ASSESSING THE LEARNING STYLES OF STUDENTS FROM TECHNICAL AND NON-TECHNICAL CAREERS: A COMPARATIVE STUDY

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Abstract

The adaptation of the Spanish Educational System to the European Higher Education Space requires emphasizing learning rather than teaching. In this paper we present the results of a survey designed to determine the learning styles of students from the Polytechnic University of Valencia (UPV) involved in either technical or non-technical careers. Analysis was made according to a taxonomy which defines four learning dimensions for an individual: active/reflective, sensing/intuitive, visual/auditory, and sequential/global. Statistical results show that the characteristics of students from both types of careers can differ greatly. Overall, we find that students from non-technical careers are able to achieve a greater equilibrium in terms of adapting to different learning styles than students from technical ones.

Keywords

Learning styles, heterogeneous careers, Documentation, Computer Engineering.

1. INTRODUCTION

The success of any learning methodology is highly dependent on the target class group. Ideally, there would be a different teaching/learning paradigm for each student in order to fully adapt to their characteristics as an individual. Obviously, this approach is not viable with limited time and human resources. Yet, experience tells us that students choosing a same university career are prone to have similar characteristics, which means that we can statistically predict the most optimum strategy to follow when adapting contents to each specific course. Determining such a strategy enables instructors to gain awareness of global characteristics of students in a certain career without previous in-class contact with the group, which can be an important aid, e.g., when preparing a new course to a career the instructor is not familiar with. It can also be an important aid in finding new approaches to the teaching style when the one being used is not successful: low scores, poor attendance, large number of dropouts, lack of interest and poor class participation.

In this work we describe a pioneer experiment at the Polytechnic University of Valencia (UPV) that aims at determining and contrasting the learning styles of different groups of students. The current study embraces both technical and non-technical careers at two Higher Education Centres: the Applied School of Informatics and the Faculty of Informatics. The experiment involves students from two different grades in *Computer Engineering* (Technical and Superior), as well as students from the career *Degree on Documentation*, which is a second-cycle grade that has a mostly non-technical orientation.

The survey we conduct is based on that proposed by Felder and Silverman [1-2], which sets the four dimensions of learning styles: active/reflective, sensing/intuitive, visual/auditory, and sequential/global.

Concerning the first dimension (active/reflective), active learners prefer experimentation in the external world based on the information they gave and are fond of working in groups, while reflective learners prefer to mentally examine and process the information gathered by themselves.

With respect to the second dimension (sensing/intuitive), learners which are mostly sensors prefer memorizing data and facts, handling repetitive problems through standard methods and do not react

well towards surprises and complications. Intuitive learners prefer to solve complicated problems by using principles and theories, and are better at grasping new concepts.
In terms of the third dimension (visual/auditory), visual learners prefer information to be presented visually, since they will understand and retain it better. Auditory learners have the exactly opposite characteristics, retaining verbal information better; they also assimilate concepts better after explaining them to others.
Focusing now on the fourth and last dimension (sequential/global), sequential learners prefer information to be presented with increasing complexity and difficulty, following a linear reasoning process to solve problems. Global learners often require the anticipation of more complex issues in order to obtain a complete overview of the concepts involved; once they understand the concepts involved as a whole they are able to synthesize them better, and so they can solve more complicated problems.
In this work we rely on an anonymous web-based survey to assess the learning style of students according the these learning dimensions. The survey is based on 44 well-designed questions, which allow properly defining the four underlying dimensions. By opting for a web-based survey we have a dual purpose: on the one hand, the results of each individual survey, along with their conclusions, are presented to the student so that they can help themselves by gaining consciousness of those learning methods which are most effective for them. On the other hand, automatic survey generation and result processing allows obtaining global statistics about the student population in a simple, quick, and straightforward manner. These global results offer an insight into those learning methodologies which achieve greater overall benefits. Moreover, the results obtained can be directly applied to any group and/or degree.
According to the Bologna Declaration guidelines, such information is quite valuable and can be an important aid for instructors when selecting the most appropriate methodology to deploy during the adaptation of the Spanish Educational System to the European Higher Education Space.
This paper is organized as follows: in the next section we will refer to some related works in this field. In section 3 we offer the details about the web survey design and functionality. Survey results are exposed and discussed in section 4. Finally, in section 5 we present the conclusions to this paper.

