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Psychometric validation of Atest-EF and attention profile of students during physical education classes

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Abstract

The present study aimed for the adaptation and validation of the Questionnaire Atest-EF, with the use of a confirmatory factorial analysis (CFA) of the measurement model, applied to students of the 3rd cycle of Basic Education. A total of 156 students of both genders, aged between 12 and 16 years ($M = 14.7 \pm SD = 1.3$) were included in the study, with 84 female and 71 males, from the 7th, 8th and 9th grade. The main results reveal that the psychometric qualities confirm the adequacy of this model, demonstrating that the Atest-EF factorial structure: 1 factor/4 items, has very acceptable indexes of Atest - EF validity: ($\chi^2 = 6.141$, $p = .000$, $\chi^2/df = 3.07$, $NFI = 0.90$ $CFI = .925$, $IFI = .930$, $MFI = .9997$, $GFI = .995$, $AGFI = .975$, $RMR = .042$, $RMSEA = .08$, $SRMR = .028$). With these results, the structural model reveals a satisfactory factorial assessment. This led to conclude that the Portuguese version of Atest-EF can be used, with high confidence in the evaluation of the student's attention profiles in Physical Education classes. Compared with the moments of the class, there were only significant differences in students' attention in the approach to sports in the first and fourth moments of the class, as well as in the general profile of attention, with significantly higher values in the approach to team sports.

Keywords Attention · Confirmatory factorial analysis · Physical education · Psychometry

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1 Introduction

The process of acquiring any motor skill is a challenge for students, who need to deal with the several information available in the practice environment, in addition to those inherent in the task being performed or ambitioned. Research in the area of motor learning has sought to investigate the influence of different variables on the learning process and knowledge acquisition (Petrica et al. 2010). The use of instruction with the purpose of taking the learner to focus attention in an important moment of the task has been an efficient strategy in order to potentiate the acquisition of skills, since the performance of attentional mechanisms is a fundamental part of the learning. However, strategies should be basically based on learner performance. Thus, the use of instructions with attention-focused targeting has the objective of assisting the learner in the selection of information regarding the critical point of the action, without overloading the processing system (Peh et al. 2011). Currently, the attention focus is a much discussed topic in the scientific community, especially in relation to learning and motor development, since the development of the teaching/learning process is of extreme importance for the performance of the practitioners (Sánchez and Sebastián 2015; Emad et al. 2017; Lazarraga 2019; Santos et al. 2019). Targeting the attention of the students through the information transmitted to them is a form of intervention that may be an asset to the students' learning. Thus, the teacher/coach can give feedbacks of two natures, internal or external. The internal focus is to direct the student's attention to something internal and associated with his or her body (e.g., feelings, thoughts or specific positions of the body) and the external focus, associated with instructions for the effects of movement, externals to their body's (e.g., the movement and positioning of colleagues and opponents in the field) (Lazarraga 2019). Perkins-Ceccato et al. (2003) conducted a study with highly skilled golfers and performed better with out-of-focus attention instructions than with internal focus instructions. Whereas, low-skilled players demonstrated better performance under internal focus instructions versus those of external focus of attention. These findings suggest some relationship between the level of proficiency of individuals and the instructions for directing the focus of attention. However, investigations indicate a positive effect of external focus instructions (Kal et al. 2013; Wulf 2007; Wulf and Prinz 2001; Wulf et al. 1998, 2010). Some authors have rejected the hypothesis of the superior effect of external focus on the internal in activities such as swimming (Pasetto et al. 2011) or in novice soccer players (Uehara et al. 2008).

Wulf and Lewthwaite (2016) went further and refer to the OPTIMAL (Optimizing Performance Through Intrinsic Motivation and Attention for Learning theory) the existence of three key variables for motor development and skill acquisition, two of motivational component (to emphasize the expectations and autonomy), and an attentional (internal and external focus), for a conducive progress to the acquisition of new skills and them development. To emphasize participants' expectations, the authors said they use simple strategies, such as correcting minor errors rather than bigger errors, in the case of autonomy, this is necessary because the participants should feel able to perform the tasks autonomously and for use of external feedbacks to enhance student or athlete performance (Wulf et al. 2017).

