
VERMUNT'S LEARNING STYLES: SEARCHING FOR PORTUGUESE COLLEGE STUDENT'S FUNCTIONING.

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Abstract

The current study addressed Vermunt's model of learning styles (Vermunt, 1987, 1996, 1998, 2005) using the clusters methodological approach. A Portuguese higher education sample was analysed in order to build a comprehensive picture of its functioning. It was intended to determine if there were gender differences, age differences, as well as to see if there were relationships between learning styles, attending year, ,studies scientific area and age. 370 Portuguese university students, (male=119, female=251) coming mainly from the Catholic University of Portugal participated in the study. The sample was between 17 to 25 years (M=20.01; SD=1.61). All students were attending the first university education cycle (according to Bologna's protocol). Respondents completed the Learning Styles Inventory (ILS, Vermunt, 1994) and a demographic questionnaire.

Results are consistent with Vermunt's proposal. It was found an association between learning styles, scientific area and students' attending year. Results are discussed at theoretical and interventional angles.

Key-words: Learning Styles; Portuguese Higher Education Students; Cluster Analysis; Demographic and contextual differences

Estilos de aprendizagem de Vermunt: à procura do funcionamento dos estudantes portugueses no ensino superior

Sumário

Este estudo abordou o modelo de estilos de aprendizagem de Vermunt (Vermunt, 1987, 1996, 1998, 2005) utilizando a abordagem da construção de *clusters*. Analisou-se uma amostra portuguesa de alunos do ensino superior em ordem à construção de uma imagem compreensiva do seu funcionamento. Pretendeu-se estudar diferenças de género, bem como observar relações entre os estilos de aprendizagem, ano, área científica e idade dos alunos. 370 estudantes portugueses (homens=119, mulheres=251), maioritariamente da Universidade Católica de Portugal participaram no estudo. As idades variaram entre os 17 e os 25 anos (M=20.01; DP=1.61). Os participantes frequentavam o primeiro ciclo do ensino superior (segundo o protocolo de Bolonha). Os respondentes preencheram o Learning Styles Inventory (ILS, Vermunt, 1994) e um questionário demográfico.

Os resultados são consistentes com a proposta de Vermunt. Encontraram-se associações entre estilos de aprendizagem, área científica e ano de frequência. Os resultados são discutidos à luz da teoria e da intervenção.

Palavras-chave: Estilos de aprendizagem; Estudantes portugueses do ensino superior; Análise de *clusters*; Diferenças demográficas e contextuais.

Introduction

Literature on learning processes support that students spontaneously make use of specific combinations of learning activities identified by Vermunt (Vermunt, 1987, 1996, 1998, 2005; Vermetten et al., 1999) as learning strategies.

Attempting to build a multidimensional diagnostic instrument on student learning, three main areas of learning components were integrated; namely cognitive processing strategies, affective activities and regulation activities, Vermunt (1998) presented the Inventory of Learning Styles (1994) where the four main areas of learning processes were tested in a model of regulation of constructive learning processes (Vermunt, 1998).

Processing strategies are thinking strategies. This main group of activities were described as, (1) Deep processing strategy which combine student's activities (1.1) learning activities of relating and structuring matters and (1.2) critical processing activities; (2) Stepwise processing strategy, the learning activities of (2.1) analyzing and (2.2) rehearsing and memorizing, and (3) the Concrete processing strategy, that is, concretising and applying matter by connecting it to one's experience while using what the subject has learned in the course throughout his/her own practice.

Regulation strategies command cognitive and affective activity domains, therefore influencing learning results. There are also three main strategies that can be observed within this sphere: (1) Self-regulated strategy described as an approach where students call upon themselves to regulate the activities which are subdivided into (1.1) learning processes and outcomes, regulating the learning process through planning, monitoring, diagnosing eventual problems, testing him/herself, making adjustments in procedures and reflecting, (1.2) Learning contents, that is, searching for learning sources outside the course outline; (2) External regulation strategy, characterized by the external regulation of the learning process, (2.1) learning process, the learning process which is regulated by teachers, textbooks, learning objectives, etc., and (2.2) Learning outcomes, testing learning results by tests, assignments and questions provided mainly by the syllabus environment; (3) Lack of regulation, that is, when students are incapable of regulating their own learning process but essentially feel that the external regulation provided does not give them enough support.

Mental learning models: "coherent system of knowledge and beliefs about learning" (Vermunt & Vermetten, 2004, p.362). (1) Construction of knowledge, learning to acquire knowledge by him/herself and to have insight

about it. To learn is the task of the student him/herself. (2) Intake of knowledge; learning is faced as incorporating knowledge of the course through memorising and imitating; the other learning activities are the teacher's responsibility (3) Use of knowledge; gaining knowledge for practice. Students and teachers are both responsible for the learning tasks. (4) Stimulating education; learning is seen mainly as the student's task, but nourishing constantly the stimulation of performing these activities by teachers and textbooks. (5) Cooperative learning; implying that much importance is given to learning with fellow students.

Learning orientations are the personal goals, intentions, motives, expectations, attitudes, concerns, and doubts regarding one's personal studies (Vermunt & Vermetten, 2004, adpt. p.362). (1) Personally interested; to study even when the interest is out of the course subjects and developing oneself beyond strict academic terms. (2) Certificate oriented; striving for academic success, passing exams and obtaining a diploma. (3) Self-test oriented; studying to test one's own competences, proving to self and to others that one has the ability to cope with higher education burdens. (4) Vocation oriented; the objective of obtaining skills in order to successfully execute a profession and to increase the possibilities of getting a job. (5) Ambivalent; demonstrating a distrusting and disbelieving attitude toward studies, abilities, course area, etc.

Learning styles can be influenced not only by demographic factors like age and gender, but also by contextual variables. Vermunt (2005) opened the theoretical possibility that learning styles are in fact influenced by age, since learning is a developmental construct. Regarding gender's influence on learning styles literature is rather inconsistent. Some studies (e.g. de Lima, Bettati, Baratta, Falconi, Sokn, Galli, Barrero, Cagide & Iglesias, 2006; Zeegers, 2001) found no differences regarding gender, while others found opposite results (Severiens & Dam, 1997; Van Petegem, Donche & Vanhoof, 2005). As far as contextual factors in the academic year and scientific course area are concerned, literature presents robust findings of both variables influencing learning styles (Vermetten et al., 1999; Rabanaque & Martínez-Fernández, 2009; Vermunt, 2005; Vermunt & Minnaert, 2003).

Finally, the Vermunt's model of regulation of constructive learning processes tested the hypothesis that Mental learning models and Learning orientations predict Processing strategies, mainly indirectly, through Regulation strategies (consult Vermunt, 1998, p. 153), which makes this model a active and attractive model to work with.

Aims

This study aimed to evaluate the function of learning styles among a sample of Portuguese higher education students, using the methodological approach of cluster's deriving theoretically each statistical group using the Vermunt's framework (Vermunt, 1987; 1996, 1998; Vermetten et al., 1999). Cluster's approach allows one to verify the learning styles model's accuracy, whilst the relative frequency of each style in the collected sample can also be established. Generally it is expected that Portuguese students replicate Vermunt's concept of learning styles.

Finally, attempting to build a more complete portrait, it is intended to verify if age, gender, academic year, and science course area were associated with learning styles.

Method

Sample:

Data was collected by means of a survey (self-administrated in the classroom and on-line). Subjects were asked to respond to the 100 items version of the Inventory of Learning Styles (ILS, Vermunt, 1987, 1994, 1996, 1998 Vermetten et al., 1999), and to give information on some demographic data concerning academic institution, year and course attended, age and gender.

