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The use of Similarity Structure Analysis in the identification of students' functional profiles of competence – A study with Portuguese elementary school students

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Abstract: This study aims to identify students' functional profiles - describing the representational functions available to consolidate certain school competences, in a sample of 670 students of Portuguese Basic Schools, in which 58,3% were girls and 41,7% were boys (33,6% from 1st level, 36,0% from 2nd level and 30,4% from 3rd level). Four instruments were used: Questionnaire of the Attitudes Towards School, Questionnaire of the Attitudes Towards Portuguese Language, Questionnaire of the Attitudes Towards Mathematics and EQi-yv. Based on the SSA the polar structure observed, combined with the relative position of the external variable, it is possible to suggest the existence of differentiated profiles considering personal and scholarly features that become more efficient with school progress, pointing out the necessity to consider these variables independently when school policy decisions are taken. The advantages of these techniques to improve the characterization and interpretation of the complexity and multidimensionality of students´ profiles and their consequences for educational and psychological assessment and intervention are discussed.

1. Introduction

Once at school, there are a set of competencies that pupils need to enhance to succeed in school and society. Those competencies are knowledge, skills and attitudes that help people to gain personal fulfilment, employability and enable them to take part in society. These include the 'traditional' competencies like mother

tongue, foreign languages, basic competences in math and science, and digital competence, but also the more 'transversal' ones such as learning to learn, social and civic competence, initiative-taking and entrepreneurship, and cultural awareness and expression (European Commission, 2013).

Teaching and learning in schools have strong social, emotional, and academic components. In one hand, emotions can facilitate or impede children's academic engagement, work ethic, commitment, and ultimate school success. Many students lack social-emotional competencies and become less connected to school as they progress from elementary to middle to high school, and this lack of connection negatively affects their academic performance, behaviour, and school engagement (Durlak, Weissberg, Dymnicki, Taylor & Schellinger, 2011). On the other hand, student's attitude towards a course is important because it affects the entire learning process. A positive attitude enables students to develop thinking skills on the subject, to apply knowledge acquired in everyday life, and to have an enjoyable experience throughout the course. Attitude is an individual way of thinking and act on a phenomenon. Positive attitude allows individuals to achieve excellence in the field of undertaking. Conversely, a negative attitude causes someone to feel depressed in the task given and not to progress. Attitude is an important element to be addressed by course instructors. However, negative attitudes such as feeling too tired to study the subject, incapacity to appreciate the subject or inability to focus in class, tend to interfere with class progress and lead to absenteeism (Judi, Ashaari, Mohamed & Wook, 2011).

The complexity progressively assumed in many studies on emotions and attitudes towards school and school learning has been calling for the need for a multidimensional look more at the interaction between the variables that explain it. The need merge the understanding of these variables and respective interactions with the understanding of its manifestations in individuals and to identify possible patterns of expression led to a resurgence of the interest in studies of profiles (Candeias & Rebelo, 2012). As referred to by González, Solano and González (2008), the differential profile analysis allow us to identify domain-specific skills that are best associated with emotional reactions, behaviour and performance in school, opening a promising field because it enable the identification of predictors of behavior and academic performance.

2. Functional Profile

Although it is well known that there are developmental differences between boys and girls, how these differences manifest themselves in the several subjects of the school curriculum is not well explored (Yeung, Lau & Nie, 2011). According to Antão and Veiga-Branco (2012) the study of the relevance of the students'

functional profiles, regarding the expression of emotions and attitudes that justify their behaviour, should now meet other components, as sex and its manifestations in emotional competency profile, which allows the researcher to think about their relations with the motivation and learning.

Profile is understood as a set of resources that can be combined to produce certain complex behaviours. The profile may diversify as we assign more importance to the description of the resources or to the resulting behaviours. What gives meaning to the profile is the combination of elements, their interactions and complexity (Castelló, 2008). As stated by this author, the type of profile that we can evaluate is the functional profile, from which we make indirect estimates based on indirect basic resources. We should not fall into the bias of passing directly from the functional equipment of one person to the field of his/her competences. Competence implies greater complexity and demands the interaction of multiple affective, cognitive and behavioural features. Therefore, a functional profile describes the representational functions available (which, until then, were built), many of them needed or essential - so that students can consolidate certain skills.

