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Translation and validation of the perceived locus of causality questionnaire (PLOCQ) in a sample of portuguese physical education students

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Abstract — Aim: This study main aim was to translate and validate one of the most used SDT-based instruments to assess motivation in PE classes, the Perceived Locus of Causality Questionnaire (PLOCQ), to the Portuguese context. **Method:** Sample was composed of 652 boys (M=15.4 years; SD=1.90) and 702 girls (M=15.47 years; SD=1.95), enrolled in physical education classes in several Portuguese schools. **Results:** The analysis provided support for a five factors and 18 items model, after excluding two items ($\chi^2 = 491.473$, $df = 125$, $p = <.001$, SRMR = .062, NNFI = .908, CFI = .924, RMSEA = .067, 90% CI .061-.073). Sample and gender invariance procedures were made to ensure proper psychometric validation. Results presented support for the model in both gender and calibration/validation samples. **Conclusion:** This study suggests that PLOCQ with five factors and 18 items has good psychometric properties and can be used to assess contextual motivation towards PE in the Portuguese context.

Keywords: psychological assessment; confirmatory factor analysis; self-determination theory; multi-group analysis; physical education.

Introduction

Motivation in Physical Education (PE) classes has been a focus of study and concern on the part of several researchers. Given the characteristics of the class and students, physical education teachers need to better understand how to improve their intervention, helping students achieving the warranted effects of PE. This can pose a difficult task when contextual motivation of students changes across time¹.

Self-Determination Theory (SDT²) has been one of the main frameworks used to study motivational processes throughout the last 30 years. This theory includes several mini-theories. One of its mini-theories (Cognitive Evaluation) postulates that two types of motivation influence one's behavior. When someone is doing an activity for the inherent pleasure or interest, it is considered that the person is intrinsically motivated; on the opposite side, performing an activity for instrumental reasons, to avoid disapproval or obtain separable outcomes characterizes an extrinsically motivated person. If an individual does not perceive a worthwhile reason to participate in an activity, then there is an absence of intrinsic or extrinsic motivation – defined in SDT as amotivation^{3,4}.

In Deci and Ryan^{2,5} seminal work, it has been proposed that the different types of motivation are expressed in a continuum that reflects the individual's level of self-determination. According to the Organismic Integration Theory, extrinsic motivation is composed of four behavioral regulations increasing in their degree of self-determination or autonomy. The less self-determined form of extrinsic motivation is external regulation, which reflects the influence of external pressures or rewards on the behavior. Next, introjected regulation reflects self-imposed pressures like guilt, shame or ego protection. These two behavioral regulations

express a form of external control in the individual behavior. Identified regulation, which refers to the recognition and acceptance of the importance of a behavior, and integrated regulation, manifesting the pursuit of an activity because it is in line with one's core values and sense of self, represent a gradual transition to more autonomous forms of motivation. In SDT, these regulatory mechanisms reflect a degree of internalization of the behavior, facilitating the understanding of exercise behavior in several contexts. Previous studies have showed that more autonomous forms of motivation are positively associated with exercise behavior and continuous adherence⁶, higher levels of concentration in PE⁷, better affective outcomes^{8,9} and preference to engage in challenging tasks^{7,8}.

Throughout the years, SDT^{2,10} has sustained the development of several instruments to assess student's perceptions about their motivation¹¹. However, these instruments are created and validated in a particular language and culture and may not accurately measure what is intended after being translated and/or adapted to a new setting, culture or language. Despite cross-cultural validations and the universality of SDT principles, little attention has been given to the validity scores of some of the most popular SDT-based measurement instruments¹².

One of these instruments is the Perceived Locus of Causality Questionnaire (PLOCQ), which is used to assess contextual motivation towards PE. This instrument was initially developed by Goudas, Biddle and Fox¹³ through an adaptation of the Self-Regulation Questionnaire developed by Ryan and Connell¹⁴. Their aim was to create a scale that encompassed the full range of the SDT behavioral regulation spectrum (except for integrated regulation). To measure amotivation, the Vallerand et al.¹⁵ subscale of the academic Motivation Scale was used.

Psychometric testing supported the reliability and validity of the PLOCQ subscales^{7,16,17}. Yet, some issues with the internal consistency of introjected regulation scores and the discriminant validity of identified regulation and intrinsic motivation scores were reported^{7,16}. Posteriorly, Lonsdale et al.¹² provided further psychometric analysis and cross-cultural validation of the instrument. Currently, the PLOCQ is considered as a valid and useful instrument to assess what it proposes.

