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Application of the item Response theory in the Interpretation of Decision Profiles

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Abstract*— *A study whose intent to examine the correlation between two dimensions that comprise decision-making profiles – "Predisposition or aversion to risk" and "Intertemporality" - in a sample comprised of 310 (three hundred and ten) individuals (undergraduate students in Business Administration). Data were collected by means of a questionnaire with 20 (twenty) questions (items) of the type (right/wrong, yes/no). With an essentially quantitative approach, a clearance of the results from the respondents was conducted and Item Response Theory (IRT) was chosen as the main methodological instrument. Results obtained include the identification of questions (items) contained in the questionnaire, which does not display relevance in the profile categorization, allowing one to identify the items that present themselves as the most qualified to categorize them into each one of the dimensions, in this case a Predisposition/aversion to risk and Intertemporality in decisions. Dimensions which do not present, a priori, correlation within the researched universe.

***Keywords*— *Decision-making, Intertemporality, Item Response Theory, Risk*.**

I. INTRODUCTION

So-called "The Knowledge Era", regards the intellectual capital as an asset, considering that entire organization should enhance it to gain a competitive advantage and, consequently, an improved economic performance. Due to this fact, the job supply created for new executives is not translated into a guaranteed professional allocation, since these professionals must have required skills and acting profiles.

One should emphasize that experiences and knowledge of new managers are not divided into different blocks, in other words, they mutually take place under an interaction of knowledge, resulting in ideas and human actions [20]. Other authors, such as [13], [25], [19], corroborate the idea that this transformation of intellectual capital into intangible capital brings competitive advantages in a market regarded as global.

Another critical point that has been under discussion is that people and organizations are part of a context permeated by complexity. Therefore, managers have a crucial role in this process, because they need to mobilize their managerial skills as a transposition link of individual skills for the collective ones, something that may favor the enhancement of institutional skills [17]. Corroborating this statement, [15] and [10] share a conception that individual skills should be collectivized in a organization.

[18] believe that a conceivable operational model for research could approach two relevant concepts on judging decisions process, which are intertemporal choices (related to impulsivity and to individual cognitive differences of temporal orientation) and risk-related choices (related to phenomenon of aversion and loss under risk when making decisions).

Therefore, one suggests the following research issue: is there a correlation between aversion-related decision profiles or predisposition to risk and intertemporal decisions?

To answer the research issue, this study has the intent to analyze profiles decision of a given sample, comprised of 310 (three hundred and ten) individuals (undergraduate students in Business Administration). To achieve its goal, criteria of analysis were: predisposition or aversion to risk, Intertemporality (preference for short or long-term decisions), relying on the IRT.

First models to answer the item emerged in the 50s. Up until that point, the Item Response Theory (IRT) had been widely used in several fields of knowledge, with special emphasis on the quantitative processes applied to educational assessment.

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Also, methodology is obtained by analysis and interpretation of a data bank with psychological decision profiles of undergraduate students in Business Administration, relying on IRT to establish a latent trait in sample used, a latent trait that is a characteristic of interest that cannot be directly observed or measured. In other words, it is based on the observation of other variables related to it (secondary variables), one expects to infer the usual decisional behavior of future managers.

This present study presents itself as relevant due to the struggle in understanding how certain decision profiles affect planning execution, often choosing individuals without skills or attitudes that are deemed necessary for exercise of the function assigned to it. Furthermore, its relevance is prompted by a differential perspective on performance´s evaluation, believing that this will be attached to decisions related to individual profiles, up to some degree, intrinsic.

II. THEORETICAL FOUNDATION

For [2], decision-making process beginning is a identification that something is not in tune with what is expected, or the existence of a problem which needs to be surpassed. In this regard, the decision-making process can be summed up as a choice between two or more alternatives which allow a given outcome.

Decision-taking is the process in which the managers provide responses to opportunities and threats, relying on the analysis of possible options and on the choice of alternatives, while focused on the ultimate goals. One should also mention that, regardless of a type of decision, function performed, characteristic(s) of the problem(s) and degree of information available, managers need to take at least two sorts of decisions: the ones programmed, which comprise routine decisions, with a recurring character, with easy problems to solve and, in order to consummate themselves, already have established rules, as well as procedures and policies which need to be followed; and the non-programmed, those that emerge with new, non-ordinary problems, where there are no rules to be followed, in which decision must be taken based on information and manager(s) intuition, following his(their) influence(s) of situation´s judgement [12].

From final choice about possible alternatives, [23] proposes Theory I, according to which the logic of the decision-making process consists in the support between ends and means, and in consensus about achievement of organizational goals, whilst also being attached to maximization of profitability.

Theory II would be attached to quest for satisfactory results, to adequacy between ends and means, taking into account other factors that are not associated to decision, as, for instance, motivations and habits, and in this case, there would be room for a logic of consensus, a conciliation, a system of rewards and contribution, which are aimed at the achievement of sequential objectives [23]. Thus, when the decision-maker is in doubt and opts for a satisfactory and not “ideal” outcome, not maximizing profit, his decisions can bring consequences to his company.

Theory III implies an acknowledgement that part of individual’s decisions is attached to work and the other part targets political activities, and, therefore, decisions will be the result of negotiations, struggles and demands, until one reaches the restructuring of the decision-making process [23]. With that understanding, it is observed that the decision-maker is far from obtaining satisfactory results, because he is conditioned by particularities.

[8] and [27] believe that decision-maker intuition is a challenge for a psychological research. According to [9], explanations for psychological ruses in decision-making process would be related to heuristics and cognitive biases such as:

- anchor: attaching oneself to long-gone data when taking present-day decisions;
- status quo: keep what has been done;
- immobilized capital: solely protecting decisions already taken;
- confirmation of evidence: see only what one wants to see;
- context: check the wrong problem;
- self-confidence: have too much confidence, based on feeling;
- emphasis on memory: focus only on the dramatic facts;
- basic rate: leaving aside valuable information;
- guessing: identifying a pattern where there is none;
- surprise: feeling impressed by casual situations, without interdependence.

