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Learning and navigating: an exploratory study of the relationships between learning styles and navigational practices in Moodle

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Abstract

This study identifies the relationships between the learning styles and certain characteristics of the navigational practices of a group of students taking an online postgraduate course in Moodle.[1] These two aspects may help to appreciate the characteristics of student learning and, therefore, to guide the teaching-learning process. They may also play an important role in the generation of theoretical and practical knowledge, thus enabling a better understanding of the topic. The study confirmed the existence of significant relationships between certain characteristics of navigational practices and one learning style in particular, thus suggesting the need for a more systematic exploration.

Keywords

navigation, learning, CHAEA, Moodle, e-learning

Navegar y aprender: una aproximación a las relaciones entre estilos de aprendizaje y la navegación en Moodle

Resumen

En el presente estudio se identifican los estilos de aprendizaje y su relación con ciertas características de navegación de algunos estudiantes de un curso en línea de posgrado en el entorno de la plataforma Moodle. Estos dos componentes podrían ayudar a considerar las características de aprendizaje de los estudiantes, y, en este sentido, a orientar el proceso de enseñanza-aprendizaje. Además, puede ser importante en la generación de conocimientos teórico-prácticos que posteriormente permitan profundizar en el tema. La investigación confirmó la existencia de relaciones significativas entre algunas características de navegación y un estilo de aprendizaje en particular, lo cual indica que debería estudiarse de manera más sistemática no solo la navegación, sino también los estilos en relación con algunas características de navegación.

Palabras clave

navegación, aprendizaje, CHAEA, Moodle, e-learning

Introduction

The incorporation of information and communication technologies (ICTs) into higher education has brought about major changes in the teaching-learning process (Salinas, 2004). Today, an educational model based on an open, flexible learning process is required. This model acknowledges the students' ability to set their own pace and intensity of learning (Moreira, 2003). The introduction of computers and their rapid technological development, specifically in relation to digital multimedia, as well as the widespread uptake of the World Wide Web, have together driven the expansion of e-learning as both a process and an educational mode (Bersin, 2004).

Moodle's design is based on a number of constructivist notions. In fact, for specialists in the field of education, constructivism encompasses an approach that enables the expected benefits from

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1. Moodle is an acronym for Modular Object-Oriented Dynamic Learning Environment. It is free, open source software.

the use of computers in educational processes to be realised (Harper, Squires & McDougall, 2000). Two of these benefits are: 1) involving students as active agents in their learning processes; and 2) dealing with the diversity of their needs. In this respect, the learning style is related to the distinct and characteristic way of learning that each individual has (González, 2000). Rowntree (1992) underscored the need to take the context and student variables into account, and to be guided by the constructivist aspect of learning; he also asserted that it was important to develop flexible designs in e-learning.

Students can be distinguished by how they learn. It is necessary to know what their ways of learning are because there is a wide diversity of learning style models.[2] In this study, the Honey-Alonso learning styles questionnaire (CHAEA) was used. It is a model that falls within cognitive approaches to learning (Alonso, Gallego & Honey 1999). The CHAEA has been widely used by higher education students, and it has proven to be reliable and valid in the Spanish and Latin American context (Adán, 2001; Figueroa et al., 2004; García-Cue, 2006; García-Cue & Santizo 2009; Massimino, 2006; Orellana, Belloch & Aliaga, 2002; Pazos & Salinas 2004; Sánchez, 2007; Ramírez & Osorio, 2008).

It is also important to ascertain how students taking online courses navigate the virtual learning environment (VLE), which, in the first instance, implies the identification of certain characteristics of navigational practices. In Mexico, there are several studies describing such characteristics (Lavigne, Organista & McAnally, 2008;[3] Lavigne et al., 2011).

Thus, the aim of this study is to identify the potential relationships between the learning styles and certain characteristics of the navigational practices of a group of students taking an online course in Moodle as part of the master's degree programme in Education Sciences at the Autonomous University of Baja California (UABC).

Previous studies

The study of learning styles has transcended the field of face-to-face education. In e-learning, emphasis has been placed, firstly, on the need for lecturers to ascertain how students learn and, secondly, on the need for students to be aware of their own ways of learning (James & Gardner, cited in Pazos & Salinas, 2004). Furthermore, designers and lecturers alike must bear in mind the various teaching-learning strategies that enable tasks associated with different styles to be undertaken. Thus, by means of content and activity navigation models, it should be possible to achieve personalised learning in online education (Cacheiro, 2006).