In the Portuguese context, PLOCQ has been used in the PE context in the last years. However, to our knowledge, no psychometric validation was made to ensure its feasibility in this particular language and context, an overly due problem in this field of study. Therefore, this study sought to translate and validate one of the most used SDT-based instruments to assess motivation in PE classes, the Perceived Locus of Causality Questionnaire (PLOCQ), to the Portuguese context. Psychometric proprieties and invariance across gender were evaluated to ensure proper instrument feasibility.

Method

Participants

Physical education students of four Lisbon public schools were invited to participate in this study. The students were enrolled in the 3rd cycle (7th, 8th and 9th grades) and secondary cycle (10th, 11th and 12th years). Study information and permissions were sent to the schools direction board and parents. After obtaining the study permissions, the students were debriefed about the study aims and their participation previous to the questionnaires delivery. The PE teachers were informed of the requirements necessary to apply the questionnaires. A calm and peaceful environment were provided in a class room to the students before the class starts, in order to read, fill and ask any doubts regarding the questionnaires. No dropouts were reported in this stage.

Two independent samples of PE students were used in this study to ensure the robustness of the measurement instrument in a sample of the same population.

The first set of participants consisted of 699 students and represented the calibration sample, with ages comprised between 12 and 23 years old (M=15.49; SD=1.93), with 332 males and 367 females, enrolled in two PE classes/week (135 min total). The validation sample was composed of 655 students, with ages between 12 and 23 years old (M=15.47; SD=1.88), 312 males and 343 females, with the same amount of PE/week than previous sample. The global sample comprised 644 boys (M=15.4 years; SD=1.90) and 710 girls (M=15.47 years; SD=1.95), were 650 students were enrolled in the 3rd cycle (ages 12 to 17 years) and 704 in secondary cycle (ages 17 to 23 years).

Measures

The Perceived Locus of Causality questionnaire¹² (PLOCQ) was translated and adapted to the Portuguese context. The PLOCQp consists of 20 items with a seven-point Likert scale, ranging from 1 (“Strongly Disagree”) to 7 (“Strongly Agree”).

The items are grouped into five factors (with four items each), which reflect the behavioral regulations encompassed in the SDT motivational continuum.

Procedures

Data collection

For the study data collection, authorizations were obtained from the school direction board. All participants enrolled voluntarily and provided an informed consent signed by them and their legal guardian. Confidentiality was guaranteed and ensured. Before a PE class, a brief explanation of the study purposes was made and comfortable conditions were provided to the completion of the questionnaire. The University Scientific Board approved this study.

Procedures of translation of the PLOCQp

For the translation and adaptation of the PLOCQ¹² from the original language (English) to Portuguese, several methodological procedures were adopted^{18,19}. Despite using the translation/back translation technique, we employed the committee approach methodology²⁰. This process was developed according to the following steps: 1) Preliminary Translation; 2) First Committee; 3) Second Committee (this stage was over only when all the specialists agreed with each other and their opinion was unanimous towards the item contents); 4) Pilot Study; 5) Final Review (only syntax aspects).

Data analysis

Descriptive statistics including means and standard deviations, for the two samples were calculated for all variables. To undertake the confirmatory factor analysis, the recommendations of Byrne^{21,22,23} regarding the use of the estimated method of maximum likelihood (ML), chi-squared (χ^2) testing of the respective degrees of freedom (df), and the level of significance (p) were used. Also, the following adjustment goodness-of-fit indexes were used: Standardized Root Mean Square Residual (SRMR), Comparative Fit Index (CFI), Non-Normed Fit Index (NNFI), Root Mean Square Error of Approximation (RMSEA) and the respective confidence interval (90% CI). Traditionally, NNFI and CFI values $\geq .90$ and RMSEA and SRMR $\leq .08$ have been used as cut-off criteria. Additionally, the convergent validity was analyzed (to check if the items were related to the respective factor) via the calculation of the average variance extracted (AVE), considering values of AVE $\geq .50$ ²² and the composite reliability (CR) was analyzed to assess the internal consistency of the factors, adopting CR $\geq .70$ as the cut-off values, as suggested by Hair et al.²². To examine if there was a distinction between factors (i.e. discriminant validity), the relation of the values of the square of the correlation between the factors was used; variance extracted estimates should be greater than the squared correlation estimate.

To check the assumptions of the nomological validity of the PLOCQ, Pearson correlational analyses were used between the PLOCQ and the different types of motivation underlying SDT framework⁵: amotivation, external regulation, introjected regulation, identified regulation, and intrinsic motivation. The analyses were undertaken using AMOS and SPSS 20.0.

