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Modeling of a Theoretical Construct in Inquiry-Based Science Education

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Abstract

The aim of this study is the theoretical modeling of a construct in research on education science. The study was conducted with an incidental sample of students of a wide range of ages and various educational levels involved in a project on the use of practical work in science and technology. The instrument consisted of a questionnaire that asked Likert conceptual issues, scientific procedures, hypothesis stating, research reports and attitudes toward science and technology in a wide range of problems of school research. The study variables affect these areas of interest. A theoretical model with three first-factors orders (experiential, conceptual and explanatory) and another third-order factor (integrating factor) was estimated. The designed model was not rejected and can provide a basis for understanding how the students perceived the experimental work on science and technology.

Keywords: structural equation modeling (SEM), inquiry based science education, students' perceptions.

Resumen

El objetivo de este estudio es la modelización teórica de un constructo sobre la investigación escolar en ciencias experimentales. El estudio se llevó a cabo con una muestra incidental de alumnado dentro un amplio rango de edades y diversos niveles educativos que participaban en un proyecto sobre el uso de trabajos prácticos en ciencia y tecnología. El instrumento consistía en un cuestionario tipo Likert que indagaba en cuestiones conceptuales, procedimientos científicos, emisión de hipótesis, realización de informes de investigación y actitudes hacia la ciencia y tecnología en un abanico muy amplio de problemas de investigación escolar. Las variables de estudio inciden en estos aspectos de interés. Se estimó un modelo teórico con tres factores de primer orden (experiencial, conceptual y explicativo) y otro factor de tercer orden (factor integrador). El modelo diseñado no se rechazó y puede proporcionar una base para comprender cómo percibe el alumnado los trabajos experimentales en ciencias y tecnología.

Palabras clave: modelización por ecuaciones estructurales, indagación en ciencias, percepción del alumnado.

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Introduction

The teaching and learning of science must integrate and enrich the everyday knowledge, because it has its own epistemological nature (García Díaz, 1998). In this sense, in the framework of "Inquiry-Based Science Education / IBSE" (European Commission, 2007), the research school is associated with educational content in the areas of science and technology (Wickman & Östman, 2014). The aim of this article is to develop a theoretical approach linked to scientific and educational work in the classroom of students; for this we have selected a set of variables involved in the process (scientific concepts, scientific procedures, hypothesis stating, reports and attitude towards science) so that, from the knowledge established in the literature and to estimate the relationship between such variables, this theoretical approach can be subjected to empirical test by SEM.

Various models SEM have revealed the importance of new scientific knowledge in learning science as a key factor on the confidence and self-efficacy of students, more than the mere passing of tests and examinations (Lin & Tsai, 2013). Other studies, based on SEM models, including also cognitive and affective variables have emphasized the importance of having adequate meaningful understanding of scientific concepts (Nieswandt, 2007), and the use of learning strategies and social support of students (Lamb, Akmal, & Petrie, 2015).

Didactic research has shown that the use of social models and activities encourage collaboration and learning motivation of students, their achievements and interest in scientific careers (Bryan, Glynn, & Kittleson, 2011), highlighting the use of the laboratory (Reigosa, 2012). Some modeling show that along with the procedures, conceptualization, strategy and self-efficacy interact fairly well to predict success to perform these procedures (Taasoobshirazi & Glynn, 2009), although other models propose that in addition to the experimental ability, the ability to interact, scientific mentality and appropriate behaviour in the classroom form a specific identity of the student that helps you in your expectations of success (Shanahan & Nieswandt, 2011). To this self-efficacy, social support and their own expectations of success (Nugent et al., 2015) are added.

The possibility that the students make predictions about certain natural phenomena is an opportunity to investigate their understanding (Bell & Otero, 2000), essential in any teaching sequence (Guisasola et al., 2012). Some modeling found that teaching students to reason, argue and think critically improves student's conceptual learning (Nolen, 2003). Other models assessments focused on the classroom environment, achievement of goals and practice of reflective thinking are strongly linked to academic performance (Phan, 2008).