Since 1990, Alonso, Gallego and Honey have conducted research studies on the learning styles of university students, especially at the Spanish National University of Distance Education (UNED) and the Complutense University of Madrid. They conducted these on students taking Technical and Experimental Humanities bachelor's degree courses in Spain's capital city. In the higher education

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2. In this study, it was necessary to analyse the characteristics of each model. See Díaz-López (2010).

3. In accordance with a free translation by Doctor Lavigne and his PowerPoint presentation in Spanish entitled *Clic y aprendizaje: un estudio provisional de la navegación en un ambiente virtual* given at the Research and Educational Development Institute (IIDE) Research Seminar, 8 May 2009.

learning styles studies conducted with the CHAEA in Europe and Latin America, the *reflective* style stood out (Alonso, 1992; Camarero, Martín & Herrero, 2000; Adán, 2001; Massimino, 2006; Ramírez & Osorio, 2008; Ramírez, 2009).

There are very few studies directly dealing with the relationships between the learning styles and the navigational practices of students taking online courses. However, there are some that explore the relationships between ICT use and learning styles. In this respect, Orellana, Belloch and Aliaga (2002) explored whether there were any relationships between the different learning styles of pedagogy students and their use of ICTs at the University of Valencia. Their learning styles were identified by means of the CHAEA. The most common ones were *active* and *theoretical*, and it was concluded there were no significant relationships between either of them and ICT use.

Pazos and Salinas (2004) also conducted a study at the University of the Balearic Islands to ascertain whether there were any significant differences between the answers given by students with different learning styles and their navigational preferences. The CHAEA was used to identify the learning styles. The results showed that the styles preferred by the majority of the students were *active* and *pragmatic*. However, no significant relationships between either of them and navigational preferences were found.

García-Cue and Santizo (2009) conducted a study on ICT use in accordance with the learning styles of lecturers and students at the State of Mexico Graduate School, the aim of which was to formulate various training proposals for teaching staff to enable the integration of ICTs into the students' curriculum, thus contributing to improved teaching quality in several postgraduate fields. They distinguished the different learning styles of lecturers and students, and studied how they used ICTs in their academic and personal lives. The results obtained from the CHAEA showed that, among lecturers and students alike, the predominant learning style was *reflective* and the least important was *active*.

In the field of log analysis, which, at the time of writing, had been performed for more than 10 years (IWGEDM, 2011), there are practically no studies like the one presented in this article. The only exceptions are the studies conducted by the educational data mining group in the United States, whose methodological focus is very different to the one followed here (Baker & Yacef, 2011).

Method

This exploratory study used a mixed approach, as data were collected by means of quantitative and qualitative methods.

Participants

Twenty-five students on the master's degree programme in Education Sciences at the Research and Educational Development Institute (IIDE) at the UABC participated; they took the Education Planning and Assessment (EPA) subject online in Moodle in 2009.

The main feature of the EPA is that it was offered online; it only included one face-to-face session.

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It was implemented within the *Sistema de @ulas-UABC*,[4] a private Moodle-based space created specifically for online courses offered by the UABC Ensenada Campus. The course structure was weekly. All the activities, instructions and tasks could be found in the respective week, with a total of six *learning forums, readings, tasks, workshops* and one *video*. Every activity was compulsory and formed part of the assessment. In addition, several optional navigation spaces were offered, such as *messages*, a *cybercafé forum*, a *forum for questions about tasks and/or assignments*, and a *technical support forum*. The course duration was 14 weeks.

Instruments

Questionnaires

The CHAEA was used to diagnose the personal learning styles of the students and the profiles of the predominant styles. Moreover, two additional questionnaires were designed to ascertain the students' opinions of their learning experience in a VLE like Moodle.

The three questionnaires were done online using LimeSurvey,[5] and the data were exported to Microsoft Excel and to Statistical Package for the Social Sciences (SPSS).

Logs

Moodle has databases containing all the logs of every student's activity throughout their courses. Consequently, these can be used to characterise navigational practices and to systematically analyse not only the number of connections and HITS that students make, but also where they went and what they did (Lavigne et al., 2008). The 'HITS' or 'Hypertext-Induced Topic Selection' notion enables movements in virtual space to be described and measured; it corresponds to clicking on a hyperlink to open a web page or mark a change of page. This means that a HITS measurement actually corresponds to the time between two HITS.[6]

The variables used to identify certain characteristics of navigational practices were: total number of HITS and connections, mean duration per HITS and per connection, total number of HITS in each navigation space of the online course (Moodle modules). These variables were subsequently related to learning styles.

