

## Factors Affecting the Individual Interest of Secondary School Students in Natural Science Lessons

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### Abstract

*Individual interest in learning natural sciences is a complex process influenced by multiple internal and external factors. The research reflects the need to determine the factors that affect individual interest in learning natural sciences in secondary school students. Two duly validated questionnaires were used, one of 18 factors that records the students' perceptual assessments and the other that measures individual interest. The questionnaires were applied to 741 students in the 3rd, 4th and 5th grades of secondary education. By means of a backward stepwise binary logistic regression, a significant model was found that explains 55.4% of the individual interest in learning natural sciences. Family problems is the factor with the highest importance (55 %), followed by study techniques (47.9 %), didactic material (47.3 %), selective attention (42 %), teaching methods and techniques (41 %), family assessment (41 %), scientific language (32.9 %), academic self-concept (31.8 %), peer bullying (26.5 %), study habits (26.4 %) and Chat in social networks (25.4 %). It is concluded that the model is composed of a broad set (11) of internal and external factors, provides a valid conceptual framework as empirical support to explain individual interest in learning the natural sciences.*

**Keywords:** *Factors; Individual interest; Secondary school; High school*

### Introduction

The learning that students acquire in basic education represents the basis for their social and educational future (Furió et al., 2001, González-Weil et al., 2009). School is the institution par excellence that has the mission to prepare them for life, providing them with basic experiences and knowledge in an increasingly changing and complex world. In secondary education, all subjects in the curriculum are of great importance, especially the learning of natural sciences (physics, chemistry, biology). In the case of Peru, they are studied during the 5 years of secondary school and are carried out in a block called Science and Technology.

The learning of natural sciences requires a high dose of emotion to awaken individual interest. However, as students progress, they accumulate a series of failures (Barmby et al., 2008), progressively losing interest in science and no longer associating it with academic

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success (Christidou, 2011). There are many causes that can affect student interest, these are called factors, a factor is a variable that has the ability to cause or not an effect on another variable (Inder, 2022), regardless of place, space or social condition.

#### Literature review

The literature highlights the role of interest in science learning as a key factor in raising motivation and fostering learners' active participation in academic activities (Harackiewicz et al., 2016; Toli and Kallery, 2021). Interest is characterised by the fact that it activates cognitive structures and stimulates the individual to seek to satisfy the need for learning (Hidi and Renninger, 2006).

As the learner satisfies his or her learning needs over time, interest does not die out, it is restructured and deepened, including new interests to re-engage (Hidi and Renninger, 2006). Its presence fosters high levels of knowledge and is key to successful learning in the natural sciences (Sanchez and Dopico, 2006). Individual interest is a factor that positively predisposes learners to encounter learning, includes cognitive and emotional components, and depends on endogenous and exogenous factors (Renninger and Hidi, 2017).

Many authors conceive of personal interest as a relatively enduring preference for certain areas of knowledge or activities (Schiefele, 1992); on the educational side, the concept is approached in terms of learners' knowledge and appreciation of a subject. It has the capacity to arouse the desire to engage in activities related to learning in that field of knowledge (Boekaerts and Boscolo, 2002). There are two well-defined characteristics of personal interest: its stability over time and its difficulty in being modified (Hidi and Renninger, 2006). This characteristic can represent a serious problem for the learning process, insofar as the teacher who directs the classroom will try to carry out activities to raise it, but may fail in the attempt.

Individual interest is a variable sensitive to internal and external factors, in this sense, Hasni and Potvin (2015) reported the results of 3 factors in relation to interest: teaching methods, family context and self-efficacy. Cheung (2017) applied a questionnaire to 591 students in Hong Kong, managing to determine 3 factors with high correlation (scientific self-concept, individual interest and situational influences). Mohtar et al. (2019) reported results on the multi-factor analysis of interest, working with a hypothetical 5-factor model, finding that self-efficacy and perceptions about studying science as a career have an influence.