There is a consensus of the Science Education (ScEd) by which to do science includes the appropriation of discursive resources and building the meaning of experience with words (Lemke, 1997). To Krajcik and Sutherland (2010) scientific literacy allows students to share their thoughts and enrich their understanding. In this sense, the realization of research reports is an essential practice in school science. SEM Studies in small children have already revealed that the effects of the attitude towards writing and achievements are bidirectional (Graham, Berninger, & Fan, 2007) and that motivation plays a key role (Lam & Sam, 2007). In the specific field of ScEd, self-efficacy plays a central role in carrying out daily scientific work in the classroom, including the preparation of reports (Uzuntiryaki & Aydın, 2009).

From the international research agenda it is demanded to include the attitude towards the experimental sciences in any theoretical model (Manassero & Vázquez-Alonso-Mas, 2011). In this sense, a model with four dimensions (interest theory lessons, for work in the laboratory, evaluative beliefs and behavioural tendencies for learning chemistry) was developed to explain the attitude towards Chemistry (Cheung, 2009). Another study revealed that self-interest and situational interest towards the Physical as well as to academic performance, they were confirmed by two teaching strategies: choice of classroom and explaining the relevance of the content (Gonzalez & Paoloni, 2015), protecting the students from disaffection towards this matter. Other models emphasize the importance of the relationship between anxiety in the chemistry laboratory, chemistry attitudes and self-efficacy (Kurbanoglu & Akim, 2010). Self-efficacy was also significant in another study highlighting its relationship to social integration capacity in the scientific community and the prediction to continue with a scientific career (Estrada et al., 2011), studies that have been extended by others where the persistence of motivation toward science was highly determined by the self-perception of autonomy and competence (Lavigne, Vallerand, & Miquelon, 2007) or the importance of science for their future careers (Glynn et al., 2007).

In short, from the state of the question, there is a clear association between the attitude that the student has towards science and implementing scientific school procedures in the classroom also conducting research reports by students is determined by its capacity to explain through scenarios, subject to their conceptual frameworks. As the main objective of this work the development of an underlying theoretical approach to scientific and educational work in the classroom, in Figure 1 the model (notation AMOS 20 ©), which has been

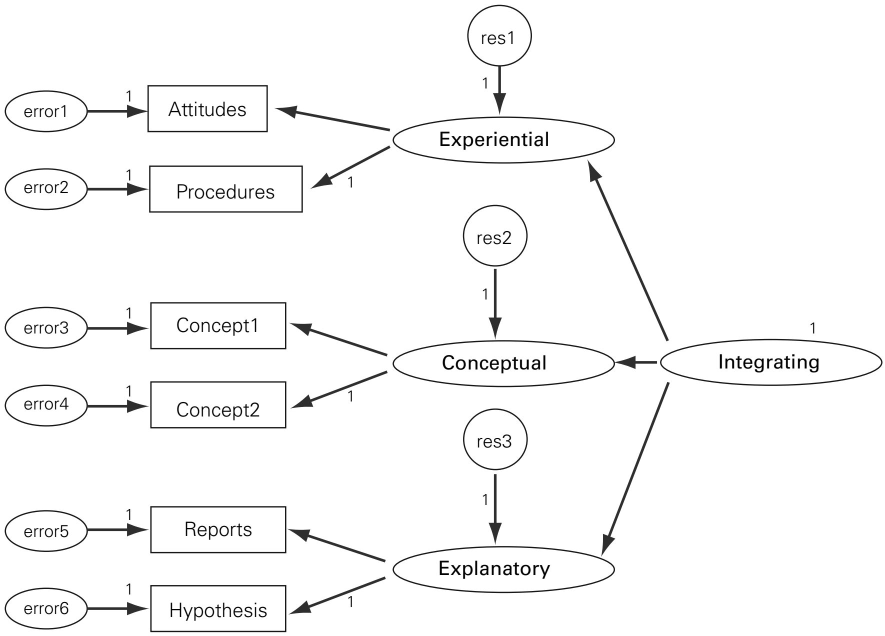

Figure 1. Conceptual diagram of the initial model on scholarly research (A).

called "Conceptual Diagram of the Initial Model on Scholarly Research", which will be subjected to empirical testing (SEM) to check if it is rejected or not.