2. BACKGROUND WORK

The field of research studied in this paper has attracted the interest of several researchers worldwide in the past. Different authors have proposed different views of the learning process.
Authors such as Herman [3] relate the learning style to the physical characteristics of the individual, especially to the dominant quadrant of the brain, defining four learning dimensions.
Other works, such as that of Swassing et al., relate the learning style to the information representation system [4], defining three learning dimensions.
Gardner and James associate the learning style to the type of intelligence [5], defining nine different learning dimensions.
Finally authors such as Kolb [6] and Felder [1-2], focus on how information is processed. These authors propose using four learning dimensions, though there are some differences between both proposals.
The issue of determining meaningful learning styles continues to be a topic of interest nowadays, with several theoretical and methodological approaches [7-12].

3. WEB-BASED SURVEY DESIGN AND FUNCTIONALITY

In order to offer an anonymous survey, and achieve efficient data acquisition and processing, we designed a web-based surveying system. The main advantages of a web-based survey are that it can be accessed from anywhere with an Internet connection, survey generation is automatic, and data analysis and storing can be automated. The main disadvantage is that participation and reliability control can not be so strict as with a traditional paper-based survey.
For this survey we consider that the results obtained are reliable for two reasons. The first one is that the survey was limited to students: they were individually notified of the survey existence through directed e-mail, and access from the outside of the UPV was blocked. The second one is that, due to the nature of the survey, we do expect that those students participating in the survey are a representative sample of the student population, without any obvious bias towards any specific group of students.

The survey itself is based on that used by Felder [13], and consists of 44 questions, 11 questions per learning dimension. Each question has two options, which are related to the different learning styles for a same learning dimension. So, the score obtained on each answer is assigned values of either -1 or 1. At the end of the questionnaire, and for each learning dimension, the scores obtained are added up. This means that score values are in a range that goes from -11 to 11, and that only odd values are possible.
We will now offer more details on the survey the generation and data analysis process, as well as on the database design.

3.1 Survey generation and data analysis

To achieve our goal of obtaining a web-based surveying system it required preparing a server machine running with a web server agent. The survey itself consisted of an ASP application that generated a web page containing 44 questions, along with means for participants to identify their career and education centre (see figure 2).

