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Learning styles and academic performance in Distance Education: a research in specialization courses

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ABSTRACT

Objective – The objective of the study is to identify whether learning styles impact academic performance and online and face-to-face assessment activities in Distance Education.

Design/methodology/approach – Learning styles were mapped using the Index of Learning Styles (ILS) of Felder and Soloman (1991). For data analysis, generalized linear models methodology was adopted; the Wald test was used to evaluate the effect of the factors.

Theoretical foundation - This research is based on cognitive theory. The model of Felder and Silverman (1988) underlies the ILS of Felder and Soloman (1991), which classifies learning styles into four dimensions: Active / Reflective; Sensory / Intuitive; Visual / Verbal; Sequential / Global.

Findings – (i) The predominant profile of the sample consists of the following styles: active, sensory, verbal and sequential; (ii) learning styles impacted academic performance only in the Active / Reflective dimension; (iii) significant differences were found between the mean of online and face-to-face assessment activities only in the Sensory / Intuitive dimension; (iv) the means of online assessment activities are larger in every styles dimensions.

Practical implications – Contributions for: (i) professors, as to how to choose and shape teaching strategies, i.e. to adopt teaching techniques that are appropriate to students' characteristics; (ii) for students, knowing their learning style is important to understand and develop new learning strategies; (iii) educational managers, who can use knowledge about learning styles to structure the LMS with better use of resources and promoting student learning.

Keywords – Learning styles; Academic performance; Distance education.

1 INTRODUCTION

Learning styles have been studied for decades by scholars from several fields of knowledge, such as Education, Psychology, Engineering and Accounting, who applied instruments to characterize the students of classroom and distance courses (Felder & Silverman, 1988; Kuri, 2004; Terrell & Dringus, 2000; Olds, Spindle & Cereola, 2007).

Certain papers investigate the validation of learning style inventories (Kuri, 2004; Litzinger, Lee, Wise & Felder, 2005; Felder, 2010), others assess whether learning styles impact academic performance and their contributions to improving the teaching and learning processes (Belhot, 1997; Diniz, 2007; Silva & Oliveira Neto, 2010) and other relate learning styles to methodologies or teaching techniques (Miranda, Miranda & Mariano, 2007; Neves Junior & Rocha, 2010).

The development of technology has enabled the use of new ways of teaching and learning and the expansion of Distance Education in Brazil. However, Valente (1993) warns that computers are not an instrument that teaches the learner, but a tool with which students develop something and, therefore, learning takes place due to the fact that they are performing a task through the computer. Technology is, then, a further component of the educational process, alongside curricular structures, methodologies, assessments etc.

In this context, this study intends to contribute to discussions involving learning styles in Distance Education, focusing on assessment activities, both online and face-to-face. Thus, we present the following question: do learning styles impact academic performance in online and face-to-face assessment activities in Distance Education?

The objective of this study is to identify whether learning styles impact academic performance in online and face-to-face assessment activities in Distance Education. To this end, we mapped the learning styles of students from three specialization courses in the field of

Public Administration, offered at a distance, in a federal and public university in the Brazilian state of Minas Gerais, using the tool developed by Felder and Soloman (1991). Subsequently, these learning styles were compared with grades obtained by students in online and face-to-face assessment activities, considering specific disciplines belonging to the field of Public Administration, and that integrate the curriculum of these three courses.

Although there is a great deal of research concerning learning styles in different fields of knowledge, we also observe a lack of studies that reveal the empirical results of its implications on teaching and learning processes in Brazil. With the increasing use of technology in educational processes, it's also important to evaluate the influence of learning styles in distance education. Thus, the main expected contribution of this research is to provide empirical evidence of the impact of learning styles on academic performance in online and face-to-face assessment activities; this evidence was not found in previous studies that address this topic.

To know learning styles is a fact that can contribute to the understanding of learning processes, even in the virtual environments of Distance Education. These environments provide new ways of learning, very different from those used in the classroom, which may or may not meet the needs of different learning styles. Therefore, studies on this subject help identify how people prefer to learn in virtual environments and ways to guide didactic and pedagogical applications to improve teaching and learning, considering the different learning styles.

This paper is divided into five sections, including this introduction. Next, we present the literature review, followed by the methodological aspects and the results, concluding with our final considerations about the discussed topic.

2 LITERATURE REVIEW

2.1 Learning styles

In literature, authors relate the different definitions of learning styles to behaviors that

characterize learning, that is, to the way people interact with the conditions, environments or structures in which learning occurs. Certain authors also emphasize the presence of physiological, emotional and affective factors in the definition of learning styles, while others relate them to strategies or positions taken up by individuals in learning situations (Silva & Oliveira Neto, 2010).

Felder and Silverman (1988) understand learning as a two-step process involving the receiving and the processing of information. In the receiving phase, external information (captured by the senses) and internal information (which arises introspectively) are available to the individual, who selects the material to be processed and ignores the rest. The processing may involve simple memorization or inductive or deductive reasoning, reflection or action, introspection or interaction with other individuals. The result is that the material is learned in one way or another, or else is not learned. Thus, we conclude that learning styles refer to the ways in which individuals prefer to receive and process information. Palloff and Pratt (2004) state that the favorite style is the one that students tend to use to approach the studied material, but they also know how to use other secondary styles, that are weaker because they are not so frequently used.

