

## **Attitudes towards natural sciences in students from mexico, colombia and peru**

## **Actitudes hacia las ciencias naturales en estudiantes de México, Colombia y Perú**

DOI: 10.46932/sfjdv2n5-060

Received in: Oct 1st, 2021

Accepted in: Dec 30th, 2021

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### **ABSTRACT**

In science didactics the study of attitudes informs about the professional and socio-scientific profiles, for this reason this study has focused its analysis on Mexican, Colombian and Peruvian students to determine their attitudes towards the knowledge, teaching and learning of the natural Sciences. For this, a study was approached with a semantic differential scale allowing to conclude that the students have an intermediate level (between neutral and positive), finding only significant differences depending on the locality.

**Keywords:** Attitudes towards science, Natural Sciences (CCNN), School Science.

### **RESUMEN**

En didáctica de las ciencias el estudio de las actitudes informa sobre los perfiles profesiones y socio-científicos, por ello este estudio ha centrado su análisis en estudiantes mexicanos, colombianos y peruanos para determinar sus actitudes hacia el conocimiento, la enseñanza y el aprendizaje de las ciencias naturales. Para ello se abordó un estudio con una escala de diferencial semántico permitiendo concluir que los estudiantes poseen un nivel intermedio (entre lo neutral y lo positivo), hallando sólo diferencias significativas en función a la localidad.

**Palabras Clave:** Actitudes hacia la ciencia, Ciencias Naturales (CCNN), Ciencia Escolar.

### **1 INTRODUCTION**

The quality of socio-scientific decisions and scientific-technological productivity in a society are related to science education (Croxford, 2002; OECD, 2013; Albornoz, 2017). For this reason, school science and what it follows as performance in science and attitudes related to science have become the core of current research for eventual reforms (Ministry of Education Science and Technology of Argentina, 2007; Sormunen & Köksal, 2008; Kaya, 2012; Calderón, 2015; Karademir & Ulucinar, 2017). Regarding attitudes, the didactics of science has subscribed to it in the research line called emotive-attitudinal (Vázquez & Manassero, 2007).

In this sense, studies indicate that attitudes related to science have dimensions (cognitive, affective and behavioral) (García & Sánchez, 2006; Cervantes et al., 2009; Hernández et al., 2011) and their approach defines the model of study (Ubillos et al., 2004); it can be qualitative or quantitative (Liaghatdar et al., 2011); implicit or explicit (Gaviria et al., 2013); with a variety of scales (Thurstone, Guttman, Likert or Semantic differential, the latter being the most used) (Ubillos et al., 2004).

On the other hand, such attitudes vary depending on the object to which they are directed (science company, school science, social impact and scientists) (Osborne et al., 2003) and the dimension from which they are born (attitudes towards science / affective and scientific / cognitive attitudes) (Osborne et al., 2003; Acevedo, 2007); in addition to the way it is approached (sociology of science / attitudes related to social aspects or epistemology / attitudes related to the nature of scientific and technological knowledge) (Vázquez & Manassero, 2007). For this reason, Vázquez & Manassero (1995) usually divide them into those related to the teaching and learning of science and technology, the interactions between Science, Technology and Society (STS) and with scientific and technical knowledge. For this reason, science didactics has decided to approach it from the CTS and the Nature of Science (NOS) approach, since it collects a lot of information (Vázquez et al., 2006; Akerson & Donnelly, 2008; Akcay & Akcay, 2015).