Due to age dispersion, and also because this study focuses on the first cycle defined by Bologna's agreement, the final sample was reduced from 500 to 370 respondents (male=119, female=251) coming mainly from the Catholic University of Portugal (n=355; other public universities n=15) with ages ranging from 17 to 25 years of age (M=20.01; SD=1.61). All students were attending the first university education cycle (according to Bologna's protocol), in undergraduate courses between the 1st and 4th. Year (freshmen=124, sophomores=169, third grade students/finalists=67, and fourth grade students/finalists=10). All respondents were Higher Education Students attending courses at Porto, Aveiro, Coimbra and Algarve's Public Universities, though the majority (91%) came from the Catholic University of Portugal, Porto Pole, a private University with a special status that makes it the only Portuguese private higher education institution equivalent to public Portuguese universities. For statistical purposes, respondents were divided into three age groups, namely, 17-19 years of age (n=157), 20-22 years of age (n=185) and finally, 23-25 years of age (n=28).

Instrument:

In order to answer the research questions the Inventory of Learning Styles a self-report in a five point *likert* scale measured by Vermunt was used (ILS-100 items version, Vermunt, 1994). ILS consists of four major scales, domains or learning components, subdivided into five subscales. Each major scale was composed of 25 items. Due to Confirmatory Factor Analysis, three items from the Portuguese ILS version were removed (item 55 from certificated directed scale and, items 52 and 69 from personally interested scale).

Each scale (Processing strategies, Regulation strategies, Mental learning models, Learning orientations) has five subscales, already described in the introduction, in a total of 20 dimensions. For Processing and Regulating strategies, subscales can be aggregated into three major scales, namely, Deep, Stepwise and Concrete processing, Self-regulated, External regulation and Lack of regulation strategies.

The ILS was translated into Portuguese according to the guidelines of the International Test Commission (Hambleton, 2005). The scale was then

submitted for statistical procedures in order to establish its psychometric properties. Local adjustment studies were initially performed in all twenty subscales. First order Confirmatory Factor Analysis presented adequate fit indexes, with CFI's ranging from .89 to .95, SRMR between .047 and .064 and RMSEA amplitude between .064 and .079.

Internal consistency was measured by the Cronbach's alpha score, presenting values between .32 (for Personally interested subscale, but being considered the optimal value for this short scale with three items in the local adjustment studies using EQS 6.1) and .87. Most alpha values found were around the cut-off point of .70.

Methodological strategy:

This study has a cross sectional design. Research questions were answered statistically appealing to clusters combinatory method (Hair et al., 1998; Leask & Parker, 2007). This technique of cluster building uses a clustering algorithm combination of the Hierarchical and the K-means analysis approaches (Hair et al., 1998). A single solution statistical strategy was used, in other words, a theoretical *A-priori* approach based on Vermunt's work was performed. All twenty dimensions composed of ILS's four scales were used in the process; the former were submitted to a bivariate the correlational procedure (Pearson's *r*, two-tailed significant test, $p \leq .05$) in order to decide if the statistical clusters validation would be performed using Multivariate or Univariate Analysis of Variance (MANOVA's or ANOVA's), due to the statistical assumptions on variance analysis (multivariate testes using Pillai's trace significance criteria and post-hoc tests using Scheffé's significance criteria, both at a statistically significance of $p \leq .05$). The same procedure was used to test multicollinearity assumptions.

Finally, chi-square procedures were carried out between the four styles clusters and the categorical variables that were the object of the last research question: (i) age (three groups: 17-19, 20-22, and 23-25 years of age), (ii) gender, (iii) first cycle academic year (from first to fourth year of the first academic cycle, although the third and fourth year were collapsed into the final year (due to the low effective of fourth graders in the sample), and (iv) science course area with courses grouped into four clusters: Biotechnologies (n=51; Biosciences, Bioengineering, Biology, Biochemistry and Nutrition Sciences); Humanities (n=34; Communication Design, Law, Languages and Communication and Translation); Economics and Management (n=114; Economics, Management); Health/Care Sciences (n=165; Clinical Analysis and Public Health; Nursing, Psychology, and Psychomotor Rehabilitation). The sample also had a group of Arts courses (n=6), though they were not included in the analysis because it violated largely the assumptions on cells count. Clusters and subsequent analysis were performed using PAWS 18 statistical package.

Results

Cluster analysis:

In order to test the assumptions of cluster analysis procedure, a bivariate correlation with a two-tailed test of significance was performed between all ILs' twenty sub-scales. As a multicollinearity between the twenty variables correlational values was not found (Pearson's r between .004 and .667), although assumptions for performing cluster analysis were met. On the other hand, validation analysis should contemplate both MANOVA and ANOVA's approaches since not all five sub-scales of each domain correlate significantly to each other.

The tested single solution resulted in a key were the groups were significantly different, with possibilities of derivation along with Vermunt's theoretical guidelines. According to cluster analysis, a line graphic was built as a first approach to the theoretically Vermunt's Learning styles derivation (see Figure 1., below).

Group 1.

Looking at Figure 1., it appears that students in this group prefer to use deep and concrete cognitive processing strategies, although appeal to stepwise strategies above the scale average. In terms of regulating of learning strategies, though clearly self or internally regulated, this group also gives importance to external sources of learning regulation. In fact, the highest scores in all the learning regulation five subscales are found in this group, maybe because the Portuguese teaching system very much appeals to extrinsic evaluating factors, giving the latter a great weight which students may also be taking in mind. For learning orientations, this group is both personally interested and also self-test oriented; however, they also score high in the other dimensions of this domain. Once more, the Portuguese learning system, parents, employers and other stakeholders, give much attention to certifications and the vocational paradigm which is still very centred on the "gift" or innate talent idea. Finally, these students are practice oriented and seem to give higher importance to stimulating education, that is, they think learning activities are their "job", but they must feel continuously supported and challenged by teachers and other learning sources (books, authors, etc.).

Group 2.

Group 2 has a profile very similar to the first group, though the average results are all lower than the latter. In terms of processing strategies, it can be traced back to an almost horizontal line between deep and stepwise strategies, though clearly the concrete processing has the primary role. As a result practice is very important for these subjects. For regulating strategies, the peaks are found on self regulation of learning contents and external regulation of learning results, so sources outside the syllabus are also very important; testing educational results by external means is also important, according to what was already mentioned concerning the importance given by Portuguese educational system to external evaluations. As in the first group, though with lower scores, group 2 is personally interested and self-test oriented, However, vocation and certificated orientation are also important. The same idea introduced in the previous paragraph is also valid for this group, that is, certification is highly valued in Portuguese culture. Finally, for mental models of learning construction,

use and stimulating education are the main functioning for this group. That is to say that this group finds the use in practice of what they learn to be important. They also consider learning to be their task, even though it is very important to have a stimulating kind of learning.

Group 3.

To relate subjects matters between them and to previous acquaintances, giving them a structure along with the practical use of that knowledge, appears to be the main function on this group, though being critical,, memorising and rehearsing are also important ways of processing the information. External regulation of learning results is the main regulation functioning of these students. This seems to be the most ambivalent group, scoring highest on self-test orientation in comparison with the other clusters, but also because they exhibit the highest average regarding all learning orientations. They scored high in personally interested, certificated and vocation orientations directed, confirming a certain lack of direction regarding the learning orientation functioning, surely to achieve the main goal that seems to be proving to one's self and the world that they are capable of performing well in higher education. As far as mental models are concerned, the highest scores are found in use of knowledge and stimulating education. Although they have the second highest score regarding the intake of knowledge, it is likely that these students value the absorption of knowledge and consider that the task of learning, regardless of it belonging to them, is also largely the teacher's responsibility.

Group 4.

Lastly, group 4 presented the lowest scores of processing and regulating strategies (with the exception of lack of regulation reaching the second position). Memorising and rehearsing, along with concrete processing, seems to be the preferred processing strategies; external regulation and lack of regulation appear at the top of regulating strategies. Although use of knowledge and stimulating education are cited as the main mental models of learning. These students had the highest scores of all concerning intake of knowledge and co-operative learning. Finally, they score high on almost all learning orientations, achieving the second highest average in what ambivalence concerns.