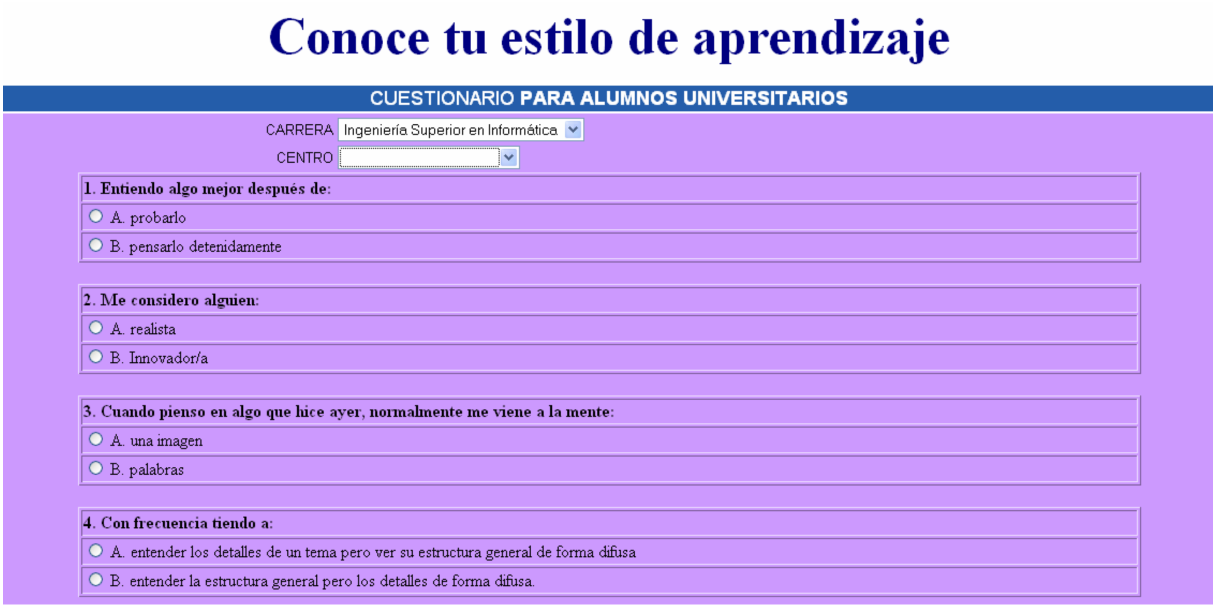

Figure 2. Screen capture of the Survey Web page including the first four questions (in spanish).

Once the whole questionnaire was filled in by a participant, a click allowed data to be sent to the server for processing and storage, and a results page was returned offering each participant detailed information about his/her score for each of the four learning dimensions, along with a guide on how to interpret their results.
We now proceed to describe the database that allowed storing both the questionnaire and the survey results.

3.2 Database design

The database used in the survey was designed so that it could simultaneously handle other surveys with different characteristics with few adaptations. It contains three tables used to generate different surveys automatically: *Surveys*, *Questions* and *Options* (see figure 1).

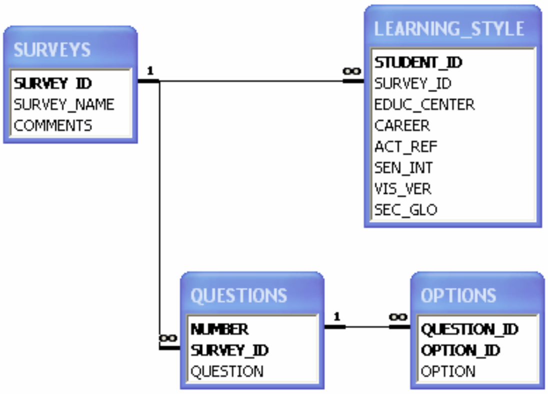

Figure 1. Tables and relations for the database used

The *Survey* table contains three field: *Survey_ID*, used to identify the different surveys, along with *Survey_Name* and *Comments*, which allow storing all the general purpose information required for a survey.
The *Questions* table contains three fields: *Number*, *Survey_ID*, and *Question*. The first two fields are used to identify a question uniquely in the scope of a certain survey. The *Question* field contains the text for the question itself.
Concerning the *Options* table, it contains three fields. The first two (*Question_ID* and *Option_ID*), identify the option within the scope of a *Question*. The *Option* field contains the text for that particular option.
Answers of a given student to each different survey can be stored in many different ways. In our design we preferred to pre-process all the answers and store the scores obtained for each learning dimension in table *Learning Style*, instead of storing the answers for each particular question and processing data later. The main advantage is that we are able to simultaneously reduce storage requirements and offer students their survey results instantly. The main disadvantage is that we cannot check if the proposed set of questions is able to accurately describe the dimensions under analysis. However, since we are relying on a previous study made by Felder [1-2], this is not one of the goals of this work.

4. SURVEY RESULTS AND STATISTICAL DATA ANALYSIS

In this section we will analyze the student participation ratio, along with the results obtained for the different learning dimensions.
Concerning the student population, the survey splits it into three groups: Technical Computer Engineering, Computer Engineering and Degree on Documentation students. All the students from each of these careers were asked to participate through an e-mail sent by the coordinator of the correspondent Higher Education Centre, and the survey was active during the entire month of June, 2006.
Table 1 shows useful information related to each of these three University careers.