In South Korea, Kim et al. (2020) evaluated school level, number and type of visits on individual interest in a study on museum fatigue in science centres. In Estonia, research was conducted with secondary school students, validating the teacher-centred, social constructivist, student-centred and teacher-centred approaches (Teppo, et al, 2021). There is also progress in the study of interest factors at the experimental level (Onanuga and Banjo, 2021; Toli and Kallery, 2021;).

### **Theoretical framework**

Individual interest is a theme that has been developed by various theories, approaches in educational psychology and pedagogy. Self-determination theory suggests that people have an innate disposition to seek personal growth and self-fulfilment through learning (Ryan and Deci, 2017). It emphasises the importance of satisfying the basic psychological needs of autonomy, competence and relatedness to foster intrinsic interest in learning. Intrinsic motivation is based on three innate needs for an individual's state of satisfaction: competence, which seeks control and mastery of experience, relatedness and autonomy (Lavigne and Vallerand, 2010).

There is different research on the contributions of self-determination theory, Liu and Chung (2016), found a positive correlation between teachers' perceptions of autonomy support and satisfaction of basic psychological needs, with respect to physical education

students. Similarly, in the work of Evans and Bonneville-Russi (2016), it is reported that satisfaction of basic psychological needs and self-motivation were positively related to repeated practice and higher quality preferred tasks. In a study by Tomás and Gutiérrez (2019), it was shown that autonomy is a variable that is related to the satisfactory responses of the individual, this being a preponderant factor in academic success. Likewise, in the work of Gutiérrez, et al. (2018), showed a positive relationship between autonomy support and the satisfaction of psychological needs, the values were very similar for students from Angola.

Flow theory explains that individual interest is a state of mind in which a person is fully immersed in an activity and enjoys the process for its own sake. Interest in learning increases when the challenges of the content are appropriate to the learner's abilities, which promotes flow experiences (Csíkszentmihályi, 1997). In the context of individual interest, flow occurs when the skills and challenge level of a task are balanced. If a task is too easy in relation to the individual's abilities, it can lead to boredom and lack of interest. On the other hand, if a task is too difficult and beyond the individual's current abilities, it can lead to frustration and anxiety.

Flow occurs when there is a match between the abilities and challenge of a task, resulting in a state of optimal engagement and enjoyment (Csíkszentmihályi, et al. 2005). During flow, people feel totally absorbed in the task, lose track of time and experience a sense of control and satisfaction. This state is highly motivating and can foster greater interest and engagement in learning.

#### Research objective

In most of the studies, the analyses were carried out with explanatory models on a limited set of factors (between 3 and 5). On the other hand, it is apparent that the factors have been previously selected through literature review and others on the basis of motivations on a single subject. The research addresses the explanatory analysis of factors related to individual interest by simultaneously testing a set of 18 factors. This range of options allows for a broader analysis based on students' perceptions. On the other hand, there are few studies at the explanatory level of factors affecting individual interest in secondary school populations (Derek, 2018). The research aims to determine the endogenous or exogenous factors that affect secondary school students' interest in learning natural sciences.

## Method

### Participants

In order to select the participants, the directors and teachers of secondary schools in the Tacna region of Peru were contacted. They were informed about the study and gave their authorisation to obtain informed consent from parents and the application of the questionnaires.

There were a total of 31 schools, including public and private institutions, and the sample consisted of 741 students in the 3rd, 4th and 5th grades of secondary education. The sampling was stratified random for each educational institution and the selection of the sampling units was carried out by simple random sampling. The 50.1% were female and 49.9% male, the age range fluctuating between 13 and 19 years. The average age of the participants was 15.5 years (CI: 15.49, 15.63), SD: 1.038.

### Design

The research is of a non-experimental nature, with data collection over a single period of time (cross-sectional design). In accordance with the stages through which it is carried out,

it is considered to be an explanatory, observational type of research. It consists of data collection through the application of questionnaires to the sample units.

#### Instruments

Two validated questionnaires were used with samples from the same population setting as the sample of the present study. The individual interest questionnaire was validated and published by García et al. (2020). The AFC reports a KMO value = 0.872; Bartlett's test = 1295.5 (df = 153; p = 0.00001). The instrument has 4 underlying factors that explain 83.34% of the total variance. The CFA corroborates the model with 4 factors and 16 items, the comparative fit indices CFI = 0.901, (acceptable), TLI = 0.892 and RMSEA = 0.064 (acceptable model). The reliability test with ordinal alpha of the dimensions obtained scores ranging from 0.79 to 0.92.