In order to understand how students develop, improve, or change, it is important to characterize the students' profiles with regard to their attitudes towards school and the school subjects, right from its beginnings and the evolution over the school years. It is also important because these beliefs will, in part, become the basis on which students interpret the academic experiences (Eccles, 1994). When perceptions of competence are negative and the attitudes become consolidated, it becomes increasingly difficult to reverse the negative perception that students have of themselves and of the school (Valeski & Stipek, 2001). On the other hand, positive attitudes and efficacy beliefs about school appear as protective factors to students at risk of school failure or students whose families have supplies (Baker; Pianta, apud Valeski & Stipek, 2001).

Thus, we analysed the difference in the students' profiles of attitudes and emotional intelligence along the school levels, previous data suggesting that as the child grows, his/her auto perceptions may differ according to the re-evaluation they made of his/her own competencies, which assessment tends to made according to specific subjects (Marsh, Craven & Debus, apud Yeung et al., 2011). Indeed, children tend to ground their perceptions of competence in unrealistic expectations and so assess those selves as more competent, but while growing up youths ground their perceptions of competence in real academic performance, leading to the decrease of self-perception of competence in later ages (Yeung et al., 2011).

Analysing the relationships between attitudes, levels of motivation, affections, perception of academic competence and emotional intelligence, and using a model of students interactions, we may see how these variables act together in different levels, shaping the way pupils see themselves in the school environment, by defining their attitudinal and emotional profile.

The study proposed in this paper aims to contribute to filling this gap by mapping, analysing and characterizing the functional profile of attitudes towards school and the disciplines of Portuguese language and mathematics, and emotional intelligence of students attending Portuguese basic schools. We aim to explain how attitudes and emotional intelligence assessment may contribute to understand students' functional profile.

3. Attitudes

According to Legendre (cit. by LaFortune & Saint-Pierre, 2001, pp. 30-31) an attitude "is a state of mind, an acquired inner disposition concerning himself or any element of the surrounding environment that encourages a way of being or acting, favourable or unfavourable". To Morissette and Gingras (1999) an attitude is "an inner disposition of the person which results into moderate emotional reactions that are assimilated and then experienced when a person is brought before an object; these emotional reactions lead in approaching the object (be positive) or away from (being negative)" (p. 31).

Knowing students' attitudes allow to access to their evaluations about the school and the main school subjects, which will allow the development of curricular and extracurricular activities that take into account their attitudes, interests and aspirations (Candeias, Rebelo & Oliveira, 2012). The knowledge of the emotional component of attitudes will, at the level of intervention, work students' emotions towards school and school subjects, facilitating the change of negative attitudes and strengthen positive attitudes.

a) Attitudes Toward School (ATS)

The interest in students' attitudes towards school results, in part, because it is there that children and adolescents spend much of their time and where they live a significant number of their social experiences. Attitudes are also important for their relationship to educational participation, including the intention to continue studies after finishing compulsory education (Attwood & Croll, 2011). Knowing the attitudes expressed by the students toward school and school subjects is important, not only, for creating adjusted educational policies, but it is also an indicator of school quality.

The way students behave in school, their relationships with peers and teachers and the investment they make in extracurricular activities and academic aspects are heavily influenced by the attitudes that they demonstrate towards school (Hauser-Cram, Durand & Warfield, 2007).

b) Attitudes Toward Portuguese Language (ATPL)

Portuguese language is a very important subject of the Portuguese educational curriculum, because besides its unique character, is a multidisciplinary subject that underpins the acquisitions to be made in other disciplines (Antunes & Monteiro, 2008). But even with this importance, little is known about the interaction between the attitudes of students and their performance and motivation to study this subject.

International studies for reading and writing reveal that girls get higher scores for reading than boys and girls have attitudes toward reading more positive than their male classmates, and this is another indicator that attitudes are related to performance (PIRLS, 2001). Other studies cited by Archambault and colleagues (2010) show that over time girls value more literacy activities and consequently report more confidence in their literacy skills than boys.

c) Attitudes Toward Mathematic (ATM)

Mathematics is a transversal knowledge, imperative in modern societies because of its unprecedented technological development, but the reality shows it as one of the most inaccessible subjects to many students (González-Pienda et al., 2007).