According to perspective of [26], decision-taking is the responsibility of the manager and also a formalized skill, because, in addition to the information that you have at your fingertips, you use your own knowledge, such as: technical references; political, social and cultural influences; institutional traits; and perception that you have

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on the problem. This way, one creates a conviction and makes a decision, mobilizing the resources that one needs.

To [6], human being's behavior is influenced by several subjective and objective factors which are interrelated and interfere with cognitive process and, therefore, end up affecting the decisions taken by individual.

Still according to [6] perspective, when taking part of a context of uncertainty, the decision-maker clings himself to elements that are outside of decision's scope, looking for a psychological comfort to cope with this uncertainty.

A previous experience of individuals is reflected in the assessments of a future decision-making process. Soon, trust developed by the decider can become a shortcut in the cognitive process of risk assessment in decision-making, particularly in an unknown environment [6].

[7] describe two types of decision making, the probabilistic one and the value judgment, where the latter is an indication of preferences, the position regarding the risk and values in a general way. The same authors clarify that the risk is a measure of uncertainty through which one has the possibility to assess probabilities associated with the expected events to see what will happen.

[11] apud [7], state that attitudes of individuals when facing risk may be different in two situations: when assessing prospects with high probability of earnings, they tend to go for a more conservative option to be sure there will be an earning; and, when exposed to choices in which there is a likelihood of smaller gains, decision-makers are likely to try to earn more, even if the odds are smaller. Therefore, authors mention existence of an effect of reflection, because, in the field of losses, individual's behavior is prone to risk, and, in the field of earnings, behavior is the opposite: the one of aversion to risk.

III. METHODOLOGY

For [28], research is an action necessary in science, because, through it, one pays attention to findings of reality, produces knowledge and seeks theoretical and practical answers.

The research here described is classified as of the applied type, in other words, it is suggested that its conclusions can be taken into consideration when similar practical contexts are analyzed. Regarding the approach, it is characterized as a qualitative research, because the observed data were based on human experience in circumstantial decisions with a business character, even if they have taken place in a controlled environment (simulated).

For data collection, a questionnaire was used as an instrument to set psychological decision profiles of graduate students in Business Administration.

According to [24], the questionnaire is a set of questions systematically articulated, with the intent of raising written information from the respondents or to know their opinion on a subject that is part of the study. For this research, 20 (twenty) questions were conducted to understand the individual decision profiles, in relation to predisposition or aversion to risk, and to intertemporality (preference for short or long-term decisions).

Initially, the data of 20 (twenty) items (questions) were analyzed using IRT as a single group of items. This preliminary analysis showed that such items could not be approached as a single dimension of latent trait of interest, i.e., "decision-making". Thus, items were divided into two dimensions: aversion or predisposition to risk and intertemporality (preference for short or long-term decisions).

[1] claim that, in organizational empirical research, the reliability of conclusions is directly related to validation of measuring instrument. They recommend using, in validation process, measures of internal consistency of scales (reliability), checking correlation of items with scales used (detailed analysis of every item) and if item can indeed measure what it proposes itself to measure (validity). In this study, a structured questionnaire (objective) was applied, with dichotomized responses within a subjective evaluation (open).

Initially, it was used the classical test theory (CTT), because this encompasses some useful tools to assess the quality of the measuring instrument. The biserial correlation coefficient and Cronbach's alpha coefficient, considering that first allows one to measure the degree of association between a dichotomized variable and a continuous variable, and second is useful to check the internal consistency of measuring instrument [3], [13].

In the analysis using IRT, logistic model was applied, which is based on fact that individuals with a greater ability (a latent trait of interest) have a higher probability of hitting an item. This model is defined by the Equation (1) and Fig. 1 presents the characteristic curve of three-parameter logistic model.

$$P_{ij} = P(U_{ij} = 1|\theta_j) = c_i + (1 - c_i)\frac{1}{1+e^{-Da_i(\theta_j - b_i)}} \quad (1)$$

Where:

i = 1,2,3,...,p representing each one of the items of the questionnaire; and

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j = 1,2,3,...,n representing the n respondent individuals in the questionnaire.

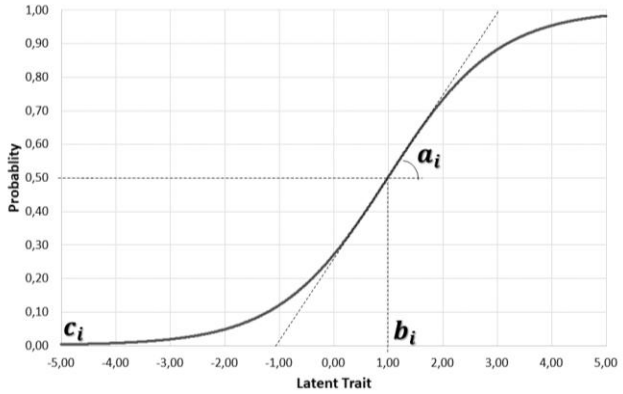

Fig. 1: The characteristic curve of an item using the 3-parameter logistic model

Source: Adapted from [3]

The parameter a_i indicates the "degree of discrimination" that an item establishes; in other words, the greater a_i, the greater will be its degree of discrimination in region of greater information and, therefore, the better item will be. By analogy, the better will values considered ideal ($a_i > 0.7$) will be;

The parameter b_i is called the "degree of difficulty". "It indicates the region, in the proposed arbitrary scale, where the item provides more information";

The parameter c_i is related to the "casual hitting". It represents the probability of low-skilled individuals to correctly respond to a certain item;

Based on a scale factor, constant and equal to 1, one uses the value 1.7 when the intent is to have the logistic function providing a result similar to that of normal ogival function;

θ_j represents the latent trait (ability) of the j-nth individual;

U_{ij} is a dichotomous variable which can assume values 0 or 1 when the j-nth individual answers the item i in accordance with the marking regarded as "correct", or 0 when a j-nth individual does not respond to the item i in accordance with the value regarded as correct.