Thus, this research is based on cognitive theory, which involves the concept of human learning that is focused more intensely on the processes of encoding, storing and retrieving information, open to strategic questions, decision-making and problem-solving, in which human beings are an organism acting on the environment and continuously monitoring it in the search for information, and not just a passive organism that reacts (Belhot, 1997).

Due to the existence of several learning styles and their various classifications and approaches, educational and psychological researchers

began to accumulate these understandings in categories or inventories, in order to organize the development of this research. Thus, the learning styles inventories (LSI), instruments to evaluate these styles, emerged.

Learning styles inventories are usually based on bipolar dimensions to represent the different ways of perceiving and processing information and of making decisions and organizing lives, and may provide good frameworks for planning education. In literature, there are theoretical models on which are based certain instruments used to assess the learning styles of college students, such as Kolb's model – LSI (1984), Myers-Briggs's model – MBTI (1970) and Felder and Silverman's model – ILS (1988), whose theory underlies the instrument used in this study.

Felder and Silverman's model (1988) includes five dimensions of learning styles: (1) perception – Sensory/Intuitive; (2) input or retention – Visual/Verbal; (3) organization – Inductive/Deductive; (4) processing – Active/Reflective and (5) understanding – Sequential/Global. From these five dimensions, two are copies of aspects from Kolb's and Myers-Briggs's models. The perception (sensory/intuitive) dimension is similar to the perception of both – Kolb and Myers-Briggs – and the processing (active/reflective) dimension is found in Kolb's model. Felder and Silverman included another three dimensions.

The Index of Learning Styles (ILS) is an instrument developed by Richard M. Felder and Barbara A. Soloman in 1991 at the University of North Carolina, to determine the learning preferences in four dimensions of Felder and Silverman's Model (1988). This instrument does not include the model's (inductive/deductive) dimension. Figure 1 summarizes the characteristics of learners according to their learning styles within the four dimensions covered by ILS.

Dimension	Characteristics of Learners
Active Reflective	Active: tend to retain and understand better the information, actively participating in some activity, discussing, applying or explaining to others; like to work in a group; are fast, but can be overly hasty. Reflective: prefer to quietly reflect about information; may be slower to start an activity; like to work individually or in pairs.
Sensory Intuitive	Sensory: like solving problems through well-established procedures and dislike complications and surprises; are patient with details; memorize facts easily; enjoy manual work, experimental and repetitive (laboratory) jobs; tend to be practical and careful; do not like courses that have no apparent connection to the real world. Intuitive: often prefer discovering possibilities and interrelationships; like innovation and dislike repetition; feel comfortable with abstractions and mathematical formulations; are quick and creative; do not appreciate subjects that involve a lot of memorization and routine calculations; appreciate variety.
Visual Verbal	Visual: remember more of what they saw; replace words by symbols; prefer visual representations – diagrams, tables, schedules, charts, films and demonstrations; reconstruct images in different ways. Verbal: take more advantage of the written and spoken explanations; like to listen and take notes; printing support materials are useful to them; repeat words, either speaking or writing; read their notes in silence; change diagrams into words.
Sequential Global	Sequential: proceed with partial understanding; understand in linear steps, each step derived from the previous; tend to follow logical and gradual ways to solve a problem; find it easy to explain; emphasize analysis, details. Global: learn fast, absorbing material almost randomly without seeing connections and suddenly understand everything; need the context of the “big picture”; are able to solve complex problems quickly; find it easy to join elements in new ways, once they have seen the “big picture”, may find it difficult to explain how they did it; focus is on synthesis, on systemic, holistic thinking.

FIGURE 1 – Characteristics of Learners According to their Learning Styles

Source: Adapted from Felder and Silverman (1988).

Regarding the reliability and validity of ILS, published papers have tested it abroad, such as the work of Zywno (2003), Spurlin and Felder (2005), Litzinger *et al.* (2005; 2007); and in Brazil, such as Kuri (2004). These studies have demonstrated reliability and validity for the instrument, indicating that ILS is an adequate psychometric tool to identify learning styles; it also highlights the accessibility of the instrument, which was translated to several languages. Zywno (2003) states that it takes many studies with different samples and data to ensure the reliability and validity of any given instrument, and, therefore, he suggests that research should continue.

Felder (2010) points out that, although the validity of ILS is challenged in Psychology literature, the most common learning styles inventories have often been used frequently and successfully to help professors teach effectively, to help students to understand their own learning processes, and to help both to realize that people are not identical and that differences should be celebrated. In this work, Felder published an answer to claims that no evidence justifies

considering learning styles in the conception of ways to teach. The author explains that learning styles preferences and trends are presented by students to process information and respond to certain teaching situations. They are not infallible guides to students' behavior, but simply descriptions of common behavior patterns.

This study aims to identify students' learning styles in Distance Education and thus, in order to guide discussions, the next section presents Distance Education concepts and characteristics, as well as its features and functionality available in the virtual learning environment.

