New Technologies Applied to Training
Evaluation of a New Teaching Methodology for the Descriptive Geometry

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The purpose of this paper is to point out the most relevant aspects of an experience which gathers research processes and teaching practices at a University level, activities in which the authors hereof have been involved for many years. Even though this question has already been widely discussed – being its analysis extremely broad and varied – it is still quite interesting. This issue deals with the incorporation of new technologies in the teaching and learning processes and in the case of this specific experience, it refers to its trial implementation in the classroom.

Keywords: Evaluation; Teaching; Geometry; Informatics

Previous Considerations: Two Projects in a Same Line
At first, the incorporation of the new technologies was suggested in a research project (1997-1999). It referred to a special study of the moving images in the teaching process of the logical-mathematical systems regarding the building and representation of the space geometry.

In the project - now under development - the research line of the previous studies prevails and the teaching practices of the Descriptive Geometry become the subject matter. Therefore, the topic of research is focused on the context of university teaching and the theoretical framework is performed along with a further definition of its operative elements under the light of this broad perspective. It refers to two essentially didactical questions. Firstly, it warns us about the negative consequences of any selection, especially one that emphasizes the means as the most responsible tools for a good teaching. In the second place, it deals with the significance of the students’ learning ways, in relation not only to the teaching process but also to its results.

Objectives of the Project
• To achieve a better teaching quality at a university level, by reviewing traditional classroom practices.
• To validate the incorporation of new technologies in the core of a remarkably open and flexible didactical configuration, which generates room for dialogue, confrontation and thinking among its members.
• To value the participation of the teacher as an irreplaceable mediator, in order to avoid false dichotomy between traditional methods and new technologies.
• To offer the students the possibility of taking part in an experience, which becomes the true theoretical pattern and methodological systematization that revalues their main role for the achievement of growing levels of autonomy.
• To try new didactical situations which always imply going along a dialectical path between the
Some Components of the Theoretical Framework According to the Three Areas of the Project: GEOMETRICAL, PEDAGOGICAL and INFORMATICAL.

GEOMETRICAL AREA

Geometrical Systems of Drawing

The study of the logical-mathematical systems intends to provide a way of representing the tridimensional space in a bidimensional manner, to match the three dimensions of space and the two ones of the drawing plane.

Based on systems of geometrical projections, its operative mechanics answers to rules and patterns, which turn the drawing into intellectual abstractions, allowing strict geometrical figures.

The geometrical systems of drawing are conceptual instruments, which organize the physical display according to a specific view, giving way to different readings and interpretations of shape and space.

Why the Development of the Monge System?

Freshmen come from diverse educational backgrounds. Their curricula might not include contents related to shape and space, its structure, its geometry or its representation. This fact makes those systems which keep the unit of image, as the perspectives, to be better understood and dealt with, than the Monge method. Since this method requires permanent mental images of the tridimensional space for its understanding, it poses difficulties, requires a big effort to be interpreted and a higher degree of intellectual abstraction in its conception and mechanics.

This mental construction allows the maturity of the abstract thinking in favor of the logical-deductive process. Seeing comes after reasoning, but never before.

The use of the digital system generates new dynamic fields for learning, it adds variables to the visualization of the tridimensional space as time, movement, light, texture, color and sound, making the concepts of shape, space and its representation easier to understand.

PEDAGOGICAL AREA

Teaching geometry as part of the curricula of the students of Architecture and Industrial Design constitutes a special case in itself within the university teaching.

In this sense, it lies on political - social, scientific, epistemological and pedagogical – didactical grounds of any classroom project which expects to overcome lack of historicy and technocratical biases.

The incorporation of new teaching technologies, far form replacing the teacher, is a challenge to his or her critical and creative capacity. The usage of means of middle and high technological complexity requires training and planning, variables in favor of the teaching quality and, hence, of the learning processes. Technologies do not cause changes in social relationships, on the other hand, the resulting demands cause technology to evolve (Tedesco, 1995).

The research process engages the classroom, as a perfect setting for communication and spreading of knowledge. To guarantee these processes are inside the didactical field, a different approach is required in relation to the pattern imposed by the contemporaneous form of a culture, which is almost exclusively ruled by the mass media, and the extreme versions of technocracy.