Therefore, $P(U_{ij} = 1|\theta_j)$ is the ratio of responses according to the options regarded as "correct". In dichotomous items, one of the items must be considered correct for the purposes of carrying a calculation with IRT. In this study, there are no correct or incorrect items, and, because of that, there is no preference about the options which should be chosen as correct. The only restriction is the choice made, in other words, one opted to consider as a reference standard the items associated with more risky and short-term decisions.

Thus, the basis for the analysis using this model lies on the fact that the individuals more prone (to take short-term decisions and with a greater risk) are more likely to mark the items reactive to that profile and that relationship is not linear, as shown in Fig. 1 [3], [14].

Considering that the type of questionnaire applied is comprised of dichotomous items, in other words, items of type Yes/No, Agree/Disagree, Apply/Does Not Apply, there is no logic in speaking about a casual hitting, because, as aforementioned, there are no right or wrong answers, and the c parameter is equal to zero [4]. The Equation (1) is reduced to Equation (2).

$$P_{ij} = P(U_{ij} = 1|\theta_j) = \frac{1}{1+e^{-Da_i(\theta_j - b_i)}} \quad (2)$$

In order to achieve that, it is necessary to establish a scale of measurement to measure the latent trait of interest (skill). [3] state that, in the IRT, the scale of measurement of the latent trait can assume, in theory, any real value between -∞ (less infinite) and +∞ (more infinite), in opposition to the classical tests, in which the scale takes only integer values. To define it, one needs to establish an origin and a unit of measure. These values should be chosen to represent, respectively, mean value and standard deviation of the abilities of the individuals in the studied population. In this scale, the parameter values typically vary between-2 and+2, and appropriate values for *a* parameter would be those greater than *1*.

For purposes of this study, a scale with a mean equal to zero and standard deviation equal to the unit is used. In IRT terminology, this scale is called (0.1). Authors also emphasize that this scale is arbitrary and the most important in it are existing order relationships between its points, and not necessarily its magnitude.

In addition, all data analyzes were conducted using R software with the assistance of packages: '*ltm'*; 'CTT'; '*irtoys'* and '*mirt'* [5], [16], [21], [22]. Using tooling available in these packages, routines were used to calculate classical analysis tests, for each of the dimensions, in other words the calculations concerning descriptive statistics and analysis using IRT. The default settings of parameters of these packages were used for all analyses.

IV. DISCUSSION AND ANALYSIS OF RESULTS

Table 1 displays behaviors results from items of each of the two groups. Column 0 [%] corresponds to percentage

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of hits on items related to a more conservative profile, in other words, averse to risks and averse to short-term decision-making. And Column 1 [%] corresponds to percentage of answers related to a profile more prone to take more risky and short-term decisions.

Table.1: Proportion of responses for each of the dimensions

Predisposition and Aversion to Risk			**Intertemporality**		
Its.	**0 [%]**	**1 [%]**	**Its.**	**0 [%]**	**1 [%]**
01	0.4419	0.5581	**11**	0.9226	0.0774
02	0.6645	0.3355	**12**	0.8355	0.1645
03	0.5032	0.4968	**13**	0.1290	0.8710
04	0.7290	0.2710	**14**	0.5355	0.4645
05	0.5516	0.4484	**15**	0.7290	0.2710
06	0.8581	0.1419	**16**	0.5516	0.4484
07	0.3032	0.6968	**17**	0.3097	0.6903
08	0.6742	0.3258	**18**	0.7968	0.2032
09	0.7129	0.2871	**19**	0.6226	0.3774
10	0.3548	0.6452	**20**	0.6194	0.3806

Source: Compiled by the authors (Adapted from R software)

Fig. 2 and Fig. 3 display ratios of responses considered "correct", in other words, consistent with a profile more prone to risk and to take short-term decisions. Ordinates axis displays proportions of correct answers, in other words, hits related to a profile more prone to risk or to take short-term decisions, and, in x-axis, there is total number of hits recorded in two dimensions assessed which comprise this profile. For instance: using item 02 in Fig. 1, among respondents who obtained only two "hits" as a total score, of these, only 10% marked the option of a greater predisposition to risk.

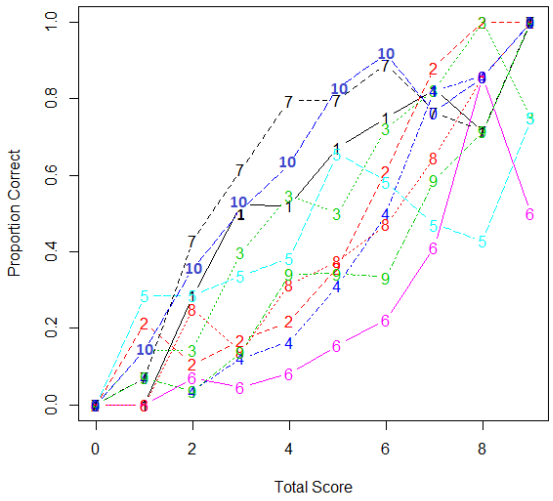

Fig. 2: Total scores and proportion for the items 01 to 10 (Predisposition/aversion to risk)

Source: Compiled by the authors (Adapted from R software)

