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Motivational factors, learning strategies and competencies in natural sciences

Factores motivacionales, estrategias de aprendizaje y competencias en ciencias naturales

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SUMMARY

It is analyzed the relationship between the motivational factors with the learning strategies that the students of the Department of Cauca in Colombia present in front of the basic standards of competencies in Natural Sciences. A non-experimental study was carried out with a quantitative approach, correlational type of study, and cross-sectional study time, with 423 participants. As instruments, the EDAOM, EMPA questionnaires, and the results of the basic standards of competencies in natural sciences according to the ICFES tests were applied. The findings indicate that motivation is not the determining factor for the low results obtained in the ICFES, but learning strategies are, so it is necessary to devise and contribute to creating these to obtain better student results.

Keywords: *Motivation, learning strategies, basic standards in natural sciences, secondary students.*

RESUMEN

Se analiza la relación entre los factores motivacionales con las estrategias de aprendizaje que presentan los estudiantes del Departamento de Cauca en Colombia frente a los estándares básicos de competencias en Ciencias Naturales. Se llevó a cabo un estudio no experimental, de enfoque cuantitativo, tipo de estudio correlacional y momento de estudio transversal, que contó con 423 participantes; como instrumentos se aplicaron los cuestionarios EDAOM, EMPA y los resultados de los estándares básicos de competencias en ciencias naturales según las pruebas ICFES. Los hallazgos indican que, la motivación no es el factor determinante para los bajos resultados obtenidos en el ICFES, pero las estrategias de aprendizaje si, por lo que se requiere idear y aportar con la creación de estas para obtener mejores resultados en los estudiantes.

Palabras clave: *Motivación, estrategias de aprendizaje, estándares básicos en Ciencias Naturales, estudiantes de secundaria.*

INTRODUCTION

Motivation is defined as the engine of human behavior, arousing the interest in an activity generated by necessity, inciting the subject to

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action, and being of physiological or psychological origin. For this reason, motivational strategies are of great importance in the educational field, allowing students optimal academic performance, and stimulating autonomous learning (1-3).

In this sense, it is necessary to address motivation from two aspects: the intrinsic and extrinsic levels. Intrinsic motivation considers internal factors such as self-determination, curiosity, challenge, and effort, which emerge spontaneously due to internal tendencies and psychological needs that promote behavior without extrinsic rewards (4). While extrinsic motivation changes concerning the autonomy that the subject has, categorized from less to more self-determined, which allows a distinction to be made between external, identified, and integrated according to Bonilla-Yucailla et al. (5). The previous means that the student is extrinsically motivated when they are going to receive a prize or benefit from the activity or task to be carried out, which allows establishing that the motivation is external and of the moment (6,7).

On the other hand, learning strategies are activities or mental methods to facilitate the educational process of students (8). The use of learning strategies implies that students propose and execute work routes, where, if there is management and knowledge about what has to be done to learn, they do it and control it, allowing them to continue their training processes independently or autonomously, processing, understanding and adopting the information acquired in the teaching-learning process in the classroom (9,10).

In turn, the Ministry of National Education in Colombia (11), determined that basic skills are one of the parameters that every boy, girl, and adolescent must know and know how to do to reach the level of quality expected when passing through the educational system, having as basic competences: scientific, citizen, communicative and mathematical competences. In this regard, it can be stated that education worldwide is in continuous change, despite efforts being made to resolve paradigms in the teaching-learning processes, motivation of students, and evaluation by competencies where students are evaluated quantitatively or qualitatively at the same time end each school year with standardized tests (7).

Fajardo-Bullón et al. (12), reaffirm the efforts made throughout history in the educational field on school performance, based on the implication that the school has as an educational system and the characteristics that students present from their social reality. Allows evidence that academic excellence has not been achieved; on the contrary, it is found that performance levels do not improve significantly concerning previous years in the competencies evaluated, as reported by the Colombian Institute for the Evaluation of Education (13), confirming the hypothesis of Suárez-Landazábal and Buendía (14), that despite the multiple efforts to improve the results of the basic competency standards in the different national and international tests, the mechanisms proposed to reach quality education are still far from meeting the objective, calling into question the public policies established by the (MEN, Prueba de ciencias naturales. Ministerio de Educación Nacional de Colombia) (15,16).

The previous allows us to formulate the following question: is there a relationship between motivational factors and learning strategies compared to the basic standards of competencies in natural sciences of secondary school students in the department of Cauca in Colombia?