2.2 Distance Education: concepts and features

According to Penterich (2009), Distance Education (DE) was registered in Brazil a little before 1900. The newspapers of Rio de Janeiro already had ads offering vocational correspondence courses, sending teaching materials by mail.

Over recent years, distance education has grown substantially in Brazil, especially after the adoption of the local Law of Education Guidelines

(*Lei de Diretrizes e Bases da Educação/LDB*), in 1996, which now allows for the use of distance education for educational purposes. The latest census published by the Anísio Teixeira National Research Institute (Instituto Nacional de Estudos e Pesquisas em Educação Anísio Teixeira/INEP) revealed that, in 2009, there was an increase of 30.4% in comparison to 2008, while regular education increased 12.5% over the same period (Instituto Nacional de Estudos e Pesquisas em Educação Anísio Teixeira [INEP], 2009).

In 2006, the Brazilian Ministry of Education (Ministério da Educação/MEC) launched the Open University of Brasil (Universidade Aberta do Brasil/UAB). UAB was established in partnership with the states, municipalities and Public Universities, in order to offer higher level courses through Distance Education. UAB aims to attend approximately 1.5 million students, providing greater access to higher education in Brazil (Universidade Aberta do Brasil [UAB], 2010).

Distance Education is the teaching process in which professors and students are separated as to space or time. According to Moore and Kearsley (1996), the development of distance education followed the evolution of the Information Technology (IT) available to each period. The authors identified three stages in the development of DE: (1) Textual generation (up to around 1960), based essentially on self-learning through printed material; (2) Analog generation (between 1960 and 1980), based on self-learning using printed texts, complemented by technological audio and video resources; and (3) Digital generation (from 1980 on), based on self-learning with the support of highly differentiated technological resources, printed text to videoconferences, strong support of computers, the Internet and satellite communications.

By analyzing the evolution of Distance Education, it is clear that IT is being increasingly used. Technological advances and the inclusion of networks (Internet) promoted transition from the traditional classroom to the introduction of Learning Management Systems (LMS), which

are information and communication systems based on the web, offering tools and supporting features to help the teaching and learning process, both for Distance Education courses as well as for classroom and hybrid courses (Carliner, 2005)

The set of computer tools used in LMS allows for the management of Distance Education courses, increasing interaction, collaboration and cooperation processes. LMS generally has several resources available to it, and the following structure: agenda; supporting material; a chat room; a discussion forum; a blog; tasks; and wiki; among others. The tools provide content interaction, which are no longer passive and become interactive, since it involves links, images and sound applications etc (Soster, 2011).

According to Chen (2009), the tools available in LMS offer several features that help students build their knowledge according to their preferences. To the author, learning based on traditional models usually guides students to a rigid learning process, while learning in virtual environments offers personalized and adaptive mechanisms to meet students' preferences.

In this context, from the moment that students know their preferences, they have the ability to guide their own learning, which justifies knowing the learning styles, which is an important step to promote individuality and to take advantage of skills (Barros, 2010). To identify and understand the different learning styles of students, on the other hand, also helps teachers in planning activities and in the availability of resources that meet a multitude of students, contributing to their motivation (Silva & Oliveira Neto, 2010).

The next section presents research that also addresses learning styles in Distant Education topic.

2.3 Learning styles in Distance Education

Research shows that learning styles are also being used in Distance Education studies. White (1999) found that individual differences may influence higher or lower adaptation to the model

of learning via Internet. Terrel and Dringus (2000) investigated the impact of learning styles on performance and retention of students in Distance Education, and found that most students can succeed in an online environment when their learning styles are considered and respected. These authors worked with the inventory of Kolb in a sample of students from an online master's degree program in Information Science, and stated that the institutions which offer online programs must be prepared to deal with questions about learning styles.

In compliance with Terrel and Dringus (2000), Martins, Meireles, Melo and Nalini (2003), they suggested the interdisciplinarity of several technologies in order to personalize learning through computerized tutors on the Internet. To this end, they proposed the use of learning style characteristics as a student's pattern identification factor in an intelligent tutoring system based on an artificial neural network. In the proposed model, the intelligent tutoring system is based on an artificial neural network which makes it possible to generalize several patterns of learners. Based on the pattern identified by the neural network, the most appropriate path to the learner's profile is established. To consider the momentary performance of this learner, rules provided by experts consider each outcome, changing the probabilistic path generated by the neural network, offering personal attention to individual students' development.

Cornachione Junior (2004) studied education technologies in Accounting courses and, according to the author, professors have greater chances of success in achieving their purposes if they know what are the learning styles of their students.

Research carried out in Distance Education, particularly with the use of the virtual environment, present information and features that involve time and space, language, interactivity, easy access to knowledge and interactive audiovisual language.

Eom, Wen and Ashill (2006) demonstrated that learning styles and interaction are influential

variables in the satisfaction of students in the Distance Education, and that satisfaction, in this case, implies in facilitated learning. Similarly, the studies of Kalatzis and Belhot (2006) discussed the perspectives and contributions that learning styles can provide to Distance Education. They concluded that it is necessary to be aware of the significant role of learning styles in Distance Education because computer-mediated DE expands the possibilities of developing new skills in the teaching and learning process.

