Intrinsic Motivation Inventory: Psychometric Properties in the Context of First Language and Mathematics Learning

Inventário de Motivação Intrínseca: Propriedades Psicométricas em Contexto de Aprendizagem da Língua Materna e Matemática

Vera Monteiro*, Lourdes Mata & Francisco Peixoto
ISPA - Instituto Universitário de Ciências Psicológicas, Sociais e da Vida, Lisboa, Portugal

Abstract
Intrinsic Motivation Inventory (IMI) is a multidimensional measurement grounded on the Self-Determination Theory (SDT) used in assessing the subjective experiences of participants when developing an activity. The aim of this study is to analyze the characteristics of IMI among Portuguese students, testing four organizational models (unidimensional, multidimensional, hierarchical and bi-factor). A total of 3685 students from the 5th to the 12th grades (50.4% boys) participated in the study (M = 13.67, SD = 2.26). Two versions of IMI were used (First Language and Mathematics) with twenty-one items distributed over five subscales: Enjoyment, Perceived Competence, Pressure/Tension, Perceived Choice and Value/Utility. The confirmatory factor analysis corroborated the multidimensionality of intrinsic motivation, and that the bi-factor model presented the best fit indexes. This model showed the existence of one general factor, resulting from the contribution of all individual dimensions and the particularities of most of them. Furthermore, results also highlighted satisfactory reliability scores both through Cronbach's alpha scores and Composite reliability scores. These results indicate that this scale is appropriate to evaluate the underlying constructs of the theoretical model of SDT and allows for the calculation of a global measure of intrinsic motivation, as well as specific measures for their predictors.
Keywords: Intrinsic motivation, mathematics, first language, self-determination theory.

Resumo
O Inventário de Motivação Intrínseca (IMI) é um instrumento utilizado na avaliação subjetiva da experiência vivida pelos sujeitos durante a realização de uma atividade, e está fundamentado, teoricamente, na Teoria da Autodeterminação (SDT). Este trabalho teve como objetivo estudar as propriedades psicométricas do IMI em estudantes portugueses, testando quatro modelos de organização (unidimensional, multidimensional, hierárquico e bifatorial). Participaram no estudo 3685 alunos (50,4% rapazes) do 5º ao 12º ano de escolaridade (M = 13,67, DP = 2,26). Foram utilizadas duas versões do IMI (língua materna e matemática), constituídas por 21 itens, distribuídos por 5 subescalas: Prazer, Perceção de Competência, Pressão/Tensão, Escolha Percebida e Valor/Utilidade. A análise fatorial confirmatória atestou a multimensionalidade da motivação intrínseca e o modelo bifatorial apresentou os melhores índices de ajustamento. Este modelo evidenciou a existência de um fator geral, resultante do contributo de todas as dimensões e a especificidade da maioria das dimensões. Os resultados permitiram igualmente constatar valores muito aceitáveis para a fidelidade, tanto através do Alfa de Cronbach, como pelo cálculo da Fiabilidade Compósita. Estes resultados indicam que esta escala é apropriada para avaliar os constructos teóricos subjacentes à SDT, permitindo obter uma medida global de motivação intrínseca e, em paralelo, medidas específicas para os seus preditores.
Palavras-chave: Motivação intrínseca, matemática, língua materna, Teoria da Autodeterminação.

Self-Determination Theory (SDT) provides a framework for the study of motivation, emotions and their development. SDT assumes the importance of internal sources for the development of personality and self-regulation of behavior (Ryan & Deci, 2000a). SDT also seeks to identify and study the factors that facilitate or undermine a person's initiative and personal sense of volition (Deci & Ryan, 2000, 2008; Ryan & Deci, 2000a, 2000b; Ryan, Mims, & Koestner, 1983). In this sense, it defines the sources of intrinsic and extrinsic motivation, characterizing its role in cognitive and social development and in individual differences. SDT considers subjects to be by nature "active

* Mailing address: Rua Jardim do Tabaco, 34, Lisboa, Portugal 1149-041. E-mail: veram@ispa.pt
This research was supported by Grants from the Science and Technology Foundation
Acknowledgments: The writing of this article was supported by the FCT (Portuguese National Science Foundation) through the project PTDC/CPE-CED/121358/2010. We gratefully acknowledge the reviews by two anonymous reviewers on an earlier version of the manuscript.

and self-motivated, curious and interested, vital and eager to succeed because success itself is personally satisfying and rewarding" (Deci & Ryan, 2008, p. 14). In short, the theory recognizes differences between subjects in terms of these characteristics, which result from "the interaction between people's inherent active nature and the social environments that either support or thwart that nature" (Deci & Ryan, 2008, p. 14).

To understand and explain motivated behaviors SDT maintains that there are basic and innate psychological needs which are essential to the psychological development and well-being of individuals. In this sense, SDT takes into consideration three basic psychological needs: autonomy, competence and relatedness (e.g. Deci & Ryan, 1985, 2000; Deci, Vallerand, Pelletier, & Ryan, 1991; Ryan & Deci, 2000b). Autonomy refers to acting with volition, with a sense of choice. Competence refers to the perception that the individual has of his/her effectiveness in a given task because these feelings of competence allow for the satisfaction of the basic psychological need of competence (Ryan & Deci, 2000a). Finally, relatedness is defined as an individual's feeling of support and affection that one might give and receive from interactions with others (Ryan & Deci, 2000b).

According to SDT, environments and social context affect individual experience and the satisfaction of some basic psychological needs, promoting intrinsic motivation. Intrinsically motivated behaviours are more flexible, autonomous, persistent, creative and effective, and beyond that they are also more enjoyable, providing pleasure and satisfaction (Filak & Sheldon, 2003).