MATERIALS AND METHODS

A quantitative, correlational, and cross-sectional study was carried out, in which 432 high school students from the Department of Cauca participated. The sampling was probabilistic, as inclusion criteria were considered: students registered and enrolled in SIMAT (Sistema integrado de matrícula) in the department of Cauca, minor students whose guardians have accepted and signed the informed consent, and students of legal age who voluntarily agreed to participate in the study. As exclusion criteria, students who were not enrolled in educational institutions in the Department of Cauca with visual, hearing, and motor disabilities were not considered.

Data collection instruments

The Learning Styles and Motivational Orientation Questionnaire (EDAOM), by

Salomón et al. (17), allows for obtaining results in learning strategies and motivational orientations in high school. This self-report instrument comprises 89 Likert-type items; the Quevedo-Blasco et al. (18) questionnaire was applied, a motivational assessment tool for the learning process (Cuestionario de evaluación motivacional del proceso de aprendizaje, EMPA) that measures both global and intrinsic and extrinsic motivation.

The study was divided into 5 phases, namely: definition of the problem (phase I), literature review (phase II), determination of the functional design (phase III), data collection (phase IV), and data analysis (phase V).

Data Analysis

Once the information collected by the EDAOM, EMPA questionnaires, and the ICFES (Instituto Colombiano para la Evaluación de la Educación) results had been systematized, the descriptive analysis of the sociodemographic variables of the participants was carried out, the analysis of each applied test, and finally, the inferential analysis correlation was made to the results obtained. For this, it was decided to carry out a triangulation that would allow determining whether there was a relationship between the independent variables and the dependent variable through the Spearman rho coefficient test, using the statistical package of SPSS version 23.0.

Ethical considerations

Considering that the participants were minors, permission was requested from the parents, and students who had informed consent were worked with. The data was protected by the study researchers, and the results are shown in a general way, taking care of the identity of the participants.

RESULTS

Within the sociodemographic characteristics, it stands out that 51 % of the participants are male and 49 % female. Most participants are between 11 and 16 years old, and only 12.4 % are older than 16 years, with a mean of 13.79~14 years and a standard deviation of 2.3 years.

Regarding the race of the students, it was found that 368 students (85.2 %) are mestizos, being the most predominant race, followed by 30 students (6.9 %) indigenous, 24 students (5.6 %) white, 8 Afro-Colombian students (1.9 %) and 2 students (0.5 %) belonged to the black race.

At first, the Spearman correlation between EDAOM and the results obtained from the ICFES test was made, as shown in Table 1, where the following was found for each subscale: (1) selective, the correlation coefficient Spearman's was 0.012, for the subscale called (2) generative it was -0.018, for (3) retrieval of various tasks it was 0.001, for (4) retrieval of exams the result was -0.015, in the subscale (5) convergent the result was -0.049, in (6) divergent it was -0.019, in (7) perceived efficacy it was -0.001, in (8) perceived contingency it was -0.026, in (9) perceived autonomy the result obtained was -0.072; for subscale (10) external approval was -0.02; in (11) achievement was -0.060; for the subscale (12) task it was -0.069 and finally for the subscale (13) self-regulation/material dimension the correlation result was -0.065, in this way it is observed that all the values are close to zero, which indicates that there is no linear correlation between the variables studied (Table 1).

The Spearman correlation was performed between the extrinsic and intrinsic motivation of the EMPA instrument and the results of the ICFES, as shown in Table 2, where the results for the extrinsic motivation subscale referring to the correlation coefficient were -0.045. The intrinsic motivation subscale was -0.001; these values were close to zero, which shows no linear correlation between the motivation measured with the EMPA instrument and the results obtained in the ICFES tests of the participants.

Once the results were obtained, the relationship between the students' motivational factors and learning strategies was analyzed and compared to the basic standards of competence in natural sciences. For this, the results obtained from the two instruments applied EDAOM, EMPA, and the results obtained from ICFES were taken into account. To this, the results showed no correlation between motivation and the scores obtained in the tests presented for natural sciences.

Table 1. Results of correlations between the results obtained in EDAOM and the ICFES.