Taking into account Vermunt's descriptions of the meaning of each one of domains' subscales (Vermunt, 1996, 1998; Vermunt & Vermetten, 2004) and Learning styles descriptions (Vermunt, 1987, 2005), and its agreement with the results found in this study, it was hypothesized that group one corresponds to Vermunt's Meaning directed style, group 2 to Application directed style, group 3 to Reproduction directed style, and the fourth group, to Undirected learning style. But MANOVA's and ANOVA's validation procedures could give robustness to this observation.

Clusters Statistic validation: MANOVA's and ANOVA's procedures

For processing strategies domain, MANOVA's results indicate a cluster's significant effect [$F(15, 1092)=26.97, p=.000, \eta^2=1.00$]. Tests between subjects effects the indicated significant differences in relating and structuring [$F(3, 366)=117.44, p=.000, \eta^2=1.00$], critical processing [$F(3, 366)=125.72, p=.000, \eta^2=1.00$], memorizing and rehearsing [$F(3, 366)=16.04, p=.000, \eta^2=1.00$],

analysing [$F(3, 366)=120.33, p=.000, \eta^2=1.00$], and concrete processing [$F(3, 366)=130.67, p=.000, \eta^2=1.00$]. Post hoc tests show that all groups are significantly different ($p<.05$) for relating and structuring, with Meaning directed style presenting the highest score and the Undirected style group with the lowest. Application directed presented the lowest mean when compared with Reproduction directed learning style; for critical processing, only Application directed style average did not differ significantly from Reproduction directed style ($p>.05$); the highest mean was found again in the Meaning reproduction style. For memorizing and rehearsing and analysing strategies, once more Reproduction directed style group did not differ significantly from Application directed ($p>.05$); Meaning directed style, curiously, presented the highest mean and Undirected style, the lowest. Finally, for concrete processing, all groups differed between them, with the highest mean belonging to Meaning directed style, and the lowest to Undirected style (consult Table 1 for all results).

Regarding regulating strategies, with the exception of lack of regulation (in this case an ANOVA was performed) a MANOVA was carried out. Again a significant effect of the clustered groups in the four dimensions was found [$F(12, 1095)=31.86, p=.000, \eta^2=1.00$]. Tests between subjects effects revealed differences in self-regulation learning processes and results [$F(3, 366)=147.09, p=.000, \eta^2=1.00$], self-regulation learning contents [$F(3, 366)=86.21, p=.000, \eta^2=1.00$], external-regulation learning processes [$F(3, 366)=57.11, p=.000, \eta^2=1.00$] and, external-regulation learning results [$F(3, 366)=83.07, p=.000, \eta^2=1.00$]. All groups differed significantly from each other (post hoc test $p<.05$) in self-regulation learning processes, results and self-regulation learning contents, and external-regulation learning processes, with the exception of Reproduction directed and Application directed styles ($p>.05$). The highest means were reached for Meaning directed style, and Undirected style the lowest ones. For external-regulation learning results, all groups significantly diverged ($p<.05$). The highest and the lowest mean were found for the same styles as before, but Application directed learning style presented a significantly lower mean than Reproduction directed style ($p<.05$). Concerning lack of regulation dimension, ANOVA's tests between subjects did not find a cluster's significant effect [$F(3, 366)=1.88, p=.132, \eta^2=.487$], so groups' means were not different between them (see Table 1).

All learning orientations subscales were submitted to ANOVA's procedures due to correlation values, and the results found a significant effect of Learning Styles on each dimension: (i) personally interested [$F(3, 366)=7.70, p=.000, \eta^2=.988$], (ii) certificate directed [$F(3, 366)=10.61, p=.000, \eta^2=.999$], (iii) self-test directed [$F(3, 366)=14.70, p=.000, \eta^2=1.00$], (iv) vocation directed [$F(3, 366)=24.30, p=.000, \eta^2=1.00$], and (v) ambivalence [$F(3, 366)=6.10, p=.000, \eta^2=.960$]. Post hoc tests found that Meaning directed learning style have a significantly higher personally interested mean when compared with students with Application directed learning style. ($p<.05$) Undirected learning style group has a significantly lower personally interested score than Meaning directed and Reproduction directed learning styles ($p<.05$). The other group's comparisons were not statistically significant ($p>.05$). For certificated directed subscale, Undirected learning style had a significantly higher score than Meaning and Application directed learning styles ($p<.05$), and Application directed group presented a significantly lower mean when compared to Reproduction directed

learning style ($p < .05$). There were not more significant statistical differences to report regarding other comparisons ($p > .05$). For means comparisons (post hoc tests) observed for self-test directed, Application directed presented significantly lower scores than Meaning and Reproduction directed learning styles ($p < .05$). Also, Undirected learning styles presented lower scores of self-test directed when compared with Meaning and Reproduction directed styles ($p < .05$). No other statistical differences were observed ($p > .05$). In terms of vocation directed learning orientation, post hoc tests revealed that Application and Undirected directed learning styles scored significantly lower ($p < .05$) than Meaning and Reproduction directed learning styles. No other significant statistical differences were found ($p > .05$) for other comparisons. Finally, for ambivalence orientation, only Undirected learning style group differed significantly ($p < .05$) from Meaning and Application directed learning styles, with the former presenting a higher mean than the latter's. No other significant results were found ($p > .05$). Consult Table 1 for a complete review of results.

Mental models of learning were variance tested resorting to a MANOVA procedure due to preliminary correlation analysis. Multivariate tests results show a significant effect of cluster groups on mental models subscales [$F(15, 1092) = 16.51, p = .000, \eta^2 = 1.00$]. This effect can be found for (i) construction of knowledge [$F(3, 366) = 46.45, p = .000, \eta^2 = 1.00$], (ii) intake of Knowledge [$F(3, 366) = 42.64, p = .000, \eta^2 = 1.00$], (iii) use of knowledge [$F(3, 366) = 41.01, p = .000, \eta^2 = 1.00$], (iv) stimulating education [$F(3, 366) = 40.90, p = .000, \eta^2 = 1.00$], and co-operation [$F(3, 366) = 19.33, p = .000, \eta^2 = 1.00$]. Post hoc tests for construction of knowledge mean differences reveal that Undirected learning style scored significantly lower ($p < .05$) than Meaning and Reproduction learning styles. Moreover, Application directed learning style presented a significantly ($p < .05$) lower mean than all other three Learning styles. No other significant results were found for this dimension ($p > .05$). As far as intake of knowledge and co-operation is concerned, the only significant differences were found between Application direct style, and all other three styles. The former presented lower scores than the other groups ($p < .05$). No other significant results were found for these two dimensions ($p > .05$). In using knowledge as Mental model of learning, Undirected and stimulating education learning styles significantly differed ($p < .05$) from Meaning and Reproduction directed learning styles; the former presented lower scores than latter's groups. Application directed learning style group also presented significantly lower scores ($p < .05$) than all other three groups in use of knowledge mental learning model. No other significant differences were found for this dimension ($p > .05$). All results can be found in Table 1.

This statistical validation gave additional support to the clusters' derivation. One can see that there are some consistencies throughout the group means which are probably due to the Portuguese learning system and cultural specificities. These particularities respect all four clusters higher values of concrete processing, external regulation of learning results, stimulating education, and self-test orientation. Note that Meaning directed learning style represents about 29% of the entire sample, Application directed learning style roughly stands for 31%, the Reproduction directed learning style for approximately 28%, and finally, the Undirected learning style in the order of 12% of the respondents.

Chi-square analysis: relationships between Learning Styles, gender, age, academic first cycle year and course scientific area

Gender

Chi-square results revealed that in this sample, boys and girls have the same probability to function at each Learning Style approximately at the same proportion [$\chi^2(3, 370)=1.800, p=.615$].