According to these authors, recent research shows an increase in learning and performance effectiveness when combining at least two of the factors (Wulf et al. 2014, 2015). Subsequently, a study was carried out to establish, if, with all three factors, the results in terms of performance were superior. Wulf et al. (2017) evaluated 60 college students in four groups with different conditions, and the task was to throw a ball at a target with their non-dominant hand. For the increase of the expectations the students received positive

socio-comparative feedbacks, in the case of autonomy they were allowed to use the dominant hand and for the external feedback one of the used ones was “Focus on the target”. From the combination of pairs and all the mentioned elements, the authors concluded that when combined these three factors scores are higher than with other combinations.

Tsetseli et al. (2018) studied the influence of the type of focus in children from 8 to 9 years of age in the development of tennis service technique. The results show that the students in the external focus group obtained better scores in the post-test techniques as well as in game conditions. More recently, an investigation into the influence of attentional focus on dynamic balancing tasks, participants performed a specific training for 1 week and the test after 24 h without any practice, the authors concluded that external feedbacks contributed more quickly to learning and development of competencies in the assigned task (Diekfuss et al. 2019). The internal versus external focus was tested by Schwab et al. (2018) in 20 adolescents and 36 male adults and soccer practitioners. Through internal and external instructions, the authors were to compare pre, post and retention test in the mentioned sample for the technique of stop ball finishing. The results showed that regardless of the age range, the focus and external instructions show to be more advantageous for performance development.

According to Peh et al. (2011), the differences on the results of these studies highlight the need for further clarification on the adoption of the internal focus of attention in order to benefit the acquisition of movement coordination. For example, for Poolton et al. (2006), there is evidence that external focus instructions are beneficial for learning and performance, but they point out that further studies are needed to investigate the mechanism by which the external focus guarantees superiority over the internal focus of attention. Several researchers (Kim et al. 2017; Park et al. 2015) present revisions to understand which of the two types of focus is most beneficial for developing students’ also of athletes, and most of the literature points to better effects when the focus is external. In relation to its targeting, Dalgalarondo (2008) states that there is: External attention, type of Attention that is projected to the exterior of the subjective world of the individual or to the body, most often of a more sensorial nature, making use of the organs of the senses; The internal attention, unlike the external, this kind of attention is more introspective and reflexive, directing itself to the mental processes of the individual himself. Parents and teachers are increasingly concerned about the concentration and attention deficit in the younger population (Budde et al. 2008). Compared to adults, children have more difficulty resisting external stimuli, controlling their impulses and motor responses (Tomprowki et al. 2008).

The lack of attention in the school context is invoked by teachers as one of the main difficulties in the classroom. It is also considered that the students who obtain better results, in the school tests and the attention tests, are those that have the capacity to focus and to select information. These same students can focus attention, unrelated to external stimuli, mostly caused by “disturbing” colleagues. Selective or focused attention is called when there is a need to focus only on a stimulus, or part of certain information (Boujon and Quaireau 2001). The ability to inhibit attention to irrelevant stimuli or distractions is paramount for the subject to maintain his or her attention to what matters to him (Diamond et al. 2007) For the evaluation of the attention one can use, among others, the d2-R test (Brickenkamp 2010), which determines the individual’s ability to concentrate on a concrete, conscious situation that is eliminating distracting factors, the Trail Making Test Chang and Etnier (2009) which assesses executive skills, selective attention and the ability to inhibit a habitual response, and in the case of Physical Education Atest-EF (Petrica et al. 2010). Thus, the Student Attention Questionnaire in Physical Education (Atest-EF) presents itself as a new

instrument to measure attentional focus. It is not too long, nor too short, with a single question or single item, with sixteen response items divided by six attentional variables.

Therefore, the present study had as first objective the psychometric validation through the confirmatory factorial analysis of Atest-EF (Petrica et al. 2010) for the Portuguese language. The use of this questionnaire will allow a characterization of the attentional focus in four moments of the class, as well as the general profile attention of the students in the classes of Physical Education. The second objective was to characterize the attentional focus and general profile of students' attention during the Physical Education class. The third objective was to characterize and compare the students' attention throughout the four moments of the class, as well as in the general attention profile, depending on the approach of individual and team sports.

