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Learning Style Preferences across Disciplines

Patrícia Albergaria Almeida, University of Aveiro, Portugal
Rita Mendes, University of Aveiro, Portugal

Abstract: Given the diversity of nowadays student population, being aware and understanding student differences in the classroom is of crucial importance. David Kolb's theory of experiential learning provides knowledge that can be valuable to gain insight into, and respond effectively to style differences, therefore improving teachers' skills to provide proper support and challenge in learning environments. This paper reports the first results of an ongoing research project aimed at examining the relationship between university students' learning styles and their academic field. This study is being conducted at the University of Aveiro, in Portugal. The Learning Styles Inventory was administered to a sample of 186 students from different academic backgrounds: biology, elementary education, design, biochemistry, biotechnology and languages. Inventories were applied in class to all students during the 2009/2010 academic year. The overall results do not confirm the association between learning styles and disciplines previously established by Kolb. Actually, all the students (except education students) possess the accommodating style as dominant. Implications of these findings are discussed and topics for further research are proposed.

Keywords: Learning Style, Kolb, Kolb's Learning Styles, Experiential Learning, Experiential Learning Theory, Disciplines, Disciplinary Differences, Academic Field, Diversity, Learning, Teaching, Biology, Languages, Multimedia, Biochemistry, Biotechnology, Education, Primary Learning Mode

Introduction

THIS PAPER IS based upon a growing body of work shaped by a research project aiming to promote the enhancement of the scholarship of teaching and learning (SoTL), at the University of Aveiro, in Portugal (Almeida, Teixeira-Dias & Martinho, 2010; Almeida, Teixeira-Dias & Medina, 2010). In the last decades, SoTL emerged as a fundamental concept to the development of good teaching practices in higher education (HE; (Albergaria Almeida, 2010; Boyer, 1990; Kreber, 2001) and, consequently, to the enhancement of the quality of student learning.

Given the diversity of nowadays student population, being aware and understanding student differences in the classroom is of crucial importance. At this point we are investigating the learning styles of university students following different degree programs, in order to conceive and implement diverse teaching and learning strategies according to students' learning styles and disciplinary fields. This does not mean that our intention is to accommodate students' learning styles by moulding teaching strategies to students' preferences. Actually, we contend that this aspect is as important as the intentional mismatch between learners' styles and teaching activities, in order to optimise students' abilities.

The research reported here analyses the learning styles of university students in different disciplinary fields. The sample includes 186 Portuguese students from education, languages, biology, biochemistry, biotechnology and multimedia. Students filled the Kolb's Learning

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Style Inventory (1999) during the 2009/2010 academic year. Two studies were conducted: study 1 aimed at investigating the relationship between students' learning styles and their disciplinary fields, and study 2 intended to analyse the association between students' primary learning mode and disciplines. Having in mind the relationships previously reported by Kolb (1981, 1984) the findings were discussed.

Thus, the main aims of this study are as follows: (i) to identify and characterise Kolb's learning styles of students from different disciplinary fields; (ii) to investigate the association between Kolb's learning styles and disciplines; (iii) to identify and characterise primary learning modes of students from different disciplines; (iv) to examine the relationship between primary learning modes and disciplinary fields.

The sections that follow present a brief literature review on the experiential learning theory, on Kolb's learning styles, and on disciplinary differences. Later, the methodology is described in detail. Finally, findings, conclusions and limitations are discussed.

Overview of the Literature

Kolb's Experiential Learning Theory and Learning Styles

Kolb's experiential learning theory (ELT; Baker, Jensen & Kolb, 2002; Joy & Kolb, 2009; Kolb, 1984; Kolb, Boyatzis & Mainmelis, 2001; Kolb & Kolb, 2005; Rainey & Kolb, 1995; Yeganeh & Kolb, 2009) is one of the best-known educational theories in higher education. It has been credited as the foundation for all experientially-based learning styles models such as Honey and Mumford (2000) and Allinson and Hayes (1996). In their controversial report, Coffield, Moseley, Hall and Ecclestone (2004) describe Kolb's model as "*highly productive*" (p.60) referring to its use in 1004 studies in diverse fields, such as education, management, computer studies, psychology and medicine.

Kolb's theory is called 'experiential learning' to emphasize the central role that experience plays in the learning process. It is based on the notion that understanding is not an inflexible element of thought but is formed and re-formed through experience. ELT defines learning as "*the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience*" (Kolb, 1984, p.41).

According to the ELT, learning is cyclical and requires four kinds of abilities: concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC) and active experimentation (AE). According to Figure 1, immediate or concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications for action can be drawn. These implications can be actively tested and serve as guides in creating new experiences (Kolb, 1984). The cycle may be initiated at any point, but the stages are then thought to be followed in sequence. So, the learning cycle provides feedback, which is the basis for new action and evaluation of the consequences of that action. According to Cowan (1998) and Kolb and Kolb (2005), the learning cycle may be better regarded as a spiral of cycles, since learners might go through it several times.