Table 1. Student participation data

University Career	Technical Computer Engineering	Computer Engineering	Degree on Documentation
Numerus clausus	400	150+50	75
Number of students	2156	1320	227
Number of participants	119	245	36
Participation ratio	5,5%	18,6%	15,9%

As can be seen in that table, the degree of participation was not high. Possible causes are: lack of interest, time consumed (44 answers required) and the proximity of the evaluation period for the semester. In years that follow we consider that a higher participation ratio can be achieved if the survey is made at the beginning of a semester instead.

With respect to the survey results, we obtain for each learning dimension and for each career an histogram that allows to make an efficient data analysis. On each histogram we have an horizontal scale between -11 and 11, where the value zero represents the frontier between one learning style and the other. The vertical scale shows the percentage of students obtaining each score.
We consider that students that obtain a score between -3 and 3 achieve a good balance for a particular learning dimension. Students obtaining a score of -7, -5, 5 or 7 show a clear preference for one of the learning styles. Finally, students obtaining values close to the edges (-11, -9, 9 and 11) are extremely biased towards one of the learning styles. Such students have serious difficulties to learn if the teaching style is the opposite one, and so should be carefully considered.
By observing the results obtained, we observed that the histograms obtained for students from Technical Computer Engineering and Computer Engineering courses were extremely similar, and so distinguishing both would not offer any additional useful information. So, we decided to join the results of both. From now on, when we refer to Computer Engineering students, we are actually referring to both these careers.

4.1 Results obtained for active/reflective dimension

With respect to the survey results obtained, figure 3 shows two histograms related to the reflective/active learning dimension, where the vertical axis shows the percentage of students obtaining each score.

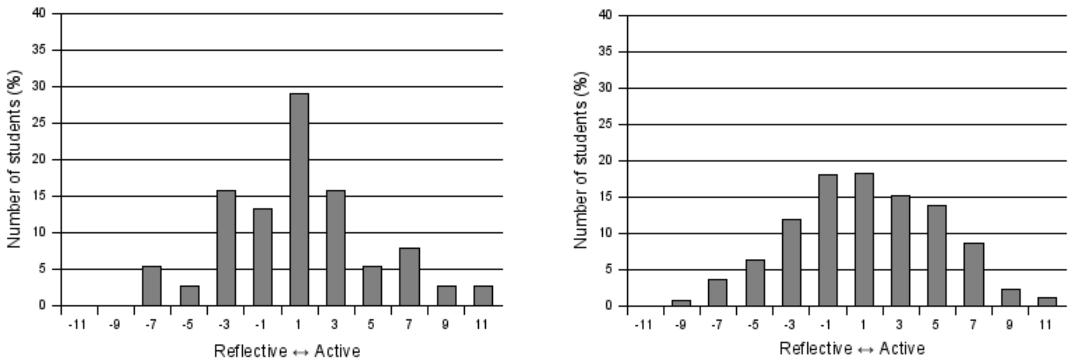

Figure 3. Results obtained for the Degree on Documentation (left) and for Computer Engineering (right) in terms of the active/reflective learning dimension.

From figure 3 we can see that there are more active students that reflective students in both careers (63% for Documentation students and 59% for Computer students).
In terms of students in the equilibrium range (-3 to 3), we find that the population of Documentation students achieves higher rates (73% vs. 63%). In both cases, the total number of students near the extremes of the scale (scores of -11, -9, 9 and 11) is of about 4-5%, a value that is not worrying.
Such data supports the changes introduced by the European Higher Education Space, where active methodologies receive greater emphasis. Nevertheless, purely active methodologies do not represent the best solution either. An equilibrium between reflective and active methodologies is required in order to achieve best overall benefits.

4.2 Results obtained for intuitive/sensing dimension

We now proceed to analyze the survey results obtained for the intuitive/sensing dimension. As shown in figure 4, we can see that there are important differences between students from both careers under analysis.

