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Resilience in successful math and physics students

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Abstract. Resilience refers to the student's ability to overcome emotional periods caused by adverse situations. In this sense, research aims to evaluate the relationship between academic performance in mathematics and physics and school success in higher education students. The research is framed within a quantitative, descriptive-comparative and micro-sociological methodological approach developed with data from primary sources. Data collection was transectional and the sample was 1500 students. The Wagnild and Young resilience scale was used. The results show that there is an important relationship between the level of demand, the application of mathematics and physics, abstraction and academic performance. Students develop emotional resilience skills that allow them to improve their quality of life. In conclusion, resilience is significantly related to all strengths of character, as well as to positive acceptance of change and personal competence. It was identified that, while resilience helps students to be more tolerant and to better understand what is happening in their environment, it is precisely in these challenges that the strengths of high educational performance are manifested. Successful students demonstrate skills in formal thinking, creative thinking, applying mathematics, physics and resilience, all of which impact on their quality of life.

1. Introduction

This research is presented as a response in the educational field, to the diverse situations that are presented today in relation to socio-emotional interaction between students who excel in mathematics and physics and their classmates. The assessment of the resilience of these students in the face of adverse phenomena allows us to establish strategies for teaching these two disciplines, which complement each other since mathematical models can explain physical behavior and vice versa, while at the same time we can take advantage of the skills of these students to generate working environments in the groups that lead to improving the meaningful learning of mathematics and physics; likewise, the processes of teaching and learning mathematics and physics can be employed through various pedagogical strategies in which students, without being aware, strengthen the values in the actions implemented by teachers.

Physics and mathematics constitute a body of knowledge with internal logic and laws that serve to characterize in a uniform and rational way the natural phenomena that man encounters in his daily life. It should be noted that the learning of mathematics and physics has always been related to that emotional state of mind in which the student finds himself, hence the interest of teachers of these sciences in seeking to change this and at the same time lead to academic improvement which in search of good results are created elements or strategic actions that help to achieve this purpose and for this research proposes the following study [1,2].

Success at school is a notion that has undergone changes in accordance with the evolution of pedagogical currents, since "from a humanist approach, academic performance is the product that students give in schools and that is usually expressed through school grades" [3]. The most visible aspect

of performance tends to be the grades, which is why it is usually analyzed from two approaches: the quantitative one that has behavioral and cognitivist nuances, or the qualitative one, in which the learning styles, predispositions and personal characteristics of the student are identified. It has a more humane outlook. In the context of research, performance is recognized as influenced by social factors, a theoretical line to be developed, as they identify other elements responsible for driving and shaping their development in classrooms. In this sense we do not want to see the student as an isolated entity that self-determines itself, but as the result of a series of stimuli originated in "the diversity of factors that influence performance, further specifying that it depends not only on intellectual aptitudes, but on a series of interrelated factors, both internal and external to the student" [4].

Interrelationship is presented as the key to analyzing performance because it allows us to see how the different aspects linked to the educational experience are put in common and lead to the identification of the main elements that determine the context of an institution and a specific group. On the one hand, behaviorism emphasizes that "there is learning when there is a behavioral change; as observable and identifiable behavior" [5] while cognitivism focuses on the elements that produce cognitive functions in the brain: ideas, thoughts, plans, memory, learning capacity intervene in them [6]. In this sense, all human beings are exposed to painful, stressful, difficult situations in life, some people collapse and become unbalanced, others transform their weaknesses, assume their potential and are even airy and strengthened by those same circumstances. Different researchers have analyzed and proven the link that exists between school success and personal motivation, some authors specify its multidimensional nature where affective and cognitive variables come into play, which in their interaction contribute to form the student's valuation of himself and his environment [6,7]. Recognizing its complexity has generated guides and classifications, such as the one formulated by Covington [8] in his model of self-evaluation, in which he identifies students oriented toward mastery, where performance and motivation are his main interests, there are also those who avoid failure and therefore do not participate in school life, in addition to those who accept failure, who assume a defeatist attitude and low effort [9]. However, none of these decisions is the result of a homogeneous environment.

Another important factor in the student's school performance is motivation, which is a general process by which behavior is initiated and directed toward the achievement of a goal. Thus, motivating students implies fostering their internal resources, their sense of competence, self-esteem, autonomy, and achievement. The need to approach academic success according to its different factors and how they are articulated mainly under an emotional logic, with the capacity to "mediatize the capacity to adapt and respond to a variety of experiences. They prepare the organism to respond quickly to the threats of the surrounding world. Social psychologists also argue that human emotions are fundamental to attachment, interaction, and social function [10]. Recognizing the role of emotions is presented as an invaluable starting point for this research project because it allows academic performance to be correlated with a number of factors that are often ignored and sometimes thought to have no theoretical/scientific basis.