Age

Chi-square association test performed between Learning Styles and age establish no significant results [$\chi^2(6, 370)=3.877, p=.693$]. In performing this Chi-square procedure it is important to note that despite not reaching the recommended 80% limit, a cell (i.e., 8.3%) was expected to count less than 5 (the minimum expected was of 3.33).

Students' first cycle frequency year

The answer to the question "is there a significant association between Learning Styles and the student's first cycle frequency year" was obtained by a Chi-square test between the four Learning styles and three frequency years: 1. freshman, 2. sophomores, and 3. finalists (collapsing the third and fourth years, because Bologna's protocol allow a first cycle length variation in three, four or five years). Results found a significant association between the two variables [$\chi^2(6, 370)=12.558, p=.051$]. It seems more probable that sophomore students would use the Meaning oriented learning style (42.1%), then their freshman (33.6%) or finalist's peers (24.3%). It is also likely that the same kind of pattern occurs concerning Application directed learning style, but this time, the percentage of use is substantially lower in the final year students (12.9%), than in freshmen (42.2%) or in the sophomores' year (44.8%). Reproduction directed learning style is expected to be used a lot more by sophomores (50.5%) than by freshmen (28.2%) or final year students (21.4%). For the Undirected learning style, its probability of use is larger, again, for sophomores (45.5%) than for final year students (31.8%) or freshmen (22.7%).

Interestingly, freshmen are more likely to call upon Application directed learning style, sophomores more probable not to appeal to Undirected learning style (11.8%), and final year students to make more use of Meaning directed learning style. Full results are presented in Table 2.

Students' course scientific area

The Chi-square test procedure was performed having Learning Styles and only four scientific domains in scrutiny as probable associated variables. Results found a significant association between both variables [$\chi^2(9, 364)=17.659, p=.039$]. As shown in Table 3. it can be observed that there is a larger probability that Biotechnology's scientific area students use Reproduction directed style more often (35.5%), than Meaning directed learning style (29.4%), Application directed learning style (25.5%) or Undirected learning style (9.8%). For Humanities courses, students are more likely to use the Meaning directed learning style (44.1%) than the Application directed learning style (29.4%), the Reproduction directed style (14.7%) or the Undirected learning style. Economics and Management students have more balanced results, though

there is a higher possibility that they use the Reproduction directed learning style (29.8%) than the Application directed learning style (26.3%), the Meaning directed learning style (24.6%) or the Undirected learning style (19.3%). Finally, Health/Care sciences' course students are more probable to use the Application directed learning style (35.8%) than the Meaning directed learning style (24.6%), the Reproduction directed learning style (27.9%) or the Undirected learning style (7.3%).

The students that are more likely to use the Meaning (45.3%), the Reproduction (44.7%) and the Application directed learning styles (52.7%) than the other three Learning Styles are the Health/Care sciences courses. On the other hand, it is expected to find more Economics and Management students functioning at the Undirected learning style (51.2%) than in other kind of Learning Styles. Table 3. Presents full results.

Discussion

This study's main goal was to evaluate a Portuguese higher education sample in light of Vermunt's Model of the regulation of the constructive learning process. In fact these results are according to Vermunt's model in what concerns the theoretical premises of Learning Styles.

It was theoretically possible to derive the four styles defined by Vermunt, despite there being some minor differences that are assigned to the Portuguese educational system's operation. Firstly, concrete processing was the most reported processing learning style for all groups, that is, the usefulness or the practical use of knowledge seems to be very important as Portuguese students' cognitive processing scheme. It is not surprising to find this outcome. Results obtained in a reflection activity that gathered higher education teachers, alumni and employers concerning the employment determinants (Rocha, Oliveira & Guimarães, 2010), illustrate that teachers and employers put, in a ten items list, in second place having work experiences when graduates are entering the labour market, although for alumni this item came only in fourth place. This could indicate a strong influence of learning environment on learning styles (Vermetten et al., 1999; Wierstra, Kanselaar, Van der Linden, Lodewijks & Vermunt, 2003), in the Portuguese case, not only from teachers, but also by students' awareness of the labour market requirements.

Another particularity is associated with the high values the students attained in the external regulation subscale. Again, in the above mentioned study (Rocha et al., 2010) one of the scrutinized items was precisely "For a recruitment process, having an average grade of 14 or more (out of 20) indicates that the person is technically skilled". The items selection was prepared by an experts group in employability matters, which implies the idea that the mean average, largely based upon external evaluations, is fundamental in the Portuguese higher education system. Portuguese higher education entrance is based upon national exams that are the "required evidence, based on national marks obtained in the examination and in combination with other factors" (Direcção Geral do Ensino Superior-DGES, 2010), to select candidates hierarchically for admission to their aimed course. The other factors mentioned

between quotation marks are pre-requirement, for example, performing certain athletic tests like swimming or athletics running in order to fulfil minimums to be ranked afterwards by the obtained marks in the national examinations. Additionally, “The use of *clausus* numbers in the access and entry to higher education was originated in 1977 and was justified by the need to safeguard the quality of education by promoting their improvement, regulating the supply of graduates relative to demand and scientific priorities (Law Decree No. 397/77 of 17 September)”, so Portuguese students must get higher averages in order to enter in their preferred course and University without any problems. In fact, the reality is that from the 10th to the 12th grade, the fight for grades is authentic, giving strength to the importance of external evaluations represented by marks that in turn can give the aimed “higher education passport”. This way, parents and teachers also press adolescents to invest mostly in activities that will help them achieve the highest grades, giving little importance to extra-curricular activities that in fact could promote what is called in Vermunt’s perspective as a more internal and personalized way of acquiring knowledge. This calls upon the reproduction or scholastic methodologies to continue in the first cycle of higher education studies, as studies about pedagogical practices in higher education point out (Andr es, 2003) However, several pedagogical reflexions also indicate this when addressing the need for more self-regulated practices and the traditional way of teaching (Ferreira, 2009; Garcia, 2001; Machaqueiro, 2000). In fact what has been stated up to this point also explains the highly stimulated education learning orientation student’s present. The continuous stimulation of learning by teachers is a propellant that calls for students’ certain lack of autonomy in the pursuit of knowledge. In fact, when expository teaching methods that appeal to the scholastic learning model are mostly used, learning self-motivation is lost in relation to theoretical suggestions given in the lectures’ context with the complementary teacher’s powerful role as knowledge detainer. Another dimension that cannot be forgotten is the teacher’s own learning style, which surely affects the learning process of their students (Coffield, Moseley, Hall, Ecclestone & Learning Skills Research Centre, 2004).

As Vermunt himself has stated, style is not a motionless synonym; on the contrary, there is a correlation between personal and contextual influences that make the use of the term pattern more adequate for explaining a ongoing process (Vermunt,2005; Vermunt & Vermetten, 2004). The features mentioned in the last paragraph, transversal to the all sample, seem to be the result of a confluence of factors which include the pedagogical practices and the kind of education traditionally used in Portugal, not only in higher education but also in previous stages of the educational system.

Regarding results by each Pattern, it might be possible to refer Meaning Pattern as Plastic learners, since they seem to call upon all processing and regulating strategies as a way to embrace their personal preferences as the constraints imposed by contextual factors they must cope with. Parallel results were presented by (Donche & Van Petegem, 2009; Wierstra & Beerends, 1996) although with a different nomenclature, flexible learners. Note, however that the main features of deep processing, and internal regulation that characterize the Meaning Pattern are also present in a meaningful way.

As for the Undirected style, it can be argued that it could be interpreted as a mix between the Undirected Pattern and the Inactive learners. (Vermetten, Vermunt & Lodewijks, 2002), However, in this sample, intake of knowledge mean is only significantly higher for the Undirected Style/Pattern in comparison with Application Directed Learning Pattern.

Reproduction Pattern seems to match Vermunt's descriptions (Vermunt, 1996), namely, a stepwise orientation, as an external regulation in terms of results (only significantly lower than the Meaning directed pattern). Clearly they are intake of knowledge oriented, and presented the highest scores on certificated and self-test learning orientations.