One possible definition of attitudes towards mathematics considers them as "a set of beliefs and affective orientations related to mathematics, such as anxiety towards mathematics, mathematical gender stereotypes, self-concept and mathematical expectations of success and failure in mathematics" (Gunderson et al., 2012, p. 153). Also, the authors note that these attitudes play a key role in math performance, the choice of courses related to mathematics and pursuit of careers related to this discipline. The willingness of students to study mathematics is related to attitudes, emotions and beliefs that the student uses to benefit, or avoid, the mathematical literacy that has already reached (PISA, 2012).

3.1. Emotional Intelligence (EI)

In recent years, the role of emotions in learning has attracted much more attention (e.g., Pekrun, Goetz, Titz & Perry, 2002a,b), because of the influence of positive attitudes or because of the negative ones. These interactions are particularly important in the self-regulation of learning, where students are often required to face negative information about themselves and their capabilities, as happens in test situations (Ruthig et al.; Maidment & Crisp, cit. by Antão & Veiga-Branco, 2012; Efklides & Petkaki, 2005).

Bar-On (1997) defines emotional intelligence as "*an array of non-cognitive capabilities, competences and skills that influence one's ability to succeed in*

coping with environmental demands and pressures" (p.14). This definition seeks to address the dimensions of emotional, personal, social and survival of intelligence that, according to the author, are often more important for daily functioning than the more traditional and cognitive aspects of intelligence. The Bar-On model of emotional intelligence (2000) considers socioemocional intelligence as a section of the interaction between social and emotional skills, capabilities and facilitators that determine how an individual effectively understand and express his/her self, understand others and relate with them and how he/she deal with daily issues (Bar-On, 2006). It represents a break with the more cognitive knowledge and seeks to understand which are the social and emotional factors that lead an individual to improve his/her psychological well-being.

The component of EI that seems to be particularly important in the school context is emotional regulation, once students who can regulate their emotions are more competent to manage stress. Also, to be able to perceive and understand emotions makes it easier for students to build the task and maintain social support because academic success is not only about having good grades, is also to establish collaborative relationships in group work (Lopes, Salovey & Straus, cit. by MacCann, Fogarty, Zeidner & Roberts, 2011). Students who can self-regulate their emotions experience less negative emotions associated with evaluation and some of them can even generate positive emotions that facilitate performance (Pekrun et al., cit. by MacCann et al., 2011).

In another perspective of the school context, the EI contributes to increase motivation, to facilitate planning and decision making, which in turn positively influence academic performance (Lam & Kirby, Salovey et al., cit. by Downey, Mountstephen, Lloyd, Stough & Hansen, 2008). While it's well recognized the importance of EI for school and professional performance, it is known that its importance varies depending on the academic or professional fields, that is, depending on the subject in study, the EI components that acquire more importance are different (Boyatzis, Goleman & Rhee, cit. by Castejón, Cantero & Pérez, 2008).

Results from several studies pointed that EI moderates the relationship between IQ and academic performance (Downey et al., 2008), for example, and has a stronger relationship with English than with mathematics or the sciences (Petrides & Furnham, cit. by Jordan, McRorie & Ewing, 2010). Jordan and colleagues (2010) found positive correlations between overall performance and adaptability and negative correlations between performance and stress management; when they analysed the sample by subjects, found positive relationships between mathematics and adaptability. These data suggest the need to consider the subscales of EI and disciplines separately when studying the relationship between EI and academic performance. Other studies show a moderate association between the EQ-i results and students' grades, particularly in groups of high, medium and low academic

success, which means that academic success, is strongly related to the different dimensions of EI (Parker et al., cit. by Downey et al., 2008).