Education is one of the domains where the SDT has been applied (Deci et al., 1991; Filak & Sheldon, 2003; Ryan & Niemiec, 2009) because motivation is considered as a central factor in the performance and engagement of students. SDT provides a framework that allows for an understanding of the reasons why people in general and students in particular, engage in activities and how contextual factors and regulatory processes associated either with interactions or to the characteristics of tasks can interfere (Boiché, Sarrazin, Gouzet, Pelletier, & Chanal, 2008; Deci & Ryan, 2008; Filak & Sheldon, 2003; Ryan & Niemiec, 2009). According to Filak and Sheldon (2003) allowing students to learn in their own way (autonomy) by providing them with opportunities to succeed (competence) and by "defusing or removing authoritarian barriers (relatedness), instructors can give their students an interesting, challenging, and intrinsically motivating educational experience" (Filak & Sheldon, 2003, p. 245).

The SDT framework has been the subject of a great deal of research taking place over several years at the University of Rochester where a group of researchers have been developing a multidimensional measure of the motivational characteristics of participants related to a target activity (Grolnick & Ryan, 1987; Ryan & Connell, 1989; Ryan et al., 1983). The result of this ongoing research is an instrument called Intrinsic Motivation Inventory – IMI (SDT, n.d.). This instrument determines the levels of intrinsic motivation as the outcome of a set of subscales: Interest / Enjoyment, Perceived Competence, Effort, Value / Usefulness, Pressure / Tension, Relatedness and Perceived Choice.

The subscale Interest / Enjoyment is the most direct measure (self-report) of intrinsic motivation. This subscale assesses the interest and inherent pleasure when doing a specific activity. Perceived Choice and Perceived Competence are theorized as positive predictors of intrinsic motivation and are related to the SDT innate psychological needs of autonomy and competence. Perceived Choice evaluates how individuals feel they engage in one activity because they choose to do it, and Perceived Competence measures how effective individuals feel when they are performing a task. Pressure/Tension, conceived as a negative predictor of intrinsic motivation, evaluates if participants feel pressure to succeed in an activity. Effort is a separate variable, which is important when taking into account motivation in specific issues and contexts. It assesses the person's investment of his/her capacities in what he/she is doing. The Value / Usefulness subscale embodies the idea that people internalize and develop more self-regulatory activities when experience is considered as valuable and useful for them. Finally Relatedness refers to the degree of a person's feelings connected to others and is used in studies where interpersonal interactions are relevant (SDT, n.d.).

The IMI has been used in research focused on intrinsic motivation and self-regulation in diverse fields such as sports activities (Fonseca & Brito, 2001; Gutiérrez, Ruiz, & López, 2010; McAuley, Duncan, & Tammen, 1989; Tsitskari & Kouli, 2010), reading (Grolnick & Ryan, 1987), computer activities (Deci, Eghrari, Patrick, & Leone, 1994), performance of puzzles (Ryan et al., 1983) and training / education (Filak & Sheldon, 2003). In all these studies the IMI versions used varied in subscales and items depending on the characteristics of tasks and participants. As the authors of IMI (SDT, n.d.) point out, it is necessary to adjust the instrument according to specific tasks and fields and even to different populations. However IMI adaptations are diversified in consistency and methods used, and also in the conceptual framework presented in tested models. As Markland and Hardy (1997) argued, Ryan and collaborators (e.g. Ryan & Connell, 1989; Ryan et al., 1983) briefly described the use of a set of scales to assess levels of enjoyment, pressure, effort and perceived competence in respect to a task, without presenting data on their psychometric characteristics. Despite the above references concerning the use of IMI and its characteristics, one of the first reported analyses of IMI scale structure and psychometric properties was conducted by McAuley et al. (1989) in a competitive sport setting. The authors focused on four different dimensions: Enjoyment, Perceived Competence, Effort and Pressure. Internal consistency was adequate with alpha coefficients varying between .68 and .87 for specific dimensions and

.85 for the overall scale. Confirmatory factor analyses were used to test and compare several alternative models: a four factor model (M4), a single factor model (M1) and a five factor hierarchical model (M5) with four first-order factors and a global second order factor. M4 and M5 presented similar appropriate fit indicators. However the authors maintain that the M5 has greater adequacy as it allows for a perspective beyond the first-order factors.

Goudas and Biddle (1994) using this McAuley et al. (1989) IMI version conducted an exploratory principal components factor analysis with oblique rotation and identify four dimensions, but as the pressure/tension subscale alpha was low and considered unreliable it was excluded from further analyses. Therefore authors use a three dimensions instrument in their research with Enjoyment (alpha .82), Competence (alpha .83) and Effort (alpha .82). They also calculate a global IMI score (alpha .88) but this global measure wasn't tested when conducting factor analysis. Later, Goudas and collaborators (Goudas, Dermitzaki, & Bagiatis, 2000) used IMI and tested the validity of the hierarchical structure. When conducting a confirmatory factor analysis with a nested factor model they concluded that the model fit was satisfactory for a general factor and three dimensions.

Fonseca and Brito (2001) also analyze the psychometric properties of the Portuguese version of IMI adaptation from McAuley et al. (1989). Confirmatory Factor Analysis (CFA) was used to examine the four factor and one factor model. Results showed the superiority of the four factor model to the one factor model. However, the fit indexes suggested that IMI can be used with confidence as a global measure for the evaluation of individual intrinsic motivation for sport and exercise activities, as well as to measure each one of its four facets.