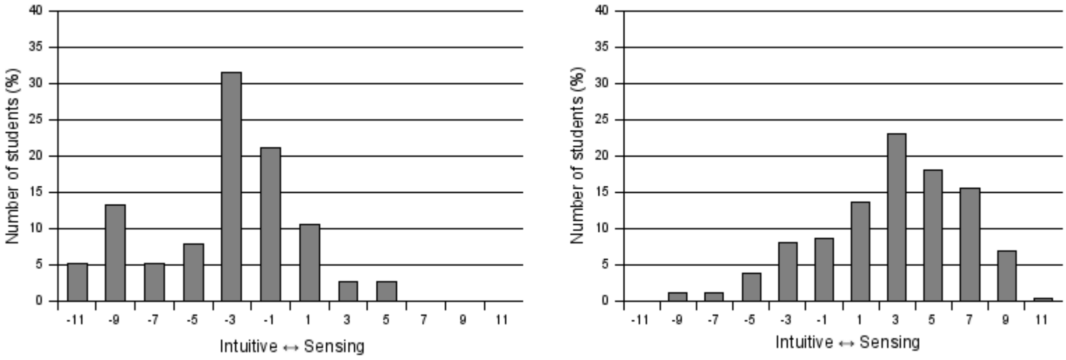

Figure 4. Results obtained for the Degree on Documentation (left) and for Computer Engineering (right) in terms of the intuitive/sensing learning dimension.

To begin with, we can see that there are clearly significant differences: 84% of the students in the Degree on Documentation are intuitive, while for Computer Engineering we have almost opposite results: 77% are sensing instead. Again we can find more students in the equilibrium range in Documentation than in Computer Engineering (66% vs. 53%). Nevertheless, the number of students near scale edges is more worrying for the Degree on Documentation (18% vs 8%). Such results show that a considerable number of Documentation students have learning difficulties when the learning process consists of mere recollection of data. Informatics students are more biased towards data recollection, and a good portion of these students are prone to have difficulties when the concepts learned must be used in a different context. We consider that this data are extremely interesting, since they mean that statistically Documentation students are better at solving completely new problems that future Engineers.

4.3 Results obtained for auditory/visual dimension

With respect to the auditory/visual learning dimension, figure 5 shows that students from both careers have something in common: they prefer visual information rather that auditory (76% for Documentation students and 87% for Computer Engineering students).

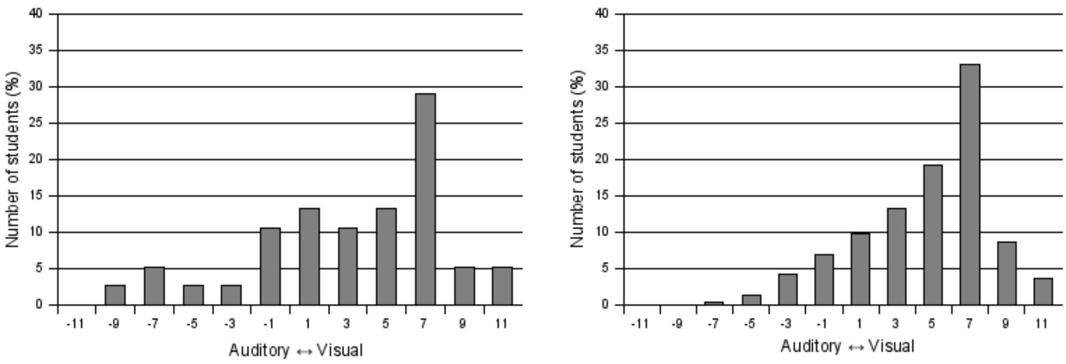

Figure 5. Results obtained for the Degree on Documentation (left) and for Computer Engineering (right) in terms of the auditory/visual learning dimension.

In this learning dimension the number of students in the equilibrium range is much less than for other learning dimensions. Also, it is very similar for in both careers (37% for the Documentation degree and 34% for Computer Engineering students). In terms of students at scale edges, we obtain 13% for the Degree on Documentation and 12% for Computer Engineering, being that for the latter career no single participating student was found to reach limit values for the auditory learning style.

