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RELATIONSHIP BETWEEN ECUATORIAN STUDENT'S LEARNING STYLES AND ACADEMIC PERFORMANCE IN SOIL SCIENCE

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ABSTRACT

Nowadays, there has been increasing interest in topics related to education on soil science, however, topics about learning on this science have been poorly studied, particularly the relationship between learning styles and academic performance has not yet been addressed in the literature. This study aimed to understand the different student learning styles of soil science and their effect on their academic performance at the career of Agronomy Engineering (University of Cuenca, Ecuador). For this purpose, this case-study research was based on the application of the CHAEA questionnaire in order to identify and relate the learning styles with the academic scores of a group of Ecuadorian students who receive introductory courses on soil science. Results demonstrated a general preference of students towards "pragmatic" and "activist" learning styles. In addition, marked differences by gender are clearly noticeable in terms of learning styles, being men more "pragmatic" than women, while women are more "activist" than men. Additionally, women revealed a tendency to be more "theoretical" and "reflective" than men. At last, our results suggest that academic performance was not influenced by learning styles. However, in students who showed multimodal preferences of learning styles, their academic performance became higher. These results highlighted the relevance that education plans in soil science need to consider the diversity of students in terms on their learning style preferences.

Key words: Academic score; CHAEA questionnaire; soil science education; gender

RELACIÓN ENTRE LOS ESTILOS DE APRENDIZAJE DE LOS ESTUDIANTES ECUATORIANOS Y EL RENDIMIENTO ACADÉMICO EN LA CIENCIA DEL SUELO

RESUMEN

En la actualidad se ha presentado un creciente interés en temas relacionados con la educación de la ciencia del suelo, sin embargo, los temas de aprendizaje de esta ciencia han sido poco estudiados y particularmente la relación entre los estilos de aprendizaje en los estudiantes que reciben instrucción sobre esta ciencia y su rendimiento académico aún no han sido estudiados en la literatura. Este estudio tuvo como objetivo conocer las diferencias en estilos de aprendizaje y el efecto que tiene en el desempeño académico de los estudiantes de Ciencias del Suelo en la carrera de Agronomía en la Universidad de Cuenca, Ecuador. Para este propósito, esta investigación se desarrolló como un estudio de caso, basado en la aplicación del cuestionario CHAEA para identificar y relacionar los estilos de aprendizaje con los puntajes académicos en un grupo de estudiantes, quienes reciben cursos introductorios de esta ciencia. Los resultados presentaron una preferencia general en los estudiantes hacia estilos pragmáticos y activistas. Además, hay diferencias marcadas por género, siendo los hombres más pragmáticos que las mujeres, mientras que las mujeres son más activas que los hombres, y también las mujeres tienden a ser más teóricas y reflexivas que los hombres. El rendimiento académico no fue influenciado por los estilos de aprendizaje, sin embargo en estudiantes que presentaron preferencias multimodales en los estilos de aprendizaje el rendimiento académico se incrementó. Estos resultados resaltan que los planes de enseñanza de la Ciencia del Suelo tienen que considerar la diversidad de los estudiantes basados en sus preferencias de estilos de aprendizaje.

Palabras clave: Puntaje académico; cuestionario CHAEA; educación en la ciencia del suelo; género

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INTRODUCTION

Nowadays, soil science has been subject to fundamental changes, and its importance is growing rapidly due to a renewed interest to study soils in relation to environmental degradation, climate change and world-food production (Hartemink & McBratney, 2008). During the last years, there has been an challenging debate about the soil science's future regarding education and research (Hartemink, 2006; Hopmans, 2007; Hartemink & McBratney, 2008; Baveye & Jacobson, 2009; Hartemink, 2015). Concerning education, teaching and learning aspects, where teachers and students are highly involved, it is not an easy task at all; according to Hartemink *et al.* (2014), the leading purposes for teaching soil science are to spread knowledge, insight and inspiration towards students.

In an overall education framework, educators, curriculum developers, as well as policy makers are concerned to improve the quality of higher education institutions' graduates around the world (Yousef, 2016). However, several studies have paid attention mainly on teaching aspects of this science (Reyes-Sánchez, 2006; Hartemink *et al.*, 2008; Kang, 2008; Havlin *et al.*, 2010; Field *et al.*, 2011; Reyes-Sánchez, 2012; Hartemink *et al.*, 2014), while the learning aspects have been neglected. To our knowledge, it can be found only a couple of studies addressing this topic (Dawson, 1956; Amador & Görres, 2004), not having found any specific study on learning styles and their effects on academic performance of students who receive introductory soil science courses at any higher education institution (HEI). Therefore, since students fulfill a fundamental role within the education system, more emphasis should be put on their learning characteristics and capabilities.