Multi-group analysis

A multi-group analysis is one of the crucial aspects in the development and use of psychometric instruments^{24,25}, because it demonstrates if the measurement model structure is equivalent (invariant) across different groups with different characteristics (in the present study, across samples and gender). According to several authors^{21,24}, invariance exists when two criteria are verified: the measurement model is adjusted to each group and to perform a multi-group analysis, considering the following invariance types: configural invariance (model without constraints), metric invariance (equality of factorial weights), scalar invariance (factorial weights and covariance equals) and residual invariance (factorial weights, covariance and equal measure errors) were assessed. Differences in values between the models without constraints (free parameters) vs. models with constraints (fixed parameters) should be verified through the difference in the $\Delta\chi^2$ test or by the differences in $\Delta CFI \leq .01$ ²⁴.

Nomological validity

To analyze if constructs in a same theory framework make sense, a correlational analysis was made between the PLOCQ

factors and another SDT based instrument – Engagement Scale (translated and validated by others; in preparation). This scale has four factors and 14 items: the Behavioral Engagement factor is composed by three items, and reflects how students engage in tasks in organizational settings²⁶; the Agentic engagement is assessed by four items that tap into the students self-motivational supportive learning²⁷; the Cognitive Engagement has three items based in achievement goal theory²⁸ that reflect students orientations in exercise practice; the Emotional Engagement has four items to assess emotional and affective dynamics in social tasks²⁶.

Results

Preliminary Analysis

A primary analysis of the data revealed that there were 10 multivariate outliers (i.e., six in the calibration sample; four in the validation sample) ($D2 = p1 < 0.01$; $p2 < 0.01$). These participants were removed prior to conducting any further analysis, as postulated by several authors^{21,22}. Additionally, Mardia’s coefficient for multivariate kurtosis in all samples was higher than five (calibration sample = 46.56; validation sample = 77.25), exceeding expected values for the assumption of multivariate normality²¹. Therefore, Bollen-Stine bootstrap with 2000 samples was employed for subsequent analysis²⁹.

Descriptive analyses in Table 1 tend to show a normal univariate distribution of the data in both samples, with a slight bias to the right, and the tendency of answering near the center of the bi-polar Likert scale (i.e., three and four in a seven point scale).

Table 1 Descriptive analysis of the answers to the items on the PLOCQ in the calibration and validation samples

Item	Min–Max	Calibration	Validation	Calibration	Validation	Calibration	Validation	Calibration	Validation	Calibration	Validation
		M±SD	M±SD	Skewness	Skewness	z value	z value	Kurtosis	Kurtosis	z value	z value
Item 1 (ER)	1-7	3.39±2.28	3.46±2.30	.399	.350	4.360	3.653	-1.319	-1.375	-7.120	-7.184
Item 2 (IJ)	1-7	3.26±2.10	3.43±2.08	.476	.335	5.137	3.504	-1.077	-1.220	-5.814	-6.376
Item 3 (ID)	1-7	4.78±1.80	4.84±1.77	-.499	-.435	-5.389	-4.540	-.653	-.758	-3.523	-3.962
Item 4 (IM)	1-7	4.85±1.77	4.97±1.68	-.486	-.596	-5.241	-6.226	-.662	-.434	-3.570	-2.268
Item 5 (AM)	1-7	2.16±1.89	1.99±1.77	1.495	1.783	16.137	18.631	.920	1.967	4.226	10.277
Item 6 (ER)	1-7	4.31±2.07	4.16±2.13	-.247	-.094	-2.666	-.981	-1.168	-1.282	-6.304	-6.696
Item 7 (IJ)	1-7	2.94±2.07	2.91±2.10	.708	.756	7.645	7.899	-.862	-.822	-4.650	-4.292
Item 8 (ID)	1-7	4.89±1.82	5.14±1.72	-.555	-.692	-5.993	-7.229	-.657	-.401	-3.545	-2.096