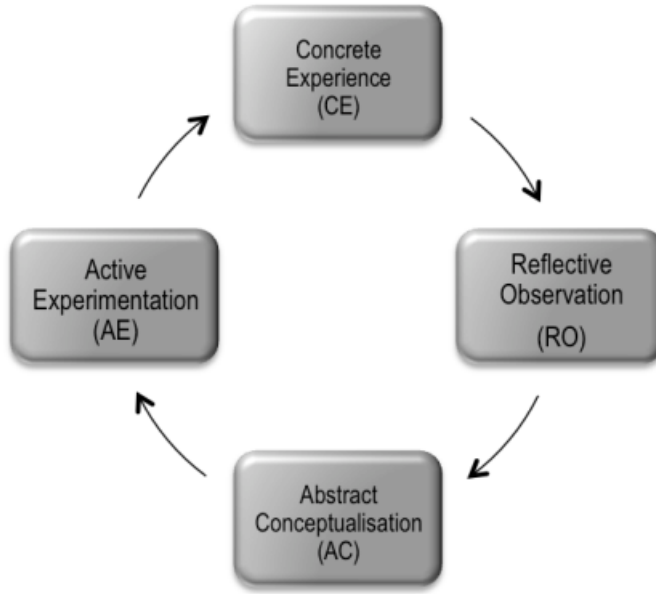

Figure 1: The 4-Stage Learning Cycle by Kolb (1984)

There are two primary axes that lie behind the cycle: an 'abstract-concrete' dimension and an 'active-reflective' dimension. These lead to the main dimensions of the learning process, corresponding to two distinctive ways by which learning takes place. Kolb's model suggests that learning is accomplished as "two dialectically opposed modes of adaptation to the world" (Kolb, 1984, p.30). The first refers to the ways in which new information or experience is grasped, and the second to how that which is perceived is then processed or transformed. The ways students perceive or grasp experience ranges from immersing themselves in the experience using their senses, feelings and knowledge in a concrete way (CE), to thinking abstractly about matters, using logic and reason (AC). Having perceived the experience, students need then to understand it through transforming it. Here individuals differ in their preference for doing so, either through active experimentation (AE) or by watching and reflective observation (RO) (Fielding, 1994; Kolb, 1984; Kolb & Kolb, 2005; Yeganeh & Kolb, 2009). Though all learning modes are significant to learning, it is implausible that many learners will excel in all areas (Kolb, 1981). Actually, the amount of time spent on each learning mode varies according to "*where the students' abilities are concentrated, their personal preferences, and the discipline of study*" (Nulty & Barret, 1996, p.343).

Based on the learners' preferences on the two dimensions – 'abstract-concrete' and 'active-reflective' – Kolb's identifies four learning styles with specific characteristics: accommodating, diverging, assimilating and converging, as shown in Figure 2. Each learning style presents its own strengths and weaknesses. Whether a learning style is favourable or not depends mainly on the demands of the learning context (Desmedt, 2004).

Accommodators grasp information concretely (CE) and process it through experimentation (AE). They are called accommodators because they easily adapt to new situations and apply knowledge in new ways (Kolb, 1981). The major strengths of this learning style are: problem-solving, using intuition in trial and error situations, trying new experiences, taking risks and

adapting to change (Kolb, 1984; Kolb & Kolb, 2005; Sharp, 1997). Accommodators are also known as 'doers' because they feel comfortable in getting involved in experiences and in carrying out plans. According to Kolb (2000), these learners are sometimes perceived as impatient and pushy.