Wagnild and Young propose a scale of 25 items, between 25 and 175 points around resilience [11], understanding it as the positive trait of personality that allows subjects to adapt to the adversities of life [12], facing them with courage and thus reducing the harmful effect of stress [7]. Resilience results from protective factors such as consistent self-esteem, introspection, independence, ability to relate, initiative, humor, creativity, morality and critical thinking [13]. In Edith Grotberg's perspective these sources can be classified into 3 categories: (i) those that have to do with the support that the person thinks he can receive (I have...) (ii) those that have to do with the person's intrapsychic strengths and internal conditions [14] (I am..., I am) and (iii) those that have to do with the person's abilities to relate to and solve problems (I can...).) For its part, Saavedra [15] develops an emerging model from the case study where it points out that (i), the resilient response is an action oriented to goals, sustained response or linked to (ii) an approachable Vision of the problem; as recurrent behavior in (iii) self-vision, characterized by affective elements and positive cognitive or proactive before the problems; which have as structural historical condition 4) base conditions, that is to say a system of beliefs and social bonds

that impregnate the basic security memory and that in a recursive way interprets the specific action and the results.

Within the psychosocial field, psychological factors are differentiated from social and cultural factors in order to define in the former the relevance of the space or place of study, the organization of collective and personal time, as well as the study techniques employed. As for the second group, it establishes the social class, the climate of coexistence and the family influence.

2. Method

The study is framed in the mixed approach of quantitative character, descriptive-comparative, according to the characteristics of the object of study and the context in which it is developed, together with the methodological perspective adopted for its study, of primary data source, referring to the quantitative approach is descriptive, transactional, followed the correlational method [10]. Regarding the qualitative approach, the investigation is based on the ethnographic method, micro sociological which allows to approach the problem of the study from three perspectives, all of great utility, since as approach it allows to understand the situations at the time of considering the point of view of the people involved, while as method it motivates to go to the field where the events occur and as text, allows for a textual description of findings and behaviors [16], addresses the nature of the problem, the personal experiences of the main actors, their attitudes and practices, as well as the characteristics of the context in which it occurs, within which the basic instruments for better analysis and interpretation are nested. All this to guarantee confidence in the results as a faithful representation of what happens with the phenomenon studied. From a holistic perspective, to see the scenario and the people not reduced to variables, but considered as an integral whole, which obeys a logic of organization of the institution, functioning and meaning to understand the events from the multiple interactions that characterize it and naturalistic, focusing on the internal logic of the reality that it analyzes.

The research has a type of sequential design with a group of 1500 students studying first to fourth semester in institutions of higher education in Norte de Santander, Colombia. The material used in the research comes from the choice and application of the instrument called Wagnild and Young's resilience scale (RS) [17,18], a self-administered questionnaire that is developed around 2 factors: (17 items) Personal competence: self-confidence, independence, decision, invincibility, power, ingenuity and perseverance. (8 items) acceptance of self and life: adaptability, flexibility, balance and perspective of stable life represented in 5 areas of resilience: personal satisfaction (4 items), feeling good alone (3 items), self-confidence (7 items), equanimity (4 items), perseverance (7 items) with corrected item-test correlation coefficients or discrimination index (ID) through the Pearson correlation coefficient (between 0.61 and 0.89), the results of the global alpha coefficient (reliability level of 0.8), and the proportion of variation of the factors. Finally, the triangulation of the findings obtained through the different collection techniques was proposed.

3. Results

The results of the research refer to the application of the techniques and instruments defined in the methodological design of the project: the Davis test [19], the interview and the non-participating observation. The Davis test comprises a series of items divided into four subcategories whose purpose is to assess empathic disposition. The subcategories perspective, personal suffering and fantasy and identification present a normal valuation, whereas the subcategory empathic concern, presents a high valuation. The following are the answers that evidence the level of identification manifested by the students in front of specific situations and ideas.

In the subcategory perspective taking, 49% find it easy to see things from another point of view 49% easy, 96% say they try to take into account different opinions in a conflict before making decisions, 93% try to understand friends by imagining how they see things, 68% say that if they are sure I am right about something I don't waste time listening to others' arguments, 86% think there are two sides to every issue and I try to take into account both, 68% say that when they are upset with someone they usually try to

put me in their place for a moment and 83% before criticizing someone try to imagine how I would feel if I were in their place.