Item 9 (IM)	1-7	4.78±1.90	4.83±1.91	-.457	-.516	-4.935	-5.390	-.862	-.832	-4.652	-4.347
Item 10 (AM)	1-7	2.32±1.94	2.12±1.74	1.330	1.484	14.350	15.501	.432	1.097	2.331	5.732
Item 11 (ER)	1-7	2.68±1.99	2.53±1.94	.908	1.069	9.797	11.168	-.480	-.095	-2.591	-.497
Item 12 (IJ)	1-7	3.50±2.12	3.37±2.20	.292	.372	3.154	3.891	-1.261	-1.296	-6.804	-6.770
Item 13 (ID)	1-7	4.87±1.88	4.95±1.84	-.600	-.704	-6.471	-7.355	-.708	-.474	-3.821	-2.096
Item 14 (IM)	1-7	4.26±1.87	4.48±1.80	-.190	-.304	-2.046	-3.179	-.914	-.813	-4.935	-4.247
Item 15 (AM)	1-7	2.22±1.83	2.10±1.71	1.425	1.525	15.377	15.936	.783	1.267	4.226	6.617
Item 16 (ER)	1-7	3.86±2.35	3.64±2.25	.096	.227	1.037	2.371	-1.527	-1.383	-8.240	-7.227
Item 17 (IJ)	1-7	3.28±1.98	3.20±2.00	.392	.445	4.234	4.653	-1.063	-1.035	-5.738	-5.409
Item 18 (ID)	1-7	4.35±2.06	4.51±1.88	-.254	-.327	-2.738	-3.414	-1.193	-.905	-6.436	-4.730
Item 19 (IM)	1-7	4.49±1.97	4.47±1.91	-.256	-.269	-2.759	-2.813	-1.105	-1.038	-5.965	-5.421
Item 20 (AM)	1-7	2.22±1.84	2.03±1.69	1.444	1.662	15.589	17.365	.881	1.700	4.755	8.882

Note. AM (Amotivation); EX (External Regulation); IJ (Introjected regulation); ID (Identified regulation); IM (intrinsic motivation); M (Mean); SD (Standard deviation)

In Table 2, it is possible to see that the initial model (i.e., five factor and 20 items) did not have a good adjustment to the data. An analysis of the individual parameters based on the modification indices revealed that two items (item 14 - intrinsic motivation, and item 2 - introjected regulation), are cross-loadings. These items were therefore removed from the model, as suggested by several authors^{21,22}. Following these modifications, the final model (re-specified) provided a good fit to the data for all samples under analysis.

In the model depicted in figure 1, ordered relations between correlated variables appear, reflecting the simplex structure which is characteristic of the SDT framework¹⁴, meaning that behavioral regulations closer to each other are positively correlated, and regulations further away in the continuum have weaker or negative correlations.

Factorial weights in each factor presented statistical differences after model adjustment (all $p < .05$), indicating factorial validity. In the calibration sample, factorial weights varied between .66 and .88 for Intrinsic Motivation, .68 and .82 for Identified Regulation, .68 and .80 for Introjected Regulation, .59 and .65 for External Regulation and .51 and .77 for Amotivation. In the validation

sample, values ranged between .61 and .83 for Intrinsic Motivation, .69 and .81 for Identified Regulation, .69 and .79 for Introjected Regulation, .50 and .67 for External regulation and .43 and .80 for Amotivation. Except for item 16 (validation sample), all the other items explained more than 25% of the variance of the latent factor ($\lambda_{ij} \geq .25$), as recommended by Hair et al.²².

Results in table 3 show that most factors in the measurement model presented an adjusted composite reliability ($\geq .70$). The only exception was for external regulation in the validation sample, where CR = .67 is considered acceptable when other indicators of construct validity are good (Hair et al., 2014). Concerning convergent validity, the AVE was calculated and presented minor issues in both samples, as some values were under the adopted in methodology (CS amotivation and external regulation $< .50$; VS external regulation $< .50$)²². In the discriminant validity analysis, some issues were detected in intrinsic motivation-identified regulation for the calibration sample and external regulation-amotivation and intrinsic motivation-identified regulation in the validation sample, where the square of the factor's correlations between factors were higher than the AVE²².

Table 2 Fit indices of the measurement models of PLOCQp (including existing versions)

Models	χ^2	df	B-S p	SRMR	NNFI	CFI	RMSEA	90% CI
PLOCQ ¹	971.83*	320	-	.090	.950	.960	.080	.070-.080
Initial Model Calibration	915.351	160	<.001	.067	.861	.883	.082	.951-1.224
Final Model Calibration	542.004	125	<.001	.061	.908	.925	.069	.063-.075
Final Model Validation	491.473	125	<.001	.062	.908	.924	.067	.061-.073
Male Model	449.601	125	<.001	.051	.917	.933	.063	.405-.604
Female Model	560.320	125	<.001	.068	.904	.921	.070	.065-.076
3rd cycle	409.633	125	<.001	.055	.925	.939	.060	.054-.067
Secondary cycle	625.733	125	<.001	.075	.900	.912	.075	.070-.081
Engagement ²	7413.507	91	<.001	.043	.913	.932	.069	-

