Computer Science and Information Systems 21(3):1203–1219 https://doi.org/10.2298/CSIS230213030B

The incidence of some critical cognitive factors that prevent change of order in university students: uncertainty analysis

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Abstract. School performance depends on cognitive impact while academic performance depends on how the qualitative and quantitative evaluation of students is carried out, which is open to a wide range of very complex criteria. Students' emotional intelligence is put to the test by the intense and constant completion of tasks to achieve the required credits. However, students do not manage to adapt to this system, which causes rejection and procrastination in completing tasks, and is evident from their really bad state of mind and stress intolerance. These factors can be so strong that they prevent adequate development; school commitments and obligations are neglected, affecting academic performance, which remains in the first order. Consequently, we aim to identify the critical cognitive factors that prevent the change of order and process them through fuzzy cognitive maps. To do so, a survey of students and teachers from Spanish and Mexican universities was carried out. Through confirmatory factor analysis, the number of items to be analysed was reduced. The variance analysis detected significant differences between students' attitude and what teachers thought, and an assignment matrix was obtained. Finally, by obtaining Hamming distance, the critical factors that prevent good academic performance could be found. The main result obtained is that the critical factors that prevent change of order in cognitive elements are mainly problem solving, stress tolerance, reality testing , empathy, self-concept and happiness.

Keywords: change of order, fuzzy, emotional intelligence, academic performance.

1. Introduction

School failure cannot be tackled through quantitative and qualitative evaluations alone. What is truly important is to define the educational objectives to be pursued by analysing the difficulties students come up against and proposing actions that enable them to continue progressing towards achieving them [33]. Academic performance from a psychological perspective comprises various cognitive factors such as intellectual level, personality, motivation, aptitudes, interest, study habits, self-esteem, and interpersonal relations ([35], [33]). However, in the different educational programs, meeting goals and objectives is represented by grades or marks awarded through quantitative and qualitative evaluations ([36], [6]). When students do not obtain the desired results, they lapse into a series of

justifications related to external factors, using them to shield themselves from any responsibility, which causes a recurrence of bad habits ([41], [42]). One of these bad habits is to put off taking action, which in turn prevents academic development ([11], [26]).

From a psychological perspective, the identification of cognitive-emotional patterns starts with the teacher's observation of their students. When they observe signs of a behaviour that prevents a student from accomplishing their learning objectives, their tutor will be informed so that they can receive early attention; since, if this is not done, a student could experience a cognitive weakness. Students can be conditioned by their own prejudices or by external events that prevent the full development of their activities, which is known as a first order state ([19]). Psychological support enables these weaknesses to be overcome by making substantial changes. If these changes manage to restructure their ways of interacting and lead them to a personal transformation, a student would then be in a second order state ([4],[46], [29], [19], [16]).

If we consider the first order, where students do not manage to overcome lagging behind in their academic and school performance, students manifest great dissatisfaction with the educational system; as a result, this prevents them from fully developing their cognitive skills ([25], [39]): According to Lamas [33], this dissatisfaction is expressed through impulsive actions that affect their learning capacity and regularly affects crystalized intelligence (teaching-learning process) but not fluid intelligence (ability to establish relationships independent of previously acquired knowledge).

Emotional intelligence can be defined as the capacity that determines learning practical skills based on self-awareness, motivation, self-control, empathy and self-regulation ([24], [20]). According to Vargas ([56]), there are some basic principles that influence people's sensitivity in their interpretation of others' emotions and feelings when socializing in groups. In this sense, Bar-On ([1]) considers that an individual relates to the people and the cultural environment around them, where intrapersonal, interpersonal, adaptability, stress management and state of mind are implicit.

Regardless of educational level, any learning process involves various sets of tasks and demands that require a large number of psychological as well as physical adaptation skills ([7], [17], [45], [13]). Generally speaking, the cognitive factors that influence the skill for understanding and showing emotions and feelings are related to emotional self-awareness, assertiveness, self-development and emotional independence ([54], [55]). One of the factors to emerge from this interpersonal dimension is self-concept, understood as the ability to understand, accept, and respect oneself. Personality and the relationship with academic, social and family self-concept is associated with self-esteem (comprising various behavioural, cognitive, emotional, and interaction variables. The patterns recognised by [22] are: withdrawal; anxiety-shyness; leadership; prosocial, anti-social, assertive, passive, or aggressive behaviours; self-assertiveness; hetero-assertiveness; and social adaptation. The interventions of these factors are behind the causes of school stress in general; a phenomenon that affects this community significantly today ([36], [8]). The theoretical structure of stress is classified as positive, normal and negative. Positive stress (eustress) permits an individual to be alert and to confront situations that they consider a threat to their performance, normal stress is necessary to confront situations that require alertness, and negative stress (distress) refers to the inability to confront threats, which can be frustrating for an individual ([2], [40], [23], [7]). Nevertheless, research into academic stress

management is still in its initial phase, and many studies have only focused on work-related stress ([3], [47])

Consequently, this study has two aims: one is to identify the differences between lagging and non-lagging students; while the other is to determine which items show a greater difference between them by using fuzzy cognitive maps.

In this article, through Bar-On surveys of non-lagging students, lagging students, and teachers, and the use of FCM, we analyse why students fall behind in their studies. Using factorial analysis, the variables included in the study are reduced and the subsequent variance analysis enables the construction of an assignment matrix in order to generate a weight matrix, which is used as the basis for applying FCM. This application will enable us to find the aspects that lead students to fall behind in their studies.