Finally, for Application Pattern, again we can find an equivalence in Vermunt's descriptions (Vermunt, 1996, 1998): students in this group presented means indicating a use of either internal or external regulation strategies, presenting the vocation oriented and use of knowledge lowest scores in comparison with the others' groups, but the highest scores between the five learning orientations and the mental models of learning.

Chi-square results find no associations between Learning Patterns and gender. Similar results were obtained in Argentina (de Lima, Bettati, Baratta, Falconi, Sokn, Galli, Barrero, Cagide & Iglesias, 2006) and in Australia (Zeegers, 2001), although Severiens and Dam (1997) found evidence that women use the Reproduction orientated learning style/Pattern significantly more compared to men. Opposite results were obtained in a sample of Belgian teaching students, where females were more Meaning orientated than men (Van Petegem, Donche & Vanhoof, 2005). In conclusion, more studies are needed to reach reliable conclusions. No age differences were found for this sample, although Vermunt highlights the high possibility that these differences in fact exist. "These differences pertain to someone's position in society, the larger amount of life experience that adults bring with them to a learning situation, learning motivation and learning ability." (Vermunt, 2005, p. 207). Maybe because these respondents' age was between the end of adolescence and earlier adulthood, these differences have not yet been found.

Regarding the two contextual factors submitted to scrutiny, not surprisingly, both were found to be related to Learning Styles/Patterns.. For example, Rabanaque and Matínez-Fernández (2009) found that initial higher education students tend to be more reproductive than their final level students' peers. The latter have a more constructive learning conception than intermediate or initial students. Similar results were reported by Vermunt (2005), concerning the Reproduction of learning orientation. Vermunt and Minnaert (2003) also mention differences between first and third semester learning strategies, orientations and conceptions scores in students within a context of student-learning environment. All students increased their deep and concrete processing scores, and also their self-regulation levels. In contrast, Busato and collaborators (1998) found no systematic differences between frequency year and learning styles in higher education students.

Results of the current study found that sophomores are more probable than the other students to use the Meaning directed learning pattern. Perhaps second year students' are more open to explore relationships between matters, and to be more self-regulated because they have more educational experience than freshman. They overcome the initial impact of the new environment (the transition from secondary schools to university), but also they are not yet as concerned about entering the labour market as their peers are in their final year (see Marton & Säljö, 1997; Vermunt, 2005).

It was expected that final year students would use a more Application directed learning pattern than all others students because of Vermunt and Minnaert's findings (2003) about a lack of distinctiveness of the pattern at the freshman's level and also the indication that this style develops later in time, (Vermunt, 1998). Maybe the dismissing process from university context that occurs currently as a career stage (Savickas, 2005) can have a word in these findings. As the perspective of obtaining a job in the third or fourth year of higher education studies is a reality within Bologna's agreement, people don't have sufficient time to develop a more practical approach to knowledge. Since there are few longitudinal studies, and conclusions are rather ambiguous (consult Busato et al., 1998), more research is needed concerning later higher education studies' levels and also to take into account the new reality built upon Bologna's assumptions and guidelines (for a critical perspective consult Morgan & Lydon, 2009).

Sophomores are more likely than final year students or freshman to use the Reproduction learning patterns which make face results from the point of view of teaching styles. Conceivably students use both Meaning and Reproduction learning patterns, since teachers could be more engaged in a teaching style more student-centred or more teacher-centred, which in turn could explain the use of both strategies by sophomores, the ones that have already experienced a first year where they could test the more successful strategy without being at the dismissing point of the academic first cycle process. Additionally, the same argument could explain why the final year students have the greatest representation of Undirected pattern in comparison with their fellow students of the other two academic levels. In fact, if they are in the process of detaching themselves from the academic context, they probably present higher levels of lack of regulation, as they expect to rely upon fellow students to fulfil their knowledge needs. In other words, because they are concerned with their entrance into the labour market, knowledge becomes secondary, as shocking as that may seem.

In general, the most employed learning pattern seems to be the Application directed, maybe because the sample has 45.3% of courses that are clearly vocation directed (Health/Care sciences) which introduce the scientific course area results.

The question about the influence of academic sort of scientific area course is well known within the Learning patterns framework (Lonka, Olkinuora & Mäkinen, 2004; Vermunt, 1987, 2005; Vermetten et al., 1999; Vermunt & Vermetten, 2004; Vermetten et al., 2002).

In this study, Meaning directed learning style was more associated with Humanities than with the other scientific course areas. Similar results were found in DeGroff and McKee study (2006). This learning area cluster was almost solely composed of Law students (31 within 34 students). Results can be explained, conceivably, because Law is a learning area where knowledge has a relativistic approach and as Rozendaal and collaborators found (Rozendaal, de Brabander & Minnaert, 2001; Vermunt & Vermetten, 2004), this epistemological principle relates more with Meaning directed kind of pattern than the absolutistic view of acquaintance.

In this sample, Application learning pattern was more associated with Health/Care Sciences. Since Nursing, Psychomotor Rehabilitation, Clinical Analysis and Public Health, and Psychology courses are essentially directed at practice, it is not surprising that it is the most vocational and matter-of-fact learning pattern, although Vermunt (2005), found this to be different in his study. Perhaps the explanation lays upon the association between psychology, sociology and arts students that the latter study performed, that we believe are not alike either pedagogically, nor in curricular terms, but it can also represent the differences in Netherlands and Portugal's learning traditions in similar areas. For example, in Portugal all the courses included in the Health/Care science group, have real training (in health institutions) during the first Bologna's cycle; in Netherlands Nursing is a professional course rather than a higher education course.

For Economics and Management courses, the current results are quite similar to those presented in Vermunt's study (2005). In both studies, economic students were those most associated with Reproduction and Undirected learning patterns. One possible explanation is that in secondary education, students in the economic field are used to a mathematical approach that makes larger use of the memorizing and rehearsing strategy. Students, therefore, may continue to use a strategy at the higher education level, which is no longer an adaptive one. In this sample, all Economics and Management students came from Catholic University of Portugal, Economics and Management Faculty, Regional Centre of Porto. This school has made an effort to make the curriculum of both courses closer to a pedagogical strategy where self-regulation, construction of knowledge, analytic and critical thinking are in order (Individual Skills Portfolio Project-PIC Project, 2010), so students could be more likely to feel a cognitive dissonance between what was a well adjusted learning style-Reproduction directed and a current exigency in a more Application/meaning directed pattern of learning.

Conclusions and paths for future research

What is the importance of knowing how students preferably learn? As previously mentioned, Economics and Management Faculty, Catholic University of Portugal, Regional Centre of Porto (FEG-UCP), has been working on a curricular reform (beyond Bologna's) whose main goal is not only to provide a challenging learning environment, but also an educational atmosphere that can boost students' success within the current labour market features. Enriching

students with a transversal skills heritage, which can be resorted to whenever necessary, was one of the first concerns within FEG-UCP organizational behavioural department. The PIC project is in fact a result of the latter. Not only to know how students, not limited only to the FEG's students, but how all Catholic University of Portugal, Regional Centre of Porto, can give ideas to facilitate the learning process. Why do Law students have a more Meaning directed pattern of learning? Could we bring to other course students' the process features that bring the latter to have this higher probability? As Linda O'Toole says, "Learning how to learn can be taught" (O'Toole, 2008, p. 73). For teachers, it is easy to become more aware of the several ways of learning when they become more in tune with their students. With this awareness also comes a sense of worry: How am I to cater to so many different ways of learning?