Diniz (2007) conducted a study in order to map the learning styles of students enrolled in a graduate course in Computing in Distance Education, and to analyze the influence of this construct in the interaction of these students in the discussion forum. This researcher used Felder-Soloman's ILS. The results confirmed that the way students interact in the forum is related to their learning styles, which can help when proposing activities that motivate and boost the participation in the virtual room.

Oliveira and Domingues (2011) evaluated the differences and similarities in students' learning styles of an undergraduate course in Business Administration offered both ways, in Distance Education and in the classroom, using Kolb's LSI. Only one Distance Education class was different in the profile of respondents. In both ways (classroom and distance), the 'pragmatic' style was identified as the one with greatest relationship with respondents; the 'executor' style was the one with the smallest relationship.

Nogueira, Espejo, Reis and Voese (2012) also used Kolb's LSI to map the learning styles of 109 students in a Distance Education undergraduate course in a federal public institution, and investigated the impact of learning styles on academic performance in subjects Accounting and Management Accounting. It was not possible to verify, from their study, that learning styles provide differences in students' performance in those subjects. The authors emphasize that, given the small number of comments, conclusions should not be generalized, but be restricted to the studied sample.

As such, several studies have been carried out to identify and use learning styles as an alternative to the improvement and use of teaching strategies and appropriate instructional methods, by professors and professionals involved, in order to help them achieve their goals. For students, we highlight the importance of adopting learning strategies to improve learning and performance, whatever the teaching style that is used. In the virtual learning environment, knowing what are the learning styles of students allows for adequate planning in the use of computing resources, so that they meet the individualities of students in the methodological approach applied to knowledge construction.

However, these mentioned studies didn't assess students' performance as to the types of assessment (online and face-to-face), and focused exclusively on the virtual environment and on online activities. Silva and Oliveira Neto (2010) analyzed only the impact of learning styles in an undergraduate course in Accounting in the classroom. Considering that the courses often use a mix of online and face-to-face assessments, it is necessary to understand what impact the learning styles may have on academic performance considering the types of assessments to which students are subjected and what consequences this may bring to students themselves, for professors and educational managers. It is in order to fill this gap that this work was carried out.

3 METHODOLOGICAL ASPECTS

3.1 Research classification and data collection

As to its objectives, this research is classified as descriptive, because it aims to describe the characteristics of a given population. Regarding the approach to the problem, it is quantitative, since it employs quantification in the collection of data and in its treatment. Regarding technical procedures, it uses a survey, because it employs a standardized instrument for data collection (questionnaire), and documentary research, about students' grades, obtained in the spreadsheets that make up their report card.

The survey was conducted in a federal public institution in the Brazilian state of Minas Gerais. The institution offers, through one of its colleges and the within the National Program for Formation in Public Management (Programa Nacional de Formação em Administração Pública/PNAP), three specialization courses at a distance: Public Management, Municipal Public Management and Public Health Management.

To conduct the survey, the authorization of the college director responsible for offering the courses was requested in April 2011. After obtaining it, a link in the virtual learning environment was made available, so that students could answer the questionnaire referring to Felder-Soloman's learning styles (ILS) from April to August 2011. Since the number of respondents was very small, course coordinators took the initiative to print the questionnaires and send them to each hub in the days of face-to-face tests, so that interested students could participate.

After mapping learning styles, a phase which ended in March 2012, we collected the grades referring to online and face-to-face assessment activities for six subjects: State, Government and Market; The Public and the Private in Public Management; Development and Change in the Brazilian State; Public Policies; The State and Contemporary Issues; Socioeconomic Indicators in Public Management. These subjects were chosen because they're common to all the three studied specialization courses.

Online activities account for 50% of the final grade in each subject, and the other 50% comes from face-to-face assessment activities. The online assessment activities can be synchronous or asynchronous; they are carried out continuously, that is, throughout the course, and consist of: discussion forum, chat, reading texts, quiz, glossary, wiki, writing review or text, interdisciplinary and final paper work. Such activities are common to all analyzed subjects and have different percentage in the final grade; therefore, they were treated together. The face-to-face assessment activities are composed of a presence test for each subject and are carried out in a summative way. The considered notes in the analysis were the final average in each subject, before revaluations.

Thus, the grades of online assessment activities and of face-to-face assessment activities are the dependent variables of this study. The independent variables are students' learning styles.

3.2 Data analysis procedures

For many years, the standard linear models have been used in an attempt to describe the most random phenomena. Even when the phenomenon did not have an answer to the reasonable assumption of normality, some kind of transformation was suggested in order to achieve the sought normality (Paula, 2013).