2. Methodology

The identification of the cognitive indicators of lagging students is proposed in order to identify the behaviour patterns that prevent their academic development. To do this, the following steps will be followed:

1. Identification of the cognitive-emotional factors that differentiate lagging students from non-lagging students
   (a) A Bar-On survey is carried out on lagging students (LS) so as to gather information about the following dimensions: interpersonal, intrapersonal, adaptability, stress management, and state of mind.
   (b) We perform a confirmatory factor analysis of 60 questions answered by lagging students through the Kaiser-Meyer-Olkin test (KMO) and Bartlett's test of sphericity in order to determine partial correlation between the variables and lagging students. This makes it possible to reduce the number of items; that is to say, the questions in the initial survey that refer to the cognitive-emotional factors.This reduced group of items is used to interview non-lagging students and teachers. With the partial correlation matrix, the initial situation of the case study of lagging students in contrast to non-lagging students will be obtained, which will serve as a basis for adjusting weight assignments wij in the assignment matrix.The weights are interpreted according to Table 1, oscillating between -1 for a p-value close to zero and +1 for a p-value close to one. The p-value corresponds to the cognitive-emotional factors in each group of students (lagging and non-lagging).
   (c) A variance analysis (ANOVA) is performed for each of the items selected in the previous section between the three target groups,non-lagging students, lagging students and teachers. The ANOVA analysis enables us to find out the cognitive patterns that indicate significant differences through the subsequent application of the Scheffé method (for groups of different sizes). The results of the ANOVA and the Scheffé method allow us to visualize the differences for each item between the three target groups of the analysis so as to detect the cognitive variables that present a greater impact on academic performance.
2. The search for the main differences between groups is carried out by following the steps outlined below:
   (a) To obtain the assignment matrix the following procedure is carried out:

i. The levels of significance obtained are transformed into weights according to Table 1. If the significance level of the null hypothesis is lower than 0.05 (Fisher distribution), as it is opposite to the null hypothesis, negative ωs weights will be taken, interpolating for the values not considered in the table. Conversely, if the acceptance level is greater than 0.05 the positive ωs weights will be taken in a similar way.

Table 1. Correspondence between p-value and weights (ωs)

Pvalue	0.000	0.010	0.025	0.030	0.040	0.050	0.051	0.095	0.380	0.570	0.760	0.950
ωs	-1	-0.8	-0.5	-0.4	-0.2	-0.1	0.1	0.2	0.4	0.6	0.8	1.0

ii. All variables belonging to the same dimension will have a value of ± 1 according to whether or not they are opposite to the null hypothesis.

iii. Based on the ωs vector, the assignation matrix for the cognitive variables is obtained, indicating the incidence between each pair of variables

$$\omega_{ij} = |\omega s_i + \omega s_j|/2 \tag{1}$$

Where ω_{ij} is the element ij of the assignment matrix, ωs_i is the significance value of the cognitive variable in row i and ωs_j is the significance value of the cognitive variable in column j. Two matrices will be constructed, one for non-lagging students and another for lagging students. Once all the elements of the cognitive matrix are obtained, academic performance (AP) will be evaluated, which is the sum of all the elements from row k divided between the number of elements in this row. Once all the elements of the cognitive matrix are obtained, AP will be evaluated, which is the sum of all the elements in row k divided by the number of elements in said row.

$$RA_i = \frac{1}{k}\sum_{j=1}^{k} \omega_{ij} \tag{2}$$

In addition, because there are two groups of students (lagging and non-lagging), the analysis requires two matrices to compare the factors between the group of non-lagging students and the group of lagging students. The first matrix contains the group of lagging students according to the valuation by teachers, while the second matrix comprises the group of non-lagging students according to the teachers' valuation.

(b) To identify, define and validate the cause-effect relations in the assignment matrix, fuzzy cognitive maps (FCM) are used as they enable decision-making strategies to be established ([18], [59]). To do so, the assignment matrix should be constructed with predictive and reflexive sensitivity oriented towards the actions carried out by the experts ([18], [28]). The experts adjust the weights of the rotated component matrix (ANOVA) according to their experience to form an assignment matrix. This adjustment means possible biases in the rotated component matrix

(survey carried out on students) can be avoided because students may misrepresent their cognitive-emotional weaknesses, and in this way it is closer to reality. ([19], [30], [15], [58]).

In order to do this, an analysis is made through graph analysis, using causal concepts and connections, where 0 indicates the absence of concept while the value +1 or -1 indicates the positive or negative presence between the two connected concepts ([12], [30]). Using assignments through experts gives certainty to the qualitative information for the interpretation of the causes and effects constructed in an assignment matrix ([32], [10], [44], [18]). In accordance with the iterative procedure, the resulting vector of concepts in state $t+1$, C_{t+1} is updated according to the t state that immediately precedes it (C_t). This update in turn depends on the weight matrix ω and the transfer function f, $C_{t+1} = f(C_t, \omega)$.

(c) The search for the critical factors that affect academic performance. The FCM method is used through multiplication of the initiator concept vector, which is chosen by discretion: $C^t = [C_i^t]_{i\times n}$ with $C_i^t \in [0,1]$ and matrix ω_{ij} , according to the following expression:

$$R_t = C_t\omega \tag{3}$$

The new vector C_{t+1} is obtained from the R_t result, each i element will be one for those elements of the product such that $R_{ti} \geq 0$, and zero for the elements of the product such that $R_{ti} < 0$. Thus, the new vector C_{t+1} obtained will be formed by zeroes and ones. This new vector will again multiply the matrix $[\omega_{ij}]$ and so on and so forth for k iterations until the vector of iteration $k+1$, C_{t+k+1} is equal to the previous vector C_{t+k}.

