as most representative of the application of the competences in Geometry in MTP (Mugie) of Higher Technical School in Building Engineering. In these works, this creative approach has been put into practice, and we have fostered intrinsic motivation in students, who have finally achieved good grades in academic qualification standards.

3.1.1 Analysis and optimization of energy efficiency based on geometric criteria by Alicia Dominguez González

Alicia Dominguez González (student) develops this MTP. The project analyses different sizes and forms of window hollows, and proposes different systems of sun protection. The project makes a comparison between all of them, measuring energy efficiency on purely geometric criteria. Finally, it establishes conclusions from different analyses that allow optimizing the energy saving of any building.

The study area is framed in Seville, province with great needs of shade in summer, as well as need of sunlight in winter. To solve these needs of sun and shade, the behavior of different types of sunshades has been analysed. The effectiveness of these will be conditioned by their own geometric characteristics, by the geometry of the window hollow and the orientation of the façade in which they are located.

To evaluate the improvement of the energy efficiency of the building, an energy simulation will be required. In order to carry out this simulation, we will recreate the actual climatological conditions of the environment into a virtual scenario with the geometric and material characteristics. We will make it by means of the computer tool for sustainable design Autodesk® Ecotec® Analysis. With the help of this software we will obtain results of insolation and lighting for each solution provided. These two items are the most relevant for the comparative analysis and subsequent conclusions.

3.1.2 Analysis of the shadow factor and proposal of a new method of calculation by Rafael Sollero López

Rafael Sollero López (student) elaborates this MTP. The work carries out an analysis of one of the geometric parameters, “the shadow factor”, that influences the energy certification of a building. After the geometric analysis, we propose a new method of calculation, denominated “Corrected Shadow Factor”.

The certification of energy efficiency of buildings is becoming increasingly important, drawing greater attention from public administrations. We will apply the knowledge of solar geometry, testing the software proposed by “Technical Building Code” (CE2). We will analyze the influence that “shadow factor” has on the calculation of “simplified energy efficiency certification” through this software (CE2),
exposing its defects and virtues. Finally, we will propose a method of calculation to overcome the deficiencies found. For this, we will create a 3D CAD model of holes, with which we will find the projections of the shadows. We will quantify these data to operate through Excel®. Taking into account the analyzed, we will finally propose calculation of the “corrected shadow factor”.

3.1.3 Analysis of the environmental comfort in relation to the soleing and solar geometry in open spaces by Rafael Bernabeu Rueda

Rafael Bernabeu Rueda (student) develops this project. His MTP focuses on improving the design of control devices for sun’s shadow. An efficient design based on solar geometry is one of the key aspects that determine that people can experience a sense of well-being in open spaces.

There are different methods to evaluate the environmental comfort experienced by the human being. These methods define a series of variables that intervene in the complex thermodynamic processes that occur in open spaces. In the present work, we chose to study the Universal Thermal Climate Index (UTCI) model, after a comparison with other existing models. This model has among its input variables the Radiant Mean Temperature (Tmrt), which is intimately linked to solar radiation. Therefore we will study in detail the existing parameters and methods for measurement, calculation or simulation. This gives us the possibility to check the influence of the sunshine on environmental comfort in open spaces through an existing comfort model, which depends on geometric variables.

We will perform a verification of the validity of the Autodesk® Ecotect® Analysis® software tool for the study of open spaces. We will compare the results of the “Tmrt” offered between Ecotect® and ENVImet® software tool. For the simulation, we will choose a real scenario of the city of Seville, specifically the Campus of Reina Mercedes.

3.2 Common results on the methodology used

The contact with the research tasks was carried out in the classroom. These experiences were common to all three students. Teachers devoted much more effort than was contemplated in principle to carry out preparation activities common to all of them.

Student empowerment actions were partially successful in this first phase of classroom experience, since it really takes a lot more time for the student to be completely immersed in the state of the matter. The lack of time to build prior knowledge made it difficult for the student to construct personal criteria of his own. However, the experience in the classroom did have importance to contextualize, in a general way, the significance of Geometry and related knowledge in the new professional scenarios, such as Energy Efficiency in Building. From these reflections, rise the interest for the investigation on the environmental comfort in buildings as well as open spaces.

The state of the art was posed as a personal challenge in each individual work. Thus, the development of creativity, and everything related to specify the research project within a field of study, were actions developed during the tutorial action. The tutorial action became the most important teaching mechanism in the course to promote student empowerment, intrinsic motivation, and all other previous goals.

The oral defences of the three projects were very varied. It was not always possible to eliminate the degree of distress that comes from the public exposure of the project nor was it possible to reduce the students’ interest in the official qualification process and to focus attention on the very action of investigating.

4 CONCLUSIONS

The formative actions carried out in the classroom on research techniques, data management, reference management, etc. are complex topics that should be addressed previously, in courses that are more specialized.

The proposed methodology aimed to produce an optimal experience, eliminating concerns and anxieties from these works thanks to the student's empowerment and involvement in research. The students themselves designed the goals and objectives of each project, which allowed a very high degree of student involvement in the whole process. We can not measure the degree of “optimal experience” lived by each student throughout the process, but with respect to other courses, we can appreciate that they have enjoyed being part of it.
The objective results of the MTP presented are very satisfactory, being works where each student has learned to produce his own research based on his own interests. Also, these are projects that respond to the demands of scientific research that have been assessed very positively by the academics, regardless of any consideration of the advantage or disadvantage of the methodology used.

We propose as an improvement plan, to define the tasks during the investigation and to favor the immediate feedback in each of them, which are the necessary aspects to generate a "flow state" in the research. Specifically, we propose that some formal aspects be better defined from the beginning, such as the type and number of references, scope and field of study, extension of the chapters, etc. The student must construct a knowledge of extensive form, which soon must be set to conform to the limits and the rules.

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REFERENCES