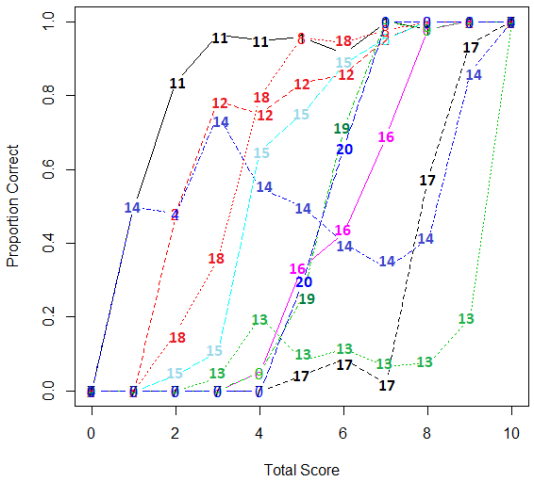

Fig. 3: Total scores and proportion for items 11 to 20 (Intertemporality)

Source: Compiled by the authors (Adapted from R software)

Fig. 4 and Fig. 2 highlight the items more and less marked for each dimension: Predisposition or Aversion to Risk and Intertemporality, respectively.

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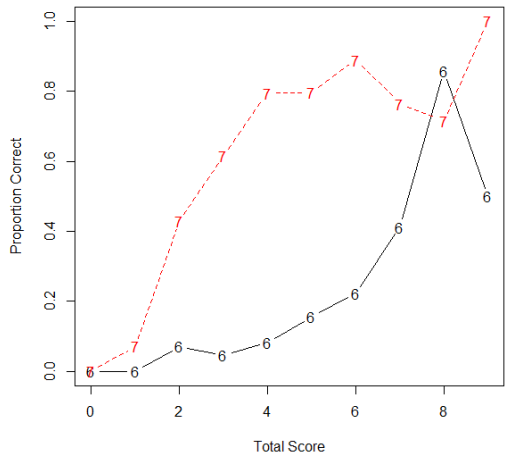

Fig. 4: Total scores and proportion of items 06 and 07 (Predisposition/aversion to risk)

Source: Compiled by the authors (Adapted from R software)

In the first group of items (1 to 10), displayed in Fig. 4, item more marked by those who have conservative profile was the item 6, with almost 86%, and item more marked for those with a profile more prone to the risk was the 07, with nearly 69.7%. Likewise, Fig. 5 presents items most marked by each profile in the second group of items (11 to 20). Item 11 was the most marked by those with a conservative profile (around 92%) and item 13 was the most marked by those with a profile more prone to take short-term decisions (approximately 87%).

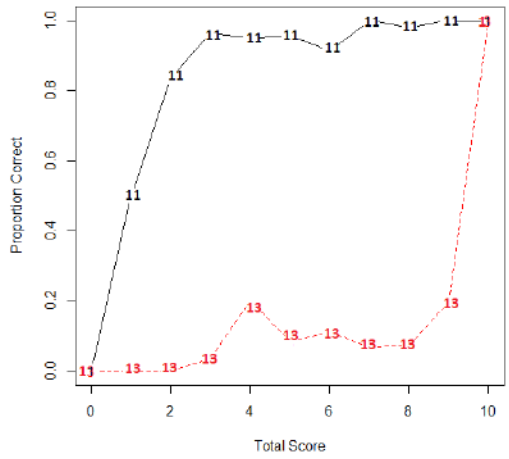

Fig. 5: Total of the scores and proportion of items 11 and 13 (Intertemporality)

Source: Compiled by the authors (Adapted from R software)

The Table 2 displays frequencies of number of "hits" in each of dimensions. Note that the larger concentration of answers is found in the intermediary items. At the edges, very conservative people (score equal to zero) or those very prone to risk (score equal to 10) correspond to only 7.7% of the group in the analysis.

Table.2: Frequency of the total scores

Score	Predisposition or Aversion to Risk (items 1 to 10)	Intertemporality (Items 11 to 20)
0	2	12
1	14	51
2	28	54
3	65	45
4	73	35
5	64	24
6	36	20
7	17	28
8	7	25
9	4	6
10	0	10

Source: Compiled by the authors (Adapted from R software)

The biserial correlation is a measure of association between performance of an item and performance of whole test (total gross score). In other words, it is the correlation between the ability to hit an item and the latent variable of interest, which is not directly measured.

Table.3: Biserial correlation (ρ) between the item and the total score

Predisposition and Aversion to Risk		Intertemporality	
Items	***Included***	**Items**	***Included***
01	0.3561	**11**	0.4376
02	0.4518	**12**	0.5724
03	0.3685	**13**	0.2680
04	0.4762	**14**	0.1716
05	0.2146	**15**	0.7747
06	0.3526	**16**	0.7799
07	0.3399	**17**	0.6546

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08	0.3687	**18**	0.7226
09	0.3504	**19**	0.8374
10	0.4030	**20**	0.8437

Source: Compiled by the authors (Adapted from R software)

In Table 3, one observes that all items between 01 and 10 show a biserial correlation coefficient with a value below the desired (ρ > 0.7). Therefore, there is a very weak correlation between each of items and total score. From items 11 to 20, item 17 has a value close to reference of item 14 (a_{14} = 0.1716). Item 17 presented a coefficient very close to the one regarded as ideal (a_{17} = 0.6546) and items 15, 16, 18, 19 and 20 showed values higher than 0.7.

Table 4 presents the values of the Cronbach's alfa coefficient for each of the tests (*All*) and internal consistency of each group, excluding each of items. Internal consistency among items from 01 to 10 is very low (α = 0.2832); in other words, the pattern of responses is random (there is no internal consistency). Among items 11 to 20, one can attest a significantly higher value (α = 0.8166), there is an internal consistency in this group of items, as suggested by [13].