In the subcategory empathic concern, 88% say that they often have tender and caring feelings, 60% sometimes feel very worried about the problems of others, 88% tend to protect someone who is being teased, 71% are not bothered by the misfortunes of others, 82% feel compassion when they see someone who is being treated unfairly 65% describe themselves as quite sensitive. In the personal suffering subcategory, only 38% feel aggressive and uncomfortable in emergency situations, 50% normally feel hopeless when in the middle of a very emotional situation, 88% tend to remain calm when they see someone who is injured, 60% are frightened when they are in an emotionally tense situation, 80% consider themselves quite effective in dealing with emergencies, and only 33% manifest a breakdown when they see someone who urgently needs help in an emergency.

In the subcategory fantasy and identification 85% say they dream and fantasize with some regularity, 45% identify with the feelings of the characters in a novel, 75% say they are usually objective when watching a movie or play and often don't get completely involved, 43% say they find it rare to get completely involved in a good book or movie, 65% have felt as if they were one of the characters after watching a play or movie, 76% can easily put themselves in the protagonist's place when watching a movie, and 68% imagine how they would feel if the events in the story happened to them when they are reading an interesting story or novel.

When comparing the test results with the academic results of the students and the interview categories, it can be inferred that the academic success in mathematics and physics of the young people is associated with motivational categories influenced from the family; psychological or social from classmates and close people and culture as a conditioner of the climate of coexistence, empathy, self-esteem, and social class emerges as a factor in private institutions. Under this point of view, the student is not an isolated presence but the sum of different influences that lead him to behave in a certain way and to choose certain priorities. The different factors identified remain related and are expressed daily, to the importance of people believing in what is promised, positive acceptance of change, personal competence, control and spirituality. These factors explain 5.39% of the total variability of the data.

The internal consistency of the factors was carried out using Cronbach's alpha model, obtaining total scale of resilience 0.87, for the subscale's positive acceptance of the change 0.86, personal competence 0.82, control 0.72 and spirituality 0.32. On the other hand, the results of the resilience test indicate that lower scores are given in points 6 ("in emergency situations, I feel aggressive and uncomfortable"), 24 ("I tend to lose control during emergencies") and 27 ("When I see someone who needs urgent help in an emergency, I fall apart"), where point 6 recorded an average of two (2) which corresponds to the subscale of personal suffering, point 24 on the other hand had an average of 2 also of the subscale of personal suffering, while point 27 reached an average of 2.07, is part of the same scale mentioned above. While the items with the highest scores were 8 ("I try to take into account each of the parties (opinions) in a disagreement (conflict) before making a decision") and 18 ("when I see someone being treated unfairly, I sometimes feel no compassion for him"), since item 8 recorded an average of 4.32 in the perspective-taking subscale and item 18 had an average of 4.15, this is part of the empathic concern subscale.

The results corresponding to the four subscales evaluated show that the highest score is associated with resilience with respect to the life project dimension and positive acceptance of change (27/high), while the lowest score was recorded in the dimension trust in god to support the other. In general, the dimensions gave a normal assessment, only the resilience dimension is at the high level. As for the four main subcategories established by the instrument: cognitive empathy, formed by the subscales of perspective and fantasy, a consistent willingness has been found among students to put themselves in the other's place and feel identified by the experiences they consume through the media or entertainment. F to the subcategory of affective empathy that involves the subscales of worry and suffering reflects a lesser willingness to feel uncomfortable or anxious with the bad experiences that their peers may experience, especially when they directly observe situations of stress or conflict. In general terms in the reagents a normality is established in terms of the total resilience of 90 in ages between 17 and 21 years

and the emotional empathy of 41 of a possible ideal score of 70, revealing a high cognitive and affective category, reason that leads to establish a normality in the global measure of empathy with an average score of 83.9 as opposed to a possible score of 40.

In total resilience no significant differences were observed for all the strengths with probabilities between P (0.15) and P (0.13), for the total resilience scale. The control subscale did not present significant differences in the average values of the strengths humility and spirituality, however, significant differences were observed for the rest of the strengths with probabilities between P (0000) and P (0.034), for the group with higher score they were statistically inferior to those of the group ≥13.87 points. On the other hand, there is a moderate correlation between self-esteem factor and altruism factor (r = 0.69 / p<0.01) and family factor (r = 0.710 / p<0.01) and a low but significant relationship with filiation factor (r=0.352/p<.01). Moderate correlations in interest motivation, effort motivation (r = 0.66 / p<0.01) and task motivation factor (r = 0.61 / p<0.01). The greater the interest, the greater its capacity. As long as the student is accepted, he is motivated, he is positively influenced. Low correlations between personal security with family (r = 0.279 / p<0.01), self-esteem (r = 0.37 / p<0.01) and altruism (r = 0.301 / p<0.01).