(d) The valuation of Hamming distance allows us to identify the critical variables that prevent a satisfactory academic performance. The Hamming distance of the two fuzzy subsets $\tilde{LS}$ and $\tilde{NS}$ is found in an interval $0, 1$ and is obtained with the following expression:

$$\delta\left(\tilde{LS}, \tilde{NS}\right) = \frac{1}{n}\sum_{i,j=1}^{n} |\mu_i^{LS} - \mu_i^{LS}| \tag{4}$$

Where μ_i^{LS} and μ_i^{NS} are the pertinence functions of the sets $\tilde{LS}$ and $\tilde{NS}$ once equilibrium is achieved in the cognitive maps. Each indicator represents the transfer function of academic performance for the subset $\tilde{LS}$, which represents the 63 lagging students, while $\tilde{NS}$ represents non-lagging students.

3. Results and discussion

A pilot survey was carried out on lagging students. Subsequently, the number of items was reduced using the KMO and Bartlett's test, with no loss of information or variable objectivity. This was done to make the survey available to 160 students and 22 teachers from three universities in Spain and Mexico. An analysis was then made of the relation of cognitive factors (intrapersonal, adaptability, stress management and state of mood) between lagging students and teachers, and between non-lagging students and teachers. Assignment matrices were obtained for the groups of lagging students with teachers and

the groups of non-lagging students with teachers. Afterwards, fuzzy cognitive maps were applied, assigning an initiator vector to both groups. Finally, once stability was reached for both groups Hamming distance between the groups was obtained to identify critical variables.

A Bar-On (2006) survey (Table 2)is made of 63 students who are lagging academically in the first semester of 2021/22 academic year in mathematics, algebra, calculus and physics at the Faculty of Civil Engineering of the University Michoacana de San Nicolás de Hidalgo (UMSNH).

Table 2. Survey made of lagging students

p1-I like to enjoy myself	p21-I argue with people	p41-I make friends easily
p2-I'm good at understanding others	p22-I understand difficult questions	p42-I think I'm the best at everything I do
p3-I can keep calm when I'm annoyed	p23-I like smiling	p43- I have no problem saying how I feel
p4-I'm happy	p24-I try not to hurt other people's feelings	p44-When I answer difficult questions, I try to think of many solutions
p5-I care about what happens to people	p25-When faced with a problem, I don't give up until I've solved it	p45-I feel bad when people's feelings are hurt
p6-It's difficult for me to control my anger	p26-I have a bad temper	p46-when I'm upset with someone I continue to feel up set for a long time.
p7-I find it easy to tell people how I'm feeling	p27-nothing upsets me	p47-I feel happy about the type of person I am.
p8-I like all the people I know	p28-it's difficult for me to talk about my inner feelings.	p48-I'm good at solving problems
p9-I feel confident	p29-I know things will work out well	p49-It's difficult form to wait my turn
p10-I know how people feel	p30-I can give good answers to difficult questions	p50-I enjoy the things I do
p11-I know how to keep calm	p31-I can easily describe my feelings	p51-I'm happy with my friends
p12-I try to answer difficult questions in different ways	p32-I know how to enjoy myself	p52-I don't have bad days
p13-what I do is good	p33-I must always tell the truth	p53-it is difficult for me to tell others about my feelings
p14-I'm respectful towards others	p34-I am able to answer difficult questions in many wats when I want to	p54-I'm easily bothered
p15-I get over upset for any reason	p35-I easily get upset	p55-I?m able to realise when my friend is sad
p16-It´s easy for me to understand new things	p36-It pleases me to do things for others	p56-I like my body
p17-I'm able to talk about my feelings easily	p37-I don't feel very happy	p57-even if things are difficult, I don't get up
p18-I think well of everybody	p38-I can use different ways of solving problems easily	p58-when I'm upset, I act without thinking
p19-I hope for the best	p39-It takes a long time for me to get upset	p59-I know when people are upset, even if they don't say anything
p20-having friends is important	p40-I feel good about myself	p60-I like the way I look

The number of items (number of questions in the initial survey) is reduced according to the confirmatory analysis using the KMO test (approval level of the survey equal to 0.709) and Bartlett's test of sphericity with zero value in order to eliminate the variables that correlate. Results are given in Table 3, which, as can be observed, is not an identity matrix; therefore, we can rule out that the correlations).Table 4 shows the reduction of items obtained for each of the indicators from each dimension through rotated component matrix.

Table 3. Reduced rotated component matrix of dimensions

	Component					
	1	2	3	4	5	6
p17- I'm able to talk about my feelings easily	.778	.002	.237	.087	-.078	.105
p31- I can easily describe my feelings	.737	-.064	.112	.025	.080	.250
P43-I have no problems saying what I feel	.626	.473	.116	-.007	-.194	-.180
P7- I find it easy to tell people how I'm feeling	.594	.048	.526	-.061	.016	-.140
p30- I can give good answers to difficult questions	.553	.334	-.059	.342	.156	.237
p40- I feel good about myself	.072	.857	.187	.000	-.069	.059
p47- I feel happy about the type of person I am	.060	.840	-.013	.136	-.001	.207
p25- When faced with a problem, I don't give up until I've solved it	.089	.568	.069	.466	.080	.172
p10- I know how people feel	.349	-.069	.770	.107	-.060	.090
p45- I feel bad when people's feelings are hurt	-.118	.403	.678	.088	-.008	.323
p2- I'm good at understanding others	.267	.126	.664	.232	.130	-.049
p48- I'm good at solving problems	.191	.024	.142	.792	.081	.016
p44-When I answer difficult questions, I try to think of many solutions	-.039	.146	.170	.758	-.201	.144
p3- I can keep calm when I'm annoyed	-.037	-.014	.002	-.020	-.823	.009
p21- I argue with people	.044	-.180	.153	-.291	.770	-.041
p35- I easily get upset	-.159	.147	-.124	.424	.635	-.161
p29- I know things will work out well	.162	.227	.037	.132	-.169	.854
p4- I'm happy	.465	.215	.208	.066	.029	.491