Note. χ^2 = chi-squared; * values reported by the authors concerning the Satorra-Bentler correction of χ^2 (S-B χ^2); df = degrees of freedom; SRMR = Standardized Root Mean Square Residual; NNFI = Non-Normed Fit Index; CFI = Comparative Fit Index; RMSEA = Root Mean Squared Error of Approximation; 90% CI = confidence interval of RMSEA; Final Model - five factors and 18 items; ¹Lonsdale, Sabiston, Taylor, Ntoumanis¹²; ² in preparation by others

Figure 1 Standardized individual parameters (covariance factors, factorial weights and measurement errors), all of which were significant in the measurement model (PLOCQp - Five factors/18 items) for the Portuguese calibration sample

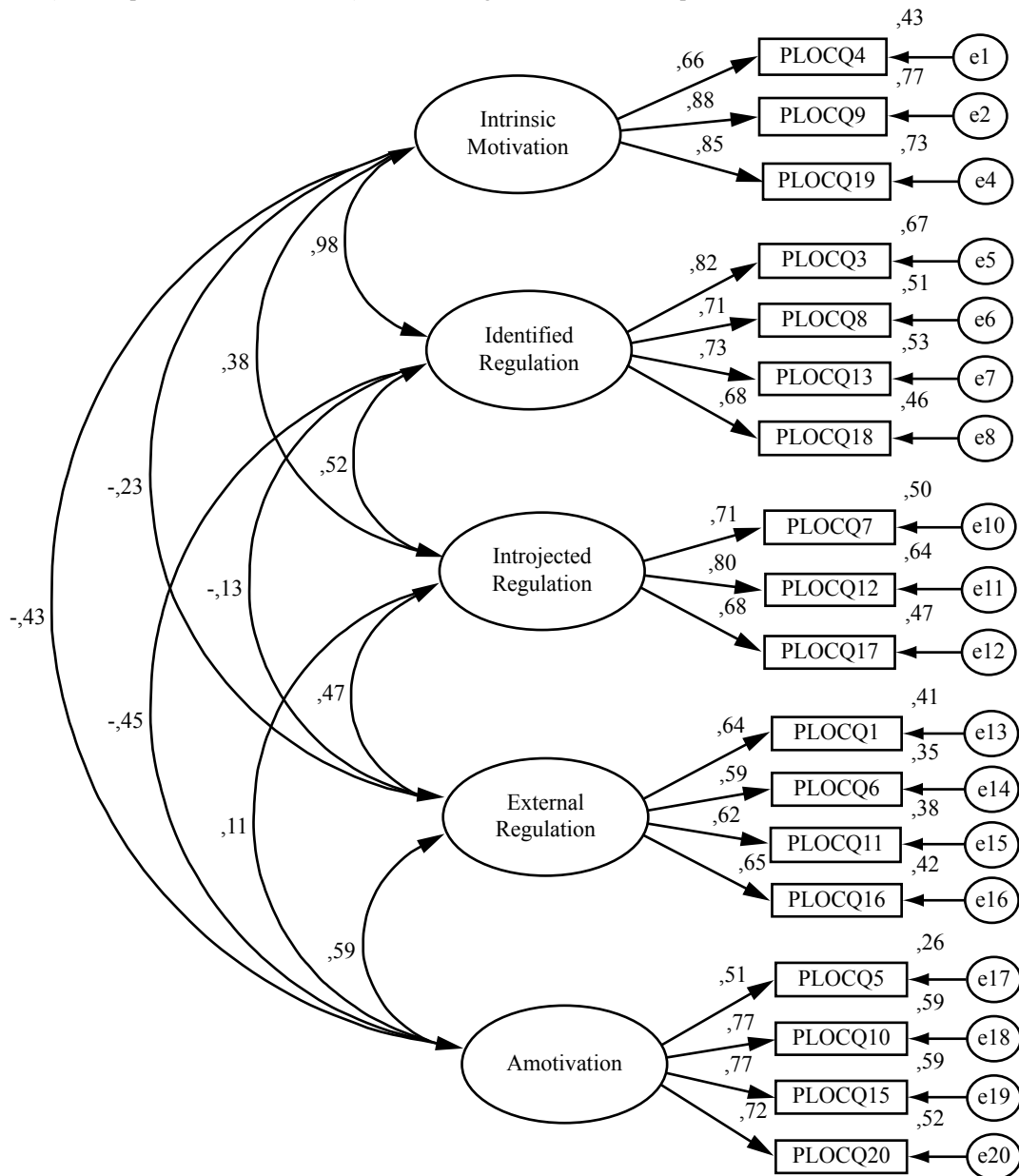


Figure 2 Standardized individual parameters (covariance factors, factorial weights and measurement errors), all of which were significant in the measurement model (PLOCQp - Five factors/18 items) for the Portuguese validation sample