Method

Participants

The study involved the entire students of a public secondary socially medium-low school of an Andalusian town of medium size (720 students) and students of third year of Pre-Primary Teacher Degree at a public university of Andalusia (120 students). In this research, the sex of the participants was not significant, although the groups, in the case of the high school, to be natural and according to the data handled, showed almost 50% distributions by sex. In the case of the university, the sample was predominantly female (degree effect), with values of 3% of men and 97% women. Table 1 expresses the distribution of educational levels (in Annex I the

Table 1

Distribution of Questionnaires among Participating Educational Level

Level Educational	Number of Questionnaires	Level distribution (%)	Age distribution by educational levels
1.º ESO	176	8.7%	12-14 years 26.5 %
2.º ESO	363	17.8%	
3.º ESO	267	13.1%	14-16 years 20.5 %
4.º ESO	150	7.4%	
1.º BAC	697	34.3%	16-18 years 37.7 %
2.º BAC	69	3.4%	
3.º Childhood Education Degree	311	15.3%	18-22 years 15.3 %
TOTAL	2033	100.0%	Average age 16.9 years

distributions by questions of scholarly research is shown).

A convenience sampling was used, showing more interest in the class group, choosing to be part of an educational research project of the Government of Andalusia, which was around two pillars: action-research in the classroom (8 teachers secondary and four university professors) and the use of inquiry methodologies (Windschitl et al., 2008), in the form of practical work by students in scientific and technological areas under the conceptual umbrella of IBS.

Design

The study is not experimentally based, more specifically, ex-post-facto (Latorre, del Rincon, & Arnal, 1996). To reduce the systematic bias, a large amount of information was obtained with an elevated sample. Moreover, to avoid problems of particular insensitivity to non-normality of the data there was a large number of cases available that compensated for the expected lack of normality (Cupani, 2012), aspect that has an impact on the following section. The variables studied affect basic aspects of a process of scholarly research in natural context, implemented by teachers also highly diversified.

Measurements

The information collection instrument is a classic Likert scale. It is defined with a value ranging from 1 (strongly disagree) to 4 (strongly agree). The central value of the scale was removed to force students to decide somehow. This helped to cause problems in the sample normality, of what was aware from the beginning, but chose to obtain high sample questionnaires to minimize its impact.

The instrument consists of 6 variables. The first two are conceptual in nature (Concept1, Concept2) and deal with the student's understanding of specific concepts of each practical work. For example, at work "Which factors influence the oscillation period of a pendulum? They are encouraged to stand on the scale regarding the following statements: "I know the concept of period of oscillation of a pendulum and its importance in the history of science "(Concept1); "I understand the factors that influence this period" (Concept2). The third variable focuses on the core of the process involved in each practical work (Procedure), for example: "I make control processes involving variables". The fourth variable (Hypothesis), common to all jobs, affects how students see their ability to make assumptions at the beginning of each experience: "I could make my initial hypothesis without difficulty."The fifth variable, also common, refers to the ability to produce research reports as a part of scientific work (Reports): "I could make research reports satisfactory". Finally, the sixth variable refers to value aspects of scientific activity or some aspect to be emphasized in each specific experience (Attitudes): "I appreciate the importance of the discipline and thoroughness in conducting laboratory experiences". Each questionnaire was supervised by the teacher in charge of the practical work, at least one month after completing each student the final report.

Regarding the validity and reliability of the instrument, frequency analysis showed a significant bias towards higher variable Likert scale values (3 and 4). With suspicions of coming from a non-normal distribution of the population, the nonparametric Kolmogorov-Smirnov test was applied, rejecting the null hypothesis (H0) in all variables, since they showed lower values at significance level of 5% ($p < .001$), then it was assumed that the sample came from a population with non-normal distribution in the variables.

The Cronbach α value was .667, below the value .7, satisfactory in exploratory research (Robinson, Shaver, & Wrightsman, 1991). However, the possibility of overestimation of the scale was small, given the small number of items of the scale and high sample (Oviedo & Field, 2005). In this regard, if any item eliminated, improving Cronbach α vary between .613 and .639, an insubstantial improvement. The value of the average variance extracted (AVE) is .523, exceeding the recommended minimum. For its part, the composite reliability is of .701, the limit set value, but acceptable.

