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Learning styles for algebra concepts: The case of engineering students at the Universidad de Santander (Valledupar, Colombia)

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Abstract. The objective of this research was to evaluate the learning styles for algebra concepts of the students of the industrial engineering program of the University of Santander, Valledupar, Cesar, Colombia. A descriptive study was developed, consisting of 40 algebra students and 6 mathematics teachers, the questionnaire is self-administered elaborated with a dichotomous scale for the student and for interpretation of the means, a scale was designed based on a scale between zero and five that reveals the score obtained in said test, the styles studied were active, reflective, theoretical and pragmatic. Concluding that the predominant style is the pragmatic and theoretical, which allowed to select and apply strategies aimed at generating interactivity between students and teachers around the knowledge of algebra.

1. Introduction

Learning is achieved when there is a modification of the knowledge one has about something. Each being or individual has an exclusive way of learning and each one chooses his style to appropriate the new concepts [1,2,3]. In every teaching process in order to optimize it, the style of each participant in this process must be taken into account, an important input for the design of the teaching strategies to be undertaken in a learning session; because experience tells us that the student learns in a better way when instructed taking into account his predominant learning style [4,5].

But this activity is immersed in a complexity that encloses the human being as an individual that interacts with its environment. Learning Styles are defined as "cognitive, affective, physiological, preferences for the use of the senses, environment, culture, psychology, comfort, development and personality that serve as relatively stable indicators of how people perceive, interrelate and respond to their learning environments and their own methods or strategies in their way of learning "[6].

According to Gómez et al. 2017 [7], these features can be specified with instruments designed for this purpose, which guide how the student interacts with their environment. It is from there that he



builds his own learning according to his style, which determines how he processes and perceives the information of his reality.

Each individual conceives his reality in a different way, this is how Safarin et al. (2013) [8], states that each student learns differently from others, uses different strategies, learns at different speeds, either more or less effectively and even if they have the same motivations, the same level of instruction, same age or are studying the same subject.

By analyzing learning styles over time and in the words of Waes et al. (2014) [9], the most outstanding and recognized studies by the academic community, are the models of Honey and Mumford in 1982 that establish four styles of learning: active, reflective, theoretical and pragmatic; and Kolb 1984 that classifies them into four stages: divergent, assimilative, convergent and accommodative.

Based on the above four types of learning styles are detailed according to how to organize and work with characteristics that clearly indicate the skill field of each of them as a result of a factorial analysis, which are shown in the Table 1:

Table 1. Types of learning styles.

Type of Style	Features
Active	<p>These people get involved in the affairs of others and center around them all the activities they undertake with enthusiasm. They are open-minded, nothing skeptical. Your days are full of activity. They think that at least once you have to try everything. Spontaneous, creative innovators eager to learn and solve problems.</p>
Reflective	<p>They like to consider experiences and observe them from different perspectives. Collect data by analyzing them carefully before reaching any conclusion. They are prudent, observe well and consider all possible alternatives before making a move. They listen to others and do not act until they take ownership of the situation, they are pondered, patient, inquisitive, slow and detailed.</p>
Theoretical	<p>Adapt and integrate observations within logical and complex theories. They approach the problems vertically staggered, by logical stages. They tend to be perfectionists. They integrate the facts into coherent theories. They like to analyze and synthesize. They are profound in their system of thought, when establishing principles, theories and models. For them, if it is logical, it is good. They look for rationality and objectivity, fleeing from the subjective and the ambiguous.</p>
Pragmatic	<p>The practical application of ideas predominates in them. They discover the positive aspect of new ideas and take advantage of the first opportunity to experience them. They like to act quickly and safely with those ideas and projects that attract them. They tend to be impatient. They tread the earth when there is a decision to be made or a problem to be solved.</p>

