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Assessment of the Attitudes of Engineering Freshman Students towards Chemistry Learning Using an Adaptation of the Colorado Learning Attitudes about Science Survey (CLASS)

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Abstract

Some studies have reported for the case of Iberoamerica that the majority of students do not have direct interest in the study of the exact and natural sciences, although the engineering ones have better acceptance, the greater tendency is towards the Social Sciences. There are many factors that determine this disinterest and its articulation is quite complex, however it is necessary to study them to have relevant information that could be taken into account for the design of effective strategies that contribute to improve this situation. One of the critical aspects is the students' attitude towards the learning of science which is associated with their conceptions of science. The promotion of favorable attitudes toward science and technology is one of the priority objectives of scientific education. The aim of this study is to assess the attitude towards chemistry and its learning in first year students of sciences and engineering of a Peruvian university. For this purpose, the Colorado Learning Attitudes about Science Survey (CLASS) for use in Chemistry was used. CLASS was designed to assess students' beliefs about chemistry and its learning by adapting an early version of the instrument designed to assess these attitudes in physics. The original version consists of 50 items for which a five-level Likert scale is available. In this study, a 36-item version was used, according to the results of the psychometric evaluation of the instrument. This version was translated into Spanish and validated before its application for the purposes of the study.

1. Introduction

The overall results of scientific education in many developed countries and in almost all developing countries are marked by a worrying decline in the interest of young people to pursue scientific careers and a high social rate of scientific illiteracy. The findings of some studies made in Iberoamerica revealed that most students did not have a direct interest in the study of the exact and natural sciences, although engineering had a better acceptance, the greater tendency was towards the Social Sciences. The causes that could be affecting the attitudes of rejection are mainly related to pedagogy and education in science, so policies to promote careers linked to science and technology should not be dissociated from the way science is taught and learned.

Vázquez and Manassero [2] analyse the critical situation that science education is going through and highlight that the promotion of favourable attitudes towards science and technology has become priority objective of scientific education. It is known the direct influence of feelings and emotions on cognition (learning) and behaviour (decision making, conflict resolution). The authors define the attitude as the personal predisposition towards an object, which implies a cognitive dimension (knowledge of the object), an affective evaluation and the explicit behaviour related to the object. The affective evaluation of the object (favourable or unfavourable) is usually the most important component of the attitude because it is determined by the various cognitions (beliefs) about the object and usually influences the behaviour towards the object, either of approximation / pleasure or of rejection / dislike.

Commonly, chemistry is perceived as the discipline that gives rise to greater students' rejection [3, 4]. Several studies have been reported with the aim of assessing students' attitudes toward science, particularly toward chemistry, especially at the secondary level [5, 6]. The results of these studies suggest that the positive attitude towards science is a complex construct that can be influenced by different factors such as educational level, cultural and social context, and gender. Therefore, the need arises to evaluate this construct in the context in which the educational action is developed; in this way it will be possible to count on useful information to make curricular decisions to improve these attitudes in students. In this sense, the aim of this study is to assess the attitude towards chemistry and its learning in first year students of sciences and engineering of a Peruvian university.

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2. Methodology

2.1 Instrument

The instrument used was the Colorado Learning Attitudes about Science Survey (CLASS) for use in Chemistry [7]. CLASS was designed to assess students' beliefs about chemistry and their learning by adapting an early version of the instrument designed to assess these attitudes in physics [8]. It consists of 50 items for which a five-level Likert scale is available (from strongly disagree to strongly agree). For an individual, a favourable score is considered to be the percentage of responses that are in agreement with the expert response. Survey statements are grouped into nine categories which encompass only 36 of the total statements.

A psychometric study of CLASS demonstrated the convenience of working with reduced versions of the instrument that can be adjusted to simple scales avoiding overlapping of items [9]. In this sense, for the purposes of this study the instrument was adapted using only the 36 items that make up the categories predicted. It was necessary to translate the survey into Spanish and perform an exploratory factor analysis to identify the category structure of the scale. In addition reliability analysis was performed through Cronbach's alpha.

2.2 Participants

The participants in this study were first year engineering students of a Peruvian university who were enrolled in a General Chemistry course. Table 1 summarizes the participants' characteristics.