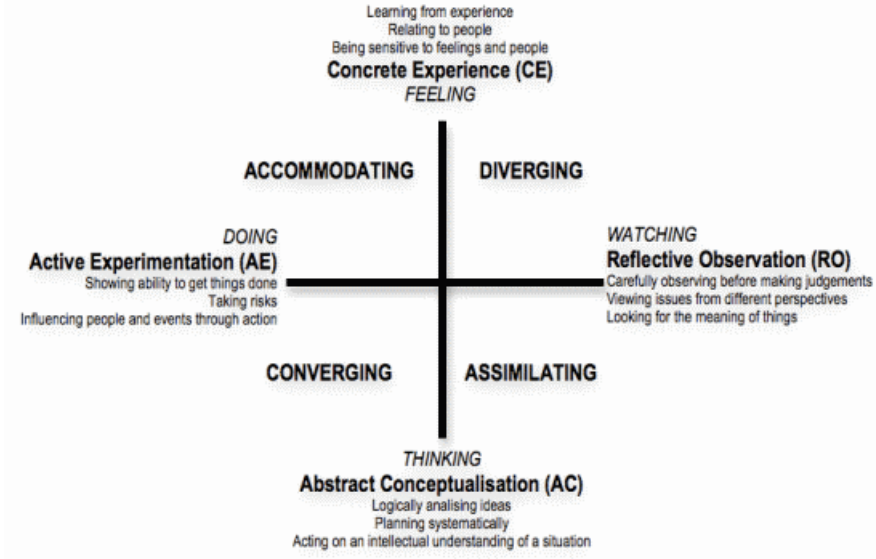

Figure 2: Kolb's Learning Styles and Modes of Learning

Divergers perceive information through concrete experience (CE) and process it reflectively (RO). These learners are called divergers because they do extremely well at viewing an event from several perspectives and at generating different ideas (Kolb, 1984). They prefer to work in groups, to brainstorm, to imagine implications and to share ideas (Kolb, 1976, 1984). Because of their great sense of creativity these learners are also known as 'creators'.

Assimilators grasp information through abstraction (AC) and process it through reflection (RO). They learn preferentially by watching and thinking. These students are called assimilators because they have the ability to assimilate diverse data and incorporate it into integrated whole, creating easily theoretical models (Kolb, 1981). This is the reason why they are also called as 'planners'. They prefer to learn alone and appreciate traditional lectures (Kolb, 1984).

Convergers perceive information abstractly (AC) and process it through experimentation (AE). They are called convergers because they have the ability to converge rapidly to get to a conclusion (Kolb, 1981). These learners prefer to comprehend an idea from the theoretical point of view without taking into account related examples (Kolb, 2000). The strengths of this learning style are making decisions, defining problems and reasoning deductively. Individuals favouring this style have been nicknamed 'decision makers' due to their ability in applying ideas in a practical way.

Table 1 summarises the main strengths and the dominant learning modes of each learning style.

Table 1: Main Strengths and Dominant Learning Modes of Kolb's Learning Styles (Fry, Ketteridge & Marshall, 2003; Kolb, 1984; Wolf & Kolb, 1984)

Learning style	*Main strengths*	*Dominant learning modes*
Accommodating	Can carry out plans Interested in action and results Adapts to immediate circumstances Trial and error style Sets objectives Sets schedules	CE and AE
Diverging	Imaginative Good at generating ideas Can view situation from different angles Open to experience Recognises problems Investigates Senses opportunities	CE and RO
Assimilating	Makes sense of distinct observations Ability to create theoretical models Compares alternatives Defines problems Establishes criteria Formulates hypotheses	AC and RO
Converging	Practical applications of ideas Makes decisions Focuses efforts Does well when there is one answer Evaluates plans Selects from alternatives	AC and AE

Yeganeh and Kolb (2009) suggest that because of the genetic background, the life experiences, and the demands of the environment, students develop a preference for learning in a particular way. The preferred style reflects only a tendency and students may adopt different learning styles in different situations, although they tend to favour some learning behaviours in preference to others. As stated by Kolb (2000, p.8), a learning style is "*a differential preference for learning, which changes slightly from situation to situation*".

Disciplinary Differences

A discipline is frequently considered to be a deep-rooted branch of learning or knowledge with a recognisable epistemology, methodology and discourse associated with it (Biglan, 1973; Cullen, Pearson, Saha & Spear, 1994; Kolb, 1981; Nulty & Barret, 1996; Smeby, 1996; Trowler & Wareham, 2008). A traditional mode of categorising different disciplines is to differentiate between hard/soft, pure/applied, concrete/abstract and reflective/active

fields of learning (Becher, 1989; Mitroff, 1982; Nulty & Barret, 1996). However, Becher (1989) contends that frontiers between disciplinary fields are complex and subtle. Nulty and Barret (1996) argue that sometimes a mismatch can exist between epistemology and methodology. As a result, even if *"the bulk of a discipline can be classified in a particular quadrant, there may be instances where the educational programmes are better characterised by the approach traditionally adopter in another quadrant"* (Nulty & Barret, 1996, p.336).

In fact, the Oxford English Dictionary proposes a definition of 'discipline' more 'learner-centred'. According to this dictionary, in its origins, a "*discipline refers to the student not the teacher: etymologically, discipline pertains to the disciple or scholar*". Hence, Pedrosa de Jesus, Almeida and Watts (2005) consider that 'discipline' has a specific mention to learning, the subject to be learned, and the practice of application of that learning – rather than to some singular philosophical abstraction or professional niche. Pedrosa de Jesus et al. (2005) argue that 'field of inquiry' can be used as a synonym to discipline, entailing the pursuit for what has yet to be known or discovered.

Other authors characterise a discipline in terms of a 'knowledge community' (e.g. Bruffee, 1993) and describe these communities according to the type of conversations that take place within them (Kyvik, 1991). Each disciplinary field possesses its own language, and the extent of integration in a specific field depends on the fluency in that language. Actually, the ease of communication in a discipline is part of the cognitive engagement amongst members of that community of knowledge (Pedrosa de Jesus et al., 2005). Bruffee (1993) argues that learning involves becoming comfortable and familiar with the language of a specific disciplinary field, and this should be accomplished through teaching.