As we can see IMI models tested and used in research are diverse. Some studies tested hierarchical models focusing on global and partial facets (e.g. Goudas et al., 2000; McAuley et al., 1989) whereas other authors focused on only one multidimensional level (e.g. Fonseca & Brito, 2001; Goudas & Bidle, 1994) and others considering intrinsic motivation as a unidimensional construct (Fonseca & Brito, 2001; McAuley et al., 1989). Conclusions are also diversified because the unidimensional model shows good fit index in Fonseca and Brito's (2001) research but not in McAuley et al. (1989). Therefore, the multifaceted IMI organization is conceptualized either as a hierarchical structure or as a group of correlated factors which can lead to different results and interpretations.

Chen, Hayes, Carver, Laurenceau and Zhang (2012) state that when researchers work with multifaceted constructs they often have to choose between two approaches: a total score approach using a composite score obtained from individual facets or the facets score approach which analyses each facet of the construct separately. The authors maintain that both approaches miss some information, as a composite score highlights the shared effects but does not separate the unique effects from the shared variance. Analyzing the facets separately taps into their unique contributions, but the specific effects of the facets are often entangled with the effects of the shared general construct (Chen et al., 2012). Along the same lines, Reise, Moore and Haviland (2010) assert that if a researcher intends to both recognize multidimensionality and simultaneously retain the idea of a single important target construct, the second-order (hierarchical) or bi-factor models are the only choices. Chen et al. (2012) and Reise et al. (2010) maintain that the bi-factorial model can be an even better alternative than second-order models. A second-order model hypothesizes that there is a higher order factor that accounts for the communality shared by the facets, which consists of the lower order factors. However, the bi-factor model can separate the specific factors from the general factor; the factor loadings in bi-factor model, reflect the strength of the relation between the specific factors and their associated items. The bi-factor model can also identify whether a facet still exists after partialling out the general factor (Chen et al., 2012). Therefore, the bi-factor model allows one to directly explore the extent to which items reflect a common target trait and the extent to which they reflect a primary or sub-trait (Reise et al., 2010). In particular, the bi-factor structural model is more amenable to study (a) whether scale items measure a single common dimension, (b) how well the scale items measure a single common dimension, (c) the effect of multidimensionality on scale scores, and (d) the feasibility of applying a unidimensional model in the presence of multidimensional data (Reise et al., 2010).

As we have seen above, researchers interested in assessing intrinsic motivation using the IMI reveal evidence of a general factor running through the items but also there is some evidence of multidimensionality in this instrument. These findings encouraged us to evaluate the Portuguese version of IMI (for Mathematics and for Portuguese Language), particularly whether this construct is unitary or multifaceted.Thus, the aim of our research is to analyze the characteristics of IMI in an adaptation that characterizes the learning motivation for Portuguese students of Mathematics and the Portuguese Language. Furthermore, our aim is to test the best model to describe the internal structure of IMI.

Method

Participants

A total of 3685 pre-adolescents and adolescents (M = 13.67, SD = 2.26) from schools in the metropolitan area of Lisbon participated in the study. The sample consisted of 49.6% (1829) girls and 50.4% (1856) boys. Overall 1250 (33.9%) were attending the second cycle of school (5th and 6th grades), 1691 (45.9%) the 3rd cycle (7th to 9th grade), and 744 (20.2%) Secondary Education (10th to 12th grades). In relation to academic achievement 70.2% had never retaken a year whereas 29.8% had retaken at least once.

From the global sample, 1882 (50.1%) completed a version of the questionnaire on Mathematics whereas 1803 (48.9%) completed the questionnaire on Portuguese Language.

Instrument

The Intrinsic Motivation Inventory (IMI; SDT, n.d.), is an instrument that aims to assess motivation in a broad array of situations and contexts and is rooted in Self Determination Theory (Deci & Ryan, 1985, 2000). The IMI has a multidimensional structure organized in 7 subscales directed towards assessing motivation in specific tasks. Authors of IMI have suggested that, according to the situation, different options can be taken with regard to the subscales to be used depending on their relevance to the issues researchers are exploring (SDT, n.d.). Items can also be removed if they appear redundant or less adapted to the situations under analysis. Moreover, the items are also flexible in formulation, and some may be adjustable to the specific activity of the study (SDT, n.d.).

In these versions of IMI, directed towards motivation in Portuguese Language and in Mathematics, we used five subscales: Interest/Enjoyment, Perceived Competence, Pressure/Tension, Perceived Choice and Value/Utility. We have not included Effort and Relatedness subscales because, in previous studies using exploratory factor analyses, the Effort subscale failed to present consistent or reliable characteristics. Relatedness items did not fit to the tasks that we sought to assess (e.g. Sousa, Monteiro, Mata, & Peixoto, 2010).

Thus, both versions of the questionnaire (Math and Portuguese Language) comprised 21 items, distributed over the 5 referred subscales: Interest/Enjoyment – items 1, 6, 11, 15 and 19 (e.g. "I enjoy doing Math's/Portuguese Language assignments, very much"); Perceived Competence – items 2, 7, 12, 16 (e.g. "I think I am pretty good at Math's/Portuguese Language activities"); Pressure/Tension – items 3 and 8 (e.g. "I felt very tense while doing Math's/Portuguese Language tasks"); Value/Utility – items 4, 9, 13, 17, 20 (e.g. "Math's/Portuguese Language are valuable to me"); Perceived Choice – items 5, 10, 14, 18, 21 (e.g. "I only do the Math's/Portuguese Language tasks because teacher orders."). All items were scored on a 6-point scale ranging from 1 ("Never") to 6 ("Always"). All items from the Perceived Choice subscale were reversed due to their negative formulation. Items were scored in a way that higher scores are related to intrinsic motivation characteristics except for Pressure/Tension, where higher scores mean greater feelings of pressure, which are negatively related to intrinsic motivation.