Focus groups

In order to explore the students' perceptions of learning styles and navigational practices, the focus group technique was used because it allowed the interest in a specific topic to be focused through

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4. There are several versions of this course within the *Sistema @ulas-UABC*, depending on the lecturers responsible for implementing it.

5. LimeSurvey (formerly PHP Surveyor) is a free, open source program written in PHP, based on a MySQL, PostgreSQL or MSSQL database. It allows questionnaires to be developed and published, and answers to be collected without any knowledge of programming. http://www.limesurvey.org/

6. The equivalent term used in Spanish is 'clics'.

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the participation of a group of students. Three core topics were discussed in two focus groups: self-perception of learning styles and self-perception of navigational practices. The participating students were selected in accordance with the learning style profiles obtained by means of the CHAEA to ensure that the participants in both groups had diverse learning profiles.

Procedure

Data collection

Firstly, the three questionnaires were done online. Secondly, the CHAEA results were analysed. Thirdly, the focus groups were held. Lastly, the log data extracted from Moodle were cleaned and analysed.

Data analysis

Using SPSS and Microsoft Excel, the CHAEA results analysis was performed in accordance with the corresponding evaluation guidelines. The questionnaire data were analysed to ascertain the students' opinions of their learning experience in Moodle and perceptions of their skills in the use of the technology.

Regarding the focus groups, the audio recordings were transcribed after the two sessions had been held; the documents were then assigned to the ATLAS.ti program to perform the data analysis, identifying codes and categories. The above led to the production of an interpretative summary in which the relationships and contrasts from the data were identified.

Regarding the characteristics of navigational practices, the data were retrieved in Microsoft Excel format for each day throughout the duration of the course (from 7 January to 30 April 2009). The logs obtained from the reports stored in Moodle provided activity data for each student (total number of HITS and connections, total duration per HITS and per connection, mean duration per HITS and per connection).[7]

Results

Contextual data

The students taking part in the study had a mean age of 30 years; there was a balanced gender and marital status distribution; and nearly half had parents with higher education qualifications. Some 40% worked 17.5 a week on average as lecturers or professionals.

The questionnaire results showed that, for 44% of the students, it was the first online course they had taken; 72% described the experience as good or excellent, and they also stated that working online motivated their learning. However, 56% of them stated that they "always" preferred face-to-face courses, whereas only 4% "always" preferred online courses.

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7. Moodle logs do not provide any of these variables, so they had to be calculated from raw data: date, IP address, full name, action and data.

Regarding the use of the technology, 96% of the students had a computer and Internet service at home; nearly half used a computer between five and six hours a day. Some 52% considered that they had good computer skills.

Learning styles

According to the raw score for each participant, Table 1 below shows the number of cases and percentages obtained in the four styles. It is possible to see that 40% of the participants displayed a high or very high preference for the *reflective* style. In contrast, 40% of the participants displayed a low or very low preference for the *active* style. Worthy of note is that 52% of the participants displayed a moderate preference for the *theoretical* style, as did 32% for the *pragmatic* style.

Table 1. Group learning styles

Preference	Active		Reflective		Theoretical		Pragmatic	
	Number	%	Number	%	Number	%	Number	%
Very high	4	16	5	**20**	3	12	3	12
High	4	16	5	**20**	3	12	5	20
Moderate	7	28	8	32	13	**52**	8	**32**
Low	4	**16**	4	16	3	12	6	24
Very low	6	**24**	3	12	3	12	3	12
Total	**25**	**100**	**25**	**100**	**25**	**100**	**25**	**100**