Table 1: Characteristics of the participants

	N	Age	Gender (%)	
			Male	Female
Exploratory Factor Analysis	326	17-21	69	31
Pilot application	51	17-20	64,71	35,29

2.3 Procedure

CLASS was administered to the first group of participants at the beginning of the semester. The survey was administered to the second group of participants as pre- and post-test, 4 months between them. The instrument was available online to facilitate student access and data processing.

2.4 Analysis of data

CLASS construct validity was estimated by exploratory factor analysis of principal components with orthogonal rotation using Statistical Package for the Social Sciences (SPSS) 21 software ®. The level alpha was established a priori in 0,05. From the data collected, a descriptive analysis of the scores obtained in CLASS categories and the whole test was performed. To verify significant differences between the results obtained in the pre and post test t test for related samples was performed.

3. Results

3.1 Exploratory factor analysis

The value obtained for the Kaiser-Meyer-Olkin (KMO) sample adequacy measure was 0.880 and the Bartlett sphericity test yielded a significance $p < 0.001$. Both values are very good and make feasible the application of factor analysis to CLASS. The average scores for each item ranged from 2,06 to 4,0, with standard deviation values from 0,668 to 1,145. All items had skewness and kurtosis less than 1 so it was possible to assume normality of data. In the initial solution, the Varimax rotation method reached convergence after 14 iterations. The results, in terms of total variance explained, indicated that the first nine components have their own values greater than unity and together account for 55.433% of the common variance. In order to achieve a better distribution of the items in each component, factorial analysis was tested for 6, 7 and 8 factors. The analysis of results showed that the first solution was the best in terms of reliability and interpretability of the components, identifying only 4 optimum components. Table 2 shows the descriptive statistics for them.

Table 2. Descriptive statistics for optimum categories after Factor Analysis of CLASS (N = 326)

Optimum categories	N° items	M	SD	min	max
Personal interest	7	3,54	0,45	3,71	3,99
Conceptual learning an problem solving	5	2,79	0,41	2,42	3,47
Atomic molecular perspective of chemistry	5	3,27	0,26	3,01	3,68
Making sense and effort	4	3,78	0,11	3,66	3,90

In Table 3, the reliability statistics corresponding to the 4 optimal components obtained for CLASS are shown. The corrected item-total and alpha correlation value ranges if the item is removed, in each dimension, support the proposed factor structure for the scale.

Table 3. Reliability statistics for optimum categories after Factor Analysis of CLASS (N = 326)

Optimum categories	N° items	Cronbach's α	Range of corrected item-total correlation values	Range of α values if the item is deleted
Personal interest	7	0,633	0,397-0,534	0,484-0,539
Conceptual learning an problem solving	5	0,738	0,379-0,625	0,6430,735
Atomic molecular perspective of chemistry	5	0,700	0,360-0,579	0,587-0,693
Making sense and effort	4	0,571	0,308-0,399	0,462-0,536

3.2 Pilot application

Table 4 shows the descriptive statistics for pre- and post-test CLASS scores. The inferential analysis performed with a t test for related samples showed that the differences between pre and post test were not statistically significant in the total score and each category.

Table 4: Descriptive statistics for pre- and post-test CLASS scores (N = 51)

	Pre-test		Post-test	
	M	SD	M	SD
Personal interest	50,42	30,14	51,54	31,95
Conceptual learning an problem solving	42,74	32,25	42,35	30,63
Atomic molecular perspective of chemistry	41,56	30,68	40,00	31,49

Making sense and effort	68,62	26,38	64,21	30,10
Total score	50,76	21,16	50,21	22,93

The results obtained according to gender showed a negative change in the case of males when comparing the total score between the pre and post test. In the case of females, the observed change was positive. However, these differences were not statistically significant. Figure 1 left shows the results obtained for males in the total score and in the categories. Figure 1 right shows the same information for females.