Data Collection Procedure

The data for this study were collected at schools after obtaining the consent from the school boards and a written consent from parents for their children to participate. Questionnaires were done in the classroom. The researcher carefully explained how to fill out the questionnaire and then assured participants that their responses would remain anonymous. Following these instructions, students completed the IMI individually.

Statistical Analysis

Confirmatory factor analysis (CFA) was used to assess the factorial structure of IMI. We started by testing four different models: unidimensional, multidimensional, second order and bi-factor model (Figure 1). These analyses were carried out on the data from both the Portuguese Language Motivation and Math's Motivation Questionnaires. After choosing the model(s) that best fit the data we undertook separate analyses for Motivation in Portuguese Language and Mathematics. All the analyses were carried out using the Asymptotically Distribution Free estimator (ADF) with Amos 19.0 (Arbuckle, 2010). The option to use ADF was due to the fact that multivariate normality was not guaranteed , despite the fact that all variables presented values for skewness and kurtosis below the thresholds usually considered (Byrne, 2010; Kline, 2011). To assess global fit of the models we used the χ^2, the Adjusted Goodness of Fit Index (AGFI), the Tucker-Lewis Index (TLI), the Comparative Fit Index (CFI) and the Root Mean Square Error of Approximation (RMSEA). As the χ^2 test of models is highly sensitive to sample size (Bentler, 1990; Kline, 2011; Shumacker & Lomax, 2004), and, as we were looking at a large sample, we based our decision of model fit on the others indices. For these, .90 can be considered an acceptable threshold for AGFI, TLI and CFI (Hair, William, Barry, Rolph, & Ronald, 2010; Kline, 2011; Loehlin, 2004). Shumacker and Lomax (2004), however, adopted a more conservative criterion, maintaining that only models presenting values higher than .95 for those indices can be accepted. For RMSEA acceptable values were those lower than .05 with a not excessively high confidence interval (Raykov & Marcoulides, 2006; Shumacker & Lomax, 2004).

To compare the models we conducted chi-square difference tests. However, as this difference can be inflated due to the large sample used we also based our judgment on TLI difference, considering that it was significant if it exceeded .01 (Gignac, 2007; Murray & Johnson, 2013).

Reliability was analyzed using Cronbach's alpha and composite reliability (Maroco, 2010) where scores should be above .70 (Hair et al., 2010). Composite reliability indices were computed following the approach of Geldhof, Preacher and Zyphur (2014).

Results

We examined four models for IMI organization, where construction was based on the arguments previously presented concerning the different models that can be used to study the adequacy of this instrument (Figure 1). Thus we tested a model who presupposes that all the items load in a single factor (Figure 1 – Unidimensional) and three different multidimensional structures: one with five interrelated latent factors (Figure 1 – Multidimensional), another with a common high order latent factor that aggregates the five latent first order factors (Figure 1 – Second order Factor), and a bi-factor model in which each item loads simultaneously in a general factor and in one of the specific dimensions (Figure 1 – Bi-factor).