The first step is to find which features are present within our student's way of learning. That much has been already done with this study, but could also present a path for future research. Longitudinal studies are needed to find the processes of learning how to learn. Not only for higher education student's , but throughout all the precedents levels of learning. It is known that several variables can interfere in the learning process, among them, culture (Joy & Kolb, 2009), course demands (Nijhuis, Segers & Gijsselaers, 2008), and gender (Philbin, Meier, Huffman & Boverie, 1995). In fact these longitudinal studies must include a comparative approach in order to find the interfering predictors of a given learning style. But is that all? An important part of the learning process refers to the teaching process. Learning self-regulation, one of the most cherished objectives of the Bologna's Treaty (Morgan & Lydon, 2009), depends much on the teachers' perceived administration of knowledge. This implies certainly, the change of paradigm from teachers' knowledge focus into a more student's knowledge focus (Rozendaal, Minnaert & Boekaerts, 2005), which implies also that the process of learning how to be a teacher must also be self-regulated (Van Eekelen, Boshuizen & Vermunt, 2005).

What has been said involves the notion of a great effort to match teaching and learning styles that cannot be achieved only by students, teachers, researchers, parents, school staff individually (counsellors, supervisors, board), but by all of them working toward reaching the same goal.

Vermunt's learning styles approach proved to be a reliable way to test students learning styles, but much more remains to be done. Comparable instruments to assess the matching teaching styles are needed. It is also necessary to build networks between all of those involved in the learning process so knowledge and learning can overcome the individual differences assessment stage.

References

Andrês, A. M. G. (2003). *Práticas pedagógicas no ensino superior: Um estudo exploratório através do conceito de dispositivos de diferenciação pedagógica*. (Unpublished Education Sciences Master Degree). Faculdade de Psicologia e de Ciências da Educação, Universidade do Porto: Porto.

-
- Baxter Magolda, M. B. (1998). Learning and gender: Complexity and possibility. *Higher Education*, 35(3), 351-355.
- Busato, V. V., Prins, F. J., Elschout, J. J., & Hamaker, C. (1998). Learning styles: A cross-sectional and longitudinal study in higher education. *British Journal of Educational Psychology*, 68(3), 427-441.
- Byron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology*, 51, 1173-1182.
- Coffield, F., Moseley, D., Hall, E., Ecclestone, K., & Learning and Skills Research Center (2004). *Learning styles and pedagogy in post-16 learners: A systematic research report for the learning and skills research centre*. Learning and Skills Development Center Edition.
- Decreto-Lei nº397/77 de 17 de Setembro. Diário da República nº 216/77 – I série.
- De Lima, A. A., Bettati, M. I., Baratta, S., Falconi, M., Sokn, F., Galli, A., Barrero, C., Cagide, A., & Iglesias, R. (2006). Learning strategies used by cardiology residents: Assessment of learning styles and their correlations. *Education for Health: Change in Learning & Practice (Taylor & Francis Ltd)*, 19(3), 289-297.
- DeGroff, E. A., & McKee, K. A. (2006). Learning like lawyers: Addressing the differences in law students learning styles. *Brigham Young University Education & Law Journal*, 2006(2), 499-549.
- Dippelhofer-Stiem, B. (1989). The development of research-oriented learning in five European countries. *European Journal of Psychology of Education*, 4, 489-503.
- Direcção Geral do Ensino Superior. (2010). *Guia de acesso ao ensino superior público*. Retrieved October, 15, 2010, from http://www.dges.mctes.pt/NR/rdonlyres/80178CDE-7BD2-4B6D-90A5-CB0A6CB37DAB/4118/GuiaPI2010_publico.pdf
- Donche, V., & Van Petegem, P. (2009). The development of learning patterns of student teachers: A cross-sectional and longitudinal study. *Higher Education*, 57(4), 463-475.
- Ferreira, M. P. M. (2009). O professor do ensino superior na era da globalização. *Revista Iberoamericana de Educación*, 50, 1-10.
- Garcia, R. P. (2001). Para um ensino superior com qualidade. *Revista Portuguesa de Ciências do Desporto*, 1, 33-43.

-
- Hair, J. F. J., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). Upper Saddle River, New Jersey: Prentice-Hall, Incorporated.
- Hambleton, R.K. (2005). Issues, designs, and technical guidelines for adapting tests into multiple languages and cultures. In R.K. Hambleton, P.F. Merenda, & C.D. Spielberger (Eds.), *Adapting educational and psychological tests for cross-cultural assessment* (pp.3-38). Mahwah, N.J.: Erlbaum.
- Individual Skills Portfolio Project (PIC Project). (2010). *The PIC project-catholic university of portugal-economics and management faculty, regional center of porto*. Retrieved 10/25, 2010, from <http://pic.feg.porto.ucp.pt/dados.php?cod=27>
- Joy, S., & Kolb, D. A. (2009). Are there cultural differences in learning style? *International Journal of Intercultural Relations*, 33, 69-85.
- Leask, G., & Parker, D. (2007). Strategic groups, competitive groups and performance within the U.K. pharmaceutical industry: Improving our understanding of the competitive process. *Strategic Management Journal*, Volume 28, 723-745.
- Lonka, K., Olkinuora, E., & Mäkinen, J. (2004). Aspects and prospects of measuring studying and learning in higher education. *Educational Psychology Review*, 16(4), 301-323.
- Machaqueiro, M. A. (2000). Contradições e disfunções no sistema de ensino em Portugal. *Actas do IV Congresso Português De Sociologia - Sociedade Portuguesa: Passados Recentes, Futuros Próximos*, Coimbra University.
- Marton, F., & Säljö, R. (1997). Approaches to learning. In F. Marton, D. Hounsell & N. Entwistle (Eds.), *The experience of learning. implications for teaching and studying in higher education* (2nd. Ed.). Edinburgh: Scottish Academic Press.
- McChlery, S., & Visser, S. (2009). A comparative analysis of the learning styles of accounting students in the United Kingdom and South Africa. *Research in Post-Compulsory Education*, 14(3), 299-315. Morgan, B., & Lydon, J. (2009). Bologna: Some thoughts on its effect on the internationalisation of higher education. *Journal of Applied Research in Higher Education*, 1, 64-72.
- Nijhuis, J., Segers, M., & Gijsselaers, W. (2008). The extent of variability in learning strategies and students' perceptions of the learning environment. *Learning and Instruction*, 18, 121-134.
- O'Toole, L. (2008). Understanding individual patterns of learning: Implications for the well-being of students. *European Journal of Education*, 43, 71-86.

-
- Philbin, M., Meier, E., Huffman, S., & Boverie, P. (1995). A survey of gender and learning styles. *Sex Roles*, 32, 485-494.
- Rabanaque, S., & Martínez-Fernández, J. R. (2009). Conception of learning and motivation of spanish psychology undergraduates in different academic levels. *European Journal of Psychology of Education - EJPE (Instituto Superior de Psicologia Aplicada)*, 24(4), 513-528.
- Rayner, S. (2007). A teaching elixir, learning chimera or just fool's gold? do learning styles matter? *Support for Learning*, 22(1), 24-30
- Rocha, M., Oliveira, E. D. &, Guimarães, I. (January, 2010). *Stakeholders perception of recruitment criteria: A Régnier's abacus approach of market valued skills* (FEG-UCP Working Papers in Management Series 01/2010). Porto: Faculdade de Economia e Gestão, Universidade Católica Portuguesa. <http://ideas.repec.org/p/cap/mpaper/012010.html>
- Rozendaal, J. S., de Brabander, C., & Minnaert, A. (2001). Boundaries and dimensionality of epistemological beliefs. *9th Biennial Conference of the European Association of Learning and Instruction*, Fribourg, Switzerland.
- Rozendaal, J. S., Minnaert, A., & Boekaerts, M. (2005). The influence of teacher perceived administration of self-regulated learning on students' motivation and information-processing. *Learning and Instruction*, 15, 141-160.
- Savickas, M. L. (2005). The theory and practice of career construction. In S. D. Brown, & R. W. Lent (Eds.), *Career development and counseling: Putting theory and research to work* (pp. 42-69). New Jersey, USA: John Wiley & Sons Inc.
- Severiens, S. E., & Ten Dam, Geert T. M. (1994). Gender differences in learning styles: A narrative review and quantitative meta-analysis. *Higher Education*, 27, 487-501.
- Severiens, S., & Ten Dam, G. (1997). Gender and gender identity differences in learning styles. *Educational Psychology*, 17, 19-93.
- Severiens, S., & Ten Dam, G. (1998). Gender and learning: Comparing two theories. *Higher Education*, 35(3), 329-350.
- Suazo, G. I., Pretch, G. A., Cantín, L. M., Zavando, M. D., & Sandoval, M. C. (2010). Existe modelamiento profesional de los estilos de aprendizaje? *International Journal of Morphology*, 28(1), 13-18. Van Eekelen, I. M., Boshuizen, H. P. A., & Vermunt, J. D. (2005). Self-regulation in higher education teacher learning. *Higher Education*, 50, 447-471.
- Van Petegem, P., Donche, V., & Vanhoof, J. (2005). Relating pre-service teachers' approaches to learning and preferences for constructivist learning