2 Methods

This is a cross-sectional quantitative study because it visualizes the situation of the population under analysis at a given moment as "snapshots" of reality (Rouquayrol and Almeida Filho 2006). The study sample included 156 students aged between 12 and 16 (14.7 ± 1.3), where 84 were female (53.8%) and the remaining 72 males (46.2%). Students attended the 7th, 8th or 9th grade in school), and were evaluated during the practice of each of four sports (Athletics, Gymnastics, Basketball and Football), which gave us a total of 624 observational units that gave 2496 statistical data.

The type of sampling used to select the participants of the present study was non-probabilistic, for convenience (Cubo-Delgado et al. 2011), since it is not based on a probabilistic basis, with an approach to subjects with specific characteristics.

2.1 Instruments

The Atest-EF Questionnaire validated by Petrica et al. (2010) was used to assess students' attention in Physical Education classes. The use of an instrument, with closed response alternatives, which included all the possibilities of response, required that it be completed as quickly as possible, interrupting as little as possible the normal course of the lessons.

As shown in Table 1, the Atest-EF, is an instrument that allows us to know what students are thinking about during Physical Education classes. This is a single questionnaire with 16 response items, subdivided into six variables with the respective levels: (5) attention to the task; (4) behavioural attention; (3) attention to information; (2) affective attention; (1) attention out of the task and (0) attention in other things.

In terms of coding and recording, ATEST-EF operates in the logic referred to by Piéron (1983, 1986, 1996), Siedentop (1983, 1998) and Ojeme (1984), of the event register, in which one unit is counted each once a response, previously defined, is chosen. Once the different harvest times are defined, we may have a picture of what the students are thinking about at each of these times and if they represent different parts of the class, we may be left with an image of the focus of the students' attention during this class.

To evaluate the external validity of the instrument, the items were then evaluated by a panel of five experts (Cubo-Delgado et al. 2011) who considered that these were adequate to evaluate the construct for which it was created. The panel consisted of three Physical

Table 1 Variables, scale and items of the Atest-EF test

Attentional variables	Level	Sub-variable	Item
Attention to the task	5	To be performed In realization Fulfilled	What am I going to do? What am I doing? What I did
Attention to the behaviour	4	Behaviour of the: Teacher Colleagues	What the teacher was doing What my colleagues were doing
Attention to the information	3	Listening Relate to. Understanding	What the professor was saying What my colleague said
Affective attention	2	Colleagues Teachers Friends Family	In my colleague In my teacher In my friends In my family
Attention outside the task	1	In class Outside the class	What my colleague did to me What am I going to do to my colleague What am I going to do on break In a computer game
Attention in other things	0	Others	Another thing. What?

Education teachers with at least 10 years of teaching experience and research experience, as well as two native-speaking professionals to evaluate grammatical and semantic issues.

2.2 Procedures

In a first phase, the selection of a school was carried out, attending a sample for convenience (Cubo Delgado et al. 2011). In order to gather information, we placed ourselves in direct contact with the institution's headteachers and those who are in charge of student's education where data collection was to be performed, by informing the objectives and development process of this study. After authorization from the school board, the parents in charge of student's education, have signed freely and Informed Consent Term (ICT) that were delivered to the students, who were informed about all the necessary procedures to carry out the research. Only the adolescents who presented the ICT signed by their educative representative participated in the study.

Subsequently, we proceed to the validation of the content and reliability of the instrument. It was applied to a small group of students, not participants in the study, with the same characteristics defined for the sample of this investigation, in order to verify the adequacy of the application protocol and the time required for its completion. This procedure was conducted in order to know if the content of the questions was fully understood by the students. During the application, students were asked to inform the investigator on how they understood the questions, whether there were doubts about the vocabulary used, and were asked to suggest any changes that would make them more understanding. After this phase, we proceed to the reliability phase, using the technique of testing/retesting. For the purposes of this stage, the first application (testing) corresponded to the application of the questionnaire in four preselected moments of Physical Education class (one moment in the initial part, two moments in the main part and one moment in the final part). The second

and third applications (retesting) were performed with a seven-day interval of the previous application.