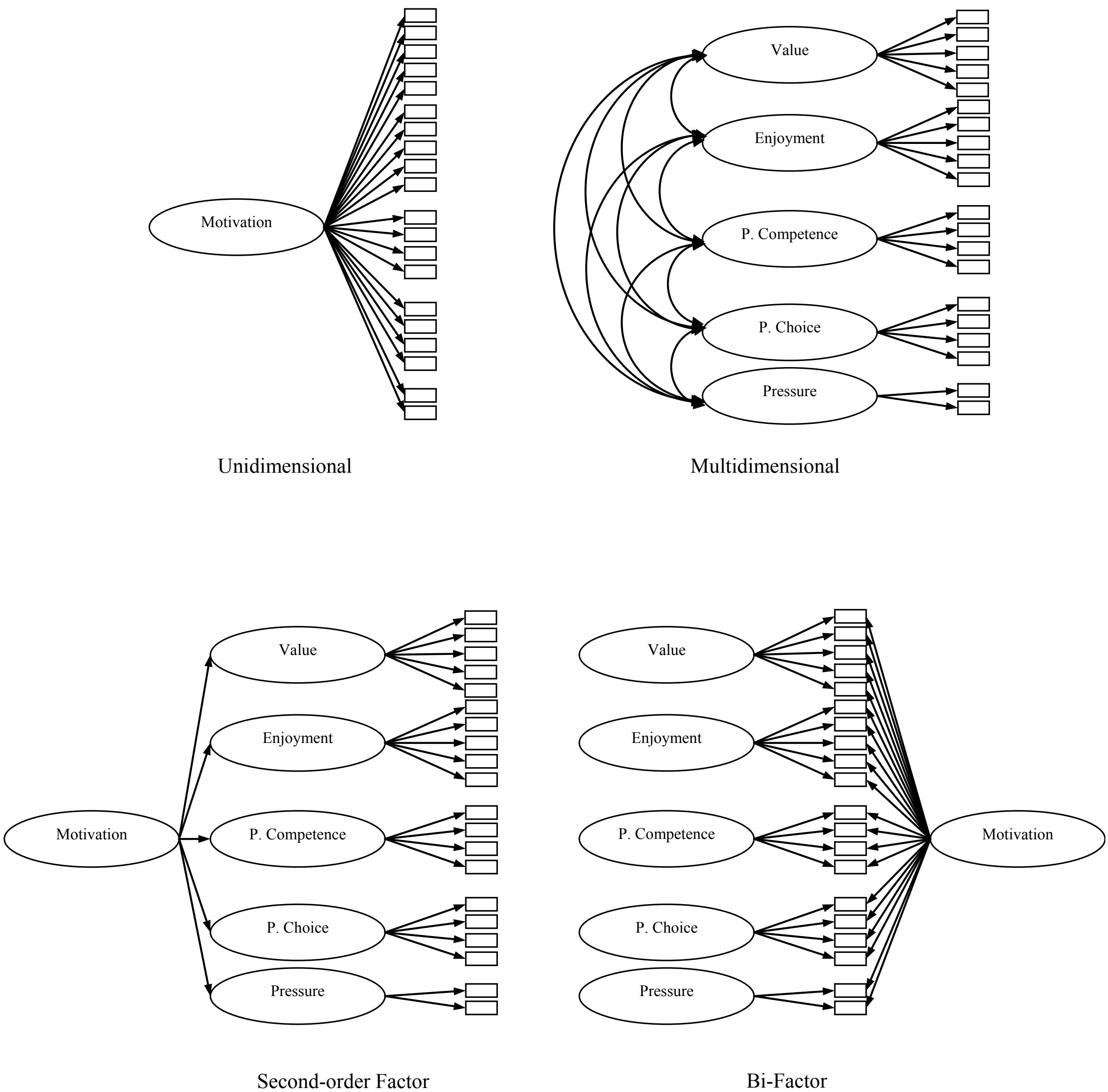

Figure 1. Models tested.

Table 1
Goodness of Fit Statistics for the Models Tested for Global Sample

	χ^2	*df*	AGFI	TLI	CFI	RMSEA (90% CI)
Null Model	4955.3	190	.67	.70	.76	.092 (.090-.094)
Unidimensional Model	3111.5	170	.74	.35	.42	.072 (.070-.075)
Multidimensional Model	1724.3	160	.84	.63	.69	.054 (.052-.057)
Second-Order Factor Model	1974.7	165	.86	.59	.64	.058 (.055-.060)
Bi-Factor Model	1283.4	151	.89	.70	.76	.050 (.048-.053)

Note. df - Model degrees of freedom; AGFI – Adjusted Goodness-of-Fit Index; CFI – Comparative Fit Index; RMSEA – Root Mean Square Error of Approximation.

Results displayed in Table 1 show that all the models tested presented poor fit. To improve model fit we used the "modification indices" provided by AMOS, excluding: items that had cross-loadings with factors other than those they were supposed to load; items in which error terms were correlated with error terms of items which belonged to a different factor. Following this strategy we excluded 2 items from the dimensions Value and Enjoyment and one item from the dimensions Perceived Competence and Perceived Choice. The items of Pressure/Tension factor were also excluded due to low correlations with the remaining factors and the inspection of the factor loadings of the items in the bi-factor model showing low factor loadings in the general factor. In addition the fact that this dimension only has 2 items presented some model identification problems, namely in the bi-factor model. The 12 items that remained were tested within the model framework previously tested.

Table 2
Goodness of Fit Statistics for the Final Models Tested for Global Sample, Mathematics and Portuguese Language

	χ^2	*df*	AGFI	TLI	CFI	RMSEA (90% CI)
Global Sample						
Null Model	3712.5	66	.61	.00	.00	.129 (.126-.133)
Unidimensional Model	2024.1	55	.75	.35	.46	.104 (.100-.108)
Multidimensional Model	213.6	48	.97	.94	.96	.032 (.028-.037)
Second-Order Model	254.3	50	.97	.93	.94	.035 (.031-.039)
Bi-Factor Model	175.3	43	.97	.94	.96	.030 (.026-.035)
Mathematics						
Null Model	2149.5	66	.60	.00	.00	.137 (.132-.142)
Unidimensional Model	1109.1	55	.75	.39	.49	.107 (.101-.112)
Multidimensional Model	145.2	48	.96	.94	.95	.035 (.028-.041)
Second-Order Model	162.7	50	.96	.93	.95	.037 (.030-.043)
Bi-factor Model	124.8	43	.96	.94	.96	.034 (.027-.041)
Portuguese Language						
Null Model	1767.9	66	.61	.00	.00	.126 (.121-.131)
Unidimensional Model	967.1	55	.74	.36	.46	.101 (.095-.106)
Multidimensional Model	145.8	48	.96	.92	.94	.035 (.029-.042)
Second-Order Model	166.5	50	.95	.91	.93	.038 (.031-.044)
Bi-Factor Model	113.1	43	.96	.94	.96	.032 (.025-.039)

Note. df - Model degrees of freedom; AGFI – Adjusted Goodness-of-Fit Index; CFI – Comparative Fit Index; RMSEA – Root Mean Square Error of Approximation.

The results presented in Table 2 show that, with the exception of the unidimensional model, all the models presented adequate goodness-of-fit indices. The chi-square difference tests show that the bi-factor model outperformed both the second-order factor model, $\Delta\chi^2(7) = 79, p < .005$, and the multidimensional model, $\Delta\chi^2(5) = 38.3, p < .005$. The bi-factor model also showed significant TLI difference from the second-order factor (Δ TLI = .018) but not from the multidimensional model (Δ TLI = .006), according to the criteria proposed by Gignac (2007). In relation to the specific subjects, Mathematics and Portuguese Language, there are slight differences. Thus, for Mathematics, the results are similar to those of the global sample [$\Delta\chi^2$ (5) = 20.4, $p < .01$; ΔTLI = .004, for the comparison between the bi-factor model and the multidimensional; $\Delta\chi^2$ (7) =37.9 = 20.4, $p < .001$; ΔTLI = .011, for the comparison between the second-order factor and the bi-factor model]. In Portuguese Language the comparison between the bi-factor model and the multidimensional present significant differences in the TLI indices (ΔTLI = .016) which does not happen either in the global sample or in Mathematics. The remaining comparisons are similar to the results of both the global sample and Mathematics with significant differences both in chi-square and in TLI [$\Delta\chi^2$ (5) = 32.7, $p < .001$ for the comparison between the multidimensional and the bi-factor model; $\Delta\chi^2$ (7) = 53.4, $p < .001$; ΔTLI = .027 for the comparison between the second-order and the bi-factor model].