A case involving especially the Likert scales is their multivariate and, more precisely, what affects the multivariate kurtosis (DeCarlo, 1997). No more than 4 values were found in absolute terms, so it can be argued that there is a substantially curtotic distribution. However, to ensure a departure from the observed variables does not mean that, taken together, it provides a normal multivariate. The value obtained for this parameter (CR) was 13,132, more than 5, indicating departure from the normal situation. In this sense, it is based on ADF estimate (N = 2033 cases, higher than the 150 cases required). The analysis of the Mahalanobis distance (D2: centroid) did not produce multivariate outliers, only the 1879 observation had a value greater than 30.157.

Procedure

Over four school years (2010-2011 to 2013-2014) teachers worked in a collaborative dynamic Secondary-University, where 23 questions of scholarly research (Annex I) were implemented in the areas of Physics, Chemistry, Biology, Geology and Technology. The works were implemented throughout the teaching units at the time it was decided by the teachers, after discussion within the group about how design could be the best. As a cross cutting issue to all of them the ideas of students under the conceptual support of the initial hypothesis must be made explicit. The final reports had similar common points to any scientific work, including literature and suggestions for improvements and through the contrast between the initial hypotheses and the results of the experience. The average student experiences stand at an average of 2.4, yielding a sample of 2033 questionnaires (Annex I).

Results

Preliminary analyses

An initial exploratory analysis was conducted briefly summarized. In Table 2 the descriptive statistics are given.

Table 2

Descriptive Statistics

	Mean	Std. Deviation	Variance
Attitudes	3.49	.746	.556
Procedures	3.19	.837	.701
Concept1	3.08	.822	.676
Concept2	2.98	.877	.770
Hypothesis	2.90	.854	.729
Reports	2.89	.868	.754

It was proceeded to carry out an Exploratory Factor Analysis (EFA), performed with SPSS 20 ©. It was observed that multicollinearity requirements were met: 15 bivariate correlations, taking the index Spearman rho significance to .01, with values below .85 (Kline, 2005) claimed that there were no problems of redundancy. The contrast values Barlett sphericity (significance of .001) and the value of KMO (.763), provided proper values. With regard to the percentage of variance, contrast and latent root fall: on the number of factors to be extracted (principal components method), three criteria were used. The results indicated that the extraction of three factors explain the 65.918% of the total variance, a satisfactory value for research under the Social Sciences (Hair et al., 1999).

In Table 3 and 4 the values of the communalities and rotated components matrix (Varimax rotation) are represented. For communalities, these should be located at .50 (half explanation of the variance of each variable). It is accepted that they are in the range of what is reasonably acceptable.

Table 3

Communalities

	Inicial	Extration
Concept1	1.000	.819
Concept2	1.000	.484
Procedures	1.000	.494
Hypothesis	1.000	.638
Reports	1.000	.726
Attitudes	1.000	.795

Table 4

Rotated Component Matrix

	Component		
	1	2	3
Concept1	.128	.011	.896
Concept2	.160	.435	.519
Procedures	.159	.570	.379
Hypothesis	.758	.225	.112
Reports	.839	.057	.138
Attitudes	.128	.882	-.034

For some authors (Hair et al., 1999), interpretation of factorial loadings should be associated with the statistical power and the sample size, this way it is considered an acceptable range ≥ .30 so that a variable is chosen in a specific factor for a sample greater than 350 (N = 2003), setting a power level of 80%, a .05 significance and standard errors supposedly twice larger than conventional correlation coefficients. Minimizing the number of significant loads on each row and the array of factors (Table 4), a first factor with the *Hypothesis* and *Reports* variables with high explanatory value it was found; a second factor comprised of *Procedures* and *Attitudes*, but the first variable is also involved in the third; and a third factor with *Concept1* and *Concept2* variables, although the latter participates in the second factor.