For the data collection, Atest-EF was applied in four classes of Athletics, Gymnastics, Football and Basketball, at certain moments of the class (initial part, main part and final part). At certain moments, it was issued by a non-participant in the class, a sound signal previously known to the students (Fox whistle), and immediately after hearing the signal, students would have to move to a predetermined location where they would have to mark with an (x) the option that faithfully catalogued what they were thinking the moment they heard the signal and immediately returned to their normal activity.

2.3 Data analysis

Firstly, the existence of normal data was obtained. For the univariate analysis of normality, the asymmetry and kurtosis indicators of the variable general attention were first used. Curran et al. (1996) established limits, in absolute value, and considered a behaviour similar to normal, values comprised up to 2 for asymmetry and 7 for kurtosis; moderately normal for values between 2 and 3 for asymmetry and between 7 and 21 for kurtosis; and extremely normal for values greater than 7 in asymmetry and 21 in kurtosis. Subsequently, to test the multivariate normality, the Mardia test was performed (Mardia 1970), which, according to Bollen (1989), should be less than $p(p+2)$, where p is the number of observed variables. Later, the confluence factorial analysis (AFC) was carried out with the objective of evaluating the construct validity, respecting the criterion of eliminating those items whose regression weight did not present an adequate value (greater than 0.40) (Revelle and Zinbarg 2009). In addition, the measurement model was calculated to prove the validity of the factors in the construct variable.

For reliability analysis, Cronbach's alpha (α), equal to or greater than 0.70 (Nunnally 1978) was used, as well as the Omega Coefficient (ω) (McDonald 1999), which also is useful to verify the consistency of the variables used in the investigation and, according to some authors (Revelle and Zinbarg 2009), demonstrated evidence of greater accuracy. In the McDonald's Omega coefficient, the established range is between 0 and 1, giving the highest values, more reliable measurements (Revelle and Zinbarg 2009). However, according to Campo-Arias and Oviedo (2008), to consider an acceptable value of reliability through the Omega Coefficient, these should be greater than .70.

It was also estimated the composite reliability (degree of consistency between the latent construct indicators) and the mean variance extracted (the amount of the variance of the indicators, captured by the construct, compared to that captured by the measurement error). Given the composite reliability, the minimum level is .70, and the mean variance extracted should be greater than .50, to conclude that a substantial amount of the variance is captured by the construct (Arias 2008). Values of $p < 0.05$ and $p < 0.01$ were used for statistical significance. For the univariate normality analysis (asymmetry and kurtosis), reliability (Cronbach's alpha) and descriptive data was used the statistical program SPSS 21.0. The analyses of multivariate normality (Mardia Coefficient), CFA, measurement model were carried out with the program E.Q.S. 6.1.

With respect to the McDonald's Omega index, calculations were performed with the "psych" 1.4.2.3 (Revelle and Zinbarg 2009) from R 3.0.3 (RCore-Team 2014). For each variable the normality test was tested using the Kolmogorov-Smirnov test and the homogeneity of the variances through the Levene test (Field 2013), which led to

the use of parametric statistics in the comparisons and correlations. The magnitude of the effect through *Cohen's d* was also calculated, assuming a “wide” effect ≥ 0.80 ; “Medium” = 0.50 – 0.79 or “small” $0 < .50$, which was adopted in the present study (Cohen 1988).

3 Results

3.1 Internal consistency analysis of the Atest-EF questionnaire

The internal consistency of each of the factors resulting from the factorial analysis (Cronbach's alpha) presented the result 0.81, as well as the Omega 0.84. Cronbach's alpha reliability coefficients (Nunnally 1978), as well as the Omega (ω) coefficient (McDonald 1999) are expected to be above 0.70. The composite reliability was 0.91 and the mean variance extracted was 0.87, fulfilling the assumptions proposed by Arias (2008) (Table 2).