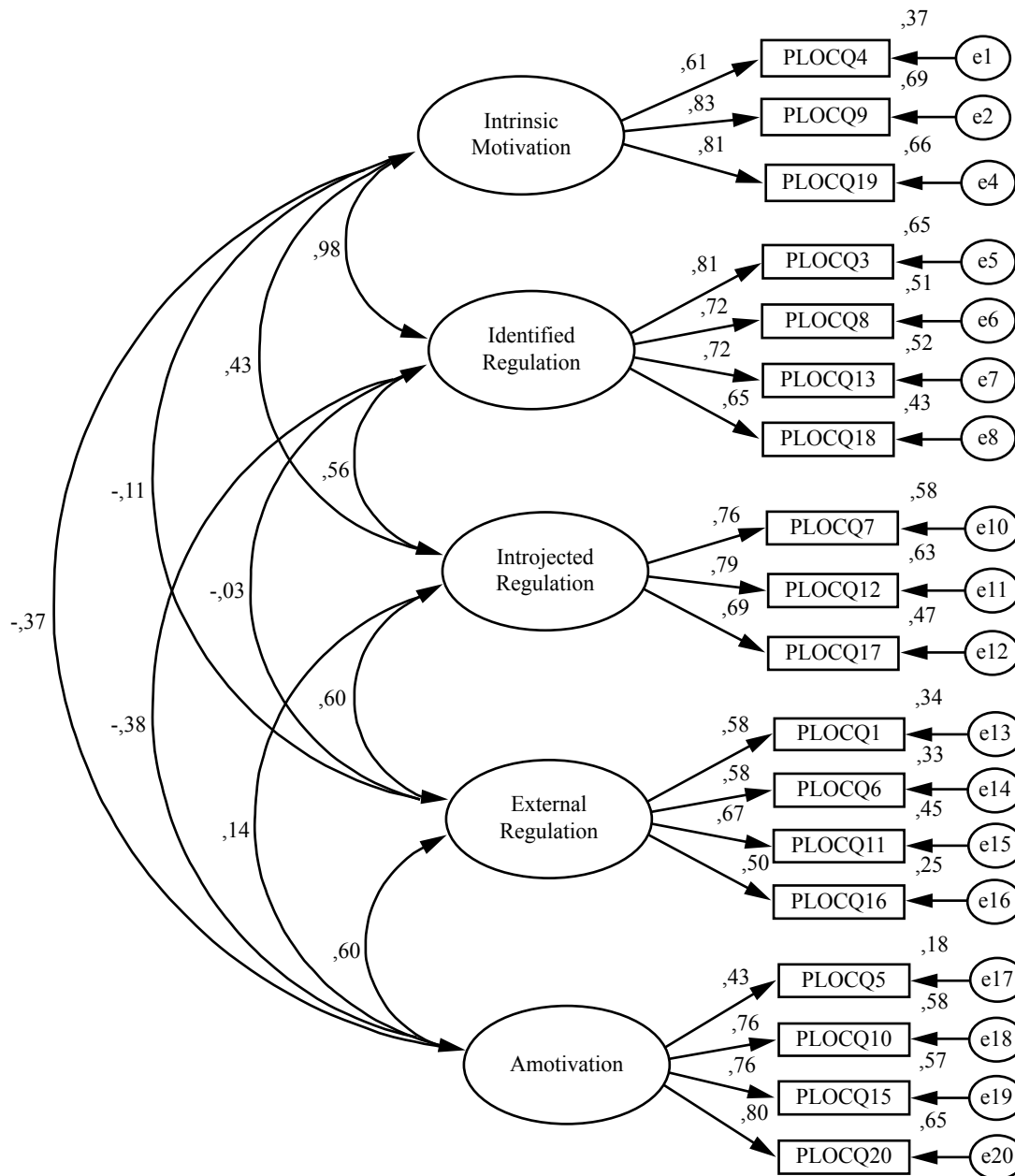


Table 3 Internal reliability, convergent and discriminant validity and average variance extracted – Calibration and Validation samples

Factors (calibration)	CR	AVE	AM	ER	IJ	ID	IM
AM	.79	.49	1	-	-	-	-
ER	.72	.39	.34*	1	-	-	-
IJ	.78	.54	.01*	.22*	1	-	-
ID	.83	.54	.20*	.02*	.27*	1	-
IM	.84	.64	.18*	.05*	.14*	.97*	1
Factors (validation)	CR	AVE	AM	ER	IJ	ID	IT

AM	.79	.50	1	-	-	-	-
ER	.67	.34	.36*	1	-	-	-
IJ	.73	.56	.02*	.36*	1	-	-
ID	.82	.53	.15*	<.001*	.31	1	-
IM	.70	.57	.13*	.13*	.19*	.97*	1

Note. Composite Reliability (CR); Average Variance Extracted (AVE); AM= amotivation; EX= external regulation; IJ= introjected regulation; ID= identified regulation; IM= intrinsic motivation; * (r²).