An alternative way to EFA is to specify a model of maximum correlation between all pairs of our variables (Arbuckle, 2011). The analy-

Table 5

Covariance Matrixes

		PROC.	ATT.	REP.	CONC2.	CONC1.	HYP.
Residual Covariance	Procedures	–.002					
	Attitudes	–.008	.017				
	Reports	.025	–.014	–.002			
	Concept2	–.005	.012	–.023	.008		
	Concept1	.008	–.021	.002	.000	.001	
	Hypothesis	–.036	.030	–.014	.011	.005	.006
Standardized Residual Covariances	Procedures	–.077					
	Attitudes	–.570	.983				
	Reports	1.504	–.980	–.072			
	Concept2	–.316	.816	–1.317	.342		
	Concept1	.536	–1.567	.100	–.001	.058	
	Hypothesis	–2.220	2.100	–.813	.653	.297	.260

sis was performed with the AMOS 20 © program, showing significant correlations ($p < .05$) between all pairs of variables, although the degree of significance is consistent with that found in classical EFA, but using this time an adjustment model based on Asymptotic Distribution Free (ADF).

Values residual covariance matrixes (unstandardized and standardized) are included in Table 5. Not more than 2.58 in absolute values were found, so we can rely on no significant discrepancies.

Structural equation modeling (SEM)

The structural model proposed rests on a number of theoretical considerations (see Figure 1). Then we point out the initial hypothesis:

— H_1: The findings in the literature and the results of initial exploratory analysis suggest that there are a set of underlying exogenous variables (observed variables) factors. It is proposed, therefore, three first-order factors or endogenous variables (unobserved variables): Experiential Factor, Conceptual and Explanatory Factor.

— H_2: In the structural model proposed there is a third-order factor, called Integrating Factor, trying to explain all the variance and covariance of the latent factors of the first order. There are good theoretical reasons for that, given the high degree of significant covariance between all variables obtained in the exploratory analysis. The results of the A model expressed that, although the model is not accepted (probability level of .001 and a relationship χ^2/df of 4.746) it is found in terms that it could be improved.

The first step to try to fix the model consisted of assessment by the modification of indices and differences between critical reasons parameter (not shown in this paper). Given the data, variances related to each major factor were made to coincide (var_a) and regressions second factor (path_a). It also seemed plausible to accept among all the suggested improvements to correlate errors 2 and 6, on the one hand and between 4 and 5 mistakes to avoid all artificiality. To make sense of the first, it must be thought what is behind the Procedures variable (actually 23 different scientific procedures) and the variable hypothesis, because whatever it is what both measurement errors measure, different from what each variable represents (Arbuckle, 2011), they are linked to the perceptions of students, since the hypothesis stating is the first step to the immediate realization of practical work. A reading of some of the 23 statements that are grouped under the Concept2 variable ("I understand the factors that influence the oscillation period

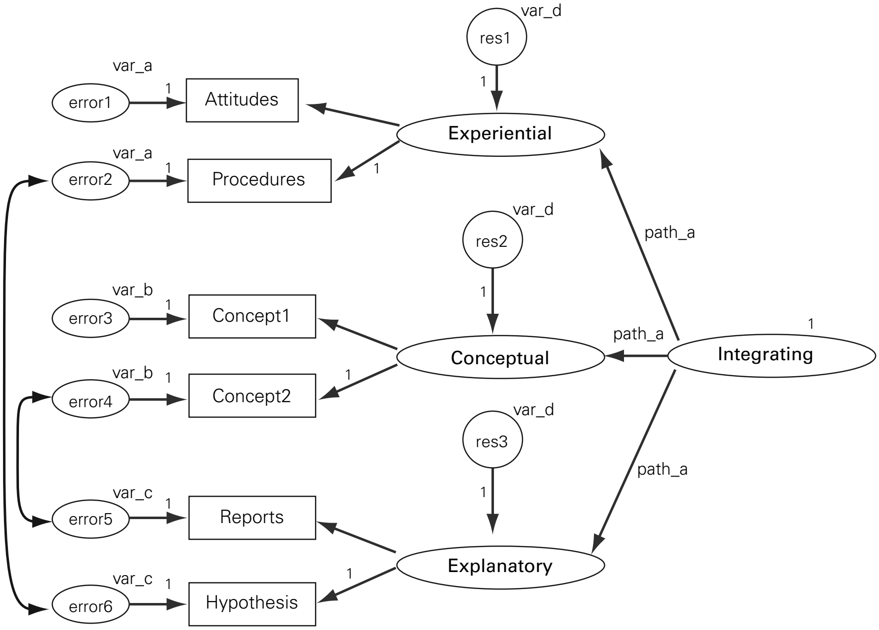

Figure 2. Conceptual diagram of model on scholarly research (B).

of a pendulum," "I understand how a spring is stretched, "I understand how a fossil is formed"; "I know to determine personal caloric expenditure"...), it is suggested that, although involving concepts, in most cases it refers to a comprehensive understanding of the investigation and, therefore, their measurement errors are perhaps correlated to varying Report. The Figure 2 contains the model B.