On the other hand, mathematics is present, to a greater or lesser extent, in each of the scientific advances and technological innovations of the contemporary world. There is a close correlation between the technological development in a society and the degree of insertion of Mathematics in its techniques [10]. In the training of engineers, the study of abstract sciences is preponderant, so much so that working with a contextualized mathematics is not an easy task neither for the teacher nor for the student since it is necessary to integrate mathematical knowledge with other areas of knowledge with the inherent implications of this process [11]. In the particular case of the concepts of algebra, when you want to use mathematics in the context of engineering, in its didactic phase, questions arise as to how to do it. This article seeks, without being the only way, to show how a teacher can work with Mathematics in the context of engineering to promote interdisciplinarity. The career of Industrial Engineer is taken as an example. With the above, it is expected to contribute to the evaluation of the learning styles for algebra concepts in engineering students of the Universidad de Santander, Valledupar headquarters in the Caribbean Colombiano.

2. Experimental

To obtain Population and Sample: For the present investigation, the population corresponds to the level of university undergraduate training in Industrial Engineering offered by the University of Santander, in the municipality of Valledupar, department of Cesar, Colombia. It is constituted by 40 algebra students and 6 mathematics teachers.

Techniques and instruments for data collection: The data collection instrument will be the survey, the questionnaire is self-administered with closed type questions to apply to students and industrial engineering teachers of the Universidad de Santander. This was elaborated with a dichotomous scale for the student and for interpretation of the means, a scale was designed based on a scale between zero and five that reveals the score obtained in said test. The categories used in the scale for these scores are: total ignorance (DT), average ignorance (DM), neither know nor ignore (NC / ND), average knowledge (CM) and high knowledge (AC). To evaluate the learning styles of the students, it was designed with a Likert scale of 5-1, with the alternatives: Strongly Agree (TA), Medium Agree (MA), Neither Agree nor Disagree (NA / ND), Medium Disagreement (MD) and Totally Disagree (TD).

Data analysis technique: The use of descriptive statistics was used with measures of central tendency, to carry out the treatment of the information obtained, in the processing of the results obtained through the application of the instruments. The average or arithmetic average was used, allowing the categorization of items, indicators, dimensions and study variables. Statistical packages such as Excel and SPSS were used for the statistical analysis of the information.

3. Results and discussion

The different learning styles of the engineering students of the University of Santander are presented next to the concepts of algebra.

Active learning style: This learning style could be evidenced in students of algebra because it involved being an animator, discoverer, risky and spontaneous. The tendency of the students regarding this style of learning was not to agree or disagree (NA/ND) with being animator, discoverer, risky and spontaneous, which can be verified in the scale with the scores respectively obtained in each indicator such as 3.7, 2.3, 2.6 and 3.4. In Table 2, the results obtained on the students' active learning style can be compared.

Table 2. Active learning style.

SUB DIMENSION	ítem	INDICATOR	TD	MD	D	MA	TA	CONCLUSION ACCORDING TO BAREMO	
ACTIVE LEARNING STYLE	3	Animator	13%	0%	0%	31%	56%	The tendency is not to agree or disagree	
	5		0%	13%	19%	25%	43%		
	6		18%	31%	13%	25%	13%		
			AVERAGE% SCORE	10%	15%	11%	27%	37%	3,7
		4	Discoverer	6%	25%	38%	0%	31%	The tendency is not to agree or disagree
		8		75%	13%	6%	0%	6%	
		12		50%	18%	13%	13%	6%	
			AVERAGE% SCORE	44%	19%	19%	4%	14%	2,3
		2	Risky	25%	19%	19%	25%	12%	The tendency is not to agree or disagree
		10		31%	13%	18%	25%	13%	
		11		31%	31%	13%	25%	0%	
			PROMEDIO % SCORE	29%	21%	17%	25%	8%	2,6
	1	Spontaneous	13%	0%	6%	50%	31%	The tendency is not to agree or disagree	
	7		13%	13%	6%	50%	18%		
	9		13%	25%	31%	25%	6%		
		AVERAGE% SCORE	13%	13%	14%	42%	18%	3,4	
HALF %			24%	17%	15%	25%	20%	The tendency is not to agree or disagree	
AVERAGE SCORE			0,2	0,3	0,5	1,0	1,0	3,0	

Finally, it can be seen that the average score of the active learning style is 3.0, which according to the scale gives the group a tendency to disagree or disagree (NA / ND) with this learning style.