Kolb's Learning Styles and Disciplinary Differences

Kolb (1981; 1984; 1999) suggests that it is possible to cluster disciplines based on students' predominant learning styles. This author proposes that the relationship between students' learning styles and their academic field results from two processes: *selection* and/or *socialisation*. Selection is the process by which a student chooses an academic discipline consistent with its preferred learning style. While socialisation refers to a student's learning styles being further moulded to suit the learning norms of a disciplinary area once in it. Thus, different academic fields would favour different learning styles. As stated by Kolb (1981, p.233-234): *"For students, education in an academic field is a continuing process of selection and socialization to the pivotal norms of the field governing criteria for truth and how it is to be achieved, communicated, and used, and secondarily, to peripheral norms governing personal styles, attitudes, and social relationships. Over time… selection and socialization pressures combine to produce and increasingly impermeable and homogeneous disciplinary culture and correspondingly specialized student orientations to learning".*

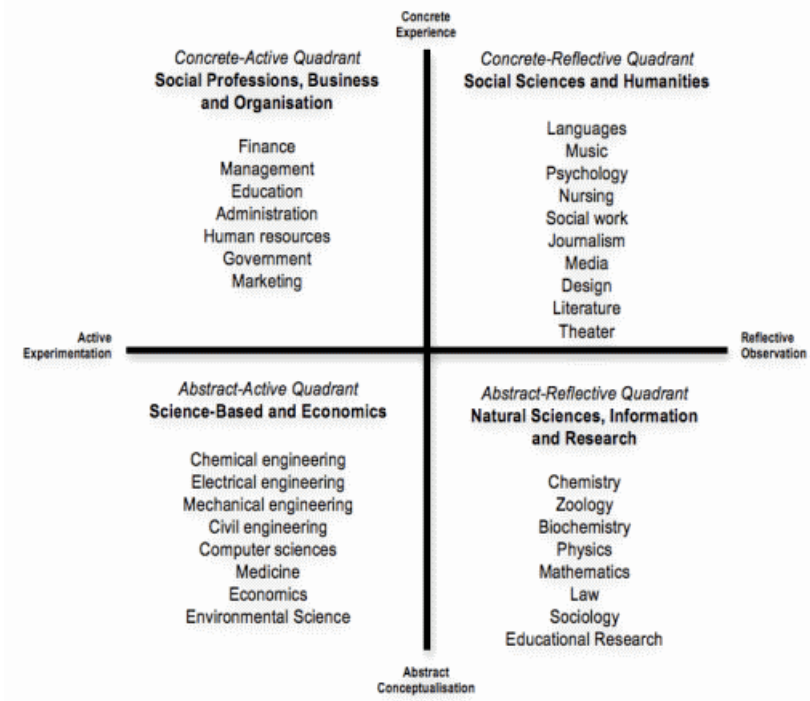

Figure 3: Disciplinary Clusters According to Kolb's Learning Styles (adapted from Kolb, 1984, 1999)

Kolb (1981, 1984) supports the division of disciplinary fields into a fourfold typology that leads to four quadrants with diverse characteristics, as shown in Figure 3. Similarly to learning styles, these disciplinary quadrants are defined according to the amount of concrete vs. abstract and reflective vs. active abilities required in each one: *"In the abstract-reflective quadrant are clustered the natural sciences and mathematics, while the abstract-active quadrant includes the science-based professions, most notably the engineering fields. The concrete-active quadrant encompasses what might be called the social professions, such as education, social work and law. The concrete-reflective quadrant includes the humanities and social sciences" (Kolb, 1981, p.243).*

This distribution of disciplinary groups is similar to the typology proposed by Cullen, et al. (1994). Later, in 1999, Kolb incorporated some changes in his original distribution of disciplinary fields according to learning styles. These changes are mainly related to the incorporation of career patterns that flourished and developed in the last decades, and that were not considerer in the original typology, such as design and computer sciences.

The Present Study

This research study investigates the preferred learning styles of Portuguese students. Following prior studies (Erlich, 2009; Desmedt, 2004; Kolb, 1976, 1984), students were selected from diverse disciplinary fields: natural sciences (biology, biochemistry), science-based professions

(biotechnology), social professions (education), and humanities (languages and multimedia). Previous studies revealed that learners from specific academic disciplines adopt different learning styles as a result of 'selection' and 'socialisation' processes (Kolb, 1984). So, *do Portuguese students possess learning styles matching their academic areas?* More specifically:

- Portuguese learners studying in natural sciences will prefer abstract and reflective learning modes, also known as the assimilating learning style?
- Portuguese learners studying in science-based professions will prefer abstractive and active learning modes, also known as the converging learning style?
- Portuguese learners studying in social professions will prefer concrete and active learning modes, also known as the accommodating learning style?
- Portuguese learners studying in humanities will prefer reflective and concrete learning modes, also known as the diverging learning style?