4. Study of Attitudinal and emotional profiles - The Facet Theory and SSA Analyse

In order to study the functional profiles of attitudes and emotional intelligence we used the Louis Guttman's Similarity Structure Analysis (SSA; a nonmetric Multidimensional Scaling - MDS procedure), a data analysis technique that display the structure of distance-like data (our variables under study) as a geometrical picture. The use of this technique, based on Facet Theory, allows formulating a cumulative explanation for the profile; every facet specifies a type of variable under study and by its location on the map of SSA is studied the conceptual relationship between them. The facet theory is useful because allows studying the experience of the individual within the world without sacrificing its complex and multidimensional nature, that is, breaks with traditional techniques which study behavior in an isolated and compartmentalized way (Roazzi & Dias, 2001).

The Multidimensional Scaling is an exploratory multivariate technique that allows to represent parsimoniously, in a reduced dimensional system, the proximities (similarities/dissimilarities) between subjects or objects, from a set of multivariate attributes measured or perceived (Moreira, 2009).

The Similarity Structure Analysis identifies relationships between variables, as factor analysis and cluster analysis do, but this is a non-metric technique (Bilsky, 2003), and so is free of assumptions, that is, it is not necessary that the data follow a normal distribution and are homogeneous (Moreira, 2009). On SSA the similarities or dissimilarities are reflected in proximities and distances between points, in order to group together in multidimensional space the similar variables and set aside the different variables (Bilsky, 2003). This type of analysis allows transforming psychological distances in Euclidean distances in the form of space-geometric representations, based on similarity judgments, meaning, and is rendered a correlation matrix between n variables in Euclidean space (Roazzi & Dias, 2001). The points in the multidimensional space mark the distance of each variable in relation to all other variables. It is assumed that the geometric distances correspond to the real psychological phenomenon under study (Nascimento, Roazzi, Castellan & Rabelo, 2008). The higher the correlation between two variables, the closer they will appear on the projection and vice versa forming regions of continuity or discontinuity which represent the correlations between the items (Roazzi & Dias, 2001).

This technique also enables the study of the external variables and these relationships with the founded dimensions, by using the technique of external

variables as points. Thus, it is possible to position spatially variables, as sex or study cycle in the structure of the facets founded with the SSA without changing the internal structure of the profile.

Thus, in this investigation our aim was to examine whether distinct student profiles would emerge from different attitudinal and emotional variables in a sample of Portuguese students. Additionally, profile differences in self-reported attitudes and emotional intelligence were examined, as well as changes in student profiles over academic levels. Within any community of learners, there probably exist subgroups that share similar attitudinal and emotional patterns. Uncovering such subgroups within the same school year and understanding what characterize them with respect to other personal aspects may give us knowledge that is important not only for theory building but also for educational practice.

5. Method

5.1. Sample

The sample consisted of 670 students from Portuguese basic schools, who were in the first, second and third levels. The sample included 392 females and 278 males, ranging in age from 8 to 17 years, with an overall median age of 11.0 years at the outset of the study. From this sample, 224 students are from de first level, 242 are from the second level and 204 students are from the third level.

5.2. Instruments

5.2.1 Questionnaire of Attitudes Toward School (QATS)

The QATS (Candeias & Rebelo, 2011, original version of Candeias, 1997, 2005) measures the attitudes of students towards school on three factors: Learning, Motivation and Competence. The questionnaire consists of 24 items to which students respond in a Likert-type scale of 4 points (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree), arranged in the factors: Learning and motivation, Competence, and time management.

5.2.2 Questionnaire of Attitudes Toward Portuguese Language (QATPL)

The QATPL (Costa et al., 2011) consists of 22 items, grouped into three factors: affections, liking and motivation and utility and facility to which students responded on a Likert-type scale of 4 points, where 1 = strongly disagree,

2 = disagree 3 = agree, 4 = strongly agree. The questionnaire has three factors: Affections, Liking and motivation, and Utility and facility.

5.2.3. Questionnaire of Attitudes Toward Mathematics (QATM)

The QATM (Pomar et al., 2011) consists of 26 items, grouped into three factors: Affections, Liking and motivation, and Facility. As in the other ones, students have to respond in a 4-points Likert-type scale, where 1 = strongly disagree, 2 = disagree 3 = agree, 4 = strongly agree.