-
- environments. *Learning Environments Research*, 8(3), 309-332. Vermetten, Y. J., Lodewijks, H. G., & Vermunt, J. D. (1999). Consistency and variability of learning strategies in different university courses. *Higher Education*, 37(1), 1-21.
- Vermetten, Y. J., Vermunt, J. D., & Lodewijks, H. G. (2002). Powerful learning environments? how university students differ in their response to instructional measures. *Learning and Instruction*, 12(3), 263-284. Vermunt, J. D. (1987). Learning styles and self-regulation. *Annual Meeting of the American Educational Research Association*, Washington, D.C. Doi: ERIC Document 285 900, 19p.
- Vermunt, J. D. (1994). *Inventory of learning styles in higher education*. Leiden University, The Netherlands: ICLON-Graduate School of Education.
- Vermunt, J. D. (1996). Metacognitive, cognitive and affective aspects of learning.. *Higher Education*, 31(1), 25.
- Vermunt, J. D. (1998). The regulation of constructive learning processes. *British Journal of Educational Psychology*, 68(2), 149-171.
- Vermunt, J. D. (2005). Relations between student learning patterns and personal and contextual factors and academic performance. *Higher Education*, 49(3), 205-234.
- Vermunt, J. D., & Minnaert, A. (2003). Dissonance in student learning patterns: When to revise theory? *Studies in Higher Education*, 28(1), 49-61.
- Vermunt, J. D., & Vermetten, Y. (2004). Patterns in student learning: Relationships between learning strategies, conceptions of learning, and learning orientations. *Educational Psychology Review*, 16(4), 359-384. Wierstra, R. F. A., & Beerends, E. P. M. (1996). Leeromgevingspercepties en leerstrategieën van eerstejaars studenten sociale wetenschappen. *Tijdschrift Voor Onderwijsresearch*, 21, 306-322.
- Wierstra, R. F. A., Kanselaar, G., Van Der Linden, J. L., Lodewijks, H. G. L. C., & Vermunt, J. D. (2003). The impact of the university context on european students' learning approaches and learning environment preferences. *Higher Education*, 45, 503-523.
- Zeegers, P. (2001). Approaches to learning in science: A longitudinal study. *The British Journal of Educational Psychology*, 71, 115-132.

References (Web)

Direcção Geral do Ensino Superior. (2010). *Guia de acesso ao ensino superior público*. Retrieved October, 15, 2010, from http://www.dges.mctes.pt/NR/rdonlyres/80178CDE-7BD2-4B6D-90A5-CB0A6CB37DAB/4118/GuiaPI2010_publico.pdf

Individual Skills Portfolio Project (PIC Project). (2010). *The PIC project-catholic university of portugal-economics and management faculty, regional center of porto*. Retrieved 10/25, 2010, from <http://pic.feg.porto.ucp.pt/dados.php?cod=27>

Rocha, M., Oliveira, E. D. &, Guimarães, I. (January, 2010). *Stakeholders perception of recruitment criteria: A Régnier's abacus approach of market valued skills* (FEG-UCP Working Papers in Management Series 01/2010). Porto: Faculdade de Economia e Gestão, Universidade Católica Portuguesa. <http://ideas.repec.org/p/cap/mpaper/012010.html>

Vermetten, Y. J., Vermunt, J. D., & Lodewijks, H. G. (2002). Powerful learning environments? how university students differ in their response to instructional measures. *Learning and Instruction*, 12(3), 263-284. Vermunt, J. D. (1987). Learning styles and self-regulation. *Annual Meeting of the American Educational Research Association*, Washington, D.C. Doi: ERIC Document 285 900, 19p.

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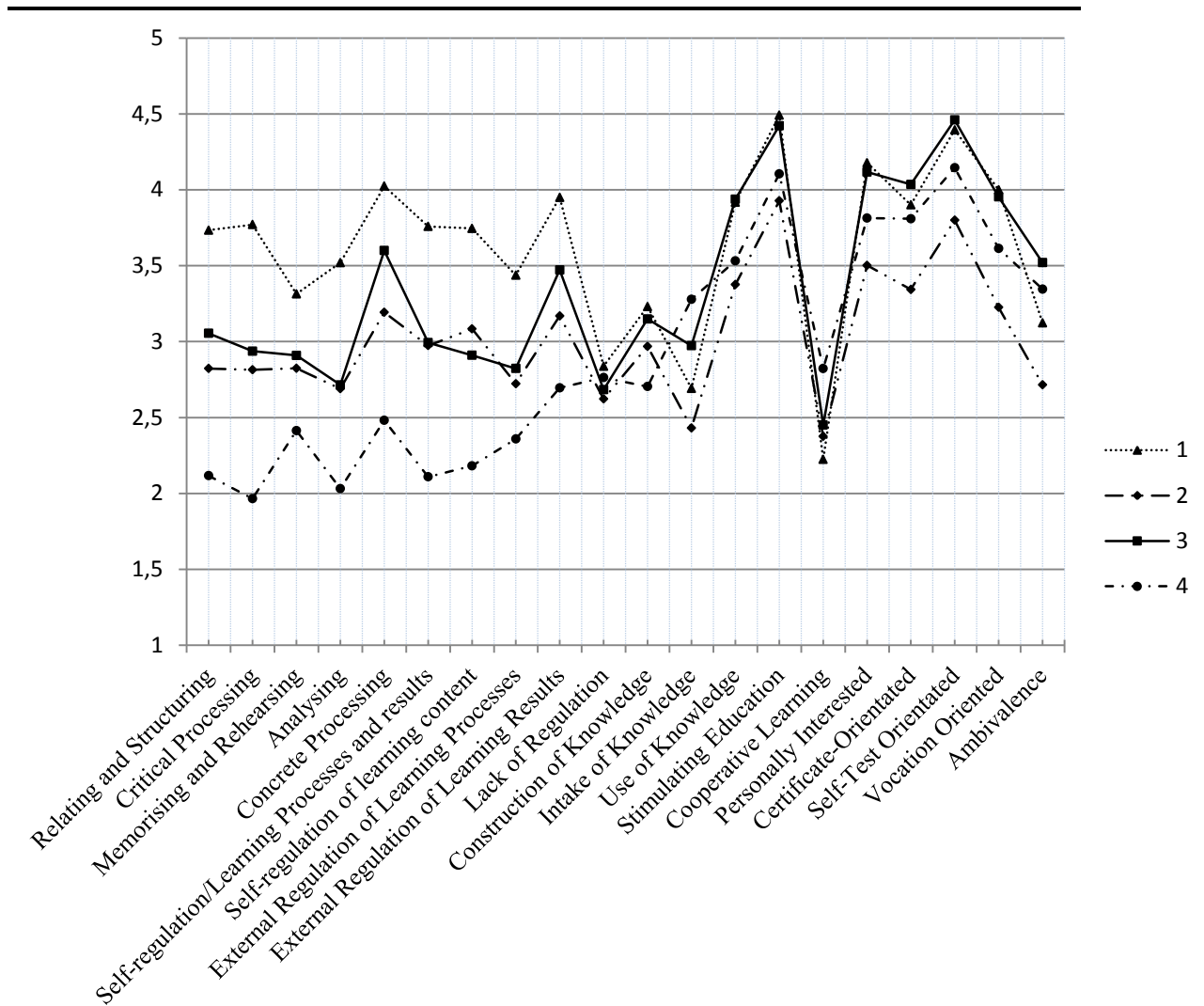