A survey of non-lagging students and teachers was made with the resulting items in Table 4 (fourth column) in order to find out if there are any significant differences in the cognitive-emotional effect on academic performance and how it is perceived in universities. Specifically, 160 non-lagging students (NS) were interviewed: 124 were from the UMSNH (Mexico), 21 were students from University Miguel Hernández (Spain), and 15 students were from the Technology University of Nuevo Ladero (Mexico). The group of 22 teachers were also from these three universities. The survey represents the five cognitive dimensions comprising 18 items (Table 4). This reduced survey adapted for

Table 4. Dimensions, indicators and relation with questions students were asked

Dimension	Indicator	Items	Reduced Items
Interpersonal (ITR)	Empathy (EM)	2, 5, 10, 45, 55, 59	2, 5
	Interpersonal Relation (IR)	14, 20, 41, 51	
	Social responsibility (SR)	36, 57	
Intrapersonal	Emotional understanding (EU)	9, 17, 28, 31, 40	17, 31, 40
	Assertiveness (AS)	7, 24, 33, 43, 53, 59	7, 43
	Self-concept (SC)	3, 6, 26	3
	Self-realization (SR)	13, 42, 57	
	Independence (IN)	32, 47	32, 47
Adaptability	Problem solving (PS)	12, 22, 25, 30, 34, 38, 44, 48, 57	25, 30, 48
	Reality testing (RT)	3, 7, 11, 12, 16, 33, 38, 44	44
	Flexibility (FL)	27, 49, 56, 60	
Stress management	Stress tolerance (ST)	3, 11, 35, 49, 54, 58	35
	Impulse control (IC)	6, 15, 21, 39, 46, 49, 54, 58	21
State of mood	Optimism (OP)	8, 18, 19, 29, 52, 60	29
	Happiness (HP)	1, 4, 23, 37, 50	4

teachers is shown in Table 5 (the non-lagging students were given the same survey as lagging students, but only with the selected items).

Table 5. Survey for teachers

Item	Questions for teachers	Indicator
2	Lagging students (LS) are good at understanding people when there are changes	EM
5	LS care about what happens to people who face the same changes as they do	EM
17	LS can talk easily about what they think	CE
31	LS can describe their feelings easily	CE
40	LS feel good about themselves	CE
7	LS find it easy to tell people what they feel about the changes	AS
43	LS have no problem syaing what they feel	AS
3	LS can keep calm when they are upset about changes	SC
32	LS know how to enjoy themselves	IN
47	LS feel happy about the type of person they are	IN
25	LS don't give up until they've solved a problem	PS
30	LS usually give good answers to difficult questions	PS
48	LS are good at solving difficult things	PS
44	When LS answer, they try to think of many possible solutions	RT
35	LS get upset easily	ST
21	LS tend to be aggressive towards people	IC
29	LS feel confident about meeting goals	OP
4	LS feel happy about the new challenges that face them at this time	FZ

In order to know about the cognitive patterns and their relation between factors, we will perform ANOVA to find out the significant differences in pairs between the two groups of students, lagging students and teachers, and between non-lagging students and teachers (Table 5) . To do so, the five dimensions are analysed in their different levels of significance.

1. Interpersonal dimension. There are only differences between the two groups of students for item number 6 (Table 3) for the indicator Empathy EM_5. However, the

teachers did show differences of opinion with respect to two items of this indicator (except for item EM_5 in the case of non-lagging students)

Table 6. ANOVA significant differences between the three pairs (the two groups of students, lagging students and teachers, and non-lagging students and teachers)

Dimension	Variable / Indicator	Item	P-value			Description of item
			Scheffé NS and LS	Scheffé T and LS	Scheffé T and NS	
Interpersonal	Empathy (EM)	2	0.056	0.000*	0.000*	They understand people when there are changes
		5	0.043*	0.000*	0.264	They care about what happens to people when facing changes
Intrapersonal	Emotional understanding (EU)	17	0.000*	0.012*	0.062	They can talk easily about what they think
		31	0.204	0.95	0.283	They can describe their feelings easily
		40	0.626	0.170	0.037*	They feel good about themselves
	Assertiveness (AS)	7	0.339	0.114	0.574	They can tell people what they feel about the changes
		43	0.288	0.506	0.073	They show people how they feel
	Self-concept (SC)	3	0.040*	0.378	0.006*	They keep calm when they are upset about changes
		47	0.111	0.727	0.780	They feel happy about the type of person they are
Adaptability	Problem solving (PS)	25	0.000*	0.000*	0.990	They don't give up until they've solved a problem
		30	0.028*	0.910	0.063	They give good answers to difficult questions
		48	0.198	0.432	0.037*	They're good at solving difficult things
	Reality testing (RT)	44	0.000*	0.008*	0.589	They try to think of many possible solutions
Stress, management	Stress tolerances (ST)	35	0.000*	0.998	0.003*	They get upset easily
	Impulse control (IC)	21	0.000*	0.005*	0.016*	They tend to be aggressive towards people
State of mood	Optimism (OP)	29	0.927	0.000*	0.000*	They feel confident about meeting goals
	Happiness (HP)	4	0.137	0.001*	0.076	They feel happy about the new challenges that face them at this time