According to the results in table 2, all samples presented a good adjustment (i.e., calibration, validation, male and female samples). The invariance analysis of these models is expressed in table 5, where results point to invariant models between samples (i.e., cross validation across calibration and validation samples; invariance across genders). These results suggest the following: in the configural invariance, the same number of factors was present in each group, remaining associated with the same group of items; in metric invariance, the factors of PLOCQp had the

same understanding for both groups; in scale invariance, the latent and observable means were compared and valid among groups; in residual invariance, comparison between observable items was supported.

Finally, nomological validity procedures showed a clear and SDT-coherent relation between PLOCQp and EEp. The autonomous types of motivation were positively related with all forms of student’s engagement, and the controlled types presented weaker or negative associations with engagement.

Table 4 Fit indices for the invariance of the measurement model of the PLOCQ in the Portuguese sample across samples, gender, 3rd cycle and secondary cycle

	χ^2	df	$\Delta \chi^2$	Δdf	p	CFI	ΔCFI
CS - VS							
Configural Invariance	1033.476	250	-	-	-	.925	-
Measurement Invariance	1052.619	263	19.144	13	.119	.924	.001
Scale Invariance	1063.991	278	30.515	28	.339	.925	.000
Residual Invariance	1113.033	296	79.557	46	.002	.922	.003
M - F							
Configural Invariance	1009.917	250	-	-	-	.927	-
Measurement Invariance	1038.488	263	28.571	13	.008	.925	.002
Scale Invariance	1060.637	278	50.720	28	.005	.924	.003
Residual Invariance	1082.785	296	72.868	46	.007	.924	.003
3rd cycle – secondary cycle							
Configural Invariance	1035.353	250	-	-	-	.924	-
Measurement Invariance	1063.099	263	27.746	13	.010	.923	.001
Scale Invariance	1107.665	278	72.312	28	<.001	.920	.004
Residual Invariance	1147.077	296	111.723	46	<.001	.918	.006

Note. χ^2 = chi-squared; df = degrees of freedom; $\Delta \chi^2$ = differences in the value of chi-squared; Δdf = differences in the degrees of freedom; CFI = Comparative Fit Index; ΔCFI = differences in the value of the Comparative Fit Index

Table 5 Nomological validity

Variables	Intrinsic	Identified	Introjected	External	Amotivation
Behavioral Engagement	.688**	.703**	.356**	-.133	-.372**
Agentic Engagement	.635**	.628**	.311**	-.088*	-.217**
Cognitive Engagement	.780**	.806**	.406**	-.134**	-.294**
Emotional Engagement	.901**	.813**	.331**	-.232**	-.509**

Note. * p<.05, ** p<.01

Discussion

The purpose of this study was to translate and validate the Perceived Locus of Causality Questionnaire (PLOCQ) to the Portuguese context. Psychometric properties and invariance across samples (i.e., cross-validation) and gender were examined to ensure proper instrument feasibility and to provide to PE professionals an instrument capable of assessing the motivational continuum in students, contributing also towards what Deci and Ryan³⁰ called the development of knowledge regarding the universality of underlying variables of SDT which, in this specific case, is related with the behavioral regulation within a PE context.

Psychometric analysis of the Portuguese version of the PLOCQ showed that the initial hypothesized model (five factors / 20 items) did not fit the pre-defined values adopted in methodology^{21,22,23}. For this matter, individual parameters (through the modification indexes) were analyzed, and two items (intrinsic motivation - 14; introjected regulation - 2) were removed because they showed associations with other factors (e.g., the item 2, *“Because I want the PE teacher to think I am a good student”* presented an association with external regulation). This may suggest that proximity in motivational continuum reflects some difficulty in interpreting what was supposed in students with this particular question. Some authors have also suggested that, when analyzing the motivational continuum in exercise settings, a bivalent introjected regulation may, in some individuals, reflect a more positive or negative valence^{31,32} that may justify these interpretations. After these items removal, the final model (i.e., five factors / 18 questions) presented good adjustment values in all samples and was in line with the pre-defined methodology requirements.