Reflective learning style: This learning style is characterized in students of algebra who are weighted, conscientious, receptive and analytical. In Table 3, the results can be observed.

Table 3. Reflective learning style.

SUB DIMENSION	ítem	INDICATOR	TD	MD	D	MA	TA	CONCLUSION ACCORDING TO BAREMO	
REFLECTIVE LEARNING STYLE	19	Weighted	38%	13%	18%	0%	31%	The tendency is not to agree or disagree	
	23		0%	31%	19%	31%	19%		
	24		19%	13%	31%	31%	6%		
			AVERAGE% SCORE	19%	19%	23%	21%	19%	3,0
				0,2	0,4	0,7	0,8	0,9	
	13	Conscientious	6%	25%	13%	25%	31%	The tendency is to be fairly in agreement	
	14		0%	13%	6%	19%	62%		
	21		6%	6%	6%	63%	19%		
			AVERAGE% SCORE	4%	15%	8%	36%	37%	3,9
				0,0	0,3	0,3	1,4	1,9	
	15	Receptive	6%	6%	26%	31%	31%	The tendency is not to agree or disagree	
	17		6%	13%	25%	43%	13%		
22	13%		37%	0%	0%	50%			
		AVERAGE% SCORE	8%	19%	17%	25%	31%	3,5	
			0,1	0,4	0,5	1,0	1,6		
16	Analytical	0%	25%	25%	25%	25%	The tendency is to be fairly in agreement		
18		13%	13%	6%	31%	37%			
20		0%	0%	19%	43%	38%			
		AVERAGE% SCORE	4%	13%	17%	33%	33%	3,8	
			0,0	0,3	0,5	1,3	1,7		
HALF AVERAGE SCORE			9%	16%	16%	29%	30%	The tendency is not to agree or disagree	
			0,1	0,3	0,5	1,1	1,5	3,5	

In the reflective learning style on algebra, students do not agree or disagree (NA / ND) with being weighted and receptive, which can be observed in the scale with the scores respectively obtained in each indicator such as 3.0 and 3.5. While they are fairly in agreement (MA) with being conscientious and analytical, which can be evidenced in the scale with the scores respectively obtained in these indicators such as 3.9 and 3.8. Finally, it can be seen that the average score of the reflective learning style is 3.5, which according to the scale gives the group a tendency to disagree or disagree (NA/ND) with this learning style.

Theoretical learning style: This learning style is observed in algebra students when it is demonstrated that they are methodical, logical, critical and structured. The students tendency towards the theoretical learning style about algebra, was to be in agreement (MA) with being logical and critical. And they do not agree or disagree (NA/ND) on being methodical and structured; which can be evidenced in the scale with the scores respectively obtained in each indicator such as 4.2, 4.1, 3.45 and 3.6. In Table 4, the results obtained with regard to this learning style are evident.

Table 4. Theoretical learning style.

SUB DIMENSION	ítem	INDICATOR	TD	MD	D	MA	TA	CONCLUSION ACCORDING TO BAREMO
ESTILO DE APRENDIZAJE TEÓRICO	31	Methodical	6%	38%	12%	6%	38%	The tendency is not to agree or disagree 3,45
	33		0%	13%	19%	25%	43%	
	36		19%	13%	19%	43%	6%	
		AVERAGE% SCORE	8%	21%	17%	25%	29%	
	26	Logical	0%	0%	19%	38%	43%	The tendency is to be fairly in agreement 4,2
	27		0%	12%	19%	19%	50%	
28	0%		6%	25%	13%	56%		
	AVERAGE% SCORE	0%	6%	21%	23%	50%		
			0,0	0,1	0,6	0,9	2,5	
SUB DIMENSION	ítem	INDICATOR	TD	MD	D	MA	TA	CONCLUSION ACCORDING TO BAREMO
	25	Critical	0%	6%	13%	13%	68%	The tendency is to be fairly in agreement 4,1
	29		0%	0%	19%	31%	50%	
	30		6%	13%	19%	31%	31%	
		AVERAGE% SCORE	2%	6%	17%	25%	50%	
			0,0	0,1	0,5	1,0	2,5	
	32	Structured	0%	0%	38%	50%	12%	The tendency is not to agree or disagree 3,6
	34		19%	6%	13%	37%	25%	
	35		0%	19%	31%	6%	44%	
	AVERAGE% SCORE	6%	8%	27%	31%	27%		
			0,1	0,2	0,8	1,2	1,4	
HALF			4%	11%	21%	26%	39%	The tendency is to be fairly in agreement
AVERAGE SCORE			0,0	0,2	0,6	1,0	1,9	3,8