The first dimension measures the student's willingness to learn basic science compared to other academic activities and consists of 3 items. The second dimension is affect, which refers to the student's feelings in relation to learning science, and consists of 5 items. The third dimension assesses the intentionality of learning science, consisting of 3 items. And the assessment of the degree of usefulness of science for personal development, consisting of 5 items. The instrument measures interest by means of propositions with a response scale from 1 to 4, where 1 is "Strongly disagree", 2 "Disagree", 3 "Agree", 4 "Strongly agree".

The second instrument applied is a multivariate factor questionnaire (independent variables), which was designed, validated and published by García et al. (2021). It measures a set of 18 endogenous and exogenous factors based on students' perceptual ratings of individual interest in science. The instrument provides information on each of the factors through scores assigned by the student to the items of the instrument. It uses a scale of 1 to 5, where 1 represents 'not at all', 2 'a little', 3 'fair', 4 'quite a lot' and 5 'very much'.

The AFE reported by the authors provides adequate values, KMO = 0.807 and Bartlett's = 1369.4 (df = 210; p = 0.00001). The model suggested an underlying 6-factor solution explaining 78.87% of the total variance. The CFA confirmed an acceptable model fit (CFI = 0.90; TLI = 0.92; RMSEA = 0.063).

#### Data collection and analysis procedure

The first steps were to obtain the necessary permissions from the educational authorities of the institutions. Then, self-reported consent was obtained from the parents. According to the sample distribution, five working groups were organised to apply the instruments. These consisted of one psychologist and two teachers per group, whose work was directed towards the application of the questionnaires, after motivation of the students, in order to ensure the adequacy of the results. The questionnaires were answered anonymously and collectively in the classrooms. Before the application, the responsible persons emphasised the importance of marking all the answers to the items, and the questionnaires took between 15 and 20 minutes to fill in.

The data were analysed with IBM SPSS Statistics 26, first the correlation was performed with the Phi statistic (2 x 2 tables) to assess multicollinearity between the independent variables: family problems (PROF), school bullying (BULE), family assessment (VALF), study groups (GRUE), selective attention (ATES), predisposition to learn (PERA), study habits (HABE), academic self-concept (AUTA), memory capacity (CAPM), study techniques (TECE), academic self-concept (AUTA) and memory capacity (CAPM), study techniques (TECE), scientific language (LENC), prior knowledge (CONP), perceived usefulness (PERU), teaching methods and techniques (METE), teaching materials (MATD), study time (TIEE), chat in social networks (CRS), laboratory practice (PRAL). Binomial logistic regression was then run using the backward stepwise method (Likelihood Ratio). The test reported 8 models (8 steps) which allowed to analyse the overall fit contrast (omnibus test) and the Cox and Snell R-squared and Nagelkerke R-squared coefficients.

## Results

The results in Table 1 show that the relationships between the 18 factors and individual interest in science learning are statistically significant ( $p < 0.05$ ), which confirms that they are not random. The findings indicate that there is no multicollinearity between the independent variables (perfect correlations or close to 1), because the Phi coefficients are less than or equal to 0.35; therefore, the binary logistic regression process can be performed (Johnson, 2000).