2. Intrapersonal dimension. Both groups of students showed significant differences for items EU_{17} of Emotional Understanding and SC_3 of Self-concept. For the former, the teachers also differed from the lagging students, while for the latter they differed from both groups of students. .
3. Adaptability dimension. The items Problem Solving PS_{25} and SP_{30} and Reality Testing (RT_{44}) showed significant differences between the two groups of students. The teachers showed differences of opinion for item SP_{25} and PR_{44} with respect to lagging students.
4. Stress management dimension. The items Stress Tolerance (ST_{35}) and Impulse Control (CI_{21}) showed differences between the two groups of students. The teachers opinion differed for item CI_{21} with respect to lagging students.

5. State of mood. None of the items in this group showed significant differences between the two groups of students, while the teachers showed differences in the two items with respect to lagging students.

Matrix assignation. Two comparison matrices are considered: one between the group of lagging students and the group of teachers (Table 7), and the other between the group of non-lagging students and the group of teachers (Table 8).

Table 7. Assignation matrix ($\omega_{ijSL\times E}$)

Iteration	EM_2	EM_5	EU_{17}	EU_{31}	EU_{40}	AS_7	AS_{43}	SC_3	SC_{47}	PS_{25}	PS_{30}	PS_{48}	RT_{44}	ST_{35}	IC_{21}	OP_{29}	HP_4	AP
EM_2	-1.00	-1.00	-0.90	0.00	-0.63	-0.40	-0.24	-0.30	-0.12	-1.00	-0.02	-0.28	-1.00	0.00	-1.00	-1.00	-1.00	-0.58
EM_5	-1.00	-1.00	-0.90	0.00	-0.63	-0.40	-0.24	-0.30	-0.12	-1.00	-0.02	-0.28	-1.00	0.00	-1.00	-1.00	-1.00	-0.58
EU_{17}	-0.90	-0.90	-0.45	0.20	-0.28	-0.43	-0.35	-0.40	-0.19	-0.90	0.16	-0.27	-0.90	0.20	-0.90	-0.90	-0.90	-0.48
EU_{31}	0.00	0.00	0.20	0.84	0.63	0.61	0.77	0.70	0.89	0.00	0.98	0.73	0.00	1.00	0.00	0.00	0.00	0.43
EU_{40}	-0.38	-0.38	-0.30	0.63	0.26	0.37	0.31	0.33	0.51	-0.75	0.61	0.35	-0.75	0.63	0.75	0.75	0.75	0.22
AS_7	-0.34	-0.34	-0.30	0.61	0.23	0.22	0.37	0.31	0.49	-0.40	0.59	0.33	-0.40	0.61	-0.40	-0.40	-0.40	0.05
AS_{43}	-0.24	-0.24	-0.14	0.77	0.39	0.37	0.51	0.47	0.65	0.24	0.75	0.47	-0.24	0.77	-0.24	-0.24	-0.24	0.22
SC_3	-0.30	-0.30	-0.20	0.70	0.33	0.31	0.47	0.42	0.59	-0.30	0.68	0.43	-0.30	0.70	-0.30	-0.30	-0.30	0.14
SC_{47}	-0.12	-0.12	-0.02	0.89	0.50	0.49	0.65	0.59	0.67	-0.12	0.87	0.61	-0.12	0.89	-0.12	-0.12	-0.12	0.31
PS_{25}	-1.00	-0.02	-0.91	0.00	-0.38	-0.58	-0.52	-0.30	-0.12	-1.00	-0.02	-0.28	-1.00	0.00	-1.00	-1.00	-1.00	-0.54
PS_{30}	-0.05	-0.05	0.08	0.80	0.61	0.59	0.75	0.68	0.87	-0.02	0.81	0.71	-0.12	0.98	-0.12	-0.12	-0.12	0.37
PS_{48}	-0.28	-0.28	-0.18	0.73	0.35	0.33	0.49	0.43	0.61	-0.28	0.71	0.46	-0.28	0.73	-0.28	-0.28	-0.28	0.16
RT_{44}	-1.00	-1.00	-0.90	0.00	-0.63	-0.40	-0.24	-0.30	-0.12	-1.00	-0.02	-0.28	-0.51	0.00	-1.00	-1.00	-1.00	-0.55
ST_{35}	0.00	0.00	0.20	1.00	0.63	0.61	0.77	0.70	0.89	0.00	0.98	0.73	0.00	1.00	0.00	0.00	0.00	0.44
IC_{21}	-1.00	-1.00	-0.90	0.00	-0.63	-0.40	-0.24	-0.30	-0.12	-1.00	-0.02	-0.28	-1.00	0.00	-1.00	-1.00	-1.00	-0.58
OP_{29}	-1.00	-1.00	-0.90	0.00	-0.63	-0.40	-0.24	-0.30	-0.12	-1.00	-0.02	-0.28	-1.00	0.00	-1.00	-1.00	-1.00	-0.58
HP_4	-1.00	-1.00	-0.90	0.00	-0.63	-0.40	-0.24	-0.30	-0.12	-1.00	-0.02	-0.28	-1.00	0.00	-1.00	-1.00	-1.00	-0.58
PA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Table 8. Assignation matrix ($\omega_{ijSN\times E}$)