Table.4: Cronbach's Alpha Coefficient

Predisposition and Aversion to Risk			**Intertemporality**		
	Its.	**Value**		**Its.**	**Value**
All		0.2832	**All**		0.8166
Excluding	**01**	0.2787	*Excluding*	**11**	0.8140
Excluding	**02**	0.2150	*Excluding*	**12**	0.8036
Excluding	**03**	0.2728	*Excluding*	**13**	0.8295
Excluding	**04**	0.1953	*Excluding*	**14**	0.8589
Excluding	**05**	0.3521	*Excluding*	**15**	0.7779
Excluding	**06**	0.2435	*Excluding*	**16**	0.7766
Excluding	**07**	0.2747	*Excluding*	**17**	0.7958
Excluding	**08**	0.2622	*Excluding*	**18**	0.7861
Excluding	**09**	0.2670	*Excluding*	**19**	0.7665
Excluding	**10**	0.2458	*Excluding*	**20**	0.7653

Source: Compiled by the authors (Adapted from R software)

According to the estimates of parameters displayed Table 5, not all items have good discrimination (a_i > 0.7) as preconized by methodology. In the first group, only items 02, 04 and 06 showed good discrimination, allowing one to differentiate those with aversion to risk from those more prone to risk. Other items allow one to attest that difference between probabilities of answers (axis y) of two individuals, with abilities 1.0 e 2.0 (axis x), for instance, is very small. Taking item 03 as an example, one perceives that through this item is not possible to discriminate with the same accuracy two individuals who have a difference equal to 1 in their abilities. When visually assessing the graph in Fig. 6 one perceives that difference in probability to distinguish such individuals will be smaller than 0.2.

Table.5: Parameters of discrimination (a_i) and difficulty (b_i) and the respective standard errors ($std.err$) of items related to Predisposition/Aversion to Risk

Predisposition and Aversion to Risk				
Item	a_i	***std.err***	b_i	***std.err***
01	0.085	0.181	-2.736	5.937
02	1.323	0.380	0.685	0.168
03	0.129	0.179	0.101	0.897
04	1.654	0.550	0.875	0.182
05	-0.199	0.184	-1.049	1.110
06	1.330	0.411	1.754	0.365
07	0.304	0.206	-2.796	1.862
08	0.248	0.203	2.975	2.416
09	0.414	0.202	2.283	1.078
10	0.301	0.206	-2.026	1.385

Source: Compiled by the authors (Adapted from R software)

The Fig. 6 displays characteristic curves of items 1 to 10; one perceives that only item 5 has shown a behavior outside of expected, in other words, a parameter of discrimination less than zero. On top of that, only three items (2, 4 and 6) presented a parameter within range regarded as ideal (a_i > 0.7).

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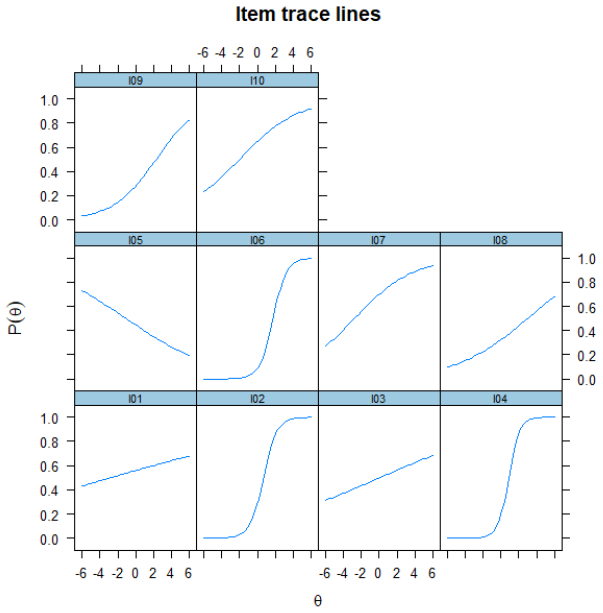

Fig. 6: Curve of items related to Predisposition/Aversion to Risk (items 1 to 10)

Source: Compiled by the authors (Adapted from R software)

With the IRT, it is possible to draw the curve of full information provided by the test. In Fig. 7 one can observe that the curve is higher, in other words, it presents a greater amount of information in the region between zero and two. This first group of items does a better assessment of individuals who are found between the mean (central position) and two standard deviations above the mean.

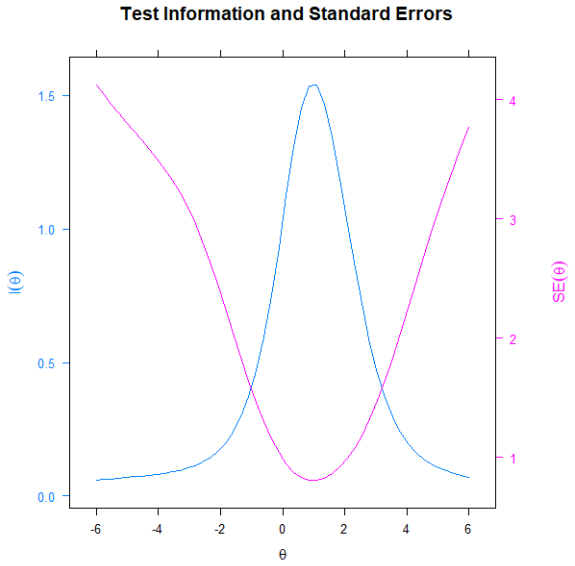

Fig. 7: The role of total information of items 01 to 10
Source: Compiled by the authors (Adapted from R software)

Fig. 8 displays the items that effectively contribute with information between items 1 to 10, related to dimension of Predisposition and Aversion to Risk. And, as shown in Table 5, items that presented the best power of discrimination were 04, 06 and 02. Thus, all relevant information provided in this dimension is concentrated in these three items.

