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Analysis of CHAEA: Contributions from the Item Response Theory and the Impact Method

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ABSTRACT

During the last years, the concept of learning styles has generated numerous questions in academic field. In spite of the great variety of instruments that exist, the Honey-Alonso Learning Styles Questionnaire (CHAEA) has been consolidated as one of the most used to know learning styles of Spanish-speaking students. In this paper, we analyse CHAEA in order to better understand its psychometric characteristics. Specifically, we use Item Response Theory (IRT) and Impact Method. We found that some items could be remove from the scale and it would have practically the same information capacity. In addition, the impact method of CHAEA items showed the items of each dimension with the highest impact coincide with the items that provide sufficient information through the IRT. It is concluded that the combined application of IRT and Impact methods can contribute significantly to the analysis of the psychometric tests.

Introduction

Student learning styles are considered by many as one of the key success factors in higher education. The concept of learning styles is essential for effective learning.

Learning styles are cognitive, affective, and physiological traits that serve as relatively stable indicators of how learners perceive, interact with, and respond to their learning environments (Keefe, 1979). Each student perceives information in a different way so it processes it in a unique way, which influences the academic performance of student (Acevedo & Rocha, 2011; Alducin-Ochoa & Vázquez-Martínez, 2017; Suazo Galdames, 2007). All styles to learn are suitable and none is better than another, but complement each other (Alonso, Gallego, & Honey, 1995; Gallego, 2013). Several studies have investigated learning styles in students (Aguilar, 2010; Juárez, Rodríguez, Escoto, & Luna, 2016; Rojas-Jara, Díaz-Larenas, Vergara-Morales, Alarcón-Hernández, & Ortiz-Navarrete, 2016; Sepúlveda et al., 2011).

In order to know the predominant learning styles in students, some researchers have developed several instruments: Student Learning Styles Questionnaire (Riechmann & Grasha, 1974), 4MAT System (Pikulski, 1982), Cognitive Styles Analysis (CSA) (Riding & Sadler-Smith, 1992), Revised Approaches to Studying Inventory (RASI) (Entwistle & Tait, 1995), The Cognitive Styles Index (CSI) (Allinson & Hayes, 1996), or Learning Styles Profiler (LSP) (O'Connor & Jackson, 2008); among others. However, in spite of the great variety of instruments that exist in this regard, there is a Spanish-speaking questionnaire that has been consolidated as one of the most used to know learning styles of students, this is Honey-Alonso Learning Styles Questionnaire (CHAEA) (Alonso et al., 1995). CHAEA is an adaptation to Spanish academic context of the Learning Style Questionnaire (LSQ) by Honey & Mumford (1986), which in turn is based on Learning Style Inventory (LSI) by Kolb (1984).). It is structured with 80 items distributed in four groups of 20 items corresponding to four styles (active, reflective, theoretical and pragmatic).

The questionnaire has two fundamental drawbacks. One is the weakness of the structure defined by the authors (Alonso et al., 1995), because they cannot verify it using principal component analysis and therefore, agree on the compromise solution of grouping the items into four dimensions of the original design (20 items in each dimension). This configuration is based on the hypothesis of four learning styles (active, reflective, theoretical and pragmatic) which in turn respond to four phases of a cyclical learning process based on experience for academic improvement (Honey & Mumford, 1986; Kolb, 1984). And the other important problem is the number of questionnaire items. The test is relatively extensive because it consists of 80 items, prolonging the response times of 15 minutes as exposed Alonso and cols. (1995) to 20, 30 or 40 minutes. This affects respondent, causing fatigue or fatigue in the process, and generating interference in the responses.

The aim of this study is to perform an analysis of CHAEA in order to better understand its psychometric characteristics. For this, some techniques of statistical analysis were applied to a data matrix composed of 2693 rows (individuals) and 80 columns (items). Specifically, analyzes were performed using Item Response Theory and Impact Method.

Method

Item Response Theory (IRT)

The Item Response Theory (IRT) represents a new perspective in psychometric statistics. The IRT analyses the behaviour of tests at a disaggregated level of each item (Ferrando & Chico, 2007; Sánchez, 2004); that is, it takes into account each particular case, without revealing the total scores, so that results depend not only on test, but on each item that composes it.

The Graduated Response Model (MRG) by Samejima (1997) is a particular model for(ν) measured on this occasion is the "level of learning style" of the student needed to select a response category for each item of the questionnaire, and thus measure their preference for learning styles.