Table 3
Bi-Factor Solutions, Cronbach's Alpha and Composite Reliability Values of IMI for Global Sample (Mathematics and Portuguese Language)

	Motivation	Value	Enjoyment	Perceived Competence	Perceived Choice
Item 13	.62 (.60/.64)	.57 (.64/.51)			
Item 17	.65 (.64/.68)	.58 (.61/.55)			
Item 20	.69 (.66/.72)	.58 (.64/.52)			
Item 6	.77 (.76/.77)		.26 (.29/.22)		
Item 15	.83 (.84/.82)		.47 (.45/.48)		
Item 19	.73 (.75/.73)		.13 (.11/.13)		
Item 2	.56 (.60/.51)			.71 (.68/.74)	
Item 7	.48 (.48/.46)			.48 (.54/.42)	
Item 12	.43 (.44/.39)			.46 (.46/.47)	
Item 5	.58 (.61/.57)				.48 (.58/.59)
Item 10	.57 (.63/.53)				.46 (.62/.62)
Item 18	.52 (.59/.47)				.58 (.62/.64)
Cronbach Alpha	.89 (.90/.88)	.91 (.92/.89)	.86 (.86/.85)	.82 (.78/.73)	.86 (.88/.84)
Composite Reliability	.92 (.93/.92)	.70 (.76/.63)	.25 (.25/.24)	.67 (.68/.66)	.75 (.74/.75)

Table 3 shows the factor loadings for the bi-factor model, for the global sample and for Mathematics and Portuguese Language. The general pattern is similar both in the global sample and in the specific subjects in which the items of the Enjoyment factor show substantial lower loadings in the specific facet than in the general factor (Motivation) and the others showing more or less similar factor loadings in both specific and general factors. Reliability results are also presented in Table 3. Cronbach's Alpha values are quite acceptable, both for the specific facets of IMI and for the global score in all situations considered (Global Sample, Mathematics and Portuguese Language).

The values for Composite Reliability were computed for the bi-factor model and show that the global score is a reliable measure and also that composite reliability is acceptable for Value, Perceived Competence and Perceived Choice but not for Enjoyment (Table 3).

Discussion

The central aim of this research was to analyze the characteristics of IMI, in a version adapted for the evaluation of the motivation for Portuguese Language and Mathematics. The intention was, therefore, to analyse the psychometric properties, including internal validity and reliability, and to test the model that best describes the structure of IMI. The results obtained in the confirmatory factor analysis highlight a multidimensional structure of IMI since among the four models tested only the Unidimensional model showed inadequate goodness-of-fit indices. These indices were poor not only when considering data of Math and Portuguese Language separately but also when taken together. The inadequacy of the unidimensional model is consistent with the results of McAuley et al. (1989) in a competitive sport setting. These data confirm the theoretical framework which underlies the construction of the original IMI (e.g. Ryan & Connell, 1989; SDT, n.d.). Therefore we may conclude that regardless of the specificity of contexts and tasks, this instrument supports the multidimensionality of motivation and is consistent with the model that takes into consideration the existence of different indicators to understand intrinsic motivation (Deci & Ryan, 1985; Grolnick & Ryan, 1987; Ryan & Deci, 2000b; Ryan et al., 1983).

Although the three multidimensional models present good-fit indices, if we take each one separately, we must decide which one is the most well-adjusted to the theoretical construct underlying IMI. In order to take into account the multidimensionality while simultaneously retaining the idea of a general construct, the second-order and the bi-factor models are the only options (Murray & Johnson, 2013; Reise et al., 2010). Looking at the results from these two multidimensional models, the bi-factor model significantly outperforms the hierarchical model (second-order). Also, if we consider the possibility that the model global fit indices could be biased in favour of the bi-factor model (Murray & Jonhson, 2013), in this case, then the bi-factor model can be a good description of IMI structure in the sense that it can separate the common variance shared for all items from the variance associated with each factor (Chen et al., 2012; Reise et al., 2010). Therefore it is possible to understand to what extent the items reflect the general construct without the impact of multidimensionality and how they reflect a specific construct controlling the general (Reise et al., 2010). As IMI intends to tap into a general construct (Intrinsic Motivation) as well as some specific dimensions which are considered predictors (e.g. Choice) or indicators of intrinsic motivation (Enjoyment), the use of the bi-factor model can help to understand the best way to interpret IMI responses. In this sense results of the analyses of the bi-factor model point to several important aspects related to the general trait (Intrinsic Motivation) and the four specific scales: (a) a general factor clearly emerges; (b) the multidimensionality of IMI is confirmed; (c) the specific scales don't have all the same organizational pattern; (d) the IMI structure is similar considering different specific school subjects. The item loading scores in the general factor and on the specific facets, allows us to evaluate the viability of considering only general or specific dimensions (Reise, 2012; Reise et al., 2010). As we have seen, in IMI, factor loadings of almost all items were very similar in the general factor and in the specific. Only Enjoyment items show a different pattern in that the lowest loading scores are in the specific and the highest loading scores are in the general factor. These results are consistent with SDT theory which maintains the enjoyment/pleasure as a direct index of intrinsic motivation and in IMI specifically is considered as a self-report measure of intrinsic motivation (SDT, n.d.). Perceived Competence, Value and Perceived Choice are considered only as predictors of intrinsic motivation, as they are related to the basic needs which are central to promoting it. The experiences of competence and autonomy are essential to intrinsic motivation, but they are not intrinsic motivation (Grolnick & Ryan, 1987; Ryan & Connell, 1989; Ryan et al., 1983). Therefore, equivalent loading scores in both general and group factors can be explained by the type of contribution of these domains to intrinsic motivation.