Nelder and Wedderburn (1972), proposed the generalized linear models, (*GLM*), whose idea is to open a range of options for the distribution of the response variable, allowing it to belong to the exponential family of distributions, as well as giving a greater flexibility for functional relationship between the average of the response variable and the linear predictor η (Paula, 2013). In the present work it was assumed that the response variable (notes) follows a Gamma distribution, because it becomes attractive for studying asymmetrical random variables. The commonly used linkages for Gamma distribution

are identity ($\mu_i = \eta_i$), logarithmic ($\log \mu_i = \eta_i$) and reciprocal ($\mu_i = \eta_i^{-1}$), the latest being the canonical link (Paula, 2013).

The model selection was carried out by Akaike information criterion (*AIC*). *AIC* was developed through maximum likelihood estimators, to decide the most appropriate model when using many models with different amounts of coefficients. The decision about the best fitted model is performed choosing the lowest value of *AIC* (Sant'Anna, 2009).

To check the adequacy of the model it was used the deviance analysis. The deviance analysis is done by comparing the measured values of deviance, $D(y, \mu, \phi)$, of the fitted models. As Lee and Nelder (1998), we usually have the deviance analysis using the critical point $\chi^2_{(n-k;\alpha)}$ of the Chi-square distribution to the significance level equal to α , being n the number of observations and k the number of coefficients models. Therefore $D(y, \mu, \phi) \leq \chi^2_{(n-k;\alpha)}$, it can be considered that there is evidences that the model under research is well-fitted to the data, at a significance level α . The deviance is to the method of *GLM* as the sum of squared residuals is to the method of least squares (Sant'Anna, 2009). Table 1 shows the results of the selection and the adequacy of fitted models.

TABLE 1 – Results of the selection and preparation of generalized linear models for the studied environments

Dimension	Distribution	Linkage function	⁽¹⁾ AIC	⁽²⁾ D(y, μ , ϕ)	⁽³⁾ χ^2
Active/Reflective	Gamma	Identity	33,850.696	265.685	
		Log			
		Reflective	43,254.698		
Sensory/Intuitive	Gamma	Identity	33,852.014	265.761	4,728.38
		Log			
		Reflective	43,254.774		
Visual/Verbal	Gamma	Identity	33,857.064	266.052	
		Log			
		Reflective	43,255.074		
Sequential/Global	Gamma	Identity	33,854.96	265.930	
		Log			
		Reflective	43,254.943		

⁽¹⁾*AIC*: value of Akaike information criterion of the adjusted models; (2) $D(y, \mu, \phi)$:deviance value of the adjusted models;

⁽³⁾ $\chi^2_{(n-k)}$: refers to the probability α -tailed of the distribution Chi-square with $(n-k)$ degrees of freedom, n is the number of observations ($n = 4.574$) and k the number of model coefficients ($k = 4$).

The criterion of *AIC* (Table 1) indicates that the best adjusted models were Gamma Identity and Gamma Log, because they showed lower values of *AIC*. About the adequacy of the model by deviance, the three models can be used to meet the purpose of the work. However, it is better to select Gamma identity, because it had a lower *AIC* and its adjustment uses the data in the original scale when the binding function is identity.

So, after choosing Gamma identity in the present study, we applied Wald test to test the significance of the parameters (effect of factors) in the four studied dimensions (Active/Reflective, Sensory/Intuitive, Visual/Verbal and Sequential/Global). Wald statistic (W) has an asymptotic distribution of Chi-square with q degrees of freedom (χ^2_q). Thus, the null hypothesis is rejected at a significance level α , if the observed value of Wald statistic is greater than the probability quantile $(1 - \alpha)$ of χ^2_q . For significant factors, Wald confidence intervals were used. Wald confidence interval is based on comparisons between the estimated marginal averages of the dependent variable (Sant'Anna, 2009). The following hypotheses have been established:

- (i) factor learning style: H1 – The averages of the learning styles are different;
- (ii) factor type of assessment (online and face-to-face): H2 – Averages of assessment are different;
- (iii) interaction: H3 – The interaction between learning styles and types of assessment is significant.

All analyzes were implemented in the *freeware R* (*R Development Core Team*, 2011) and the results are presented in the next section.

4 PRESENTATION AND RESULT ANALYSIS

4.1 Sample profile

In a universe of 945 students of the three courses of specialization, it was obtained a total of 412 (43.6%) answered and valid questionnaires,

which composed the study sample. Table 2 shows the characterization of the sample.

TABLE 2 – Sample characterization

Characteristic	Category	Percentage
Gender	Female	63.3
	Male	35.4
	No answer	1.3
Learning Style	Active	52.2
	Reflective	47.8
	Sensorial	81.6
	Intuitive	18.4
	Visual	47.6
	Verbal	52.4
	Sequential	55.6
Global	44.4	

It is observed that most students of the analyzed specialization courses are female, which is in line with the public Distance Education in general. According to data from Census 2013 EAD. BR Associação Brasileira de Educação a Distância (ABED), the predominance of women among the students of Distance Education courses in educational institutions is not new, even compared to classroom courses. Also according to the census, women represent over 56% of all distance learners, a percentage very similar percentage to the previous studies of EAD. BR Census 2010, 2011 and 2012 (Associação Brasileira de Educação a Distância [ABED], 2013).