PC-assisted teaching will free institutions and classrooms from the load imposed by the exclusive use of traditional resources. The purpose is clear: to save actual and symbolic time for a meaningful and socially shared learning, which allows us to focus on the reality of the context and the subject on its multiple and complex interrelationships. Hence, it will be possible to favor the critical appropriation of all cultural products (Benavides, Oliva G., Ramos, 1998).
Through a planned research, it is expected to obtain data to support the idea that methodologies which lie on multimedia programs may favor the learning processes, without affecting the teacher’s active participation and the valuable contribution of the communication among peers. Therefore, both, technical means and human involvement will lead to the development of cognitive skills and abilities, which can guarantee students to regulate their own learning processes by themselves.

**INFORMATIC AREA**

General guidelines
The concept of multimedia refers to the combination of sound, graphics, animation and video through the computer.

A multimedia environment intends to bring informatics closer to more intuitive and familiar realities, relating digital information and the objects we usually handle.

The user’s interphase includes the way in which the operator interacts with the computer, the messages he or she receives on the screen, the answers of the computer to the use of other devices, etc.

The hypertext is a document, which gathers images, texts, sounds or videos related through links in such a way that when selecting a word or a graphic one leads to another. It is a system of work presentation in which certain highlightened words are links to other related documents.

Didactical Ways: The Reason for Going from General to Specific
The problem of the method and the methodological options is a question of knowledge, that is the cause of its epistemological basis. This circumstance shows the unique character of each didactical situation, discarding all possible generalization. That is why it is said that the method and its methodological operation always imply a construction.

We have chosen a methodological way, which goes from general to specific, as this kind of learning is strongly related to the perception. Research work in this field supports the concept that the subject faces the image, firstly in a broad manner, then, syncretically, and after the analytical process, it creates a new synthesis which is closer to the real one but never its copy. The meanings of the perceptions vary according to each person.

About the Modes
In order teach the Monge System in the digital program two types of modes are used: *the tutorial and the heuristic*. (Cabezas, Mariano, Oliva S, 1998). In the first case, the way has been previously stated and the program guides the student. The heuristic mode suggests an open path and it is the student who takes the decisions according to the success of each step taken. Thus, the students have the chance of checking their own learning process searching for growing levels of autonomy.

The Construction of a Sequence for a Digital Educational Program
The suggested sequence leads the students from the figurative image of a socially acknowledged cultural object to the drawing – as the formal representation of an object in the space – to go on, in successive screen images, to projections within a space axonometric scheme. This space scheme is used in the Monge System to make projections clear. Due to the simultaneous visualization of the three dimensions of the shape, the system allows a quick understanding and an easy geometrical configuration of the space where, through animation, the vertical planes fold over the horizontal one showing the projections in the Monge System. These short and lineal sequences, organized according to the “tutorial mode”, will be a sufficient contribution of information and introduction of the most complex appendixes of the program, developed through heuristic modes.

These provide a method of inverse performance; there are no predefined ways, but only a starting point that is the conceptual support of the geometrical abstraction and an objective to be reached. The subject-matter has been deeply analysed in its logical
structure, with the resulting choice of concepts and their relationships, organized by items to which the students will have access, depending on their own choices.

The students will be the ones who will define their way between the starting point and the expected target, doing it in a dynamic manner and along an open path. Therefore, the objective is not only the understanding of the topic, but also the possibility of building a logical way for the conceptual and operational incorporation.

The information appears on a screen and within it, a graphical window or a hypertext, which overlaps with the next one in a simple manner, through the help of indicators for each option, according to the students’ requirements. They can go forward or backward, and also be helped by a text which appears along the graphical development.

- Semistructured initial survey. It recorded previous knowledge on computers, orientation of middle-education studies and expectations from the course.
- Performance of the cognitive self-report (Oliva G, 1996 and 2000), to know their usual ways to react before learning, their perception as learners, and their preferences in relation to the teacher’s participation in the management of the process.
- Group formation: The three following groups were formed according to the students’ decisions: digital, traditional and mixed.
  - Application of intervention methodologies for each of the groups: trial of the educational program with theoretical and practical assistance only by computer, for the digital group; teaching through digital and analogical means for the mixed group; teaching with analogical means, for the traditional group.
  - Interviews: An open interview was carried out with each group. The students provided their own thinking about every teaching way, reasons for their choices, suggestions, changes and corrections in each case.