In addition to the contribution of the bi-factor model for the conceptualization of intrinsic motivation, it can also be useful to decide on which measures to compute. According to Chen et al. (2012) and Reise et al. (2010) positions on bi-factor models when items have low loadings in the specific factor primarily reflect the general, so it does not make much sense to compute scores for the specific facet. Nevertheless when factor loadings are substantial and more or less identical in the general and specific factors, then we can take into consideration to compute scores for both the aggregate measure and the specific dimension (Reise et al., 2010). Thus, the results presented suggest that we can compute measures for Perceived Competence, Value and Perceived Choice and also for Intrinsic Motivation global score. In regard to the reliability of the instrument, results also point to the adequacy of IMI. All the specific facets present satisfactory Cronbach's alpha scores, either when the data is analyzed together (Portuguese Language and Mathematics) or in separate analyses of the scales. In the case of Cronbach's alpha for the global analysis, scores ranged from .82 to .91. Note that these scores, although similar, are higher in all dimensions than those found in other research which adapted IMI for sport activities (Gutiérrez et al., 2010; McAuley et al., 1989; Tsitskari & Kouli, 2010). In addition to Cronbach alpha scores, composite reliability was computed, which can be considered a better estimator of reliability as it acknowledges the heterogeneous item-construct relations taking into account the factor loadings of each factor (Geldhof et al., 2014). Composite reliability scores show that not only the global measure but also some specific dimensions scores (Value, Perceived Competence, and Perceived Choice) are reliable measures. The low composite reliability value for Enjoyment is consistent with the weak loadings on the specific factor referred to above and also points to the inadequacy of computing a measure based only on the items of this dimension.

Some limitations should be highlighted when considering the present findings and which also have the benefits of pointing to new directions for future research. Firstly the data in our research is all self-reported. Future studies are needed in order to provide additional support for the validation of the IMI dimensions in these specific tasks, through correlations with other assessments of motivation indicators such as behavioral indices or through the observations of others who can corroborate the reports made independently by students (e.g teachers). Another concern focuses on something already mentioned by authors of the original IMI (SDT, n.d.) and refers to the redundancy of items within the subscales which can sometimes overlap with each other. However, we have tried reduce this so as not to include as many items in each dimension and randomizing their presentation in the scale and mixing the items of the five subscales. We think that this option was a positive step as the result was a relatively short instrument, allowing for a tool that can be utilized easily and usefully in research and intervention in school and educational settings.

To summarize, the Portuguese version of IMI showed adequate validity and reliability for the assessment of intrinsic motivation in Portuguese Language and Mathematics. The bi-factor model was shown to be the best model, which enabled us to highlight the contribution of the different dimensions for the general factor of intrinsic motivation. Therefore the Portuguese version of IMI not only represents a cross-cultural and specific domain adaptation of the initial IMI but it is also a reliable and valid instrument in its own right. Its ability to assess three dimensions of motivation and a global measure is of central importance as it allows for a diverse understanding of student engagement with academic tasks. This may also help technicians and teachers to understand levels and types of student motivation in specific curricular subjects. Such information may be fundamental to the definition of new teaching strategies, aims and tasks in order to promote intrinsic motivation and a deeper engagement of students with school subjects and knowledge.

References

Arbuckle, J. L. (2010). *AMOS 19.0 user's guide* [Manual software]. Chicago, IL: Statistical Package for the Social Sciences.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*, 238-246. doi:10.1037/0033-2909.107.2.238

Boiché, J., Sarrazin, P., Grouzet, F., Pelletier, L., & Chanal, J. (2008). Students' motivational profiles and achievement outcomes in physical education: A self-determination perspective. *Journal of Educational Psychology, 100*, 688-701. doi:10.1037/0022-063.100.3.688

Byrne, B. M. (2010). *Structural equation modeling with Amos: Basic concepts, applications, and programming* (2nd ed.). New York: Routledge.

Chen, F., Hayes, A., Carver, C., Laurenceau, J. P., & Zhang, Z. (2012). Modeling general and specific variance in multifaceted constructs: A comparison of the Bifactor model to other approaches. *Journal of Personality, 80*, 219-251. doi:10.1111/j.1467-6494.2011.00739.x

Deci, E., Eghrari, H., Patrick, B., & Leone, D. (1994). Facilitating internalization: The self-determination theory perspective. *Journal of Personality, 62*, 119-142. doi:10.1111/j.1467-6494.1994.tb00797.x

Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Deci, E., & Ryan, R. (2000). The "What" and "Why" of goal pursuits: Human needs and self-determination of behavior. *Psychological Inquiry, 11*, 227-268. doi:10.1207/S15327965PLI1104_01

Deci, E., & Ryan, R. (2008). Facilitating optimal motivation and psychological well-being across life's domains. *Canadian Psychology, 49*, 14-23. *doi:10.1037/0708-5591.49.1.14*

Deci, E., Vallerand, R., Pelletier, L., & Ryan, R. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist, 26*, 325-346. doi:10.1080/00461520.1991.9653137

Filak, V., & Sheldon, K. (2003). Student psychological need satisfaction and college teacher-course evaluation. *Educational Psychology, 23*, 235-247. doi:10.1080/0144341032000060084