About learning styles, the predominant profile consists of styles: active (52.2%), sensory (81.6%), verbal (52.4%) and sequential (55.6%). Such features are converging with the predominant learning styles profile identified in Silva and Oliveira Neto's studies (2010) and Neves Junior and Rocha (2010), with graduate students in Accounting in classroom and distance, respectively, unless Visual/Verbal dimension. We can also notice that, in the sensory/intuitive dimension, there is an absolute control of Sensory style, unlike the other three dimensions, that present a certain balance between the styles.

This profile reveals the characteristics of students that can and should be considered in the development of resources and activities in the

LMS of Distance Education, in the specialization courses we are focusing on and in other courses of this type. Corroborating Chen (2009) and Soster (2011), the available tools in LMS can offer several functions to help students build their knowledge according to their preferences, unlike what happens in traditional teaching models, which are more inflexible on these aspects.

In Distance Education the student studies alone much of the time and, students with active learning style will prefer synchronous activities such as chat and collaborative activities, such as wiki, than just asynchronous activities. So, tools that provide more interaction among students and between students and professors can help these active learners. One suggestion would be that besides watching video lessons and/or other videos of activities, the students could be required to record short videos explaining some subject or content to others. To reflective students, asynchronous activities, such as reading texts, questionnaires, preparation of reviews or texts etc. meet their learning preferences.

The visual and verbal learners tend to adapt to synchronous or asynchronous activities, but the visuals will be more likely to tasks that offer images, graphics, links than the verbal ones, who enjoy learning from written and/or spoken information. A virtual environment that merges those two things is essential in any distance course.

Learn linearly in logically sequenced steps is a characteristic of students with Sequential learning style, most of the sample investigated. Students with Global style can learn in great leaps and assimilate the material almost randomly without seeing connections, and suddenly understand everything. This dimension seems favored by Distance Education, since students can often choose to attend classes and perform tasks as these are available in LMS. Allowing free access to all activities in a particular subject of the course may favor both styles, so that students decide if they want to carry out the activities in some predetermined sequence or randomly, this one, the most attractive to global ones.

In these three dimensions, with balanced styles, it's easier to adapt to different teaching methodologies and characteristics and

requirements of the subjects. On the other hand, a high percentage of sensory learners were found in the sample. This means that activities and tasks that lead students to learn facts and solve problems through well-established methods, without complications and surprises, encourage a larger number of students. On the other hand, a lower percentage of intuitive students like new things, discovering possibilities and relationships, and get bored with repetition. This may be the dimension that deserves most attention in the investigated courses, so as to avoid poor academic performances by students who haven't met their learning preferences.

The knowledge of these different learning styles aims to contribute to a better allocation of resources and achievement of objectives to which Distance Education is oriented. In Distance Education, where the professor-student contact is restricted and often, the professor doesn't even know the student, it is essential to define more appropriate strategies for teaching and learning. The point of view of the students in Distance Education, the knowledge of learning styles can lead to changes in individual perspectives, such as motivation, attitude and behavior. Obviously, all styles need to be encouraged, not only those that can appear mostly. Thus, the ability to quantitate the different learning styles can help distance education in many ways. Looking for ways to improve the teaching and learning process and consequently the academic performance and general education of students, is very important in a continuous growth scenario of courses in distance, especially with the emergence and dissemination of online courses and of the Massive Open Online Course (MOOC). It is a path of no return and increased attention to the quality of courses and students' performance is essential. And learning styles can contribute to accomplish this.

4.2 Learning styles and performance

In Table 3, we observe Wald test results for the model with Gamma distribution and identity link function in the four dimensions of Felder and Soloman's learning styles of ILS (1991).

TABLE 3 – Wald test to factors of Gamma model with identity linkage function in the four dimensions

Dimension	Factors	⁽¹⁾ W	gl	p-value	IC 95% of Wald	
					⁽²⁾ LI	⁽³⁾ LS
Active/Reflective (AR)	intercept	79,242.625	1	<0.000	--	--
	AR	5.657	1	0.017	-1.281	-1.240
	⁽⁴⁾ Aval	27.502	1	<0.000	0.970	2.128
	AR * Aval	1.050	1	0.305 ^(ns)	--	--
Sensory/Intuitive (SI)	intercept	47,730.430	1	<0.000	--	--
	SI	0.186	1	0.667 ^(ns)	-0.911	0.582
	Aval	7.103	1	0.008	0.269	1.761
	SI * Aval	5.201	1	0.023	"Deployment"	
Visual/Verbal (ViVe)	intercept	79,237.784	1	<0.000	--	--
	ViVe	0.190	1	0.663 ^(ns)	-0.707	0.450
	Aval	27.855	1	<0.000	0.979	2.137
	ViVe * Aval	0.135	1	0.713 ^(ns)	--	--
Sequential/Global (SeGl)	intercept	78,371.876	1	<0.000	--	--
	SeGl	0.514	1	0.473 ^(ns)	-0.369	0.795
	Aval	26.090	1	<0.000	0.935	2.099
	SeGl * Aval	1.936	1	0.164 ^(ns)	--	--

⁽¹⁾W: value of statistic in Wald test; ⁽²⁾LI: value of lower limit of Wald confidence interval; (3) LS: value of upper limit of Wald confidence interval; (4) Aval: type of assessment (online or face-to-face).