Within this framework, if learning can be defined as a relative and permanent change in the behavior resultant from the experience (Alonso *et al.*, 1995), then learning styles can be referred as the ways people learn (Pashler *et al.*, 2008) and they constitute a part of a broader concept of personality of each individual (Hawk & Shah, 2007). Therefore, it has been demonstrated that each individual show a cognitive preference or learning style (Kolb, 1981; Ifenthaler *et al.*, 2011). As a result, having an audience of learners with a range of different learning styles and individual characteristics, learning tools should be designed considering the diversity of knowledge, gender, age and development of individuals (Sawyer, 2014).

Regarding research on learning styles applied to specific disciplines at HEI's, several studies have been developed so far. For example about business (Jaju *et al.*, 2002; Njoroge *et al.*, 2006; Hussain & Ayub, 2012), statistics (Christou & Dinov, 2010; Yousef, 2016), biology (Reinecke *et al.*, 2008; Madrid *et al.*, 2009), public health (Piane *et al.*, 1996), pharmacy (Czepula *et al.*, 2016), optometry (Prajapati *et al.*, 2011), dentistry (Asiry, 2016), among others. At this point, the lack of research concerning soil science (or related subjects) is evident. In this framework, the objectives of this paper are: i) to identify the learning styles of students who receive introductory courses on soil science at the Career of Agronomic Engineering, University of Cuenca (Ecuador), and ii) to identify the possible effect of learning styles on the academic performance of students. This study contributes to better understand some learning's aspects under the typical environment of Ecuadorian students; this in turn could support education planning and improvement of the high education level in general.

MATERIAL AND METHODS

Data collection

The population of this study was eighty-two undergraduate students. Their age ranged from 19 – 21 years. They received and approved introductory courses on soil science at the career of Agronomic Engineering at the Faculty of Agricultural Sciences, University of Cuenca. This university is one of the largest Ecuadorian high education public institution (located in the city of Cuenca, Azuay province, southern Ecuador). The data collection was carried out from March 2015 up to February 2016.

At the career of Agronomic Engineering, introductory courses on soil science are taught in two semesters. The first semester concentrates on the "Edaphology" part, while the second semes-

ter focuses on "Soil Classification and Soil Mapping". These two subjects are directly related to the general structure of the International Union of Soil Sciences (International Union of Soil Sciences, 2016), specially with the divisions "Soils in space and time" and "Soil properties and processes". Both are taught in the regular academic program at the mentioned career (Agronomic Engineering).

Data was collected by the application of the Honey-Alonso Learning Styles questionnaire or CHAEA (Cuestionario Honey-Alonso de Estilos de Aprendizaje) (Alonso *et al.*, 1995). This questionnaire is based on the Kolb's theory of experiential learning (Kolb, 1984). Prior the CHAEA questionnaire application, the student population was clearly informed about both the objectives of the research and the methodology itself. Additionally, students were informed about the non-obligatory nature of participating in the survey, as well as about the use and confidentiality of the data collected.

This research applied a quantitative approach through the CHAEA questionnaire technique. This questionnaire compromised 80 randomized questions to characterize four learning styles: activists, reflectors, theorists, and pragmatists (**Table 1**). Each style was represented by 20 questions. The predominant learning style is given by the highest total score for each one, being 20 the maximum score per style (Alonso *et al.*, 1995).

Table 1. Characterization of learning styles according to Honey and Mumford (Honey and Mumford, 1986).
Tabla 1. Caracterización de los estilos de aprendizaje según Honey y Mumford (Honey & Mumford, 1986).

Learning styles	Characteristics
Activist	Enthusiastic, improviser, pathfinder, bold, and spontaneous
Reflector	Prudent, conscientious, receptive, analytical, and exhaustive
Theorist	Methodical, logical, objective, critical, and organized
Pragmatist	Experimenter, practical, direct, effective, and realistic

The CHAEA questionnaire is an instrument that has been widely used, including Spanish-speaking students (Madrid *et al.*, 2009). The survey was carried out during two consecutive academic semesters (March - August 2015; and September 2015 – February 2016), meaning that the surveyed population was different from one semester to another.