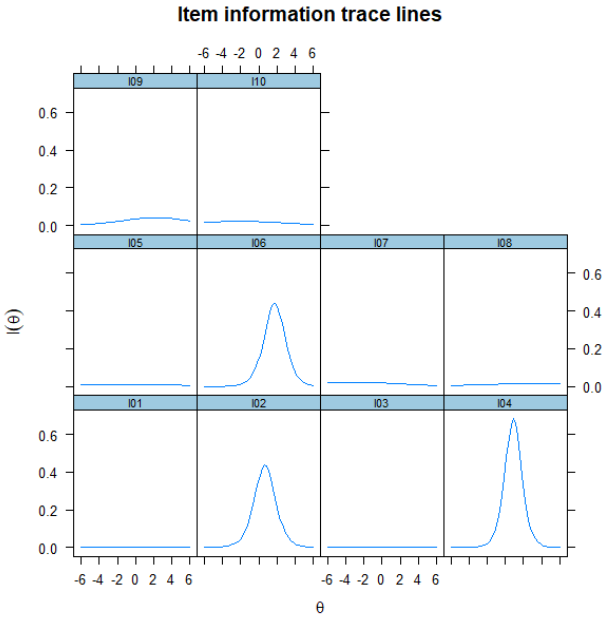

Fig. 8: The role of information of items 01 to 10

Source: Compiled by the authors (Adapted from R software)

Fig. 9 displays the positioning of the items in the scale created with IRT for the dimension Predisposition or Aversion to Risk. It is visible that the items were distributed throughout the scale, something regarded as positive. Nevertheless, only three items had significant information for the test. Therefore, it is suggested that, in a new application, new items should be added to the questionnaire, taking into consideration that most of the items used (01, 03, 05, 07, 08, 09 and 10) barely contributed with useful information for this analysis.

To do so, these new items should be prepared and calibrated, hence creating the possibility to assess other regions of the scale of redisposition or aversion to risk created by the IRT, therefore also increasing the power of discrimination of individuals with different profiles.

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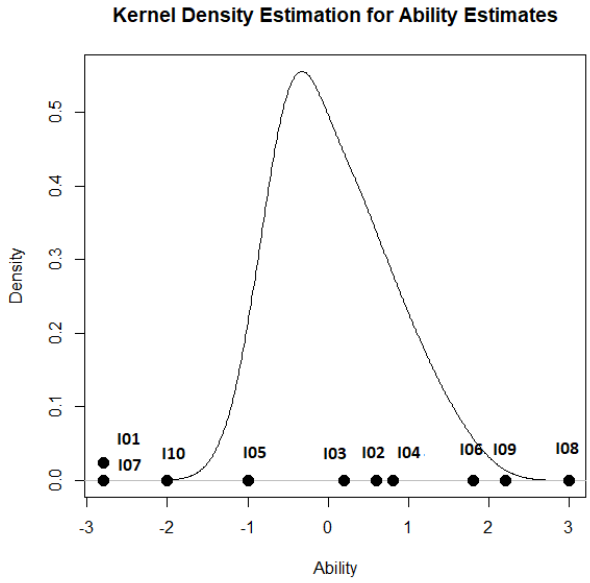

Fig. 9: Positioning of items on the scale of the test of items 01 to 10

Source: Compiled by the authors (Adapted from R software)

In the dimension related to intertemporality, items from 11 to 20, the ones that obtained a higher parameter, ai in other words, better power of discrimination were items 11, 12, 15, 16, 17, 18, 19 and 20, which can be attested in Table 6.

Table.6: Estimates of the parameters of discrimination (a_i) and difficulty (b_i) and the respective standard errors ($std.err$) of items related to Intertemporality

Intertemporality				
Item	***ai***	***std.err***	***bi***	***std.err***
11	1,588	0,337	2,186	0,295
12	1,717	0,284	1,431	0,162
13	0,523	0,197	-3,838	1,352
14	0,041	0,121	3,499	10,636
15	3,232	0,433	0,726	0,070
16	3,134	0,412	0,160	0,060
17	3,464	0,647	-0,558	0,078
18	4,396	0,851	0,939	0,077
19	10,031	1,851	0,281	0,058
20	21,354	93,102	0,133	0,582

Source: Compiled by the authors (Adapted from R software)

In Table 6, regarding estimates of parameters for this dimension, it is observed that items 13, 14, 19 and 20 displays values of discrimination a_i. outside the range deemed ideal ($0.7 < a_i < 7.0$), as per mentioned in the methodology. Items 11, 12, 15, 16, 17 and 18 are items with good power of discrimination in relation to this dimension of decision-making.

Items 13 and 14 presented very low values of discrimination (parameter $a_i < 0.7$), which did not allow a proper distinction between people with close values of intertemporality in this scale. Items 19 and 20, on the other hand, presented very high values of a_i above 7, and therefore they present very steep and characteristic curves (having the shape of a step). Items with such trait end up discriminating the respondents in only two groups: one below value of parameter b_i and another group with scores above that parameter. Thus, they also are items that do not properly assess latent trait. In Fig. 10, characteristic curves of items in this group are presented.