Initial results indicate model B probability level of .088 and a relationship χ^2/df 1.61. In light of the results of the above table, the introduction of restrictions resulting in an improvement and fixing the model, since the model B has a percentage chance of 8.8%, above the minimum of 5% that is not rejected. In Table 6 the goodness of fit indices are compared between models A and B.

From Table 6 it follows that all indexes of fit evolved positively (Arbuckle, 2007; Hu & Bentler 1995; Jöreskog & Sörbom, 1993), which gives validity to the initially obtained results and confirms that the data is adjusted well to model B and leads to not reject. Thus, the RMSEA index shows a value less than .05 (.017) indicating that the proposed model fits the data quite well. The RMR (.013) index evolved positively as well as GFI, NFI, TLI and CFI indices which are higher than .95. The AIC (58.476) or approach Akaike index shows values below the saturated model (42.000), which is a good result.

Table 6

Comparative Summary goodness of fit indices for Models A and B

	A Model	B Model
χ^2	28.476	17.737
df (freedom degree)	6	11
χ^2/df	4.746	1.612
Prob. level	.000	.088
RMSEA	.043	.017
RMR	.016	.013
GFI	.994	.996
NFI	.938	.961
CFI	.949	.985
TLI	.873	.979
AIC	58.476	37.737
ECVI	.029 LO 90: .022 HI 90: .039 MECVI: .029	.019 LO 90: .015 HI 90: .026 MECVI: .019

The ECVI index (.029) is below the values of the independent models (.021) and the saturated (.230).

Next visually the non-standardized outcomes (Figure 3) and standardized (Figure 4) are shown for the model B:

The analysis of the total effects (direct and indirect of some variables on others) showed, as the most remarkable fact that the influence of the Integrating Factor is lower on Attitudes than other variables.

In Table 7 the value of the construct reliability (CRe) and the average variance extracted (AVE) are stated, based on the factor loadings and measurement errors confirmatory extracted from FA (see Figure 4) for the first order latent variables. They indicate values below the ones recommended, .7 and .5 for

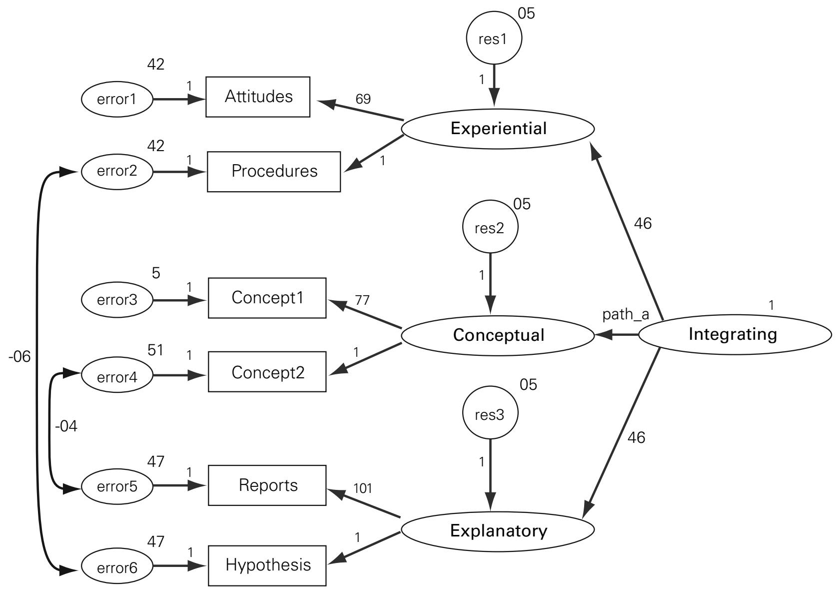

Figura 3. Non-standardized outcomes for the model B (ADF estimation).