Fonseca, A. M., & Brito, A. P. (2001). Propriedades psicométricas da versão portuguesa do *Intrinsic Motivation Inventory* (IMIp) em contextos de actividade física e desportiva [Psychometric properties of the Portuguese version of Intrinsic Motivation Inventory (IMIp) in contexts of sports and physical activity]. *Análise Psicológica, 19*, 59-76. doi:10.14417/ap.344

Geldhof, G., Preacher, K. J., & Zyphur, M. J. (2014). Reliability estimation in a multilevel confirmatory factor analysis framework. *Psychological Methods*, *19*, 72-91. doi:10.1037/a0032138

Gignac, G. E. (2007). Multi-factor modeling in individual differences research: Some recommendations and suggestions. *Personality and Individual Differences*, *42*, 37-48. doi:10.1016/j.paid.2006.06.019

Goudas, M., & Biddle, S. (1994). Perceived motivational climate and intrinsic motivation in school physical education classes. *European Journal of Psychology of Education, 9*(3), 241-250. doi:10.1007/BF03172783

Goudas, M., Dermitzaki, I., & Bagiatis, K. (2000). Predictors of students' intrinsic motivation in school physical education. *European Journal of Psychology of Education, 15*(3), 271-280. doi:10.1007/BF03173179

Grolnick, W., & Ryan, R. (1987). Autonomy in children's learning: An experimental and individual difference investigation. *Journal of Personality and Social Psychology, 52*, 890-898. doi:10.1037/0022-3514.52.5.890

Gutiérrez, M., Ruiz, L., & López, E. (2010). Perceptions of motivational climate and teachers' strategies to sustain discipline as predictors of intrinsic motivation in physical education. *The Spanish Journal of Psychology, 13*, 597-608. doi:10.1017/S1138741600002274

Hair, J. F., William, C. B., Barry, J. B., Rolph, E. A., & Ronald, L. T. (2010). *Multivariate data analysis* (7th ed.). Upper-Saddle River, NJ: Pearson Education.

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York: Guilford Press.

Loehlin, J. C. (2004). *Latent variable models: An introduction to factor, path and structural analysis* (4th ed.). Mahwah, NJ: Lawrence Erlbaum.

Markland, D., & Hardy, L. (1997). On the factorial and construct validity of the Intrinsic Motivation Inventory: Conceptual and operational concerns. *Research Quarterly for Exercise and Sport, 68*, 20-32. doi:10.1080/02701367.1997.10608863

Maroco, J. (2010). *Análise de equações estruturais: Fundamentos teóricos, software & aplicações* [Structural equations analysis: Theoretical foundations, software & applications]. Pêro Pinheiro, Portugal: ReportNumber.

McAuley, E., Duncan, T., & Tammen, V. V. (1989). Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: A confirmatory factor analysis. *Research Quarterly for Exercise and Sport, 60,* 48-58. doi:10.1080/02701367.1989.10607413

Murray, A. L., & Johnson, W. (2013). The limitations of model fit in comparing the bi-factor versus higher-order models of human cognitive ability structure. *Intelligence*, *41*, 407-422. doi:10.1016/j.intell.2013.06.004

Raykov, T., & Marcoulides, G. A. (2006). *A first course in structural equation modeling* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum.

Reise, S. (2012). The rediscovery of bifactor measurement models. *Multivariate Behavioral Research, 47*(5), 667-696. doi:10.1080/00273171.2012.715555

Reise, S., Moore, T., & Haviland, M. (2010). Bifactor models and rotations: Exploring the extent to which multidimensional data yield univocal scales scores. *Journal of Personality Assessment, 92*(6), 544-559. doi:10.1080/00223891.2010.496477

Ryan, R., & Connell, J. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domain. *Journal of Personality and Social Psychology*, *57*, 749-761. doi:10.1037/0022-3514.57.5.749

Ryan, R., & Deci, E. (2000a). Self-determination theory and the facilitation of intrinsic motivation, social development and well-being. *American Psychologist, 55*, 68-78. doi:10.1037110003-066X.55.1.68

Ryan, R., & Deci, E. (2000b). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54-67. doi:10.1006/ceps.1999.1020

Ryan, R., Mims, V., & Koestner, R. (1983). Relation of reward and interpersonal context to intrinsic motivation: A review and test using Cognitive Evaluation Theory. *Journal of Personality and Social Psychology, 45*, 736-750. doi:10.1037/0022-3514.45.4.736

Ryan, R., & Niemiec, C. (2009). Self-determination theory in schools of education – Can a empirically supported framework also be critical and liberating? *Theory and Research in Education, 7*, 263-272. doi:10.1177/1477878509104331

Self-Determination Theory. (n.d.). Retrieved from http://www.selfdeterminationtheory.org/questionnaires/10-questionnaires/50

Shumacker, R. E., & Lomax, R. G. (2004). *A beginner's guide to structural equation modeling* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum.

Sousa, T., Monteiro, V., Mata, L., & Peixoto, F. (2010). Motivação para a matemática em alunos do secundário [Motivation for mathematics among secondary students]. In C. Nogueira, I. Silva, L. Lima, A. T. Almeida, R. Cabecinhas, R. Gomes, ...M. C. Taveira (Eds.), *Actas do VII Simpósio Nacional de Investigação em Psicologia* (pp. 2805-2819). Retrieved from http://www.actassnip2010.com

Tsitskari, E., & Kouli, O. (2010). Intrinsic motivation, perception of sport competence, and life-satisfaction of children in a Greek summer sport camp. *World Leisure Journal, 52*, 279-289. doi:10.1080/04419057.2010.9674653

Received: 25/07/2013
Accepted: 22/07/2014