Data Processing
The table 1 summarizes the variables, indicators and significance of each case.

Interpretation of the Information
Digital Group: In relation to the strategic level, 50% show a logical or relatively logical sequence when studying; the other 50% either provide an insufficient description —where no behavior could be defined - or do not answer to the item.

Regarding the requirement level of the teacher’s participation in the learning process; 70% of the students prefer an external teacher’s participation; however, this option does not cancel their decision-making process.

Finally, their own perception as learners with a higher or lesser degree of self-determination agrees

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<th>Variables</th>
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<td>Group composition</td>
<td>-Gender</td>
<td>Low</td>
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<td></td>
<td>-Age</td>
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<tr>
<td>Starting level of the students</td>
<td>-Previous knowledge about computers</td>
<td>Middle</td>
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<td></td>
<td>-Middle education orientation</td>
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<td>-Expectations from the course</td>
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<td>Cognitive style</td>
<td>-Strategic level</td>
<td>High</td>
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<td></td>
<td>-Requirement degree of the teacher’s participation</td>
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with the former results, since answers such as “relatively” or “only in some cases” represent an 80%. Only 10% consider themselves as totally independent and the remaining 10% do not answer.

The group believes this is a very satisfactory experience; they consider the program is very clear and easy to understand.

The most outstanding aspect is the possibility of working at one’s own pace. “You can manage the class; you can go forward or backward”, they comment.

Special interest is given to the characteristics of the digital program, which has other communication codes.

The group suggests adding a help menu and practical exercises in the program.

In short, the following quote summarizes their testimony: “I liked the program, having the chance of stopping and getting the image right there, and drawing it...”

**Traditional Group**: Regarding the strategic profile, 50% fall in the logical or relatively logical sequence; 33% refer to an indifferent sequence and 17% do not provide sufficient description.

In relation to the process management, although 60% of the group prefer the teacher’s participation, some choices indicate self-determination. Therefore, most of them consider themselves as relatively independent students.

During the interview the group restated their choice: “To learn in a traditional way” from expressions such as: “You see things more clearly....” “We’d rather not work with the computer. At least me, I like to draw with a pencil.” “Drawing with the computer gets away its essence, its grace...”

**Mixed Group**: 50% of the group fall in the logical or relatively logical sequence, 28% provide an insufficient description and 22% prefer an indifferent sequence.

In this group, 65% choose the teacher’s participation, with lower levels of autonomy. Almost 80% indicate between relatively alone and alone, in some cases.

During the interview, this group tends to consider the digital program as a complement of the theoretical class, to be used in case of doubts. All of them believe both teaching ways are reiterative and time-consuming if systematically and massively applied, hence, the digital modality should be used for clarifying or rounding-up topics.

When they were asked whether they would talk to the assistant teacher or they would rather resort to the digital program to clear doubts, both possibilities were considered. Some students stated they would use the program if this included the image-building process; other students clearly chose the program and others said they would talk to the assistant teacher.

This group shows a slight tendency to higher levels of dependence and external management. It should be stated that this characteristic affected the choice of the teaching modality, which indicates both the traditional class and the access to the digital program as ways of guaranteeing the understanding.

In short, the groups are very homogeneous. Their strategic levels are similar. It is possible to observe half of the members answer to logical or relatively logical sequences in all cases. The prevailing strategies are, searching and organizing material and organizing and reviewing information. Nevertheless, in each group there are cases of disorganized behavior and, in some of them it is possible to infer memory reactions. It is also observed lack of answer or insufficient answer, which leaves room for uncertainty regarding this variable in half of the cases.

At the same time, the number of students who chose the teacher’s involvement in the learning process is similar here. In all groups, the teacher’s participation is expected to be from 60% to 70%, showing a relative degree of student’s dependence.

**Relationship – Cognitive Style – Performance**
The examination criteria, procedures and instruments to be used were fixed in order to score the students’ performance.

Three quizzes were given to the groups. Those quizzes consist of application exercises which
involved both the conceptual understanding and the progressive performance of procedure abilities.