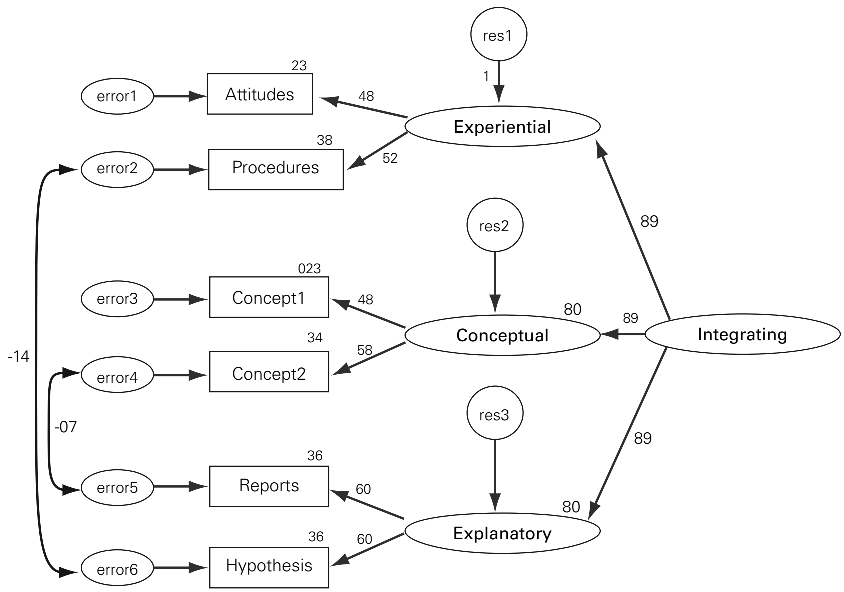

Figure 4. Standardized outcomes for the model B (ADF estimation).

Table 7

Calculation of Values CRe and AVE for Reliability and Validity of the Measuring Instrument

Endogenous latent variables	Indicator (Y_i) endogenous variable η_i	Contrust variance λ_{ij}^{y}	$(\lambda_{ij}^{y})^2$	Var ε_i	CRe	AVE
Experiencial Factor (η_1)	Attitudes Procedure	.48 .62	.23 .38	.77 .62	.47	.31
		$\Sigma\lambda_{ij}^{y} = 1.1$ $(\Sigma\lambda_{ij}^{y})^2 = 1.21$	$\Sigma(\lambda_{ij}^{y})^2 = .61$	Σ Var $\varepsilon i = 1.39$		
Concept Factor (η_2)	Concept1 Concept2	.48 .58	.23 .24		.44	.29
		$\Sigma\lambda_{ij}^{y} = 1.28$ $(\Sigma\lambda_{ij}^{y})^2 = 1.44$	$\Sigma(\lambda_{ij}^{y})^2 = .57$	Σ Var $\varepsilon i = 1.43$		
Explanatory Factor (η_3)	Reports Hyphotesis	.60 .60	.23 .24		.53	.36
		$\Sigma\lambda_{ij}^{y} = 1.43$ $(\Sigma\lambda_{ij}^{y})^2 = 1.12$	$\Sigma(\lambda_{ij}^{y})^2 = .72$	Σ Var $\varepsilon i = 1.28$		

Auto-elaboration.

CRe and AVE, respectively, which is a substantial limitation that has its origin with plausible likelihood that all bivariate correlations between observable variables were significant (although the degree of significance coincides with exploratory pointed out by AF).

Discussion

The first part of the work was basically an oriented exploration using descriptive and multivariate techniques (Pérez, 2006). The second part to the formulation of a theoretical approach related to the SEM (Mateos-Aparicio, 2011).

The findings involve three factors of the first order for the set of observed variables. In Experiential Factor are linked general attitudinal aspects of students to school science in processes of inquiry, with the entire set of procedures that characterizes every implemented experience (experimental design, validation, data, and control over variables, etc.). The word “experience” has this double nuance in the RAE (2014): Note a feeling and / or make scientific operations. Teachers should be aware of that the perceptions and behaviour of the learners are heavily influenced by their expectations (Hofstein & Lunetta, 2004). As Clough (2002) said, what a teacher does with the activities is more important than the activities themselves. In this sense, the design activities can promote the development of scientifically abilities when they are involved in an investigation and reflection cycle (Etkina et al., 2010) and also the improvement of the conceptual comprehension of the students (Olympiou & Zacharia, 2012).