Research also informs us that attitudes related to science are influenced by multiple factors (Genç, 2015) being internal (student's own) or external (student independent) (White & Harrison, 2012), but it is the teacher and gender the most influential (Osborne et al., 2003). Although for this work the classification of Liaghatdar et al. (2011) (sex, socioeconomic level and teacher). In this sense, it is affirmed that attitudes are associated with the teaching and learning practices generated by the teacher (Solbes, 2011; Timur, 2012; Türer & Kunt, 2015; Ulukök & Sari, 2016) and disappear as progresses in the school career (Escudero & Lacasta, 1984; Murpy & Eggs, 2003; Martínez & De Pro, 2009; Akarsu & kariper, 2013; Cuevas et al., 2015). And although the value for the work of scientists, its importance and usefulness remains intact at the end of the school stage, the same does not happen with the scientific vocation since one ends up seeing studies in science, especially those related to mathematics, physics and science. Chemistry as boring and difficult (Arana et al., 1987; Espinosa & Román, 1991; Rocard et al., 2007; Polino & Chiappe, 2009; Bravo, 2012; Falabella et al., 2014; Arias, 2015; Spanish Foundation for Science and Technology, 2011, 2016); being more intense in women (Amal et al., 2011; Desy et al. 2011; Bang & Backer, 2013; Oluwatelure, 2015) and in societies with a better socioeconomic level (Rocard et al., 2007; Vázquez & Manassero, 2008a) although there are exceptions (Thom, 2006; Omema, 2014; Sakariyau et al., 2016) when the type of education (coeducation vs differentiated) is taken into account (Vázquez & Manassero, 2008b), location and family composition (Alrehaly, 2011; Lutfullah, 2013;

Prakash & Amaladoss, 2014; Kenar et al., 2016; Hacıeminoglu, 2016), giving strong reasons to continue researching and thus clarifying this problem (Mael, 1998).

In this sense, an attempt was made to diagnose the level of attitudes related to teaching-learning in CCNN in students from three countries belonging to the political-economic group called “Pacific Alliance” (Peru, Mexico and Colombia)<sup>2</sup> under three categories: attitudes towards the knowledge, teaching and learning of the CCNN. Considering within it the variables of sex and locality. In this way it will be possible to determine and deduce the attitudes related to the school elements (products, resources, contents, objectives, subjects, teachers, etc.) of the CCNN. This can be taken as a small thermometer of the current situation of science education in these countries, without falling into vain generalizations; but encouraging to deepen the study in what attracts attention (especially related to science, research and innovation)

## 2 METHODOLOGY

The present investigation is non-experimental (diagnostic); using the SPSS program. The factor extraction method used has been that of principal components and the rotation method is the Varimax normalization with kaiser, providing a factor analysis reliability index. The Kolmogorov-Smirnov test was used to study the normal distribution. And the non-parametric Kruskal-Wallis test was used to search for significant differences between independent samples, according to sex and locality.

The sample has been selected incidentally reaching 100 students (40 men and 60 women / 40 Peruvians, 28 Colombians and 32 Mexicans). The Peruvians and Mexicans are from the city of Trujillo and Monterrey respectively; while Colombians belong to the rural area of Helicon. The ages of the participants have ranged between 15 and 18 years and belong to the last year of basic education. Furthermore, the sample sizes necessary for each factor load value to be considered significant are based on

achieving a power level of 80%, a significance of 0.05 and the standard errors supposedly twice as large as the conventional correlation coefficients. . For this sample the minimum value necessary for a sample of 100 is 0.55 (Hair et al., 1999).

En este estudio no se ha considerado la edad, el tipo de gestión de la escuela, el nivel socioeconómico y sociocultural de los estudiantes encuestados.

In this study, the age, the type of school management, the socioeconomic and sociocultural level of the surveyed students were not considered.

The semantic differential scale survey was used, which was made up of three categories with the purpose of evaluating “the attitudes towards knowledge, teaching and learning of the CCNN”. These

categories had 12, 11 and 12 variables; and each variable corresponded to three columns (favorable adjectives, punctuations and opposite adjectives). These scores were to evaluate each variable. If an unfavorable (negative attitude) or favorable (positive attitude) adjective was assigned, this was translated as 1 and 3 points respectively. The 2 points were for a neutral position. To obtain the result of each category, the scores of the variables it contained were averaged. This average was classified into five intervals (levels): negative (1), between negative and neutral (greater than 1 and less than 2), neutral (2), between neutral and positive (greater than 2 and less than 3) and positive (3).