Table 1 Relationship between factors affecting interest in science learning

F	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
P2	0,35																
P3	0,10	0,05															
P4	0,18	0,14	0,19														
P5	0,13	0,12	0,11	0,19													
P6	0,08	0,06	0,18	0,20	0,17												
P7	0,09	0,13	0,13	0,15	0,23	0,08											
P8	0,13	0,15	0,15	0,16	0,15	0,17	0,29										
P9	0,43	0,06	0,12	0,15	0,17	0,09	0,16	0,17									
P10	0,04	0,03	0,10	0,12	0,11	0,04	0,08	0,06	-0,01								
P11	0,23	0,19	0,06	0,13	0,13	0,08	0,12	0,10	0,12	0,06							
P12	0,12	0,13	0,16	0,11	0,12	0,13	0,07	0,13	0,10	0,10	0,20						
P13	0,02	0,02	0,21	0,20	0,05	0,22	0,08	0,18	0,07	0,09	0,09	0,12					
P14	0,09	0,12	0,17	0,17	0,13	0,20	0,16	0,19	0,17	0,16	0,13	0,13	0,31				
P15	0,13	0,20	0,11	0,16	0,16	0,14	0,15	0,15	0,09	0,08	0,22	0,15	0,14	0,27			
P16	0,15	0,10	0,02	0,04	0,04	0,15	0,12	0,07	0,01	-0,02	0,20	0,11	0,02	0,14	0,07		
P17	0,14	0,18	-0,01	0,08	0,08	0,03	0,06	0,09	0,03	0,10	0,24	0,14	0,05	0,04	0,15	0,27	
P18	0,16	0,19	-0,02	0,14	0,08	0,06	0,10	0,07	0,05	-0,03	0,19	0,05	-0,02	0,06	0,09	0,23	0,33

Table 2 presents the result of the overall goodness-of-fit test by comparing the likelihood between the null model (-2LLO) and the eighth step model (-2LLM). The p-value is less than the significance level ( $p = 0.00 > 0.05$ ), which indicates an adequate goodness of fit, given that equality between the coefficients is ruled out and it is assumed that a significant estimated model is obtained (Páez et al., 2022). Likewise, the Nagelkerke R<sup>2</sup> coefficient of determination that explains individual interest in learning science as a function of the set of predictor variables in the model is 55.4 % (>50 % adequate model). The log likelihood -2 contains an optimal score of 311.562 compared to the 7 preceding steps, thus confirming that the model is plausible.

Table 2 Goodness of fit of the eighth step model R<sup>2</sup>

Aspects	Omnibus tests of model coefficients			Pseudo coefficient R <sup>2</sup>		
	$\chi^2$	gl	Sig.	-2LLM*	R <sup>2</sup> Cox y	R <sup>2</sup>
				Snell	Nagelkerke	

Pass	-2.376	1	0.123	311.562	0.299	0.554
Block	263.605	11	0.000			
Model	263.605	11	0.000			

Note. \*Log-likelihood -2

Table 3 contains the factors that make up the final model that adequately explains interest in learning science. The family problems factor predicts 55 % of chances of having interest in learning science, followed by study techniques (47.9 %), didactic material (47.3 %), selective attention (42 %), teaching methods and techniques (41 %), family appreciation (41 %), scientific language (32.9 %), academic self-concept (31.8 %), peer bullying (26.5 %), study habits (26.4 %) and chatting on social networks (25.4 %). It is worth mentioning that the following factors were eliminated: GRUE, PERA, CAPM, CONP, PERU, TIEE and PRAL; as a product of the 8 steps preceding the final model.

Table 3 Factors contained in the eighth step model

Factors	B	E.T	Wald	p	OR	OR 95%	
						Lower	Upper
PROF	-0.598	0.336	3.165	0.075	0.550	0.285	1.063
BULE	-1.327	0.327	16.504	0.000	0.265	0.140	0.503
VALF	-1.123	0.351	10.250	0.001	0.325	0.164	0.647
ATES	-0.867	0.304	8.115	0.004	0.420	0.231	0.763
HABE	-1.330	0.337	15.624	0.000	0.264	0.137	0.511
AUTA	-1.144	0.328	12.198	0.000	0.318	0.168	0.605
TECE	-0.735	0.314	5.487	0.019	0.479	0.259	0.887
LENC	-1.112	0.313	12.648	0.000	0.329	0.178	0.607
METE	-0.891	0.329	7.333	0.007	0.410	0.215	0.782
MATD	-0.749	0.310	5.826	0.016	0.473	0.257	0.869
CRS	-1.370	0.321	18.213	0.000	0.254	0.135	0.477
Constant	7.535	0.658	131.255	0.000	1872.097		

Note. OR = ODDS RATIO (Effect Size)

## Discussions

Based on students' perceptions, a set of factors affecting individual interest in natural science learning was identified. The study offers a framework of analysis whose results provide a significant model of 11 factors explaining individual interest, with 7 out of 18 factors that were assessed being discarded.