Based on Wald test results, the level of significance 5%, the rejection of the hypothesis H1 that characterizes the learning style impacts the student's academic performance. This happened in three dimensions: Sensory/Intuitive; Visual/Verbal and Sequential/Global, but didn't happen in Active/Reflective dimension. Thus, in Active/Reflective dimension, the performance was affected in accordance with the learning styles and in the other three dimensions there was no impact of the learning styles about the performance. The Active/Reflective dimension refers to the processing of information and, based on this result, reflective students who prefer to learn through reflection about information and may be slower to start an activity and who enjoy the individual work or in doubles, had a better performance.

This result is contrary to Silva and Oliveira Neto's (2010) in a similar research, but developed only in the classroom environment, in an undergraduate degree in Accounting, because these authors identified that the learning styles of students, measured by Felder and Soloman's ILS

(1991), impacted the academic performance in all dimensions, except for the Active/Reflective dimension. However, the results presented here confirm, in part, the findings of Nogueira *et al.* (2012), who found no evidence that the learning styles impacted the performance in two subjects of accounting field in Distance Education, which could indicate that the used tools in this way satisfy all learning styles, although the used research instrument by these authors was Kolb's LSI.

We must consider, however, that this paper presents an innovation in research about learning styles and academic performance, with regard to research by type of assessment: online and face-to-face assessment activities. Thus, as observed in Table 3, the 'Aval' factor that characterizes the type of assessment (online and face-to-face) was significant in all dimensions, that is, there is a significant difference between the average scores of online and face-to-face tests, with the average of online grades higher than face-to-face. This implies that there is not enough evidence to reject hypothesis H2.

In all dimensions were evaluated interactions among factors. When the interaction among them is significant it can be said that there is an association (dependency) among the factors, that is, the learning style impacts the academic performance if we consider the type of assessment. On the other hand, if the interaction is not significant, we can state that there is evidence that the factors are independent, so, there is no association between them; there is no impact of learning styles on academic performance considering the type of assessment.

Based on the results shown in Table 3, we can check the listed claims, with a significance level of 5% using Wald Test and CI (confidence interval) 95% of Wald.

In Active/Reflective dimension, 'AR' factor is significant, i.e. there is a significant difference between the students' performance about the active and reflective learning style, and the average of the grades in active style are lower than in reflective. The interaction between the two factors 'AR' and 'Aval' was not significant, so there is no dependence (association) between the effects of 'AR' and 'Aval' factors.

In the analysis of sensory/intuitive dimension, 'SI' factor is not significant, i.e. there is no significant difference between the students' performance about sensory and intuitive learning style. Therefore, the average scores in sensory style are statistically equal to those of intuitive. The interaction between 'SI' and 'Aval' factors is

significant, there is a dependency between 'SI' and 'Aval' factors. The results of this interaction are presented in Table 4.

For the Visual/Verbal dimension, 'ViVe' factor is not significant, i.e. there is no significant difference between the students' performance about Visual and verbal learning style. Therefore, the average scores in Visual style are statistically the same as the Verbal ones. The interaction between the two factors 'ViVe' and 'Aval' is not significant, so there is no dependence (association) between the effects of 'ViVe' and 'Aval' factors.

About the Sequential/Global dimension, 'SEGL' factor is not significant, i.e. there is no significant difference between the students' performance with Sequential to Global learning style. Therefore, the average scores in sequential style are statistically the same as the Global ones. The interaction between the 'SEGL' and 'Aval' factors is not significant, so, there is no dependence (association) between the effects of 'SEGL' and 'Aval' factors.

So, H3 hypothesis – The interaction between learning styles and types of assessment is significant – was rejected in all dimensions except in Sensory/Intuitive. As mentioned earlier, in the Sensory/Intuitive dimension the interaction between 'SI' and 'Aval' factors is significant, there is a dependency between the effects of factors. Thus, Table 4 shows the results of development for this dimension.

TABLE 4 – Effects of interaction scrolling results of SI and Aval factors in the Sensorial/Intuitive dimension.

Learning Style	Rating factor		Averages
	Online	Face-to-face	
Sensory	42.462 aA	40.579 bA	41.521
Intuitive	41.758 aA	41.611 aA	41.685
Averages	42.110	41.095	

*Averages with different lowercase letters in line differ by Wald test and average with different capital letters in the column differ by Wald test, at a significance level of 5 %.

Based on the results of Table 4, Wald's test at a significance level of 5%, first analyzed the learning style scrolling within the type of

assessment. It was found that the average score of students with sensory learning style in online assessment activities is higher than the average

score of students with sensory learning style in face-to-face assessment activities, and that the average score of students with intuitive learning style in online assessment activities does not differ from the average grade of students with intuitive learning style in face-to-face assessment activities.

Within the learning style, it was found that the average grades of students' online assessment activities with sensory learning style do not differ from those with an intuitive learning style, and the average grade of the students' face-to-face assessment activities with sensory learning style doesn't differ from the average grade of students face-to-face with an intuitive learning style.