This theory explains the existence of a nonlinear relation between the individual and the given answer to item that can be expressed in probabilistic terms. The probability in the MRG by Samejima (1997) for an item (i) that an individual responds to the category (r) or higher of an item is: $P_{r}(\theta) = \frac{1}{1 + e^{-Da(\theta - b_{(r-1)})}}$

being $P_{r}(\theta)$ categorical response function. The model describes operation of the item using a discrimination parameter (a) and a series of threshold parameters (b1,2,…k) for response categories (Attorresi, Abal, Galibert, Lozzia, & Aguerri, 2011).

The IRT uses a defined function for all possible values of θ which indicates how accurately measures the test or the item (Information Function). The Test Information Function for a given value of θ is the inverse variance of the measurement errors for that value (Birnbaum, 1968), and therefore is a precision indicator of the test. The Item Information Function indicates the amount of information that item brings to the measurement of θ and at what level it provides such information; it is necessary to look at the discrimination of the item (greater slope indicates more information) and in the typical error of the item in θ (less variance indicates more information) (Martínez, 1995).

The assumptions of unidimensionality and local independence of the instrument were assumed to apply the MRG independently in each of CHAEA factors (Active, Reflective, Theoretical and Pragmatic style), so that the estimation of the models' parameters was performed using Maximum Likelihood method.

Impact Method

The impact method (Juniper, Guyatt, Streiner, & King, 1997) is an alternative technique that consists in multiplying the frequency by the importance of each one of items.

The frequency of each of questionnaire items is the proportion of students using a particular learning style. It should be noted that each of 80 items has five categories of response (0 = Never, 1 = Almost never, 2 = Sometimes, 3 = Often, 4 = Always). The percentage of individuals that provide an impact is calculated; that is, those who scored in the questionnaire 1, 2, 3, 4, 5. To do this, each item is re-coded in 0 (original score 0) and 1 (rest of scores) and the frequency of the new score 1 is calculated, in order to identify the items most selected by the subjects.

The importance (average importance score attached to each item) of each of the items in each learning style is to calculate the average score of each items, without counting those with a score of 0 (Locker & Allen, 2002).

Software

The analysis was carried out with the MULTILOG 7.03 program (Thissen, 1991) and the R Project for Statistical Computing (R Core Team, 2016).

Results

When analysing data through the MRG independently in each of the factors of the CHAEA (Active, Reflective, Theoretical and Pragmatic), it is observed that not all the items of the questionnaire provide the same information and some of them have discriminating capacity.

Table 1 sets forth the maximum information value and the mean of total information expected from 20 items that make up each learning style. These data are provided by the global information function of each dimension.

Table 1 about here.

Table 1. Values of global information curves by learning styles

	Active	Reflective	Theoretical	Pragmatic
Maximum Information	5.493	7.083	6.067	5.581
Expected Average Information	.275	.354	.303	.279

Collating the maximum information of each items with the average information of the style to which it belongs, 29 items are obtained that contribute a great amount of information to the CHAEA scale. Figure 1 shows these relevant items in obtaining information about university students' learning styles (six items in Active style, seven items in Reflexive style and eight items in the Theoretical and Pragmatic styles).

Figure 1 about here.

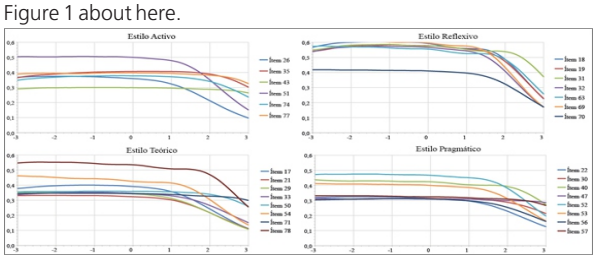

Figure 1. Information provided by the most relevant items in each learning style.

The iterative process of estimating items' parameters reached the convergence criterion of .001 in cycle 25. This estimates for each item a parameter of discrimination (a) and five of location or difficulty (b1, b2, b3, b4 y b5).

Table 2 presents the estimated discrimination parameters that show the ability of each item to discriminate or differentiate between different students with diverse preferences for learning styles. In Active style, the items with the greatest power of discrimination (a) are 26, 35, 51, 74 and 77. In Reflective style, the items are 18, 19, 28, 31, 32, 63, 69 and 70. In Theoretical styles, are 17, 21, 29, 33, 50, 54, 71 y 78. And in Pragmatic style, the items with higher discriminant values are 22, 30, 40, 47, 52, 53, 56 and 57. The rest of the items could be considered expendable in the scale. (See Table 2).

Table 2 about here.