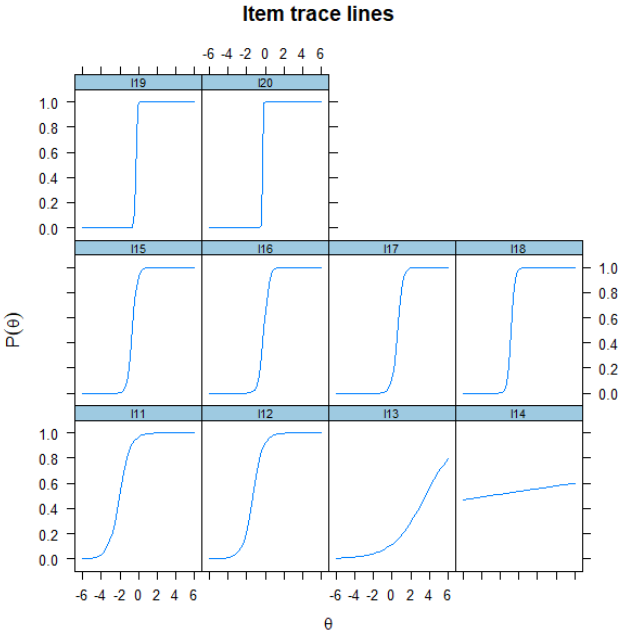

Fig. 10: Curve of the items related to Intertemporality (items 11 to 20)

Source: Compiled by the authors (Adapted from R software)

Fig. 11 presents an information curve whose peak is around the mean, indicating that there is a lot of information available in a very narrow range of scale for dimension of intertemporality.

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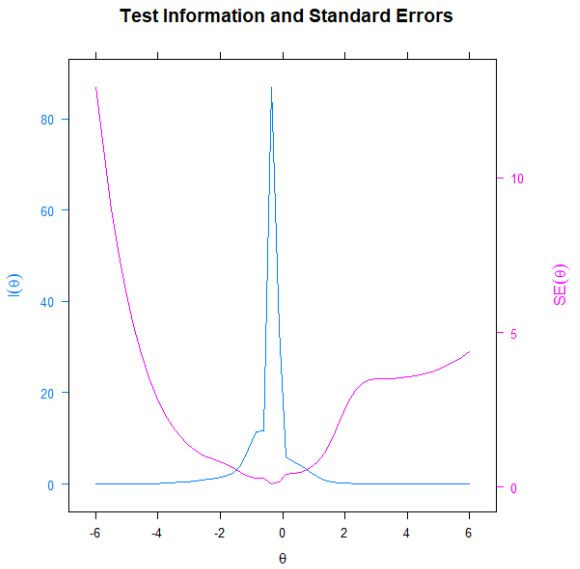

Fig. 11: The role of total information of the items related to Intertemporality

Source: Compiled by the authors (Adapted from R software)

Fig. 12 presents the contribution of information for each of items in this dimension, separately. Therefore, it is perceived that peak of information in Fig. 11 is attributed to the contribution of items 11 to 20, which, as already seen here, does not properly discriminate the decision-making profiles.

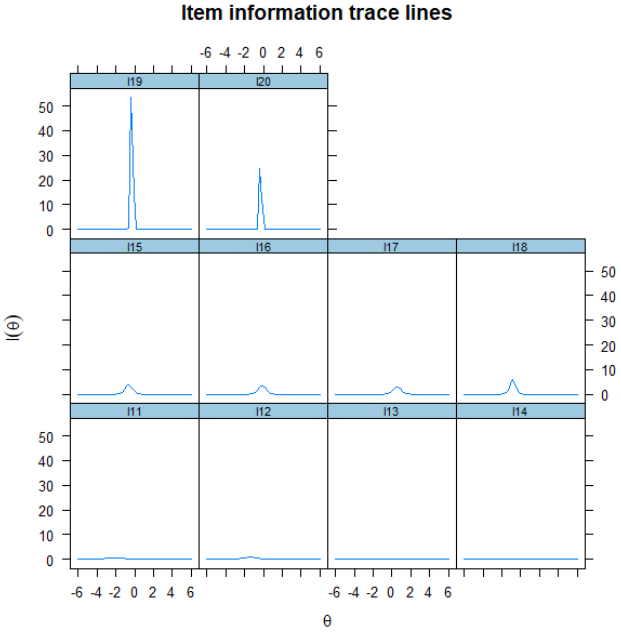

Fig. 12: Function of information related to Intertemporality

Source: Compiled by the authors (Adapted from R software)

Removing contribution of these two items, one can attest that items 11, 12, 15, 16, 17 and 18 contribute with information on a range of scale which happens to be a little wider (from −1 a +2. Thus, items of this dimension allow an assessment of individuals situated between average (central position) and one standard deviation below and two above mean, as shown in Fig. 13.

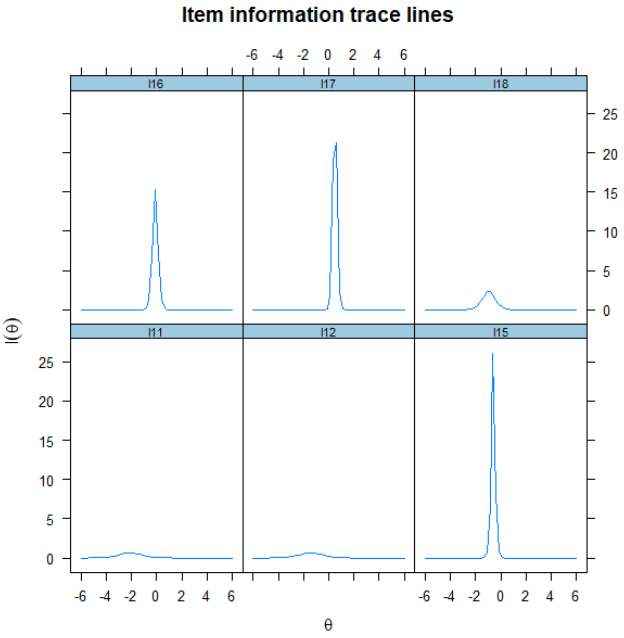

Fig. 13: Role of information of items 11 to 18

Source: Compiled by the authors (Adapted from R software)

Fig. 14 displays positioning of items in the scale of intertemporality dimension. Items 11, 12, 15, 16, 17 and 18, which presented greater information, were positioned around center of scale, allowing one to conclude that items 11, 12, 15, 16, 17 and 18 conduct a proper assessment of the profiles of individuals who are close to the mean, up to two standard deviations above or below the mean.