For its part, the Conceptual Factor refers to the theoretical framework needed to work in every research experience, from a more or less complex conceptual structure to be restored with experience. The reflection on the difficulties of concepts by the students allows the generation of knowledge, since such difficulties are interesting symptoms of obstacles (Astolfi, 1999).

Meanwhile, in the Explanatory Factor (variables perceived as more problematic by the students), it refers to the need to "explain" and test our initial knowledge (hypotheses). The emission capacity of the own hypothesis on school stages has not been without controversy, some advocates believe it necessary at an early age (Gopnik, 2012; Sandoval et al., 2014), the development of the research report half fit for the purpose, as revealed Reigosa (2007).

In the second case a non-rejectable structural model implies the existence of a third-order factor, called Integrator Factor of reflective nature (Hoyle, 2011) proposes, however, they have imposed restrictions on the covariance affecting errors and waste. The complexity of the study, which analyzes transversely the student's perceptions across 23 different investigations, could have induced these results (Arbuckle, 2007). Therefore it represents a serious limitation, but leaves the door open to work on a specific topic and see how the model B is fitted and what changes it induced.

Another important limitation is the use of big samples to make an ADF approach for the categorical variables. If we have to make use of a 5-value-mark scale, perhaps the terms of normality could be reduced, being able to put a solid Satorra-Bentler ML focus into practise (Byrne, 2010) without having to use big samples.

Although sex is not a variable in the study, female bias in the university sample is a serious limitation; it would be interesting to have more balanced future samples in sex. Another limitation is the low values of the CRe and AVE for confirmatory measuring instrument FA, one of the causes may be significant correlations between all variables observed.

An important issue in the study is related to the statistical power or probability of not making β type mistakes (Aron & Aron Coups, 2013). RMSEA boundaries obtained for model B (LO 90 = .00 y HI

90 = .032), with a value of α of .05, the study sample (N = 2033) and degrees of freedom (df = 11) they were introduced for computation (Preacher & Coffman, 2006), giving a value of 92.51%, a remarkable value. The idea that an equivalent model better fits the data always remains, however, the advantage of the proposed model is based on years of research in Science Education, which is a good indicator of validity of the model (West, Taylor, & Wu, 2012).

Finally, as a future perspective, it is known that emotions have a strong impact on students (Sinatra, Broughton, & Lombardi, 2014). It would be interesting to know what role they could play in the model.

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Annex I

Distribution Cart Research Questions and Questionnaires

Research Questions	Questionnaires distribution $N = 2033$ (%)
1. Which factors influence the oscillation period of a pendulum?	211 (10.4%)
2. Which factors influence the lengthening of a spring?	175 (8.6%)
3. How do we distinguish the basic from the acidic substances?	61 (3%)
4. What kind of substance is the ink of our pens?	269 (13.2%)
5. What is our daily caloric use?	280 (13.8%)
6. Do we follow a balanced diet?	281 (13.8%)
7. What influences the solubility of the salts?	28 (1.4%)
8. How is a sedimentary rock formed?	39 (1.9%)
9. Can we simulate the formation of a fossil?	91 (4.5%)
10. What do we know about the preparation of solutions from a solid into liquid?	23 (1.1%)
11. What should we know about preparing solutions of impure liquid into another liquid?	24 (1.2%)
12. How an acid and base are neutralized?	22 (1.1%)
13. How do the LDR sensors behave faced with light?	12 (.6%)
14. Where does the food digestion begin?	26 (1.3%)
15. How to detect food fraud?	25 (1.2%)
16. Do plants have the same aqueous composition?	178 (8.8%)
17. Is there a relationship between lunar phases and tides?	96 (4.8%)
18. Can we convert mechanical work into heat?	25 (1.2%)
19. What are the main pigments of plants and their functions?	80 (3.9%)
20. Is it possible to simulate a digital circuit?	7 (.3%)
21. What behaviour does a semiconductor diode have?	30 (1.5%)
22. Can we use an RC circuit as a timer?	9 (.4%)
23. Is there a relationship between Weather and pollution?	41 (2%)