Finally, it can be shown that the average score of the theoretical learning style is 3.8, which, according to the scale, gives the group a tendency to agree moderately (MA) with this learning style.

Pragmatic learning style: This learning style is characterized by algebra students who are experienced, practical, effective and realistic. In Table 5, we can see the results in percentage and score that were obtained on the pragmatic learning style of the students.

Table 5. Pragmatic learning style.

SUB DIMENSION	ítem	INDICATOR	TD	MD	D	MA	TA	CONCLUSION ACCORDING TO BAREMO
PRAGMATIC LEARNING STYLE	38	Experimenter	0%	6%	13%	31%	50%	The tendency is not to agree or disagree
	41		13%	25%	25%	37%	0%	
	43		6%	25%	19%	13%	37%	
	AVERAGE% SCORE		6%	19%	19%	27%	29%	
	39	Practical	0%	0%	6%	44%	50%	The tendency is to be fairly in agreement
	44		0%	6%	19%	25%	50%	
	46		25%	25%	12%	19%	19%	
	AVERAGE% SCORE		8%	10%	12%	29%	40%	
	40	Effective	6%	0%	13%	38%	43%	The tendency is not to agree or disagree
	42		13%	6%	38%	43%	0%	
	47		0%	0%	38%	50%	12%	
	AVERAGE% SCORE		6%	2%	30%	44%	18%	
37	Realistic	0%	13%	13%	43%	31%	The tendency is to be fairly in agreement	
45		13%	13%	19%	13%	42%		
48		0%	0%	6%	25%	69%		
AVERAGE% SCORE		4%	9%	13%	27%	47%		4,0
HALF			6%	10%	18%	32%	34%	The tendency is to be fairly in agreement
AVERAGE SCORE			0,1	0,2	0,6	1,3	1,7	3,8

In the pragmatic learning style on algebra, students agree fairly (MA) with being practical and realistic, which can be observed in the scale with the respective scores of 3.8 and 4.0 obtained in these indicators. While in the group they do not agree or disagree (NA / ND) with being an experimenter and effective, which can be evidenced in the scale with the score for these indicators of 3.5 and 3.7. Finally, it can be observed that the average score of the pragmatic learning style is 3.8, which according to the scale gives the group a tendency to agree moderately (MA) with this learning style.

Students' predominant learning style: Based on the previous analyzes, it can be affirmed that the predominant learning styles in the students of algebra are the theoretical learning style and the pragmatic learning style, where the students obtained a score of 3.8 for each one of them, which according to the scale gives a tendency to the group to be fairly in agreement (MA) with these learning styles. Second, there is the tendency of students with the reflective learning style, where a score of 3.5 was obtained, which according to the scale gives a tendency to the group to disagree or disagree (NA / ND) with this style of learning. And finally the students identify with the active learning style where

they obtained a rating of 3.0 which according to the scale gives a tendency to the group not to agree or disagree (NA / ND) with this style of learning.

4. Conclusions

The learning styles of the Engineering students of the University of Santander were identified, highlighting that it is very important to recognize which are the learning styles (active, reflexive, theoretical and pragmatic) that predominate most in the students, concluding that the predominant style is the pragmatic and theoretical, which allowed to select and apply strategies aimed at generating interactivity between students and teachers around the knowledge of algebra.

Conflict of Interest.

The authors report there are no conflicts of interest.

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