Figure 1. Graphic representation of the obtained groups in cluster analysis (N=370)

Table 1

Means and standard-deviation on the 20 ILS's subscales accordingly with cluster analysis (N=370)

			ILS Learning Styles							
			Meaning ^a		Application ^b		Reproduction ^c		Undirected ^d	
			(n=107)		(n=116)				(n=44)	
			M	SD	M	SD	M	SD	M	SD
Domain	Scal	subscale								
Processing Strategies	Stepwise processing	Relating and structuring	3.73 ^{bc} _d	.54	2.82 ^{ac} _d	.53	3.06 ^{ab} _d	.52	2.12 ^{ab} _c	.43
		Critical processing	3.77 ^{bc} _d	.57	2.81 ^{ad}	.51	2.94 ^{ad}	.58	1.97 ^{bc}	.52
		Memorizing and rehearsing	3.31 ^{bc} _d	.93	2.82 ^{ad}	.78	2.91 ^{ad}	.63	2.41 ^{ab} _c	.65

	Regulation Strategies		Mental Models of Learning Learning Orientations					
	External regulation	Self regulation						
Analysing	3.52 ^{bc} _d	.55	2.69 ^{ad}	.46	2.71 ^{ad}	.44	2.03 ^{ab} _c	.44
Concrete processing	4.02 ^{bc} _d	.45	3.19 ^{ac} _d	.47	3.60 ^{ab} _d	.51	2.46 ^{ab} _c	.42
Learning processes & results	3.76 ^{bc} _d	.47	2.97 ^{ad}	.45	3.00 ^{ad}	.43	2.11 ^{ab} _c	.51
Learning content	3.75 ^{bc} _d	.59	3.08 ^{ad}	.53	2.91 ^{ad}	.61	2.18 ^{ab} _c	.56
Learning Processes	3.44 ^{bc} _d	.57	2.72 ^{ad}	.51	2.82 ^{ad}	.52	2.36 ^{ab} _c	.49
Learning results	3.94 ^{bc} _d	.47	3.17 ^{ac} _d	.52	3.47 ^{ab} _d	.43	2.70 ^{ab} _c	.62
Lack of regulation	2.84	.75	2.62	.67	2.68	.70	2.76	.70
Personally interested	3.23 ^{bd}	.68	3.00 ^a	.61	3.15 ^d	.65	2.70 ^{ac}	.85
Certificate directed	2.69 ^d	1.08	2.43 ^{cd}	.81	3.00 ^b	1.12	2.76 ^{ab}	1.00
Self-test directed	3.92 ^{bd}	.83	3.38 ^{ac}	.69	3.94 ^{bd}	.70	3.53 ^{ac}	.74
Vocation directed	4.49 ^{bd}	.43	3.93 ^{ac}	.67	4.42 ^{bd}	.48	4.10 ^{ac}	.63
Ambivalence	2.22 ^d	.88	2.38 ^d	.71	2.45	.75	2.82 ^{ab}	.86
Construction of knowledge	4.18 ^{bd}	.50	3.50 ^{ac} _d	.50	4.12 ^{bd}	.38	3.81 ^{ab} _c	.55
Intake of knowledge	3.90 ^b	.54	3.43 ^{ac} _d	.46	4.04 ^b	.45	3.81 ^b	.50
Use of knowledge	4.39 ^{bd}	.46	3.80 ^{ac} _d	.57	4.46 ^{bd}	.40	4.15 ^{ab} _c	.53
Stimulating education	4.00 ^{bd}	.58	3.23 ^{ac} _d	.61	3.95 ^{bd}	.49	3.61 ^{ab} _c	.74
Co-operation	3.12 ^{bc}	.88	2.72 ^{ac} _d	.75	3.52 ^{ab}	.77	3.35 ^b	.84

Note. Different letters identify significant statistical differences in the cell values at a significance value of $p \leq .05$ (Scheffé's post hoc test). In bold the highest mean, in italic the lowest mean.

Table 2
 Chi-square test (Pearson): association between Learning Styles and First cycle frequency year (N=370)

Variables		First cycle frequency year			
Learning Styles		Freshmen	Sophomores	Finalists	Total
<i>Meaning directed learning style</i>	Count	36	45	26	107
	% within Clusters	33.6%	42.1%	24.3%	100%
	% within Year	29%	26.6%	33.8%	28.9%
	% of Total	9.7%	12.2%	7%	28.9%
<i>Application directed learning style</i>	Count	49	52	15	116
	% within	42.2%	44.8%	12.9%	100%

	Clusters	39.5%	30.8%	19.5%	31.4%
	% within Year	13.2%	14.1%	4.1%	31.4%
	% of Total				
<i>Reproduction oriented learning style</i>	Count	29	52	22	103
	% within Clusters	28.2%	50.5%	21.4%	100%
	% within Year	23.4%	30.8%	28.6%	27.8%
	% of Total	7.8%	14.1%	5.9%	27.8%
<i>Undirected Learning Style</i>	Count	10	20	14	44
	% within Clusters	22.7%	45.5%	31.8%	100%
	% within Year	8.1%	11.8%	18.2%	11.9%
	% of Total	2.7%	5.4%	3.8%	11.9%
Total	Count	124	169	77	370
	Expected count	124,0	169,0	77,0	370,0
	% of Total	33.5%	45.7%	20.8%	100%

Note. Zero cells (0%) have expected count less than 5; two-sided significance test at $p < .05$

Table 3
Chi-square test (Pearson): association between Learning Styles and Students' course scientific area
 (N=364)

Variables		Students' course scientific area				
		<i>Biotechnologies</i>	<i>Humanities</i>	<i>Economics and Management</i>	<i>Health</i>	Total
<i>Meaning directed learning style</i>	Count					106
	% within Clusters	15	15	28	48	100%
	% within Area	14.2%	14.2%	26.4%	45.3%	29.1%
	% of Total	29.4%	44.1%	24.6%	29.1%	%
		4.1%	4.1%	7.7%	13.2%	29.1%
					%	
<i>Application directed learning style</i>	Count					112
	% within Clusters	13	10	30	59	100%
	% within Area	11.6%	8.9%	26.8%	52.7%	30.8%
	% of Total	25.5%	29.4%	19.5%	35.8%	%
		3.6%	2.7%	4.1%	16.2%	30.8%
					%	
<i>Reproduction oriented learning style</i>	Count					103
	% within Clusters	18	5	34	46	100%
	% within Area	17.5%	4.9%	33%	44.7%	28.3%
	% of Total	25.3%	14.7%	29.8%	27.9%	%
		4.9%	1.4%	9.3%	12.6%	28.3%
					%	
<i>Undirected Learning Style</i>	Count					43
	% within Clusters	5	4	22	12	100%
	% within Area	11.6%	9.3%	51.2%	27.9%	11.8%
	% of Total	9.8%	11.8%	19.3%	7.3%	%
		1.4%	1.1%	6%	3.3%	11.8%
					%	
Total	Count	51	34	114	165	364
	Expected count	51,0	34,0	114,0	165,0	364,0

% of Total	14%	9.3%	31.3%	45.3%	100%
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Note. One cell (6.3%) have expected count less than 5; two-sided significance test at $p < .05$