The identification of the learning style preference of each student is not linear and it is different per style (Alonso *et al.*, 1995), therefore we used the scale proposed by the same authors of the questionnaire.

Data on students' academic performance was obtained from their university official records for each semester. A 100-score scale per semester ranked each surveyed student. In order to avoid the influence of teaching styles over learning styles, only students, who received the introductory courses of soil science and dictated by the same professor, were taken into account.

Data analyses

Differences in learning styles were analyzed by descriptive statistics based on the highest preference of learning styles that corresponds to the "Very High" category according to the scale proposed by Alonso *et al.* (1995). Mann-Whitney U-test ($P<0.05$) was applied to determine significant differences between gender and trend's preference per learning style. Differences among academic scores on learning styles were assessed by the ANOVA tests. Previously, data normality and homoscedasticity were tested by means of the Shapiro-Wilks test ($P<0.05$), and Levene's test ($P<0.05$), respectively. Differences on academic scores according to levels of learning styles preferences were assessed by the One-way ANOVA ($P<0.05$), and Tukey's post hoc was applied after ANOVA's. If data did not fulfill assumptions for parametric analysis, the Kruskal-Wallis test ($P<0.05$) was applied with the post-hoc followed by Benjamini and Hochberg pairwise procedure (HB) after the Kruskal-Wallis test. Finally, the Mann-Whitney U-test ($P<0.05$) was applied to assess if academic scores are related to gender. All statistical analyses are managed by the R software program (Version 3.3.2) (R Development Core Team, 2016).

RESULTS AND DISCUSSION

Preferences of learning styles among students

Sixty-eight students completed the CHAEA questionnaire. Results demonstrated that most students were classified as "Pragmatist" followed by "Activists", since they showed the highest level of preference ("Very high" category) for these two learning styles (**Table 2**). These results can be expected because, although soil science covers a wide spectrum from pure to applied studies, it is skewed towards its practical application (applied science) (Churchman, 2010; Hartemink, 2015)consequently, students pursuing a degree related to Agricultural Sciences – where soil science is a core subject into the academic program –, they might be expected to have learning styles around the praxis (for example associated with the pragmatic learning style). Furthermore, since Edaphology is taught into an engineering career at the University of Cuenca, current results are similar to those obtained by a research carried out at the "Universidad Central de Chile", where students enrolled also in engineering careers, showed to be "Activists" and "Pragmatists" in terms of their learning styles (von Chrismar Parejo, 2005).

Table 2. Levels of preference (%) per learning styles in students of soil science at the Faculty of Agricultural Sciences, University of Cuenca.
Tabla 2. Niveles de preferencia (%) por estilos de aprendizaje en estudiantes de la ciencia del suelo en la Facultad de Ciencias Agropecuarias de la Universidad de Cuenca.

Learning Style	Levels of preference (%)				
	Very low	Low	Moderate	High	Very high
Activist	11,5	7,4	39,7	32,4	19,1
Reflector	13,2	19,1	54,4	11,8	1,5
Theorist	0,0	17,6	45,6	25,0	11,8
Pragmatist	2,9	16,2	27,9	32,4	20,6
Average	**4,4**	**15,1**	**41,9**	**25,4**	**13,2**

On the other hand, there are students having more than one preferred learning style, independently of the level of preference. In this context, there were 25% and 16% of surveyed students with preferences of two and three learning styles, respectively; meanwhile most students had one learning style (56% of students) and only 3% showed no any dominant preference. In this framework, according to Alonso *et al.* (1995), the ideal scenario would be that the high level of preference reaches every category, this would mean that students could learn better in any situation.

Regarding the relation between students' gender and their learning preferences, women represented 59% of the surveyed students. This growing number of women in careers where soil science is taught, has been recognized not only in the local context, but also at regional level. As is the case, in countries like the USA, Canada, Netherlands, Australia, and New Zealand that have experimented a up-growth in female students during the last years (Hartemink, 2006; Hartemink *et al.*, 2008). Nevertheless, there were no significant statistical differences between gender and learning preferences, except for the "pragmatist" style, at which the male population was the dominant (Mann-Whitney U-test, *p*-value=0.0027). However, considering the analysis of the dominant preference ("Very High" category) according to gender, women were more "activists" than men, and male students were more "pragmatists" than women. In contrast, female students were more "theorists" and "reflectors" than male students (**Figure 1**). These tendencies suggest that learning styles are somehow influenced by gender. According to Severiens & Ten Dam (1994), women prefer the abstract conceptualization in the learning process that is directly related to "theorists", which is similar to the findings of the current research.