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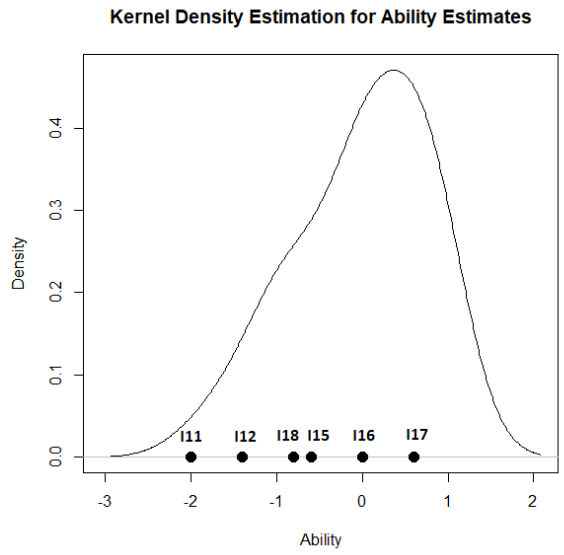

Fig. 14: Positioning of items related to Intertemporality

Source: Compiled by the authors (Adapted from R software)

In Fig. 15, each axis displays values of scores of predisposition and aversion to risk (axis x) and of intertemporality (axis y) of each of students assessed, allowing one to display position of each student within the scales of measurement created with IRT. Visually speaking, one notices that there is no apparent correlation between these two dimensions of decision-making.

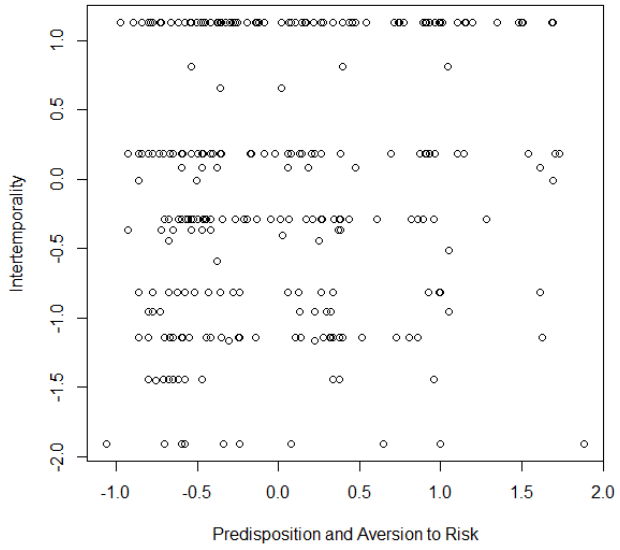

Fig. 15: Dispersion graph of the skills of respondents in each dimension

Source: Compiled by the authors (Adapted from R software)

The result obtained in the Pearson correlation among the proficiencies among each dimension was: value of t = 2.5455, with df = 308 degrees of freedom, probability value obtained was p= 0.0114 with a confidence interval of 95% equal to [0.03266561; 0.25092465]. Pearson's correlation coefficient obtained was equal to 0.1435401. Akin to what has already been inferred by analysis of the dispersion graphic shown in Fig. 15, and from obtained coefficient value of correlation, it can be stated that there is no correlation between the dimensions studied.

V. CONCLUSION

This study relied on models of analysis and interpretation suggested by IRT, aiming to find out the existence of a relationship between two dimensions of judgment in decision-making. Naturally, IRT suggests that original instrument of data collection (questionnaire) must be, beforehand, an object of analysis, to create and validate a scale of interpretation of results. To achieve that, sample comprised individuals who can assume positions of decision in the future; in this case, students from Administration course.

With effective creation of an interpretable assessment scale of profiles of decision-making, the advantages of applying IRT are now demonstrated, taking into consideration that: it was possible to assess each individual item that comprised the questionnaire; positioning them on a scale that represents the latent trait of each dimension analyzed (predisposition/aversion to risk and intertemporality).

With such placement, it was therefore possible to carry out an assessment based on the latent trait of interest and independent of the respondents. Furthermore, it also showed how the instrument can be improved, by discarding or replacing inappropriate items, to increase amplitude and sensitivity of assessment scale of profiles.

Thus, aiming to establish a new application of data collection instrument (questionnaire), one suggests deleting the items identified with a low power of discrimination, due to the loss of information related to those items would be minimal. And, the inclusion of new items calibrated with IRT, so that other regions of assessment scale originally proposed can be assessed. Regarding items to be included, one suggests that they should be less repetitive, and submitted to preliminary assessment of professionals in the field of behavioral studies, to detect possible inconsistencies in its formulation and minimize failures of interpretation from the new respondents.

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Moreover, there is also the suggestion to expand the application of the instrument, already calibrated, to more heterogeneous groups, so that preliminary results can be compared to a different sample universe, whose goal is to obtain better positioning of the items and, as a consequence, set a pattern of probable decisions based on the interpretation and analysis of the scales created with the IRT.

Finally, when checking the Pearson's correlation among two dimensions (predisposition or aversion to risk and intertemporality), its absence was preliminary found, because scopes of analyzed items in each one of dimensions do not suffer a mutual interference. For future studies, one suggests inclusion of new items calibrated for both dimensions, with an analysis of dimensionality being applied. Given that IRT is often applied in instruments that presuppose existence of only a latent trait, in other words, use of a unidimensional instrument, unlike what is attested the items used in this study. Therefore, based on factorial analysis, it will be possible to verify how many dimensions are necessary to properly represent the items and the assessed individuals, and what skills and abilities the test is measuring.

Using multidimensional models still lacks a methodology that is consecrated in literature, which already appens with unidimensional IRT. Therefore, this study proposed itself to conduct some initial methodological trials with data used.

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