We can conclude, therefore, that learning styles, in this study, affected the academic performance of students in the Active/Reflective dimension, and a greater number of active students in the sample presented worse performance. When considering the type of assessment, online or face-to-face, there was an impact on the sensory style only, with higher grades in online assessment activities. However, for all styles, there were higher scores in online assessment activities than face-to-face.

These results may indicate that the possibility of holding different online assessment activities within the virtual environment satisfactorily met the needs of several learning styles. But other factors not necessarily linked to learning styles may have influenced the students' academic performance, such as online assessment activities that, being diversified, favor more the student's performance than a face-to-face assessment with a defined date and time, requiring even the movement of students to the poles; students can use different strategies to make the online reviews while a face-to-face assessment requires the student a predetermined and equal stance about defined content; the students' background, who may have done other courses in distance and be better suited to this method than those who have perhaps studied in the classroom and are experiencing the Distance Education for the first time, among

other personal and professional reasons and not related to learning styles.

Our results don't suggest that learning styles should be abandoned about assessing the student's performance, considering some positive relationships between styles and performance, as well as other studies that identified this relationship, such as Eom et al. (2006), Kalatzis and Belhot (2006) and Diniz (2007). Knowledge of their students' learning styles can contribute to the professor in order to plan the course, the subjects and resources and tools that will be available, so that it can maintain the positive results and promote improvements in the teaching-learning process in general.

There are mapping tools of learning styles with free access and studies that validate these instruments, such as the applied in this research that would not be difficult to be available in the platforms of Distance Education courses and to get the learning styles of students in registration, or even before, when the student has an interest in the course. Professors themselves could know their learning styles, because, as recommended by Felder and Silverman (1988) professors tend to teach the way they would like to learn.

Thus, with the mapped styles, some general practical recommendations include: merge interaction and action activities with activities that require more thinking; insert pictures, graphics, links, movies, written texts, testimonials and audio information recorded in a balanced way; provide real examples, general contexts, always linked with the subjects and course etc., from the learning styles present in the classes. It must be admitted that these efforts can attract and, more importantly, keep students in a distance education course, because they will better meet the learning preferences. It's important to keep in mind that learning styles reflect common patterns of behavior, but they are not the only factor that can influence academic performance, nor prevent evasion in the courses. As mentioned earlier, several other factors that were not the subject of study in this work can impact academic performance, such as age, students' background,

the necessity of the diploma, the search for professional development among others.

In addition, the students themselves, knowing their learning style, can develop strategies to adapt to tasks that are not their favorite, improving their performance and becoming more motivated to conclude the course. The solution is not only with the professor, especially in Distance Education, that is, it's not just from professors' point of view that there are different learning styles in a certain class, because they will have to understand all of them. The change is in students, in a more personalized education. From the moment students know their styles and their support field, strategies can be planned to help them.

5 FINAL CONSIDERATIONS

By analyzing the students' academic performance in the sample, it was found that this was impacted, positively, by just the Reflective learning style, present in 47.8% of the mapped students and other learning styles didn't impact in the performance. However, in all dimensions, when analyzing the students' grades in the two types of assessment in the courses, it was observed that the average scores of online assessment activities are greater than the average face-to-face assessment. This may be an indication that the student's in Distance Education is more prepared to handle synchronous and asynchronous activities of the learning management system, although it is not possible to say that their learning preferences explain such behavior in all analyzed dimensions. However, based on these results, it is possible that the online assessments encourage a greater number of learning styles.

Focusing on the main objective of this study, there was no significant interaction between learning styles and the type of assessment for three of the four dimensions from Felder and Soloman's ILS (1991), i.e. the active, reflective, visual, verbal, sequential and global learning styles didn't

impact in the students' academic performance as measured by the final grades obtained by them in online and face-to-face assessment activities. In summary, it should be said that the found empirical evidence are not able to state that the learning styles can encourage a better performance about online or face-to-face assessments because the average was statistically similar for both, regardless of the student's style.

This consideration does not apply to Sensory/Intuitive dimension, where it was found that the sensory learning style positively affected the students' performance in online assessment activities. Features like: like to solve problems through well established procedures; do not appreciate complications and surprises; be patient with details can explain this better performance in activities in the virtual environment, because in this environment tasks are already established and require much attention from students. The same cannot be said with regard to intuitive learning style, because this didn't impact the academic performance of students and the type of assessment.

Styles can contribute to the three main actors in the process of teaching and learning: professors, students and managers.

Knowledge about learning styles can help professors to choose and shape teaching strategies, i.e., to adopt appropriate teaching techniques to the students' characteristics.

For students, knowing their learning style is important to understand and develop new learning strategies when the professor teaches in a non-preferential style.

The research will also be able to contribute to educational managers who are interested in implementing the Distance Education and will employ knowledge about the learning styles to structure the learning management system with a better use of resources and to encourage the students through all learning styles.

It is suggested for further research, that this study is expanded to new samples of students, both in specialization courses as undergraduate,

in other Brazilian states, in order to compare the present results and obtain-subsidies to validate Felder and Silverman's model – ILS.

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