Differences on learning styles conditioned by gender have also been described in several studies from different careers and countries, for example in computer science (Lau & Yuen, 2010), medicine (Chaput De Saintonge & Dunn, 2001; Kulac *et al.*, 2013; Nuzhat *et al.*, 2013), public Health (Piane *et al.*, 1996), information technology (Alumran, 2008), optometry (Prajapati *et al.*, 2011), and even on students presenting learning disabilities (Yong & McIntyre, 1992). Such evidence suggests that diversity on learning styles is

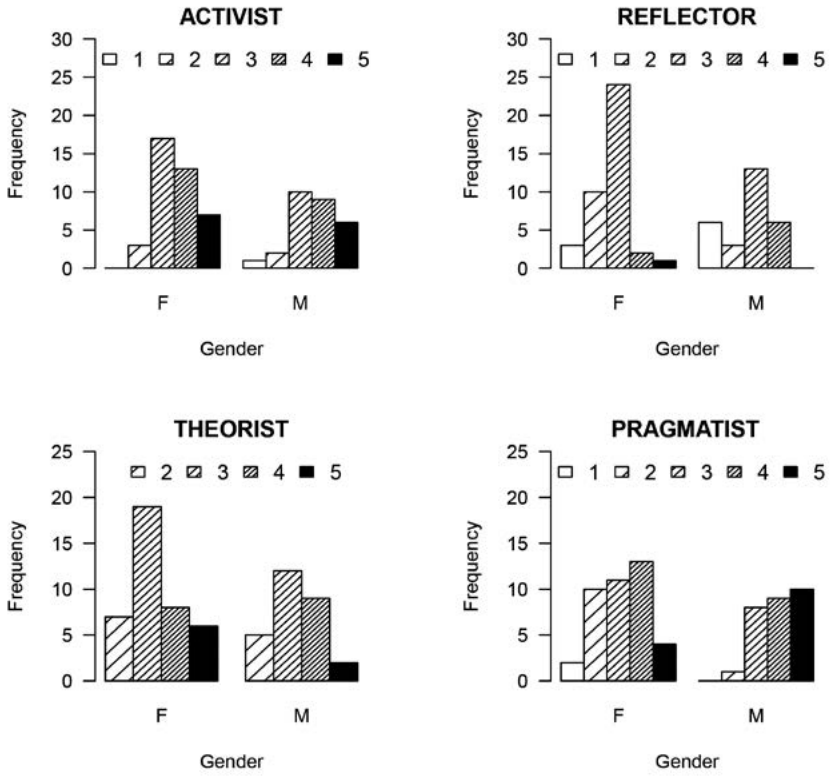

Figure 1. Level of preference for learning styles according to student's gender (F = Female; M = Male). Preference levels: 1 = "Very low"; 2 = "Low"; 3 = "Moderate"; 4 ="High"; 5 ="Very high".
Figura 1. Niveles de preferencia de los estilos de aprendizaje según el género de los estudiantes (F = Mujer; M = Hombre). Niveles de preferencia: 1 = "muy bajo", 2 = "bajo", 3 = "Moderado", 4 = "alto", 5 = "muy alto".

a fundamental element for planning teaching strategies in soil science, therefore is of upmost importance to consider a multidisciplinary approach, using real-life applications and practical examples to catch the students attention and interest, as well as taking advantage of the current information and communication technologies (ICT's). Nevertheless, the soil science education in Ecuador, is a truly challenge, because currently there is still a low number of students who are directly involved in careers where soil science is taught, for example the University of Cuenca – one of the largest universities in Ecuador – has only approximately 2,5% of students coursing Agronomy – a career where soil science is a core subject in the student's formation –. As a consequence of this panorama, the financial support to improve the infrastructure for education and research is still reduced in this country. However, it is expected that this current situation may change bearing in mind the new initiatives at global scale to relaunch this science, for instances, 2015 was declared as the "International year of soils", including the declaration of the "International Decade of Soils, 2015-2024".

The relationship between academic performance and learning styles

There were no statistical differences between the academic performance related to learning styles (Kruskal-Wallis test, P=0,782). In addition, no significant differences were obtained for the possible relationship between academic performance and the level of preference (Kruskal-Wallis test, P=0,392), neither for the level of preference per each style (**Table 3**). Additionally, no statistical differences (Mann-Whitney U-test, P= 0,136) were obtained in the possible relation between gender and the academic performance of students.