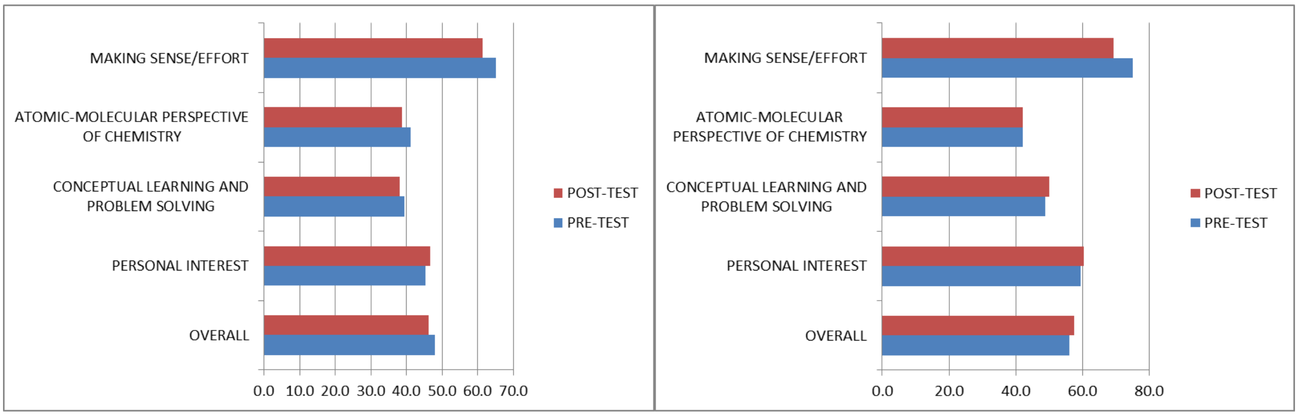

Figure 1. CLASS scores obtained by males (left, N = 33) and females (right, 18)

4. Conclusions

The results obtained may be considered good although it is necessary to continue the study by performing a confirmatory factor analysis for the confirmation of the model. It has been observed what other authors pointed out in relation to that only some of the categories of the original instrument can be replicated in the application in different contexts. However these fitted well to the proposed interpretations for each factor. The 4 categories identified are relevant to begin exploring the attitudes of first year chemistry students. These can be complemented with other information, such as interviews with students, evaluation of motivation as well as the use of metacognitive strategies. All this becomes a valuable input for the decision making in the planning and design of the teaching of this discipline.

References

[1] Polino, C. “Las ciencias en el aula y el interés por las carreras científico-tecnológicas: Un análisis de las expectativas de los alumnos de nivel secundario en Iberoamérica”, Revista Iberoamericana de Educación, 2012, Vol. 58, 167-191.

[2] Vázquez, A. and Manassero, M.A. “En defensa de las actitudes y emociones en la educación científica (I): evidencias y argumentos generales”, Revista Eureka sobre Enseñanza y Divulgación de las Ciencias, 2007, Vol. 4 (2), 247-271.

[3] Kurbanoglu, N. I. and Akin, A. “The Relationships between University Students’ Chemistry Laboratory. Anxiety, Attitudes, and Self-Efficacy Beliefs”, Australian Journal of Teacher Education, 2010, 35 (8), 48-59.

[4] Eddy, R. M. “Chemophobia in the college classroom: Extent, sources, and students characteristics”, Journal of Chemical Education, 2000, Vol 77 (4), 514–517.

[5] Barnes, G.; McInerney, D. M. and Marsh, H. S. “Exploring sex differences in science enrolment intentions: An application of the General Model of Academic Choice”, The Australian Educational Researcher, 2005, Vol. 32 (2), 1-23.

[6] Cheung, D. “Students' attitudes toward chemistry lessons: The interaction effect between grade level and gender”, Research in Science Education, 2009, Vol. 39, 75–91.

[7] Barbera, J., Adams, W., Wieman, C. and Perkins, K. “Modifying and validating the Colorado Learning Attitudes about Science survey for use in chemistry”, Journal of Chemical Education, 1988, Vol. 85 (10), 1435-1439.
[8] Adams, W., Perkins, K., Podolefski, N., Dubson, M., Finkelstein, N. and Wieman, C. “New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey”, Physics Education Research, 2006, Vol. 2, 2-15.
[9] Heredia, K. and Lewis, J. “A psychometric evaluation of the Colorado Learning Attitudes about Science survey for use in chemistry”, Journal of Chemical Education, 2012, Vol. 89, 436-441.