The instrument has been validated by Mazzitelli & Aparicio (2009) whose Crombach alpha for attitudes towards knowledge, teaching and learning have been 0.68; 0.82 and 0.75 respectively.

Complexity hypotheses were developed (Vázquez Bernal et al., 2007; 2012) based on the original questionnaire<sup>1</sup>

### 3 DISCUSSION

For reasons of space, a synthesis of the results is presented.

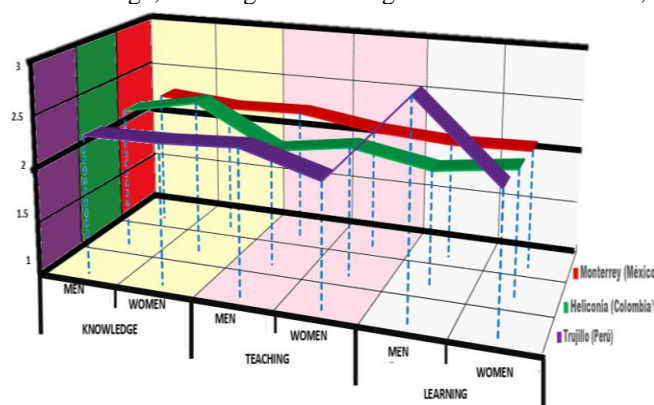
It was verified (see figure 1 and figure 2) that the attitude towards knowledge (2.33), teaching (2.23) and learning (2.28) of the CCNN ranged between neutral and positive (2.25 points- 74.01%); Although the best profile is for knowledge but that advantage does not make a significant difference. If the locality and sex are taken into account, certain heterogeneity between the groups is verified, however, significant differences are only manifested

according to the locality. Even when this happens, men (2.31) have a slight advantage over women in terms of attitude level (2.23); but it is the female gender (74.17%) whose percentage concentration is greater than that of the male (73.86%) in the range "between neutral and positive". The only significant difference according to sex was when the attitude was analyzed according to the variable "contribution to personal development" in the teaching category. There, men show a significant advantage ( $P = 0.047 < 0.05$  and with the 95% confidence level)

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<sup>1</sup> To know the systematization of the categories with the variables and their respective indicators, the study by Tapia (2017) and Mazzitelli & Aparicio (2009) can be accessed.

Figure 1. Attitude towards the knowledge, teaching and learning of the natural sciences, according to sex and locality



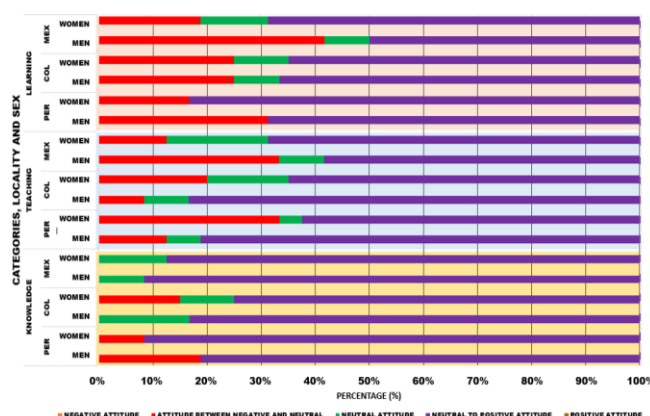
On the other hand, it was found that in localities with more unfavorable socioeconomic conditions the attitude is better. This is the case of the Trujillanos (2.38 points- 78.13%), of the Colombian rural environment and of the South American countries (Peru and Colombia).

Let us remember that of the three countries the best and the worst economic systems are in Mexico and Peru respectively; and generally the economies of the north tend to have more advantages than those of the south.

These findings are supported by studies that argue that attitudes towards science and attitudinal differences by sex are better and shorter, respectively, in societies with a low socioeconomic level (ROSE in Vázquez & Manassero, 2009; Sakariyau, et al., 2016).