4. Discussion

In authors of social psychology such as Mattelart [12], heir to a long tradition of theorists such as Doob and Allport, it is considered that the attitude is responsible for leading the behavior, in some cases congruent relationships are established, while in others considerable differences are identified as to what someone believes and what he ends up doing once he is immersed in a certain social situation. Successful students present normal to high scores on all assessed strengths. The self-perceived strength with the highest value is hope followed by gratitude, kindness, honesty and fairness, representing the top five in students. The strengths with the lowest mean scores correspond to; self-regulation, prudence. A multiplicity of individual characters is observed in the profile of strengths, since each subject develops them according to his or her personal history and relationship with the environment, so necessarily the context and the socio-demographic characteristics of each must be taken into account.

The first reveals how empathic concern can be a source of tension and suffering for students, who describe that when they see their classmates affected by a conflict or problem, they feel uncomfortable and do not know how to respond. Adapting to unforeseen situations (factor 1), possessing a positive vision of the future, and flexible to adapt to new situations (factor 2), with capacity to promote their own well-being, with abilities to act according to what they have decided to do with their lives (factor 3) with positive influences in family life and associated with it spiritually (factor 4). The two dimensions that stand out largely dictate the behaviors of students who share conflicting positions, since some of them have not felt deceived or excluded, while others stand out among their comments that mess with me when I remind them of the quiz teachers, the exams also emphasize that one receives reproaches when something goes wrong and gets a bad grade (E-102), "when I ask in class" (E-058).

In general, school success has a multidimensional nature in which cognitive and emotional elements participate [7], in this sense students shape their disposition and behavior according to their acceptance of the academic environment [20]. Faced with this, it is observed that students have doubts since students with normal or poor performance tend to feel more comfortable in school, while those with excellent performance are those who are more critical about how they should edit their personality and behaviors to please, (E-890) "we are indifferent to negative comments or congratulations, we focus on learning more and more" (E-457), "I like it to go well, I pay no attention to anything" (E-367), "I participate indifferent to what others think" (E-901).

The results indicate that it is the younger students who have the highest levels of total resilience, positive acceptance of change, and control. However, fourth semester students take on the challenge of initiating actions, requesting inventiveness, linking to projects, talking to teachers, implementing all their capacities as human beings, adapting to changes, assuming responsibilities, and using social, moral, and spiritual resources for successful development in their new lives [21]. On the other hand, those who have problems with grades are the most expressive and tend to have no more friends of two friends.

Another of the behaviors observed in coexistence is the superiority or egocentrism with which students can respond when disturbed by their peers, in this line expressed that "I like to know more than others and always understand what is happening" (E-021).

The responsibility for their good performance also generates a social pressure in which their difficulties in some areas such as physical or artistic education stimulate negative comments in the other students of the group, when they are judged they are withdrawn, they close more and more to their closest social circle, formed by one or two and they increase one of their characteristic behaviors, the triumphant and stable, since they do not like changes and reflect great distrust. The oscillation between the outstanding dimensions of suffering and perspective reveals, among other things, that these young people are still in a crucial stage to form their social personality, in that sense, although their basic impulses instigate them to care or help, they do not know how to stop feeling overwhelmed and choose not to risk, pretend disinterest or simple indifference towards the subject.

5. Conclusions

Factors associated with building resilience in university students were positive acceptance of change, personal competence, control, spirituality, generated from factor analysis. Younger and once graded students show significantly higher values in total resilience, as well as in the subscale positive acceptance of change.

Resilience is significantly related to all character strengths, as well as positive acceptance of change, personal competence except prudence. Research identifies that while resilience helps them to be more tolerant and better understand what is going on in the environment, external behaviors move them away from their focus, values, and personality. It is precisely in these challenges where the strengths that provide them with high educational performance are manifested.

Successful students have normal to high resilience, have differences in their achievement motivation, interest and effort based on the average, their inner self and generate it through their effort, those who study in vulnerable environments, have characteristics that help them to live and cope with their living conditions.

Successful students in mathematics and physics demonstrate skills of formal thinking, creative thinking, application of mathematics, physics and resilience that affect the quality of life, each student recognizes and uses their strengths and capabilities developed, accepting the need to cultivate the less obvious in their common behavior.

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