Figure 1 below shows the means of the scores obtained for each learning style. Worthy of note is that the participants' highest mean was in the *reflective* style, whereas the lowest was in the *active* style.
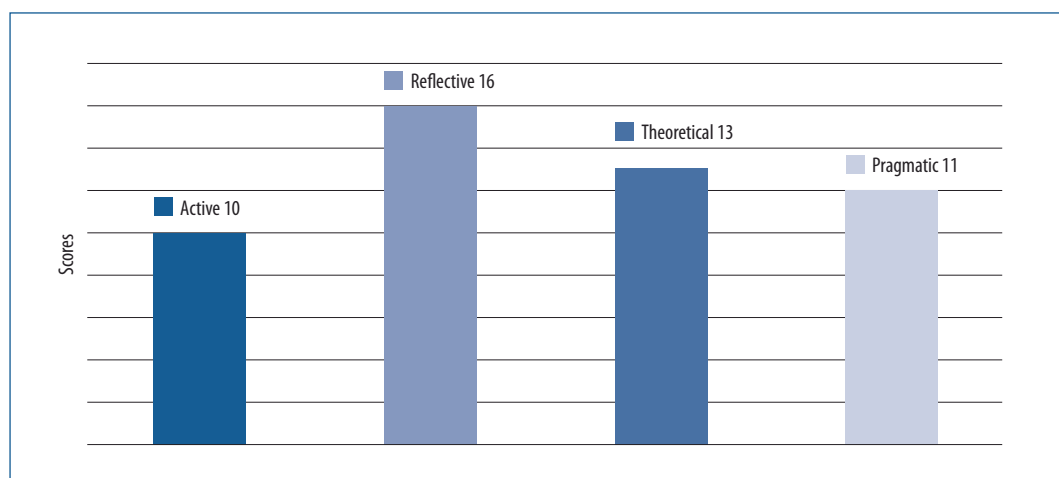

Figure 1. Overall means for the CHAEA learning styles

The CHAEA evaluation guidelines were followed to obtain the learning style profiles shown in Table 2 below. The two highest raw scores shaped the learning style profile. In cases where the raw results were even, the profile consisted of more than two styles. Thus, two higher frequency profiles were identified, the *reflective-theoretical* profile and the *reflective-pragmatic* profile; in addition, five other low frequency profiles were identified.

Table 2. Distribution of the learning style profiles obtained by means of the CHAEA

Learning style profiles	Frequency	Percentage (%)
Reflective-theoretical	12	48
Reflective-pragmatic	6	24
Reflective-active	2	8
Reflective-theoretical-pragmatic	2	8
Active-pragmatic	1	4
Theoretical-active	1	4
Theoretical-pragmatic	1	4
Total	**25**	**100**

Navigational practices

Table 3 below shows the differences between the total number of connections and the total number of HITS. It is possible to observe sharp differences between the minimum and maximum scores, showing a broad distribution around the mean. The results also showed that a large majority of the students (17 out of 25) made between 1,000 and 2,000 HITS, and between 50 and 100 connections.

Table 3. Distribution of total mean number of HITS and connections per student

Basic statistics	Total number of connections	Total number of HITS
Mean	80	1,678
Standard Deviation	33.24	1,034.15
Minimum	43	805
Maximum	191	5,859

Table 4 shows that the mean duration per HITS was 95 seconds (1 minute 35 seconds), whereas the mean duration per connection was 1,890 seconds (31 minutes 30 seconds). It is also possible to observe sharp differences between the maximums and minimums of both.

Table 4. Mean duration per HITS and per connection, in seconds

N=25		Mean	Minimum	Maximum
Duration per HITS	in seconds	95	37	225
	h:min:s	0:01:35	00:37	03:45
Duration per connection	in seconds	1890	642	5586
	h:min:s	0:31:30	0:10:42	1:33:06

Table 5 below shows that the highest mean number of HITS made by the students was on the *cybercafé* option, with a total of 272 HITS. This was an optional activity for the purpose of socialising. In contrast, the total mean number of HITS on *readings* (compulsory) was 145. Regarding *learning forums* (compulsory), the minimum number of HITS was 17 and the maximum was 209, thus indicating a sharp difference.

Table 5. Distribution of the total mean number of HITS obtained in the navigation options

Navigation spaces (activities)	Mean	SD	Minimum	Maximum
Tasks	75	31	26	161
Readings	**145**	77	75	455
Workshops	60	34	13	162
Cybercafé forum	**272**	195	97	1076
Forum for questions about tasks and/or assignments	36	27	2	113
Learning forums	74	44	17	209
Messages	12	43	0	209
Technical support forum	30	31	2	123
Instructions	36	21	9	107
Videos	4	3	0	10

Learning styles and navigational practices

The two learning styles were grouped together in accordance with the TwoStep Cluster technique in SPSS, which is useful for revealing natural groupings (or clusters) in a dataset. The resultant clusters were obtained with four of the variables (total number of HITS, total number of connections, mean duration per HITS, mean duration per connection). Table 6 below shows the cluster results (F= 4.541, p=0.044). There are two classifications: *reflective* and *other* (whether *active*, *theoretical* or *pragmatic*). Worthy of note is that the *reflective* style was identified in a large majority of the group of participants.