Methods

Participants

The participants involved in this study were 186 students (128 females, or 68,8%; and 58 males; or 31,2%) at the University of Aveiro, in Portugal (Table 2). The students' age ranged from 17 to 41 (mean=21 years; SD=3,8).

Table 2: Characterisation of the Participants

Category	Frequency	Percent (%)
Gender		
Female	128	31,2
Male	58	68,8
Age		
17 - 20	120	64,5
21 – 24	46	24,7
25 - 28	10	5,4
> 28	10	5,4
Year of study		
1	69	37,1
2	64	34,4
3	28	15,0
4	25	13,5

Disciplinary field		
Biology	48	25,8
Biochemistry	20	10,8
Biotechnology	27	14,5
Languages	57	30,7
Multimedia (design)	23	12,4
Pedagogical Sciences	11	5,9

There were 57 language students (30,6%), 48 biology students (25,8%), 27 students of biotechnology (14,5%), 23 students of multimedia (12,4%), 20 students of biochemistry (10,7%), and 11 students of elementary education (5,9%). Sixty-nine students were freshmen (37,1%), 64 were sophomore (34,4%), 28 were junior (15,1%) and 25 were senior students (13,4%).

Kolb's Learning Style Inventory and Procedure

Kolb's LSI is one of the most prominent and extensively disseminated instruments used to determine individual learning preferences. LSI is organised into 12 groups of statements, four statements per group, with one statement in every group corresponding to one of the stages of the learning cycle (feeling, reflecting, thinking and doing). Within each group, students must rank from 4 ("*best describes you*") to 1 ("*least like you*") the four statements according to their own preferences. For instance:

"When I learn:
I like to deal with my feelings.
I like to think about ideas.
I like to be doing things.
I like to watch and listen" (Kolb, 1999).

The structure of this inventory matches Kolb's notion of learning: "*learning is by its very nature a tension and conflict filled process*" (Kolb, 1984, p.30).

A Portuguese version of the third version of the LSI was used. Kolb's LSI was adapted to a Portuguese context by Goulão (2001). The results indicated an acceptable degree of reliability, with coefficient alpha reliabilities ranging from 0.76 to 0.82. These results are similar to those of Kolb and Smith (1986), Desmedt (2004) and Willcoxson and Prosser (1996), and suggest that the LSI has high reliability in terms of internal consistency, with evidence of strong validity.

Students completed the LSI in class during the 2009/2010 academic year. The researcher explained the purpose of this activity as part of a research project which aimed to improve students' learning. The students were invited to write their contact (mail and/or phone number) on the inventory sheet. In this way, they were given the opportunity to know the results from the inventory and discuss its implications with the researcher.

Results and Discussion

Study 1

Students' preferred learning style scores were defined by calculating individuals four scales scores (CE, RO, AC and AE), and two combined scores (AC-CE and AE-RO) as suggested by Kolb (1999) (Table 3). Then, the population average of these two dimensions were calculated and used as the cut-off point on the learning style graph. Katz (1988) suggests these adjustments to the x-axis (AE-RO) and y-axis (AC-CE) as a means of balance out cultural bias for one orientation over another. After adjusting the intersection point to the Portuguese sample, students' learning styles were determined by plotting learners' combined scores along the two dimensions of the graph.

Table 3: Minimum and Maximum Scores, Mean and Standard Deviation

	N	Minimum	Maximum	Mean	Std. Deviation
CE	186	13	44	24,07	6,76
RO	186	16	43	30,41	5,56
AC	186	12	47	33,04	5,98
AE	186	17	46	32,38	5,88
AC - CE	186	-32	31	8,97	11,14
AE - RO	186	-22	24	1,97	9,66

The dominant learning style of each academic discipline was determined by taking the students' individual scores, belonging to the same disciplinary field, and then calculating the mean and standard deviation scores. Afterwards, these data were used to determine the AC-CE and AE-RO scores. These group learning style scores were then plotted along the Kolb's grid, as shown in Figure 4.