	EM_2	EM_5	EU_{17}	EU_{31}	EU_{40}	AS_7	AS_{43}	SC_3	SC_{47}	PS_{25}	PS_{30}	PS_{48}	RT_{44}	ST_{35}	IC_{21}	OP_{29}	HP_4	AP
EM_2	-1.00	-0.34	-0.41	-0.33	-0.52	-0.22	-0.41	-0.78	-0.15	-0.07	-0.41	-0.52	-0.22	-0.80	-0.69	-1.00	-0.41	-0.48
EM_5	-0.34	0.33	0.26	0.34	0.15	0.45	0.26	-0.11	0.52	0.60	0.26	0.15	0.45	-0.14	-0.03	-0.34	0.26	0.18
EU_{17}	-0.41	0.26	0.18	0.27	0.08	0.37	0.19	-0.19	0.45	0.52	0.19	0.08	0.38	-0.21	-0.10	-0.41	0.19	0.11
EU_{31}	-0.33	0.34	0.27	0.35	0.16	0.46	0.27	-0.10	0.53	0.61	0.27	0.16	0.46	-0.13	-0.02	-0.33	0.27	0.19
EU_{40}	-0.52	0.15	0.08	0.16	-0.03	0.27	0.08	-0.29	0.34	0.42	0.08	-0.03	0.27	-0.32	-0.21	-0.52	0.08	0.00
AS_7	-0.22	0.45	0.37	0.46	0.27	0.56	0.38	0.01	0.64	0.71	0.38	0.27	0.57	-0.02	0.09	-0.22	0.38	0.30
AS_{43}	-0.41	0.26	0.19	0.27	0.08	0.38	0.19	-0.18	0.45	0.53	0.19	0.08	0.38	-0.21	-0.10	-0.41	0.19	0.11
SC_3	-0.78	-0.11	-0.19	-0.10	-0.29	0.01	-0.18	-0.55	0.08	0.16	-0.18	-0.29	0.01	-0.58	-0.47	-0.78	-0.18	-0.26
SC_{47}	-0.15	0.52	0.45	0.53	0.34	0.64	0.45	0.08	0.71	0.79	0.45	0.34	0.64	0.06	0.17	-0.15	0.45	0.37
PS_{25}	-0.07	0.60	0.52	0.61	0.42	0.71	0.53	0.16	0.79	0.86	0.53	0.42	0.72	0.13	0.24	-0.07	0.53	0.45
PS_{30}	-0.41	0.26	0.19	0.27	0.08	0.38	0.19	-0.18	0.45	0.53	0.19	0.08	0.38	-0.21	-0.10	-0.41	0.19	0.11
PS_{48}	-0.52	0.15	0.08	0.16	-0.03	0.27	0.08	-0.29	0.34	0.42	0.08	-0.03	0.27	-0.32	-0.21	-0.52	0.08	0.00
RT_{44}	-0.22	0.45	0.38	0.46	0.27	0.57	0.38	0.01	0.64	0.72	0.38	0.27	0.57	-0.02	0.10	-0.22	0.38	0.30
ST_{35}	-0.80	-0.14	-0.21	-0.13	-0.32	-0.02	-0.21	-0.58	0.06	0.13	-0.21	-0.32	-0.02	-0.60	-0.49	-0.80	-0.21	-0.28
IC_{21}	-0.69	-0.03	-0.10	-0.02	-0.21	0.09	-0.10	-0.47	0.17	0.24	-0.10	-0.21	0.10	-0.49	-0.38	-0.69	-0.10	-0.17
OP_{29}	-1.00	-0.34	-0.41	-0.33	-0.52	-0.22	-0.41	-0.78	-0.15	-0.07	-0.41	-0.52	-0.22	-0.80	-0.69	-1.00	-0.41	-0.48
HP_4	-0.41	0.26	0.19	0.27	0.08	0.38	0.19	-0.18	0.45	0.53	0.19	0.08	0.38	-0.21	-0.10	-0.41	0.19	0.11
PA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

The initiator concept vector of empathy in the variables EM_2 and EM_5 was $C_{t=0} = [1100000000000000]$. Successive iterations were made with matrix $\omega_{ijSL\times E}$ as well

as matrix $\omega_{ijSN\times E}$. Table 9 shows the results of the successive iterations for lagging students versus teachers and their effect on academic outcome, while Table 10 shows the results for non-lagging students versus teachers. As can be observed in the graph in Figure 1, the items that negatively affect academic performance are: EM_2, EM_5, EU_{17}, PS_{25}, RT_{44}, IC_{21}, OP_{29} and HP_4. Once equilibrium was achieved, Hamming distance was

Table 9. Iteration results for $R_{t+1,LS\times T} = C_{t+1} * \omega_{LS\times T}$