In the quizzes, the student is reelaborating the theory, but he or she may count on the teacher’s help if he or she considers it necessary. The teacher only takes part at the student’s request, as the former observes and registers his or her performance in the resolution of the assignment.

The conclusions obtained from the performance in these cases were taken into consideration according to an extensive criteria of procedure shown in the following categories: high level of performance (H), middle level (M), low level (L).

First mid-term exam: In this case, the regular numerical scale: 0 – 10 was used to score.

On a second stage, two quizzes and a further second mid-term exam were distributed.

Those students who had failed any of the two mid-term exams, had the opportunity of sitting for a make-up exam.

Finally, a general conclusion of the performance of each student was obtained, shown both in a qualitative and quantitative way.

Relationship – Cognitive Style – Teaching Modality
The protocols were newly examined and the information obtained was compared with the performance results and with the observations done by those teachers in charge of the students during the instruction work, quizzes and examinations. For each of the three groups the following should be stated:

Mixed Group
In 75% of the cases, there is a positive relationship between the cognitive style, according to the information provided by the students, the performance results obtained and the teachers’ observations. There are certain coincidences between those who show a logical sequence (LS) or a relatively logical one (RLS) with an explicit reference of metacognitive activities or between those who, at least, show signs of autonomy and middle or high performance.

On the contrary, when sequences that involve memory signs, without autonomous strategies are given, the performance is also low and the teachers observe difficulties in the understanding.

This relationship is not seen in 17% of the cases in which, for instance, the resources above are so poor that we might think they fall into erratic style, but the performance is middle to high. In other example, due to the mentioned sequence and the autonomy characteristics which are inferred from the record, a high or at least middle performance should be expected, however, the performance is low and teachers point out that “individual attention is required”.

In the other 8% of the cases, no self report by the students is provided.

Digital Group
The relationships between the mentioned styles and the performance is positive.

There is no record for the remaining 20%.

Traditional Group
60% of the cases show absolute coherence between the mentioned procedures, styles and the obtained performance.

20% of the cases, do not match with the expectations, given the information provided by the students.

A case with clear signs of autonomous behavior, use of self-determining strategies and defined preference for the self-management in the process is provided as an example. All these conditions could lead us to expect a high performance; in spite of this, a middle one is obtained.

Other 20% is clearly incongruous: the poor procedures informed by the students do not match with the high performance obtained.

Interpretation
We have found an interesting inflection point where we could base the decisions that will direct future actions: it is the congruence or non congruence
obtained between the cognitive styles and the teaching modalities. In this way, those cases in which the examined variables are related in a positive way and in an important proportion (75% for the mixed group and 80% for the digital group) carry out a trial use of the digital program which seems to be successful both in the single and mixed modality.

The traditional group shows the most diverse results: however, this does not allow us to think it as inapropiate or obsolete, it only make us believe that both, the cases of congruence and non congruence are our point of inflection, and although they are fewer, the latter encourage us to believe that those that show the complex links between the cognitive styles and the teaching methods are not easy to understand. The power of regulation of these kinds of teaching resources (didactical measures), specially in the theories of the teaching design are presumed...

The real influence of these resources of external regulation, in relation to the use of study strategies... is not very clear (Vermunt 1996)

Conclusions and Prospects
The obtained and mentioned results offer the possibility of new links of research. They could be analysed through the following questions:

Are the cases which support the congruence between the cognitive style and the performance also representative of a good coupling, that is to say, an articulation or adjusted union between cognitive style and teaching method?

Those who mean to focus their research on meeting points and mutual enrichment between teaching and research certainly hope to continue this task.

In this case, should the repetition of the experience assume that those students who respond to a self-directed style, with an efficient use of metacognitive strategies will take more advantage of the single digital modality?

For those who respond to a style which requires a greater external direction, could the mixed modality be more efficient?

At the time of writing this paper, the members of the Geometry group are neither in conditions to anticipate the decisions that will guide our future work nor if we are going to have the human and material resources required by this project.

Nevertheless, we can state that the research process here described has provided a valuable contribution to the group, both for its growth as researchers and for its performance as teachers, as it has allowed us to restate our regular practice in the classroom and to give a new dimension to the intrinsic value of the components of the didactical system. This value increases in the interactive patterns as long as they cooperate with each other.

References