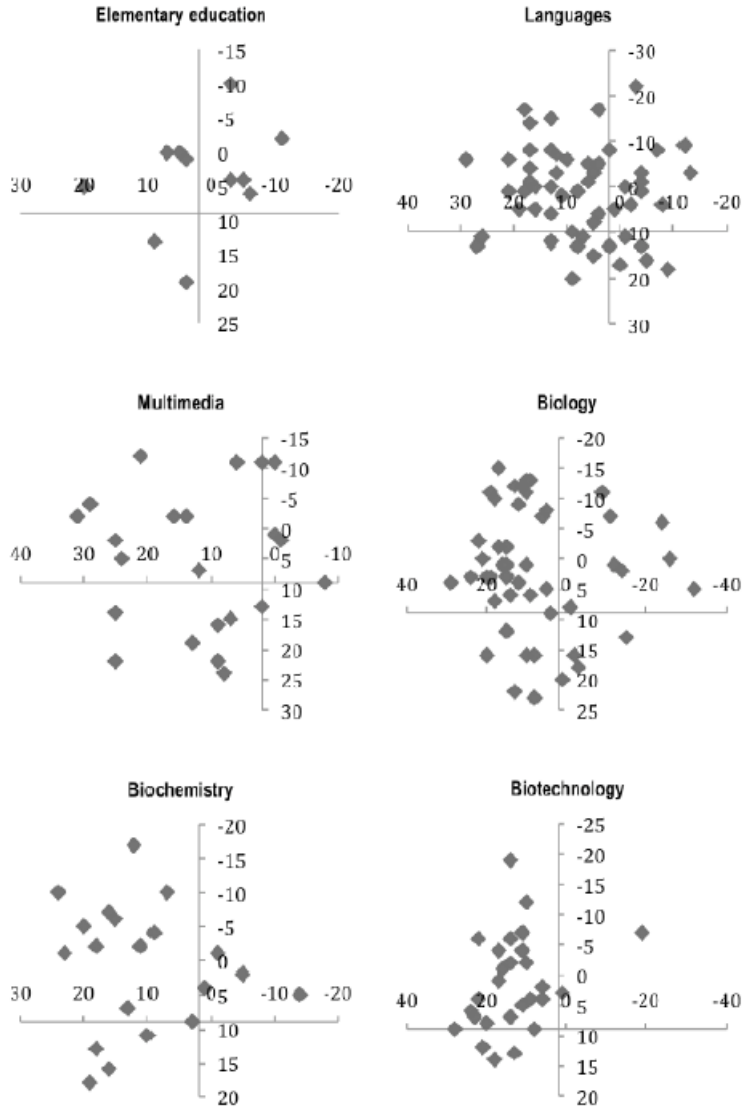

Figure 4: Distribution of Students' Learning Styles According to their Disciplinary Fields

In general, students from different backgrounds (languages, multimedia, biology, biochemistry and biotechnology) do not seem to possess different learning styles. Since the sample of elementary education students is smaller, from the analysis of the graphic it is not possible to determine which learning style is dominant, or even if there is a dominant learning style. So, we have calculated the means of the composite values (AC-CE and AE-RO) of the six disciplines, in order to allow a better comparison between the dominant learning styles of the different disciplinary fields (Figure 5).

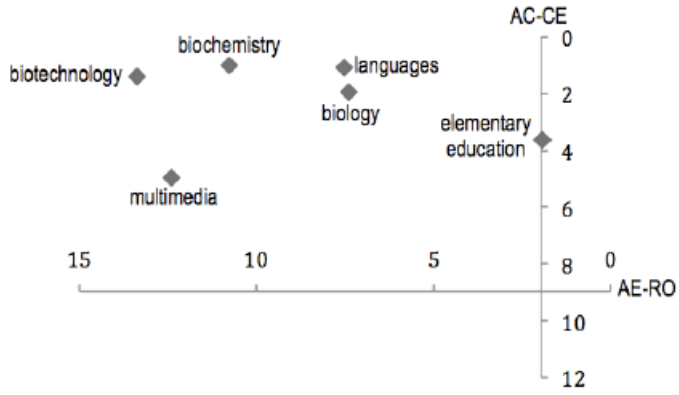

Figure 5: Dominant Learning Styles of the Six Disciplinary Fields

Even if the position of each discipline is placed in a different spot in the grid, mean values of AC-CE and AE-RO plotted in Kolb's grid point out that individuals studying biotechnology, multimedia, biochemistry, biology and languages typically possess an assimilator learning style. This learning style reflects a preference for concreteness over abstraction and a preference for action over reflection.

Elementary education students do not have a predominant learning style. These students show a preference for the accommodating and diverging learning styles. Students with this kind of learning preferences are also known as "*northerners*" (Abbey, Hunt & Weiser, 1985, p. 485). It is possible to state that these students use concrete experience as their preferred learning mode to perceive information. However, they do not possess a dominant learning mode to process information.

According to Kolb's distribution of disciplines: language and multimedia students should possess a diverging learning style; biology and biochemistry students should be assimilators; biotechnology students should prefer a converging learning style; and elementary education should be accommodators. However, none of these relationships between learning styles and disciplinary fields was found in our sample. Actually, all disciplines (except elementary education) revealed a preference for the accommodating style. In our sample, the majority are 1st and 2nd year students (n=133; 71,5%), so maybe these students are not sufficiently embedded in the spirit of their discipline yet. Consequently, they may still not have a learning style matching their academic field. Probably this will be achieved later, along their academic life.