Although, in general terms no statistical differences were found, there are some slight trends for "reflectors" and "theorists", who showed a direct relationship between academic scores and the preference for such learning styles (the higher the preference, the higher the academic score) (Table 3). Although the level of preference is actually an intrinsic attribute for each person, teachers should develop didactic strategies in order to involve students presenting low preferences for this type of styles.

Table 3. Least square means of academic scores according to their learning style preference for each style in students of soil science at the Faculty of Agricultural Sciences, University of Cuenca.
Tabla 3. Media de los mínimos cuadrados de las calificaciones según la preferencia del estilo de aprendizaje para cada estilo en estudiantes de la ciencia del suelo de la Facultad de Ciencias Agropecuarias de la Universidad de Cuenca.

Learning style	Level of preference						
	Very low	Low	Moderate	High	Very high	SED	*p*-value
Activist	80,00	77,20	76,80	75,68	73,84	6,73	0,61
Reflector	75,62	77,00	76,08	73,25	81,00	6,52	0,62
Theorist	-	74,33	76,16	74,94	79,62	2,75	0,23
Pragmatist	84,50	76,10	76,68	75,36	74,50	4,67	0,26

Score differences in learning style preferences at the 95% significance level according to Tukey's post hoc for multiple comparisons derived from ANOVA.
SED: standard error of the differences of means.

In general terms, current findings of this research suggest that high-score achievements in soil science were not conditioned by learning styles, however, future research has to be addressed to improve the representativeness of our findings. Nevertheless, there are also studies which have reported a no relationship between academic performance and learning styles but in other academic disciplines (Prajapati *et al.*, 2011; Nuzhat *et al.*, 2013)

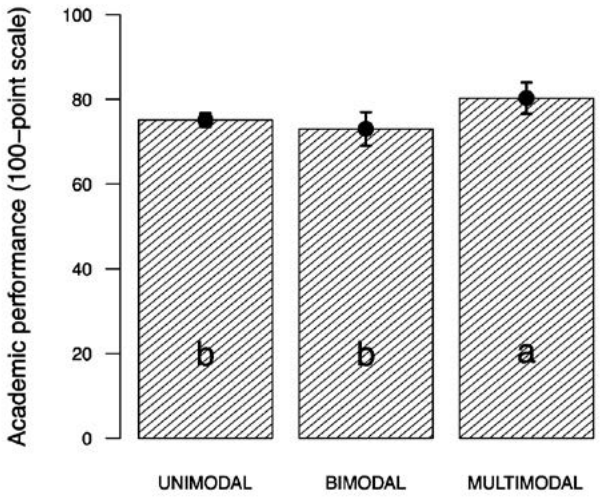

Figure 2. Academic performance according to level of modal (statistical mode) preference for learning styles. Different letters indicate significant differences (P<0,05; BH post-hoc comparison after Kruskal-Wallis test).
Figura 2. Rendimiento académico según el nivel de modalidad (modelo estadístico) de preferencia para los estilos de aprendizaje. Las letras indican diferencias significativas (P<0,05; BH post-hoc de comparación después del test de Kruskal-Wallis test)

On the other hand, taking into account students presenting more than one preferred learning style, it is important to notice that there are differences given by students that presented more than two preferred learning styles (multimodal) (**Figure 2**), contrary to the tendency of lower academic performance given by the highest preference for only one style, that has been reported in similar studies (Tantawi, 2009; Nuzhat *et al.*, 2013). In this regard, Kolb (1981) and Honey & Mumford (1986) claim that the best learning achievement could be obtained when an individual present all learning styles well balanced.

CONCLUSIONS

This study revealed variations in learning style in a group of students who received introductory courses on soil science at the University of Cuenca (Ecuador). The learning styles were conditioned by gender. Academic performance was not influenced by neither learning style nor gender. However, a directly proportional relationship was spotted between students who showed multimodal preferences on learning styles, and their higher academic performance. At last, in the context of an ideal learning scenario, a very low proportion of the surveyed students presented a balanced preference for all learning styles. This suggests the development, application and/or adaptation of didactic methods to promote a wider range of learning skills on students. This can be considered as one of the main cornerstone for maximizing the students' professional potential. Overall,

the current findings of this research suggest that learning styles should be taken into account for developing effective educational plans in soil science education at HEI's in Ecuador.

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