Table 6. Distribution of students by learning style, as a result of TwoStep Cluster analysis

Styles / Groups	Active		Reflective		Pragmatic		Theoretical		Total	
	F	%	F	%	F	%	F	%	F	%
Other	3	100	0	0	1	100	4	100	8	32
Reflective	0	0	17	100	0	0	0	0	17	68
Total	3	100	17	100	1	100	4	100	25	100

Applying Student's *t*-test, statistically significant differences between learning styles and the total number of HITS were found. The students with a *reflective* style had a higher number of HITS than those with *other* styles. No statistically significant differences were found in the total number of connections or the mean duration per HITS or per connection (see Table 8).

Table 8. Relationships between learning styles and total number of HITS

Navigation	Learning styles	N	Mean	Standard Deviation	t	Sig.
Total number of HITS	Reflective	17	2,100	1,642.27	-8.670	0.013(*)
	Other	8	1,480	541.86		

(*) Level of significance less than 0.05

Table 9 shows the statistically significant differences between learning styles and several navigation spaces: *tasks*, *readings* and *messages*. On average, the *other* students made more HITS. In contrast, the *reflective* students made more HITS on the *cybercafé* option. However, there were no significant differences in *instructions*, *videos*, *learning forums*, *workshops*, *technical support forum* or *forum for questions about tasks and/or assignments*.

Table 9. Relationships between learning styles and navigation spaces

Total number of HITS	Learning styles	N	Mean	Standard Deviation	t	Sig.
on tasks	Reflective	17	66	29.96	-13.868	0.005(*)
	Other	8	81	36.85		
on readings	Reflective	17	130	39.02	-8.438	0.014(*)
	Other	8	179	121.82		
on the cybercafé forum	Reflective	17	343	312.97	-25.336	0.002(*)
	Other	8	229	110.22		
on messages	Reflective	17	3	5.48	-45.250	0.000(*)
	Other	8	34	73.46		

(*) Level of significance less than 0.05

Self-perceptions

The results obtained in the focus groups were centred on self-perception of learning styles and self-perception of navigational practices. The students concurred that every individual had their own way of learning. Worthy of note is that the learning styles previously diagnosed by means of the CHAEA were reflected in their discourses. While some said that they preferred to avoid activities that required group discussion and the presentation of ideas, others said that they had a proclivity towards activities that included group discussion, critique, analysis, reflection and confrontations of ideas, as well as learning about the different views and stances of others.

Various stances on the relationships between learning styles and navigational practices were also identified. While some students unambiguously asserted that relationships between their learning styles and navigational practices existed, others said that they did not, because they felt that the structure and design of the course did not allow them to express their learning styles. For the students, the differences in navigational practices could be put down mainly to their prior experience of online courses and to their personal preferences.

Generally speaking, the majority of the students followed a specific navigational process within the course: firstly, they generally explored the space; after that, they checked out the task objectives; and, lastly, they took part in the forum. Other cases were slightly different: firstly, they checked out the task; after that, the checked out the readings; and, lastly, they focused on the forums. It is important to mention that some of the students pointed out that they did not always follow the same path.

Conclusion

Identified by means of the CHAEA, the predominant learning style in the 2008 group was *reflective*; this result is in keeping with the findings presented in studies by Alonso (1992), Camarero et al. (2000), Ramírez (2009), Massimino (2006), Ramírez and Osorio (2008), and García-Cue and Santizo (2009), where the most important learning style among university students was *reflective* and the least important was *active*. According to Gallego (2008), university students must have high levels of the *reflective* and *theoretical* learning styles to be able to satisfactorily complete their studies because the current design of teaching actually fosters them, which, to a large extent, is why they are the most effective. Alonso (1992) adds that there is a problem of semantic comprehension with regard to the concept of learning styles. She also points out that, besides this complexity and the myriad definitions, an understanding of changes in style associated with time, the context, didactic strategies and learning modes is still lacking.

Bearing in mind that the differences between the learning style categories are still significant, it is concluded, in part, that it is possible to identify relationships between learning styles and certain characteristics of navigational practices in VLEs. It is not known whether the lack of significant relationships between certain characteristics of navigational practices and/or variables and learning styles had anything to do with the fact that, in this study, the majority of the students favoured the

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reflective learning style, especially when considering that the activities offered on the course probably tended more towards the other styles (or were better related to them).

It should be noted that there are very few studies directly dealing with the relationships between learning styles (irrespective of the model) and the characteristics of navigational practices in VLEs, hence the important need to consider them in the teaching-learning process, since it implies a student-centred approach that, as already mentioned, is consistent with the notions of today's constructivist pedagogy.

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