The explanation for this phenomenon can be given if the Scandinavian paradox is taken into account; which indicates that when there are no socioeconomic advantages, freedom of choice diminishes, therefore vocational aspirations are dismissed or postponed and options of all kinds are taken to get out of poverty; like it or not. This is reinforced by the type of teaching they receive in their schools. It is known that in countries and societies with low socioeconomic levels, too much student-centered teaching methods (of a constructivist nature) are practiced, which although they do not achieve good performance in science, they do manage to obtain better attitudes towards science, both in terms of men as well as women (OECD, 2016).

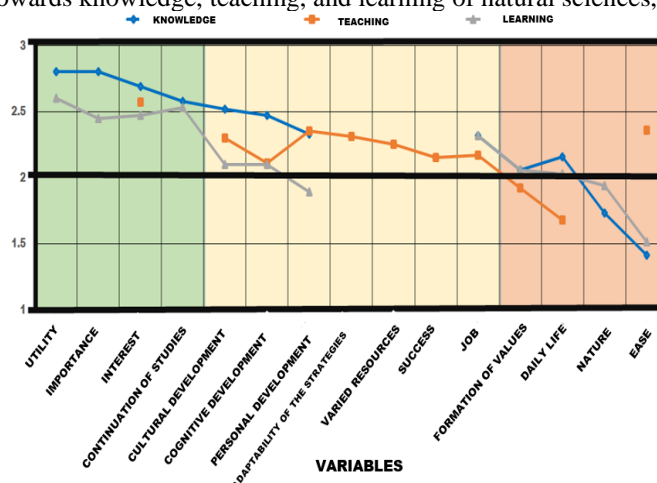
Figure 2. Percentage of students on their attitude level towards knowledge, teaching and learning of natural sciences, according to sex and locality.



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On the other hand, analyzing the variables of each category (see figure 3) we discovered that the variables of the knowledge category obtained the best and worst scores in “importance (2.80)” and “ease (1.41)” respectively; which ratifies the findings of the Spanish Foundation for Science and Technology (2011, 2016), Polino & Chiappe (2009), Arias, 2015, among others; on the ambivalence that one has for scientific knowledge (it is important, but it is difficult) The same is verified with the variables of the learning category. Regarding the teaching category, the score of its variables is located slightly above the intermediate level; Therefore, it can be deduced that for the respondents there are doubts as to the contribution that CCNN teaching has in their training for work and their ethical (values), cognitive, personal and cultural development. This same doubt is manifested when the same variables are analyzed but within the categories of knowledge and learning. Nor are they sure if the teaching they receive has a variety of resources and strategies; however they affirm with certainty that they are “interested” in being taught CCNN and that such teaching is “something easy”.

Figure 3. Attitude towards knowledge, teaching, and learning of natural sciences, according to variable



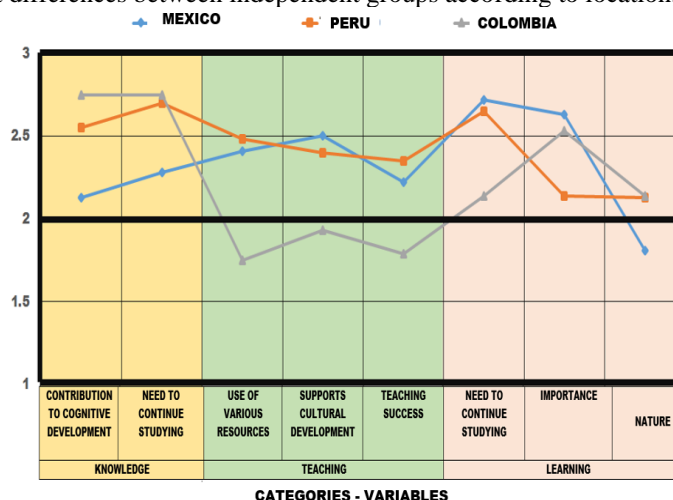
This can be explained by the OECD report (2016) who indicates that in developing countries such as Latin America, teacher training is weak, so they tend to use student-centered (constructivist) methods, so that teachers Students feel motivated to learn, but they do not achieve good results since the teacher is strongly established in the method by problems or discovery, leaving aside the content. This is the reason why the student claims to feel easy and interesting the teaching of CCNN that she receives, since who does not like to play the scientist? But when he is asked about the contribution of that knowledge to his life, it is verified that he does not find it, and it is because he does not have the knowledge systematized, since he did not receive it from his teacher. The same holds for Enkvist (2012), Tobias & Duffy (2009) among many others, since science training is more fruitful with teacher-led teaching (traditional), since with constructivism so far there are no favorable results, Except when it comes to improving the attitude towards science somewhat; although it is a misleading profile; because it is based on a wrong concept of scientific work.