			Correlations													
	Subescale		Subscale 1	Subscale 2	Subscale 3	Subscale 4	Subscale 5	Subscale 6	Subscale 7	Subscale 8	Subscale 9	Subscale 10	Subscale 11	Subscale 12	Subscale 13	Resulted ICFES
Rho of Spearman	Subescala 1	Correlation coefficient	1.000	0.563**	0.454**	0.537**	0.516**	0.431**	0.647**	0.286**	0.534**	0.107*	0.485**	0.559**	0.550**	0.012
		Sig. (bilateral)	--	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026	0.000	0.000	0.000	0.804
	Subscale 2	Correlation coefficient	0.563**	1.000	0.528**	0.622**	0.593**	0.673**	0.584**	0.264**	0.425**	0.025	0.716**	0.548**	0.698**	-0.018
		Sig. (bilateral)	0.000	--	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.610	0.000	0.000	0.000	0.704
	Subscale 3	Correlation coefficient	0.454**	0.528**	1.000	0.600**	0.396**	0.603**	0.515**	0.243**	0.414**	-0.083	0.389**	0.490**	0.453**	0.001
		Sig. (bilateral)	0.000	0.000	--	0.000	0.000	0.000	0.000	0.000	0.000	0.084	0.000	0.000	0.000	0.984
	Subscale 4	Correlation coefficient	0.537**	0.622**	0.600**	1.000	0.491**	0.639**	0.551**	0.236**	0.544**	0.006	0.502**	0.514**	0.514**	-0.015
		Sig. (bilateral)	0.000	0.000	0.000	--	0.000	0.000	0.000	0.000	0.000	0.906	0.000	0.000	0.000	0.760
	Subscale 5	Correlation coefficient	0.516**	0.593**	0.396**	0.491**	1.000	0.607**	0.514**	0.387**	0.476**	0.012	0.761**	0.610**	0.730**	-0.049
		Sig. (bilateral)	0.000	0.000	0.000	0.000	--	0.000	0.000	0.000	0.000	0.811	0.000	0.000	0.000	0.310
	Subscale 6	Correlation coefficient	0.431**	0.673**	0.603**	0.639**	0.607**	1.000	0.545**	0.219**	0.335**	-0.163**	0.593**	0.516**	0.614**	-0.019
		Sig. (bilateral)	0.000	0.000	0.000	0.000	0.000	--	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.691
	Subscale 7	Correlation coefficient	0.647**	0.584**	0.515**	0.551**	0.514**	0.545**	1.000	0.409**	0.491**	0.132**	0.521**	0.656**	0.579**	-0.001
		Sig. (bilateral)	0.000	0.000	0.000	0.000	0.000	0.000	--	0.000	0.000	0.006	0.000	0.000	0.000	0.991
	Subscale 8	Correlation coefficient	0.286**	0.264**	0.243**	0.236**	0.387**	0.219**	0.409**	1.000	0.573**	0.421**	0.433**	0.468**	0.327**	-0.026
		Sig. (bilateral)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	--	0.000	0.000	0.000	0.000	0.000	0.593
	Subscale 9	Correlation coefficient	0.534**	0.425**	0.414**	0.544**	0.476**	0.335**	0.491**	0.573**	1.000	0.408**	0.552**	0.569**	0.433**	-0.072
		Sig. (bilateral)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	--	0.000	0.000	0.000	0.000	0.134
	Subscale 10	Correlation coefficient	0.107*	0.025	-0.083	0.006	0.012	-.163**	0.132**	0.421**	0.408**	1.000	0.063	0.106*	0.060	-0.020
		Sig. (bilateral)	0.026	0.610	0.084	0.906	0.811	0.001	0.006	0.000	0.000	--	0.193	0.027	0.212	0.675
	Subscale 11	Correlation coefficient	.485**	.716**	.389**	.502**	.761**	.593**	.521**	.433**	.552**	0.063	1.000	0.641**	0.774**	-0.060
		Sig. (bilateral)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.193	--	0.000	0.000	0.213
	Subscale 12	Correlation coefficient	0.559**	0.548**	0.490**	0.514**	0.610**	0.516**	0.656**	0.468**	0.569**	0.106*	0.641**	1.000	0.643**	-0.069
		Sig. (bilateral)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.000	--	0.000	0.151
	Subscale 13	Correlation coefficient	0.550**	0.698**	0.453**	0.514**	0.730**	0.614**	0.579**	0.327**	0.433**	0.060	0.774**	0.643**	1.000	-0.065
		Sig. (bilateral)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.212	0.000	0.000	--	0.180
	Resulted in ICFES	Correlation coefficient	0.012	-0.018	0.001	-0.015	-0.049	-0.019	-0.001	-0.026	-0.072	-0.020	-0.060	-0.069	-0.065	1.000
		Sig. (bilateral)	0.804	0.704	0.984	0.760	0.310	0.691	0.991	0.593	0.134	0.675	0.213	0.151	0.180	--

Note. **. The correlation is significant at the 0.01 level (bilateral).
*. The correlation is significant at the 0.05 level (bilateral).

Table 2. Results of correlations between the results obtained from EMPA and the ICFES.