The model identifies 6 external factors that come from the student's environment (Romero and Hernández, 2019). The first, family problems (PROF), is the factor with the greatest impact on individual interest; students show that an unstable and conflictive family environment generates a negative atmosphere that affects interest in learning basic sciences (Davis, 2005; Razali, 2021). Added to this factor is the family value (VALF) of the parents; their position has a great influence on the children's opinion, due to the leadership and authority they exercise within the family group (Razali, 2021). Teaching methods and techniques (METE) together with teaching materials (MATD) are two factors that integrate the didactic strategy applied by teachers during lessons. According to the pupils' perception, the rational organisation of learning sequences, accompanied by appropriate teaching

resources, are important for individual interest in science. Another factor is the language of science (LENC), the natural sciences are characterised by the use of proprietary terms. This element acts as a linguistic barrier to learning and discourages students (Lidbury and Zhang, 2008). In addition to the above factors, school bullying (BULE), that is, bullying by classmates during lessons, is a distractor and affects individual interest in learning science (Bulunuz and Özgür, 2021).

The model also reports 5 endogenous factors, those that have their roots within or are the student's own skills (Romero and Hernández, 2019). Among them are study skills (ECTS), students show that the study of science requires them to have these tools. Another component of the model is selective attention (ATES), the learning process requires an individual to focus their senses to connect with new knowledge. This allows them to activate their cognitive and emotional structures and to become interested (Keller 2010). Added to the above factors is the academic self-concept (AUTA), which represents a positive or negative feeling about learning the basic sciences. As students move up the educational ladder, they experience setbacks and failures, which progressively affect their interest in science (Christidou, 2011). Incorporated into the model are study habits (HABE), students recognise that studying science requires consistency. Finally, the factor of social network use (CRS), called "Chatting", is considered as a distractor of interest. Its continuous use, both in and out of class, means an investment of time for non-academic purposes, postponing school activities (Alshalawi, 2022).

Over time, studies have been conducted at the explanatory level based on the analysis of a set of factors on individual interest in science. Some of the reported factors are part of the present study, for example, Potvin and Hasni (2014) found that science self-concept, science value and teaching methods are predictors of individual interest. However, they include the promotion of science activities as an additional element, which in this case behave as catalysts for stimuli affecting interest. Another work that distinguishes science self-concept as a strong factor on individual interest, together with situational influences, was reported by Cheung (2017), which, unlike this research, includes the gender factor and the degree of studies, but in both factors they found no significant influence.

Ito and McPeherson (2018) analysed 4 factors, concluded that social belonging and self-efficacy, school belonging and science skills have a significant impact on the interest of high school students. In the present research only self-efficacy, which conceptually could be equivalent to self-concept, was analysed. Razali (2021) found that parental authority has a strong effect on the cultivation of children's individual interest in science. This factor is linked to the family valuation reported in this research, both of which refer to the importance parents attach to science within the family environment. On the other hand, the author also reports other variables such as science motivation and 21st century skills, which are not part of the present model.

## Conclusions

The results reveal that individual interest in learning natural sciences is affected by 11 factors, where family problems, study techniques and didactic material show the greatest effect. On the other hand, the direct or indirect participation of three agents surrounding the student's life is evident: parents, teachers and classmates. The model of factors identified provides a valid conceptual framework and empirical support to explain interest.

Interest in science is a complex problem that requires comprehensive strategies to intervene in the field of student behaviour. Therefore, it is essential to consider a model that includes internal and external aspects in order to capture students' interest. We must bear in mind that the results offer limitations in terms of sampling context and temporality. However, they have a very useful educational value that can serve as a guide for teachers and other stakeholders in general. It can be used in future studies that adopt the model of predictors

and include other factors not foreseen in the present research, and from there pedagogical proposals can be constructed.

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