Iteration	EM_2	EM_5	EU_{17}	EU_{31}	EU_{40}	AS_7	AS_{43}	SC_3	SC_{47}	PS_{25}	PS_{30}	PS_{48}	RT_{44}	ST_{35}	IC_{21}	OP_{29}	HP_4	AP
1	-2.00	-2.00	-1.80	0.00	-1.26	-0.80	-0.48	-0.60	-0.20	-2.00	-0.04	-0.56	-2.00	0.00	-2.00	-2.00	-2.00	-1.20
2	0.00	0.00	0.40	1.84	1.26	1.22	1.54	1.40	1.78	0.00	1.96	1.46	0.00	2.00	0.00	0.00	0.00	0.87
3	-9.60	-8.63	-7.42	7.17	0.51	0.49	2.78	2.13	5.14	-9.53	7.00	2.54	-9.62	7.51	-8.61	-8.61	-8.61	-1.10
4	-1.71	-1.71	-0.66	6.97	3.93	3.90	5.09	4.63	6.17	-1.63	6.98	4.82	-2.21	7.31	-0.71	-0.71	-0.71	2.34
5	-1.71	-1.71	-0.66	6.97	3.93	3.90	5.09	4.63	6.17	-1.63	6.98	4.82	-2.21	7.31	-0.71	-0.71	-0.71	3.34
6	-1.71	-1.71	-0.66	6.97	3.93	3.90	5.09	4.63	6.17	-1.63	6.98	4.82	-2.21	7.31	-0.71	-0.71	-0.71	3.34

Table 10. Iteration results for $R_{t+1,NS\times T} = C_{t+1} * \omega_{NS\times T}$

Iteration	EM_2	EM_5	EU_{17}	EU_{31}	EU_{40}	AS_7	AS_{43}	SC_3	SC_{47}	PS_{25}	PS_{30}	PS_{48}	RT_{44}	ST_{35}	IC_{21}	OP_{29}	HP_4	AP
1	-1,34	0,67	-0,16	0,02	-0,37	0,23	-0,15	-0,89	0,38	0,53	-0,15	-0,37	0,24	-0,94	-0,72	-1,33	-0,15	-0,26
2	-1,31	3,35	2,23	3,39	1,6	3,81	2,26	0,04	4,11	4,41	2,26	1,6	3,83	-0,11	0,55	-1,31	2,26	1,94
3	-5,43	4,55	3,65	4,67	0,39	5,93	3,71	-2,73	6,83	7,73	3,71	0,39	5,99	-2,63	-1,71	-5,43	3,71	2,95
4	-3,97	4,69	3,94	4,79	0,89	5,84	3,99	-1,27	6,59	7,34	3,99	0,89	5,89	-1,57	-0,25	-3,97	3,99	3,45
5	-3,97	4,69	3,94	4,79	0,89	5,84	3,99	-1,27	6,59	7,34	3,99	0,89	5,89	-1,57	-0,25	-3,97	3,99	3,45

used to evaluate the distance between the values of the variables corresponding to the last rows of Tables 9 and 10. The results are shown in Table 11.

Table 11. Hamming distances

Iteration	EM_2	EM_5	EU_{17}	EU_{31}	EU_{40}	AS_7	AS_{43}	SC_3	SC_{47}	PS_{25}	PS_{30}	PS_{48}	RT_{44}	ST_{35}	IC_{21}	OP_{29}	HP_4	AP
LS*T	-1.71	-1.71	-0.66	6.97	3.93	3.90	5.09	4.63	6.17	-1.63	6.98	4.82	-2.21	7.31	-0.71	-0.71	-0.71	3.34
NS*T	-3.97	4.68	3.93	4.78	0.88	5.83	3.98	-1.26	6.58	7.33	3.98	0.88	5.88	-1.56	-0.24	-3.96	3.98	3.45
Δ	2.26	6.40	4.60	2.20	3.05	1.94	1.10	5.90	0.42	8.96	3.00	3.94	8.10	8.88	0.47	3.26	4.68	0.11

In Table 11, the indicators of why lagging students have a low academic performance can be observed in the difference between non-lagging students and lagging students. The 10 items of greatest distance between the groups ordered from the greatest to the least are:

$$SP_{25} > ST_{35} > RT_{44} > EM_5 > SC_3 > HP_4 > EU_{17} > PS_{48} > OP_{29} > EU_{40} \tag{5}$$

This leads us to the following analysis of each of the five dimensions:

1. Interpersonal. The differences in the variances of the empathy factor for the group of non-lagging students and the group of lagging students reveals the influence of emotional intelligence and the differences in how they perceive, understand, and manage

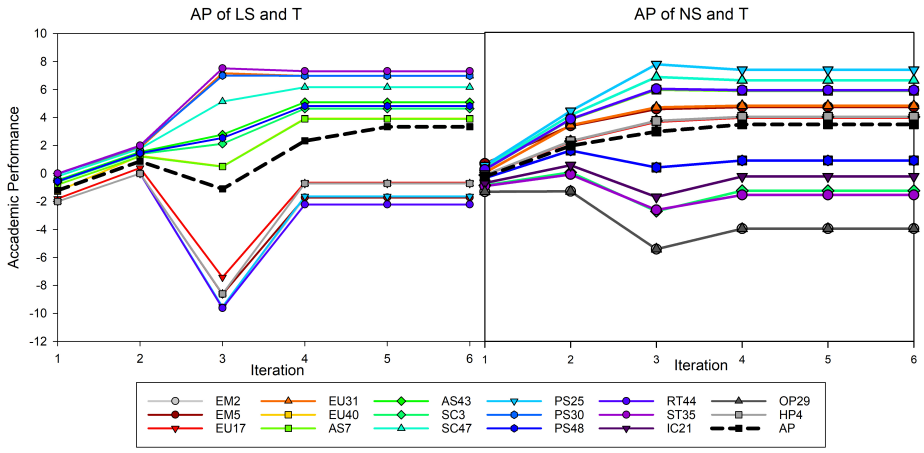

Fig. 1. Results for lagging students (LS) versus teachers (T) and non-lagging students (NS) versus teachers

their emotions. The variability between these groups implies different ways of perceiving, understanding and managing the emotions of others, represented in adaptation and social relationships ([38], [20], [37],[50]). Psychological support can influence lagging students' emotional intelligence, enabling them to cope with their feelings and emotions without it causing them any embarrassment.