Table 2. Discrimination parameters by learning styles

Active		Reflective		Theoretical		Pragmatic	
Items	a	Items	a	Items	a	Items	a
3	.62	10	.86	2	.71	1	.81
5	.59	16	.59	4	.93	8	.61
7	.66	18*	1.42	6	.70	12	.89
9	.59	19*	1.38	11	.94	14	.59
13	.82	28*	1.05	15	.54	22*	1.02
20	.83	31*	1.40	17*	1.13	24	.85
26*	1.10	32*	1.38	21*	1.04	30*	1.01
27	.82	34	.73	23	.32	38	.74
35*	1.14	36	.90	25	.33	40*	1.20
37	.78	39	.47	29*	1.06	47*	1.02
41	.83	42	.53	33*	1.06	52*	1.25
43	.99	44	.82	45	.86	53*	1.16
46	.84	49	.68	50*	1.09	56*	1.00
48	.69	55	.67	54*	1.23	57*	1.05
51*	1.29	58	.70	60	.53	59	.94
61	.51	63*	1.38	64	.98	62	.35
67	.49	65	.46	66	.89	68	.48
74*	1.10	69*	1.43	71*	1.07	72	.31
75	.61	70*	1.17	78*	1.35	73	.67
77*	1.15	79	.75	80	.45	76	.48

Note: More discriminative items (*).

The results according to this analysis indicate that the items that do not provide sufficient information to the questionnaire also do not present great discriminating capacity to know the preferred learning styles in university students. Except for the item 43 (I bring new and spontaneous ideas in the discussion groups) which, although it does not present discriminating capacity does provide information and item 28 (I like to analyse and turn things around) what is the opposite.

Table 3 shows the frequency, importance and impact values of 25% of the items of each dimension with the highest impact. It is observed in the calculation of each item's impact that the obtained frequencies are very high (over 95%). The items with the highest

impact index in Active style are item 26 (I feel at ease with spontaneous and fun people) and item 51 (I like to look for new experiences), in Reflective style are item 69 (I reflect on the issues and problems) and item 70 (Working in full consciousness fills me with satisfaction and pride), in the Theoretical style are items 21 (I try to be consistent with my criteria and value systems) and 54 (I try to get clear conclusions and ideas), and in Pragmatic style, items 22 (When there is an argument I do not like to go around) and item 53 (I think we should get to the point soon, at the heart of the issues) are the ones with the highest impact scores.
Table 3 about here.

Table 3. Items by dimensions with the highest impact values

Items	Frequency	Importance	Impact
Active Style			
Item 26	99.50	3.81	379.10
Item 51	99.10	3.57	353.79
Item 41	98.10	3.58	351.20
Item 9	99.60	3.41	339.64
Item 20	99.00	3.43	339.57
Reflective Style			
Item 69	99.00	3.58	354.42
Item 70	98.70	3.53	348.41
Item 79	97.90	3.54	346.57
Item 32	99.40	3.48	345.91
Item 55	98.50	3.48	342.78
Theoretical Style			
Item 21	99.60	3.83	381.47
Item 54	99.30	3.80	377.34
Item 29	98.80	3.73	368.52
Item 2	99.40	3.70	367.78
Item 17	98.90	3.61	357.03
Pragmatic Style			
Item 22	99.20	3.68	365.06
Item 53	99.00	3.60	356.40
Item 52	99.20	3.48	345.22
Item 8	99.10	3.42	338.92
Item 24	99.00	3.41	337.59

Discussion

This paper has studied the behaviour of CHAEA's items with different statistical techniques. First, from the IRT point of view, the results indicate that only 30 items provide sufficient information and / or discriminating capacity at CHAEA scale. The rest of the items that do not provide enough information do not present great discriminating capacity to know the preferred learning styles in university students; except for items 43 and 28. These results suggest that several items are dispensable and could be eliminated from the scale, resulting in a coherent instrument that would obtain practically the same information.

In addition, the impact method has applied to the CHAEA items. It has observed that the items of each dimension with the highest impact (items 26, 51, 69, 70, 21, 54, 22 and 53) coincide with items that provide sufficient information through IRT.

This is the first study to use the IRT with Impact Method to obtain better understand the psychometric characteristics of the CHAEA. However, prior to the proposal to use these methods in this study, the IRT was also used but combining it with other techniques like Biplot Methods to study other questionnaires (Laca, Pérez-Verduzco, & Vargas, 2016).

Future research could expand sampling to other higher education institutions and repeat the analyses made to check if the items that according to that study are expendable continue to be. A bootstrap method could be used. Besides, the formal reduction of CHAEA could be realized, and applying this new instrument to a sample of students to make a comparison of obtained results.

Finally, the impact method proved to be a complementary tool that provides different information to the analysis of data derived from application of a questionnaire, in this case CHAEA.

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