On the other hand, as mentioned, significant differences have only been found when they are analyzed according to the student's place of origin.

In this sense, it was verified that in the knowledge category there are significant differences on the variables "need to continue studying" ( $P = 0.004 < 0.05$  and with the 95% confidence level) and "contribution to cognitive development" ( $P = 0.000 < 0.05$  and with a confidence level of 95%) between the towns of Trujillo (Peru), Heliconia (Colombia) and Monterrey (Mexico). Therefore, it is understood that Colombians and Mexicans show significantly higher and lower average levels of attitude towards both variables, respectively. In the teaching category, the first was in the variable "the use of varied resources" ( $P = 0.000 < 0.05$  and with the 95% confidence level), the second in "teaching success" ( $P = 0.009 < 0.05$  and with the 95% confidence level). In both, the best profile is of the Peruvians. The third variable has been "favors cultural development" ( $P = 0.004 < 0.05$  and with the 95% confidence level) favoring Mexicans.



Figure 4. Significant differences between independent groups according to location, variable and category



For the learning category, the significant differences were accentuated in the variables of "nature" ( $P = 0.038 < 0.05$  and with the 95% confidence level), "importance" ( $P = 0.016 < 0.05$  and with the confidence level of the 95%) and "need to continue studying" ( $P = 0.001 < 0.05$  and with the 95% confidence level). Of the three, the latter is the one with the greatest significant difference found. In addition, in the last two variables, Mexicans take advantage, but in the first, Peruvians and Colombians stand out at the same time.

Taking into account the minimum accepted values of composite reliability ( $FC = 0.7$ ) and of the extracted mean variance ( $AVE = 0.5$ ), we can say that the values of the composite reliability ( $FC = 0.74$ ) and that of the extracted mean variance ( $AVE = 0.50$ ), starting from the factorial weights and the measurement errors extracted from the confirmatory FA, indicate adequate values for the reliability and relevance of the factorial analysis.

In this sense, the factors found for the category knowledge, teaching and learning have been 4, 3 and 4 respectively. However, we will highlight only some of them. In the knowledge category, the factor made up of the variable "importance", "need at work" and "usefulness" stood out. In the teaching category, two factors stood out whose associated variables were "ease" and "adaptability of strategies", as well as "contribution to personal development", "teaching success" and "contribution to the formation of values". Finally, in the learning category, a factor was highlighted, which was made up of "need to continue studying", "usefulness" and "importance".

From these factors it can be deduced that the interest and usefulness for knowledge of the natural sciences depend on its association with work. That is why it is important to learn it, since it not only gives job opportunities, but also allows you to continue studying.

Its ease depends on the degree of adaptability of the strategies. Likewise, the success of the teaching of natural sciences is associated with the personal and ethical contribution of the student.



#### **4 CONCLUSIONS**

The attitude towards the knowledge, teaching and learning of the CCNN oscillates between the neutral and the positive, being able to say that it is intermediate. This attitude is the same in men and women (there are no significant differences), however there are significant differences when the locality is taken into account. In this case, it is found that the most socioeconomically disadvantaged (such as Peruvians) have a better attitudinal profile.

On the other hand, it is verified, as in the diverse existing bibliography, that students consider important, useful and necessary for work and studies both knowledge and learning of natural sciences; however it is boring and difficult. This could be understood if one takes into account the statements about teaching and its characteristics, which do not stand out either.

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