Further analysis also revealed good psychometric properties. According to Hair et al.²², construct validity is defined as the extent to which the research is accurate. The internal consistency (i.e., composite reliability) of the factors was adequate, according to the criteria adopted as part of the methodology, although one factor (external regulation in the validation sample) had a value of less than .70, but always greater than .60, which can be considered an acceptable limit²², especially when dealing with factors with few items. Besides that, in the study of Lonsdale et al.¹², specifically in the Hong Kong sample, the authors also found a similar value of composite reliability.

Regarding convergent validity, some issues can be verified within the factors amotivation and external regulation (calibration sample) and external regulation (validation sample), because the AVE values were lower than the ones adopted as part of the methodology ($\geq .50$), that is, the items were not strongly associated with these factors, although, the factorial weights were greater than .50 and statistically significant within the respective factors. According to Hair et al.²², this is an indicator of suitable convergent validity. Also, neither of these items showed cross-loadings nor very high residual values, being an adjustment indicator of the items on those factors²¹.

On the other hand, some factors showed issues, namely identified regulation-intrinsic motivation and amotivation-external regulation (both samples), that is, the factors were not distinguishable enough from each other²². Similar results were

reported in the original version of this questionnaire developed by Lonsdale et al.¹² and other studies in the physical education domain. Still, in the sports domain, similar results were found, both in the Behavioral Regulation Sports Questionnaire version (BRSQ³³) and in the two versions of Sports Motivation Scale (SMS^{34,35}). This seems to indicate that there is not a universal support for the discriminant validity involving these constructs. However, Ryan and Connell¹⁴ justify the high correlation patterns because the behavioral regulations are presented in a continuum of motivation where contiguous regulations are theoretically close and positively associated, which seems to be the justification for the lack of discriminant validity involving amotivation and external regulation, as well as, identified and intrinsic motivation. Deci and Ryan^{3,30} highlight this issue, emphasizing that the SDT constructs underlying the autonomous and controlled motivation types correlate highly among themselves. Several studies in different contexts have reported the same results: exercise^{36,37} and Sport^{33,34,35,38,39}.

For the invariance analysis (i.e., across samples and gender) the suggested recommendations from several authors were followed (e.g., Byrne²¹). The re-specification of the model implies that when a model does not present adjustment to the data, the final (re-specified) model should be tested in another sample of the same population, ensuring proper validity and robustness. Therefore, the final model, primarily defined and tested in the calibration sample, was once again tested on the validation sample, presenting an adjustment to the data and in line with the values adopted previously^{21,23}. In both cross-validation and gender invariance, all criteria were met, showing that the theoretical constructs underlying the measurement model were perceived in the same way by both genders, allowing comparisons between male and female PE students²⁵.

Thus, considering the assumptions from operationalized multi-group analysis in the methodology^{21,24}, it is possible to affirm the following to both samples, gender, 3rd cycle and secondary cycle: i) configural invariance is verified as the same items group that explains the same factors group is maintained, independently of sample and gender; ii) the factorial weight of the items is equivalent for both samples and gender (measurement invariance), in other words, the items have the same importance regardless of the group; iii) the item intercepts are invariant (equivalents) in both samples and gender, consequently representing scale invariance (i.e., strong invariance). This type of invariance is the most important, because when this assumption is verified, it means it is legitimate to make results comparisons in different groups, in this case across samples and genders, based on the behavioral regulation, underlying SDT⁴⁰; iv) residual invariance was verified, because the factorial weights, covariance and error of measurement model operate the same way across samples and genders^{21,24}. Thus, these results support PLOCQ use in PE context, as the model presented cross-validation criteria and revealed to be gender invariant, supporting that the theoretical construct underlying the measurement model is interpreted in the same way between male and female students.

Despite addressing a gap in the literature regarding motivational regulations measurement in the present context, some

limitations are evident: i) the validated version do not encompass all of the SDT behavioral regulations (i.e., integrated regulation). Thus, we suggest that future endeavors should try to address this issue for the PE context; ii) in addition to cross-validation, future studies should focus in longitudinal invariance analysis (e.g., throughout the school year) in order to increase the robustness of the instrument.

Therefore, and despite study limitations, the present work provides an instrument that allows behavioral regulation in Portuguese and PE settings, providing teachers a specialized tool to help them better understand student behavior in class. This may be important in order to prevent some unwanted behaviors, low in-class task adherence, or feelings of boredom, simultaneous helping teacher to plan more engaging and joyful classes, acting as promoters of intrinsic motivation. This issue is particularly important as intrinsic motivation is among the most highlighted factors to the maintenance of behavior over time⁴¹.

In short, this study suggests that PLOCQp with five factors and 18 items has good psychometric properties and can be used to assess contextual motivation towards PE in the Portuguese context. Invariance analysis shows support for the use of the instrument in both genders.

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