We have conducted the study 2, in order to explore in a deeper way the possible relationships between each discipline and each learning mode.

Study 2

In this study, the LSI scores were analysed following the method suggested by Cornell & Manfredo (1994) and Desmedt (2004). We have defined a nominal variable named *'primary learning mode'* (PLM), using just each student's first rank order of the final LSI ipsative scores. The PLM refers to one of the four learning modes: concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC), and active experimentation (AE). The

final ipsative score is calculated as the sum of the 12 separate items, so this final score (PLM) should be more reliable than the individual scores (Cornell & Manfredo, 1994; Desmedt, 2004).

When it was not possible to identify a PLM, because two original ipsative scores both received the same value (first rank), we followed the process proposed by Desmedt (2004): these cases were treated as missing values. A total of 168 valid cases remained.

The frequency and percentage of the PLM for each disciplinary field are presented in Table 4.

Table 4: Frequency and Percentage of the PLM for each Academic Discipline

	Elementary education	**Multimedia**	**Languages**	**Biology**	**Biochemistry**	**Biotechnology**	∑
CE	0	2	4	9	0	1	16
	0,0%[pls]	12,5%	25,0%	56,3%	0,0%	6,3%	100%
	0,0%[ad]	10,0%	7,5%	19,6%	0,0%	4,0%	9,5%
RO	2	1	15	10	4	7	39
	5,1%	2,6%	38,5%	25,6%	10,3%	17,9%	100%
	28,6%	5,0%	28,3%	21,7%	23,5%	28,0%	23,2%
AC	0	8	16	15	6	11	56
	0,0%	14,3%	28,6%	26,8%	10,7%	19,6%	100%
	0,0%	40,0%	30,2%	32,6%	35,3%	44,0%	33,3%
AE	5	9	18	12	7	6	57
	8,8%	15,8%	31,6%	21,1%	12,3%	10,5%	100%
	71,4%	45,0%	34,0%	26,1%	41,2%	24,0%	33,9%
∑	7	20	53	46	17	25	168
	4,2%	11,9%	31,5%	27,4%	10,1%	14,9%	100%
	100%	100%	100%	100%	100%	100%	100%

[pls]% within primary learning style
[ad] % within academic discipline

Table 4 and Figure 6 show that the majority of the education students has a preference for AE primary learning mode, while 28,6% of education students prefer RO primary learning mode. The concrete experience and abstract conceptualisation are not represented in this disciplinary group. One of the reasons for the absence of these two learning modes may be related to the small sample of this discipline.

The majority of the multimedia, languages and biochemistry students show a preference for AE as primary learning mode, while the second predominant primary learning style is AC. The biology students are the ones with a more balanced distribution of primary learning modes, with the majority (32,6%) preferring AC. The biotechnology students prefer AC as their primary learning mode, and none of these students adopts concrete experience as their primary learning mode.

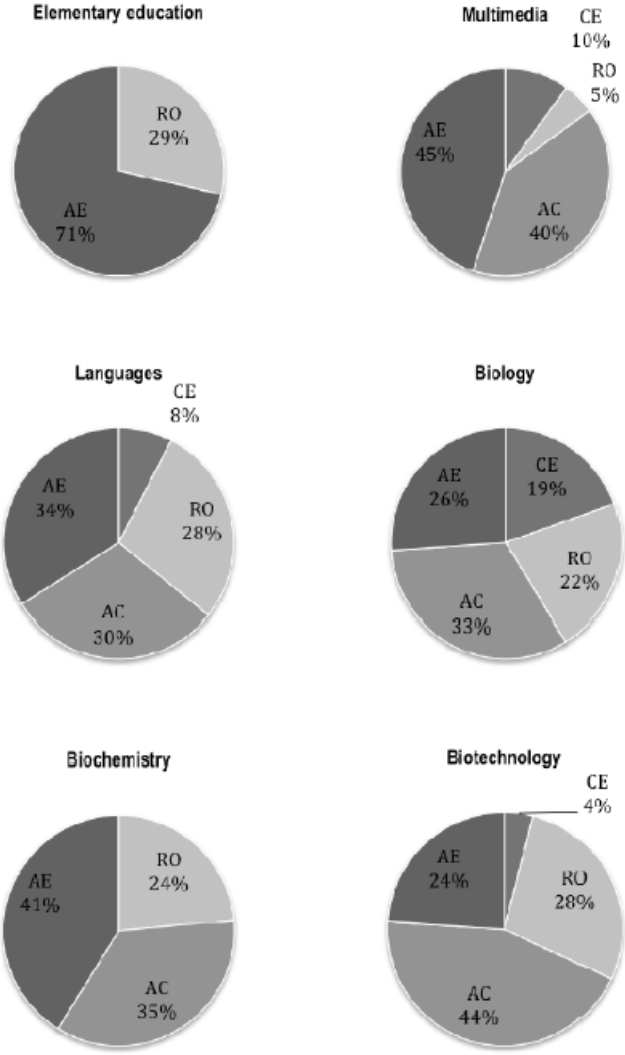

Figure 6: Distribution of Primary Learning Modes (PLM) across Disciplinary Fields

Figure 6 and Figure 7 show that concrete experience is, in general, the least preferred primary learning mode, followed by reflective observation. Abstract conceptualisation and active experimentation are the primary learning modes preferred by a larger percentage of students.