2. Intrapersonal. The significant differences in self-concept between non-lagging students and lagging students is evident in item EM_5 "They care about what happens to people when facing changes". This is in line with [9] and [22], since social behaviour has an impact on self-concept and prosocial behaviour relationships in academic and family environments ([27]). High levels of self-concept ([48], [11], [26]) and social respect [60] imply defensive behaviours of a victim who has been attacked and justify procrastination in completing required activities.In this case, support for lagging students would be adequate since it would improve their abilities to perceive, understand and appreciate the feelings of others. For example, problems of empathy can be improved by forming a group of students from socially marginalized communities and supporting them in their emotional needs.
3. Adaptability. The differences between the non-lagging students and lagging students are significant and the items with the greatest Hamming differences are: PS_{25} "they don't give up until they've solved a problem"; PS_{48} "good at solving difficult things"; and RT_{44} "try to think of many possible solutions". As in [34], students from both groups do not react with the same intensity to the stimuli that university generates. Many adapt quickly, but there are others who do not, and they risk not fulfilling their academic goals. If university students adapt rapidly, this enables them to succeed academically, otherwise they are faced with overload generated by the activities themselves and demand. These potential problems trigger an inability to do the activities and tasks required, which causes stress and a negative attitude, giving rise to physical exhaustion and a low competence level ([5]). Without an appropriate adaptation their performance is compromised, resulting in abandonment, remaining longer

at university, and low completion efficiency ([53]).Support in mathematical reasoning could help any student; therefore, extracurricular courses are recommended as they will enable students to identify, define and put into practice effective solutions.

4. Stress management. The differences between non-lagging students and lagging students are expressed by the second greatest Hamming distance in the item "They easily get upset" (ST_{35}). Academic stress in university students is apparent in alarm, resistance and exhaustion ([52]). In the analysis between the groups, we can appreciate notable differences in how they value stress management. In this line, numerous studies have identified some prevailing elements, such as academic overload and evaluation, which are elements that generate stress and in the most critical cases lead to school abandonment ([45] ; [51]). The strategies oriented towards cognitive and behavioural efforts to resolve specific internal and external demands constantly change from first and second order. They are regarded as exacting or excessive for a person's resources ([16]) and are known as coping or stress management. To confirm whether a student is stressed or not, it is necessary to look into what worries them at that moment and if there are other types of symptoms. In line with [3], one indicator that a student is stressed is associated to unclear symptoms of illness: mental block, sleeping disorders, headaches, chronic fatigue, digestion problems, etc. Psychological support is fundamental for lagging students to be able to confront any adverse event in their life. Although there are a large number of stressful situations caused by school dynamics, stress management should be well oriented so that their health is not affected and strong emotions can be managed without incapacitating students, which will allow them to cope with them actively and positively.
5. State of mood. Item OP_{29} "feel confident about meeting goals" is another difference between the two groups, although according to the Hamming distance, it is weaker than the others discussed above. Despite this, it does have an impact on academic performance since negative results due to internal and external causes increase vulnerability to depression ([49], [14], [57]). Strategies directed at generating positive attitudes within school life are associated with motivation. For example, promoting cultural and sports events can generate positive optimism through the presence of other schoolmates, whereby their internal and external satisfaction is consolidated.

4. Conclusions

The analysed indicators included in the five cognitive dimensions (interpersonal, intrapersonal, adaptability, stress management and state of mind) are shown to influence students' academic outcome to a greater or lesser extent according to the rotated component matrix in the factor analysis. The expert assignment matrix is formed with the rotated component matrix, and along with the use of fuzzy cognitive maps and Hamming distance it is possible to obtain the critical variables that affect lagging students perfomance: problem solving, stress tolerance, reality testing, empathy, self-concept, happiness, emotional understanding, optimism.The values from the assignment matrices (weights) indicate the level of causality between cognitive-emotional variables. A positive value between empathy and happiness indicates that an increase in the first one causes the second to increase, and vice-versa. In this respect, different authors agree that state of mood and stress tolerance have a strong relation with academic performance ([21],[28], [31], [13], [39], [43]). Evidently, these two cognitive dimensions affect the others and academic performance.

On observing the greatest differences between lagging students and non-lagging students with respect to the cognitive elements, the greatest difference corresponds to: problem solving - "they don't give up until they've solved it; the next is associated with stress tolerance - "easily get upset"; this is followed by "try to think about many possible solutions" associated with reality testing; and "they understand people when there are changes" which is associated with empathy; then self-concept - "keep calm when they are upset about changes"; and lastly, associated with state of mind - "feel happy about the new challenges that face them at this time". The combinations of all these cognitive elements do not seem to synchronize with academic performance in lagging students, which remains in a first order state, while non-lagging students can synchronize this without any problem, thereby enabling an individual's transformation and second order change.

In summary, it can be asserted that lagging students have difficulties in problem solving; therefore, providing extracurricular courses to reinforce mathematical techniques will allow students to identify, define, and put into practice effective solutions. With respect to emotional problems, given that teachers and tutors are not trained to directly influence students' emotional intelligence, they should be dealt with through therapies which would allow students to understand their own feelings. Finally, the promotion of cultural and sports activities generate an atmosphere of positive optimism, facilitating interpersonal relations, strenghtening empathy and ultimately improving their happiness substantially.

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Received: February 13, 2023; Accepted: September 30, 2023.