5.2.4. Emotional Intelligence Questionnaire - EQi-yv

The EQi-yv (Candeias et al., 2011) results from adaptation to Portuguese of the original version of Bar-On and Parker (2004). The EQi-vy consists of 28 items, ranged in five factors: interpersonal, intrapersonal, adaptability, stress management, general mood. The student must respond by evaluating the items using a numerical Likert-type scale, where 1 = never, 2 = sometimes, 3 = Often, 4 = Always

.

6. Design

The study of the profiles was computed using SSA (Similarity Structure Analysis; Borg, Groenen & Mair, 2013). To characterize the profiles of the students through the SSA analyses, it is considered that each construct under study is a facet, what means, there are four facets: Emotional intelligence (EQ); Attitude towards school, Attitude towards Portuguese and Attitude towards mathematics, which are the variables of content. Once the SSA builds a representation of proximities based on correlations between variables, we can say that the closer two variables are in the Euclidean plane, the more they contribute to explain the profile.

To study the relationship of these profiles with the sex of the students, we used the technique of external variables as points (Roazzi & Dias, 2001) in order to establish the correlation between sex and the structure found (Oliveira & Roazzi, 2007). The inclusion of these external variables will not change the internal structure of the SSA projection, so instead of creating a map for each sex, we only have an integrated map that represents both the profiles of attitudes and emotional intelligence in each cycle and the two subgroups (male and female) (Roazzi & Dias, 2001).

7. Results

7.1. 1st level of elementary school (LES)

The SSA analysis for students of 1st level (Figure 1) identified three partitions, in a polar configuration: Attitude towards school, Emotional Intelligence and Attitudes towards Portuguese and Maths. To this level, it appears that the affections to the disciplines correlate mainly with the factors of school and stress management from emotional intelligence. The ability to handle the stress comes away from the emotional intelligence and gets closer to the attitude towards school and affections for the subjects. This shows how the four variables in study are grouped in three regions, and not the four foreseen.

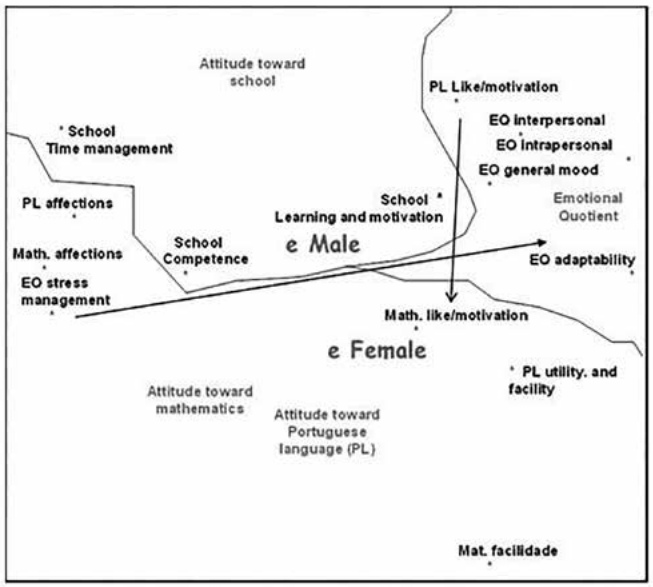

Fig. 1. SSA factor of the 4 scales for 1st LES considering as external variables (e) sex (1x2 Coordinated Solution 3-D, Coefficient of Alienation .08)..

7.2. 2nd level of elementary school (LES)

The configuration in Euclidean space to the SSA from the 2nd level (Figure 2) is organized in polar format, revealing the distinction between four regions. Here it appears that the EQ region is placed in opposition to the region's attitude towards school, and region that marks the Attitude towards the Portuguese language is located in opposition to the region's Attitude towards mathematics.

This shows how the four groups of variables are grouped in the four regions theoretically assumed.