		Correlations	Resulted in ICFES	Extrinsic	Intrinsic
Rho of Spearman	Resulted in ICFES	Correlation coefficient	1.000	-0.045	-0.001
		Sig. (bilateral)	--	0.346	0.984
	Extrinsic	Correlation coefficient	-0.045	1.000	-0.124*
		Sig. (bilateral)	0.346	--	0.010
	Intrinsic	Correlation coefficient	-0.001	-0.124*	1.000
		Sig. (bilateral)	0.984	0.010	--

*The correlation is significant at the 0.05 level (bilateral)

In this regard, the results of the ICFES tests were analyzed concerning the natural science component, presented by students from the sixth to eleventh grades of the year 2021, as indicated in Table 3. The results show that the average performance level of the students is low. The students are, on average, at level 1; therefore, the student lacks skills to recognize explicit information presented in tables or graphs with habitual language, which implies reading a single independent variable for competencies in natural sciences.

Table 3. Descriptive statistics of the ICFES 2021 results

	Statistics descriptive				
	N	Minimum	Maxime	Media	Deviation
Resulted in ICFES	432	8	61	28	8.301

Note. Results obtained according to the tests applied and interpreted by the assigned scale of the ICFES 2021

Table 4 shows the averages of the EDAOM test applied to the group of 432 students, observing that these results range between 37 and 83 points according to Table 1 of interpretation of the score obtained; most of the scores are located in the range with regular learning ability. Among them are the selective, generative, various task recovery, exam recovery, convergent, divergent, and sub-task subscales; for a total of seven subscales, the scale of perceived efficacy, perceived autonomy, and external approval are located at a low level, and the subscale of perceived contingency, achievement subscale, and self-regulation/material dimension is in a high learning capacity.

With the above, it can be established that there is no significant relationship between the motivational factors with the learning strategies compared to the basic standards of competencies in natural sciences of the students participating in the study. In this way, it is necessary to consider the results, not in a group for the independent variables: motivation and learning strategies, but rather the result obtained from one of these variables about the dependent variable: basic standards of competencies in science natural. In this sense, it is guaranteed to obtain more conclusive results that allow the institution to propose actions in search of achieving educational quality, taking into account the context, the realities of the students, and the inputs with which they have for the development and strengthening in their teaching-learning process and their formation as a human being.

DISCUSSION

Authors such as Palencia and Barragán (6); Simbaña (2); Casanova et al. (3) state that intrinsic

Table 4. Average results of the EDAOM

Scales EDAOM	Subscales EDAOM	Mín.	Máx.	$\bar{x}$	s	Average capacity
Acquisition	1 Selective	31	94	68	11.687	R
	2 Generative	20	100	75	15.944	R
Memory resource management	3 Recovery Various Tasks	13	93	69	14.973	R
	4 Exam Recovery	17	100	67	15.217	R
Information processing	5 Convergent	29	100	77	15.568	R
	6 Divergent	0	100	74	17.094	R
Self-regulation / Person dimension	7 Perceived Efficacy	0	80	50	14.372	L
	8 Perceived Contingency	56	100	83	11.946	H
	9 Perceived Autonomy	9	76	51	12.197	L
	10 External Approval	0	93	37	23.923	L
Self-regulation / Task dimension	11 Achievement	31	100	82	15.305	H
	12 Subtask	29	100	75	13.622	R
Material dimension	13 Self-regulation scale	26	100	81	14.342	H

Note. The average capacity is given as follows: L: Low R: Regular and H: High according to the interpretation of Salomón et al. (17)

and extrinsic motivation are related to academic performance in the classroom and external tests. In this study, it is observed that extrinsic motivation is low compared with intrinsic motivation according to the results provided by EMPA, and it is evident that in the high school student population of the Department of Cauca, motivation does not depend on them but on external factors. Of the environment where they live and where they are educated.

The results of EDAOM in the learning strategies, compared to the average learning capacity obtained in the applied instruments, were regular. Therefore, it can be said that how the information is acquired is not the best way, and therefore, when applying it later in school activities, its results are not those expected in the student population for the study area as natural sciences (19).

Regarding the results from the analysis analysis associated with the basic standards of competence for natural sciences, it is found that 92.8 % of the students are located at performance level 1 established according to ICFES (20). These results show that, in general, students have little ability to develop competencies: extensive use of scientific knowledge, explanation of phenomena, and inquiry. This means that the objective set by the Organization for Economic Cooperation and Development (21) is not being met since they reaffirm that the use of various standardized tests, both nationally and internationally, is to achieve educational quality in addition to generating skills to that students respond once they finish each school year.

The results obtained in this study contribute with various studies carried out to date in Colombia, such as that of Timarán-Pereira et al. (19), in which they socialized patterns that allowed identifying good or poor academic performance in the natural sciences test for the ICFES. Likewise, Tapasco-Alzate et al. (16), attributes poor school performance to high school education in line with the results obtained in the ICFES tests and the admission record to the first semester of university careers. What led to a detailed analysis of the formation and development of natural science skills in the classroom of the students of the population studied.

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