In both courses we can easily verify that class time is mostly consumed with verbal explanation of concepts. The results found in the survey suggest that the majority of students learn mainly from pictures, graphics, diagrams, etc., rather than from what the teacher is actually saying. Therefore, it suggests that using a support such as slides is quite important, and that the pictures shown should be detailed, descriptive and, whenever possible, completely define the concepts being analyzed.

4.4 Results obtained for global/sequential dimension

Finally, we proceed to analyze the last learning dimension: global/sequential.
Figure 6 shows that, as occurred for the active/reflective dimension, the results obtained are more balanced.

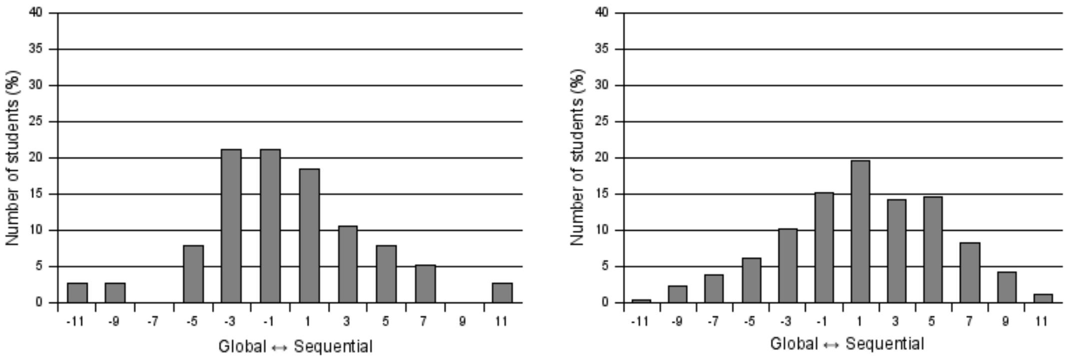

Figure 6. Results obtained for the Degree on Documentation (left) and for Computer Engineering (right) in terms of the global/sequential learning dimension.

Statistically, we find that for the Degree on Documentation 55% of the students prefer global information, while 63% of Computer Engineering students prefer information to be presented sequentially. We consider that these results have some relationship with those shown in section 4.2, since data recollection is more prone to a sequential learning, while intuitive learning processes are more related to a global overview. Nevertheless, any learning difficulties related to the global/sequential dimension are significantly reduced (on average).
As for edge values, we find that the percentage of students that could potentially have difficulties to learn when their preferred learning style does not apply is of 8% in both cases.

5. CONCLUSIONS

In this paper we presented the results of a web-based survey conducted at the Polytechnic University of Valencia (UPV), Spain, whose purpose was to assess the learning styles of students from both technical and non-technical careers, and to find statistical indicators that evidenced their distinctive characteristics. The main purpose of the survey was to aid instructors in their task of adapting their courses to the European Higher Education Space in an optimal manner by focusing on the expected characteristics of the target students.
Analysis of the results gathered shows that students from the *Degree on Documentation* (non-technical) are mostly intuitive (84%), while Computer Engineering students are mostly sensitive (78%). Also, while the former prefer information with a global scope (55%), the latter prefer it to be presented sequentially (62%). However, in both cases, we have a similar equilibrium between active and reflexive students (60% are active). We also find that, in general, most students prefer visual rather than verbal information, and that Computer Engineering students are particularly fond of visual information, being that only less than 13% of the students prefer verbal information instead.
Overall, we find that students from the *Degree on Documentation* achieve a greater equilibrium in terms of adapting to different learning styles than students from *Computer Engineering* (62% vs. 41%), which can be explained by a more heterogeneous learning process experienced by the former ones.
In the light of these results, we believe that improvements can be made in terms of preparation of classes and new courses, preparation of exercises and preparation of exams.

To complete and extend this survey we pretend to design a distinct survey that reduces the number of questions while offering more options for the answers. The purpose is to obtain more accurate information about our students, and also to validate the results described in this work. Besides, we believe that by reducing the total number of questions the number of participants should increase.

6. ACKNOWLEDGEMENTS

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