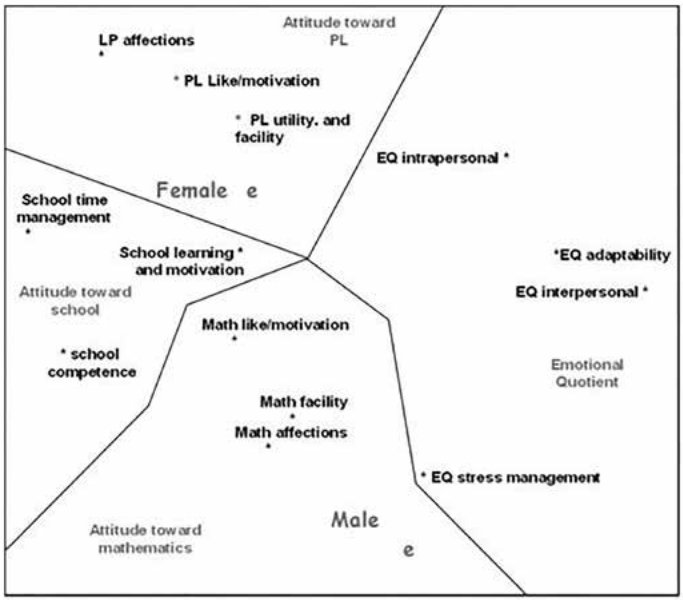

Fig. 2. SSA factor of the four scales for 2nd LES considering as external variables (e) sex (1x2 Coordinated Solution 3-D, Coefficient of Alienation .15).

7.3. 3rd level of elementary school (LES)

In the SSA considering the 3rd level students a polar structure can be observed dividing the plot in four regions (Figure 3). The Attitude towards mathematics forms a unique region with its factors, which are placed in the space in direct opposition to the Attitude towards the Portuguese language and closer to the external variable "male". Again emotional competence emerges on the opposite attitude towards school, even with the two factors that appear closer to the field of Attitude towards the Portuguese. Likewise Figure 2, this Figure shows how the four variables in study are grouped in the four regions theoretically assumed.

Stress Management from EQ arises at this map in a more central position, between the four facets in the study. The factor affecting LP comes closest to school Learning and motivation than the other facet Attitude towards the Portuguese.

In this school level, the external variable "female" is closer to the Portuguese language, but also to the intrapersonal competence. The female profile is mediated by emotion regulation (Intrapersonal EQ).

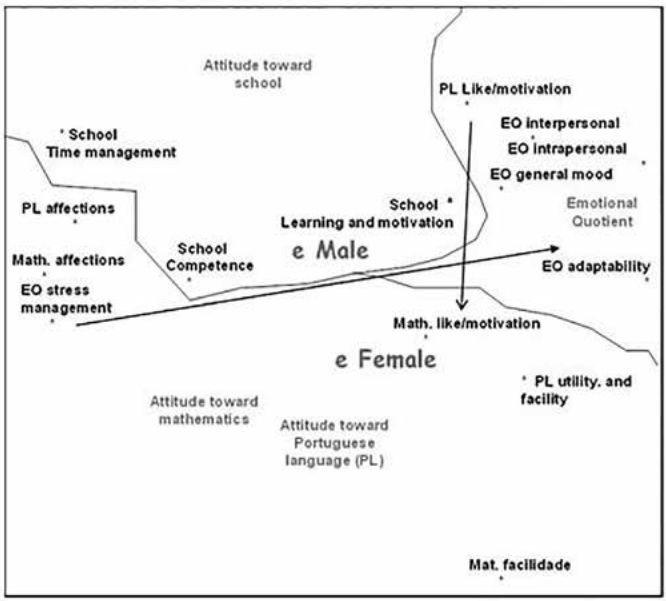

Fig. 3. SSA factor of the 4 scales for the 3rd LES considering as external variables (e) sex (1x2 Coordinated Solution 3-D, Coefficient of Alienation .14).

8. Discussion and Conclusion

At the 1st level of elementary school (LES), we found a profile characterized mainly by the separation of emotional competence, attitude toward school and attitude towards the subjects of Portuguese and Mathematics. That is, students do not have an attitude formed for each of the subjects in the study, which may be due to the fact that children in this study level are very optimistic about their ability to have good results in various areas, including those related to school work, such as reading and math (Eccles, 1999). The non-perception of competence by study areas comes from these students auto-evaluating the overall performance of the class and not just related to their actual abilities and performances. The judgments of competence in relation to the performances appear after the age of 10 and after that tend do progressively decline, leading students to avoid certain courses (Eccles, 1999).