This confirms that all students (except education students) possess an accommodating style as their dominant learning style.

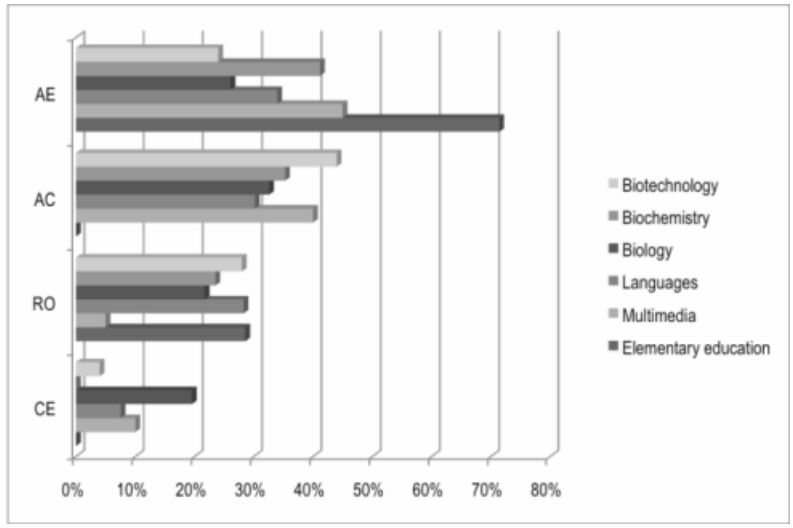

Figure 7: Distribution of Disciplinary Fields across Primary Learning Modes (PLM)

In 2005, Pedrosa de Jesus and colleagues also conducted a study at the University of Aveiro, in Portugal, with 100 1st year science students. The majority of these students presented a dominant accommodating learning style. According to Kolb (1981; 1984), it was expected that these students were mainly assimilators. It is pertinent to hypothesise to what extent cultural reasons can explain the predominance of the accommodating style.

The findings of this research have important implications for university teaching and learning. It is well-known that lectures are the most prevalent mode of instruction at university. Lecturing is the teaching strategy preferred by assimilators. However, the learners in this sample possess predominantly an accommodating learning style (preference for CE and AE), with the opposite characteristics to the assimilating style (preference for RO and AC). We contend that teaching strategies should not always match students' learning styles. However, we believe that in a first moment matching teaching and learning can enhance motivation and engagement on students. Thus, we consider that it is important for the teacher to be aware of students' learning preferences in order to design, implement and evaluate adequate teaching and learning strategies. On the other hand, students should also be aware of their learning preferences. Jones, Reichard and Mokhtari (2003) emphasise the importance of increasing student awareness of their own learning styles in order to increase their academic performance. As stated by Zualkernan, Allert and Qadah (2006, p.443), "*there is a growing realization that learning style awareness contributes to teaching and learning effectiveness*".

Conclusions, Limitations and Further Research

This research study did not allow us to confirm the associations between disciplines and learning styles found by Kolb (1981, 1984). Education students in this study do not possess a dominant learning style. These students showed to have what Abbey et al. (1985, p.486)

named a "*three-mode pattern*", where one of the learning modes is underdeveloped. In this case, it was abstract conceptualisation that summed a weak score. According to Kolb (1984) it was expected that these students had an accommodating dominant style.

All the other disciplines were associated to an accommodating learning style. However, as reported by Kolb: language and multimedia students should possess a diverging learning style; biology and biochemistry students should be assimilators; and biotechnology students should prefer a converging learning style.

Yet, even if all multimedia, languages, biology, biochemistry and biotechnology possess the same learning style, we can advance that these students hold different 'degrees' of accommodating style. For instance, biotechnology students have a stronger accommodative style than biology students.

This study has several limitations, one of them related to the sample size. One of our aims is to conduct a similar study with a larger sample (more students from each discipline and, if possible, include students from other disciplines and from other Portuguese universities) to confirm (or not) and expand the results obtained in this study. We also would like to analyse the effect of gender, age and year of study on learning style. In what concerns age and year of study, we believe that a longitudinal study would be the most adequate. Furthermore, we also would like to investigate the influence of culture on Portuguese students' learning styles.

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About the Authors

Dr. Patrícia Albergaria Almeida
University of Aveiro, Portugal

Rita Mendes
University of Aveiro, Portugal

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