In this level there is no typical male or female profile. In these ages is common that social comparisons do not occur or that is just at the beginning (Jacobs, Lanza, Osgood, Eccles & Wigfield, 2002), or furthermore that there are not many opportunities to make these comparisons (Jacobs et al., 2002), in such a way that children will be guided to be interested in the disciplines considered more appropriate for their gender (Hill & Lynch, 1983).

In the 2nd LES it is possible to find two profiles, one featuring the female students and another featuring male students, and it is also visible the distinction of the four theoretical dimensions in this study. Thus, girls' attitudes are characterized by higher attitudes toward Portuguese language, more intrapersonal competence and general mood, motivation to learn more and better time management in school. At the other hand, boys have more positive attitudes in mathematics, improved stress management and more sense of responsibility to be at school. The emotional skills adaptability and interpersonal are equidistant and so are important for both profiles. From these profiles it should be noted that stress management comes closer to attitudes towards mathematics than emotional intelligence, demonstrating that the ability of the student to regulate their impulsivity is important to have a good attitude to mathematics.

In the 3rd LES results are similar to 2nd LES, that is, it is possible to differentiate between emotional intelligence, attitude towards school, attitude towards Portuguese language and attitude towards mathematics. Moreover, the males and females profiles are even more marked, as can be seen by the extreme positions of external variables. In this cycle, the female profile is characterized by more positive attitude to the Portuguese language, motivation for school learning and intrapersonal skills. The relationship between intrapersonal competence and liking and being motivated to learn Portuguese language which occurs in girls can be explained by the content of the items.

Factor Affections PL refers to joy, enthusiasm and tranquillity transmitted by this discipline and Intrapersonal Competence refers to self-knowledge of the emotions and the ability to assertively express, knowing and recognizing individual skills in a specific area. The male profile is characterized by positive attitudes towards mathematics, perception of time management in school and stress management with emotional competence. Students' choices are strongly influenced by their attitudes and performances in school subjects and these are, in turn, profoundly influenced by school experiences that students have in these subjects (Nardi & Steward, 2003). Similarly, but on an emotional level, dissatisfaction or negative affections experienced in schools result from previous school experience.

Students with lower levels of engagement in learning tasks, those who perceive the subjects as unimportant or uninteresting to the world outside school and to their needs, interests and experiences, or those who perform the tasks but are not engaged, are those who have more negative attitudes, less investment and more negative emotions towards the school, and those with weaker performances. We can then say that what leads students to enjoy school are, not only the curriculum, but an environment promoting self-discovery and global development that fosters continuity in school (Nardi & Steward, 2003).

Results presented here enable decision-makers on education policies, as well as teachers and students themselves, to set new goals and establish specific learning procedures that fit the needs of all students.

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Facet Theory

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Facet Theory (FT) is a meta-theory for designing structural and other theories in the behavioral sciences. Basic assumptions of FT are that social and behavioral concepts are complex constructs and that their study, therefore, requires a systematic design for defining observations and for examining the correspondence between the observations and the theory. Because such a definitional design should facilitate the evaluation of systematic relations between the data and the theory, it should lead to cumulative results. In the above sense, FT is a systematic approach for coordinating theory and research.

FT comprises the universe of observations, the population of respondents, and the range of observations. It stratifies these universes by facets and integrates the design by means of a mapping sentence which guides the construction of items and the formulation of hypotheses. Finally, particular multivariate data analysis methods (such as SSA, POSAC, MSA) have been developed to test these hypotheses.

Facet Theory has been successfully applied to a large number of research areas where it has significantly contributed to the discovery and refinement of empirical laws.

Our aims in this book are:

1) To review recent and innovative research results arising from the application of the Facet Theory approach to complex social and psychological issues;

2) To present methodological advances in comparative studies and applications of Similarity Structure Analysis (SSA), Multidimensional Scalogram Analysis (MSA), Factor Analysis (FA), Confirmatory Factor Analysis (CFA), Partial Order Scalogram Analysis (POSAC), and other multivariate procedures and techniques related to FT;

3) To present theoretical advances in Facet Theory and related approaches;

4) To present new reflections on the role of Facet Theory in modern science and in the emergence of new scientific paradigms.

Editors
Antonio Roazzi
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