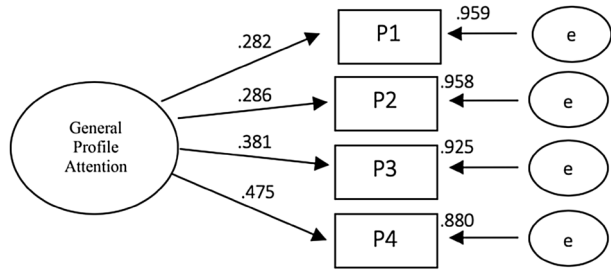
3.2 Confirmatory factorial analysis of the Atest-EF questionnaire

A confirmatory factorial analysis was performed to evaluate the Attention Questionnaire in Physical Education. In the analysis, a combination of indexes (Bentler 1995) was used, and for this reason, the indicators recommended by Byrne (2001) were: χ^2 , χ^2/gf , CFI (Comparative Fit Index), IFI (Incremental Fit Index), TLI (Tucker Lewis Index), RMSEA (Root Mean Square of Approximation) and SRMR (Standardized Root Mean Square Residual). The χ^2 indicates a similarity of the covariates observed with those that are predicted in the hypothetical model, however, it is very sensitive to the size of the sample, so it is recommended (Jöreskog and Sörbom 1993) that is complete with χ^2/gf 1. (degrees of freedom), whose values below 2 indicate a very good fit of the model, although values below 5 are considered acceptable (Schumacker and Lomax 2010). The incremental indexes (CFI, IFI, TLI) compare the hypothetical model and the null model, not being affected by the sample size. Values greater than .90 are considered acceptable (Schumacker and Lomax 2010). The error rates RMSEA and SRMR should be less than .08 (Browne and Cudeck 1993; Hu and Bentler 1999). After the analysis, it was verified that the 4 items were grouped into one factor, giving rise to the measurable construct of general care profile. Likewise, the standardized factor loads were all statistically significant ($p < .01$), so it can be concluded that the model presented in Fig. 1, at the analytical level presents satisfactory results.

Table 2 Descriptive statistic and reliability analysis of the study variable

Variable	Ampleness	Mean	SD	Cronbach's alpha	McDonald's Omega	Composite reliability	Extracted mean variance
1st Moment	0–5	3.86	1.21	–	–	–	–
2nd Moment	0–5	4.12	1.15	–	–	–	–
3rd Moment	0–5	4.15	1.15	–	–	–	–
4nd Moment	0–5	3.71	1.41	–	–	–	–
General attention profile	0–5	3.96	0.73	0.81	0.84	0.91	0.87

Fig. 1 Structural equation model of the Atest-EF questionnaire



The previous analysis of the data indicated that the sample met the criterion of univariate normality through kurtosis and asymmetry. The Mardia coefficient was adequate (5.28), lower than “p (p + 2)”. Therefore, based on Bollen (1989), it was considered that there is multivariate normality, using the robust estimation method maximum likelihood (Byrne 2001). After a first analysis, the overall results of the model indicated a reasonable adjustment of Atest - EF: ($\chi^2=6.141, p=.000, \chi^2/df=3.07, NFI=0.90, CFI=.925, IFI=.930, MFI=9999, GFI=.995, AGFI=.975, RMR=.042, RMSEA=.08, SRMR=.028$). With these results, the structural model reveals a satisfactory overall fit. Evaluating the concurrent validity between the moments of the class and the general profile of attention, from the analysis of the data in Table 3, we observed moderate positive and significant correlations between the moments of the class and the general profile of attention.

Considering the comparison of data between individual and team sports addressed in Physical Education classes (Table 4), it was observed that in each of the four moments of the class, as well as in the general attention profile, the descriptive values are higher in the classes of team sports. It should be noted that attention values are higher in the main part of the lesson regardless of the subject approach. Regarding the focus of attention, it was observed that in the four moments of the class, as well as in the general profile of attention, the attention focus tends to the internal focus in both modalities, being higher in the collective ones. Comparing the moments of the class, only significant differences in the attention of the students to the sports practiced were observed in the first ($p=0.035$) and fourth ($p=0.019$) moments of the class, as well as in the general attention profile ($p=0.008$), with significantly higher values in the approach to team sports. Only a small effect magnitude ($d=0.219$) was observed at the level of the general attention profile.

Table 3 Correlation coefficient between moments in class and the general profile of attention

	1	2	3	4	5
1st Moment					
2nd Moment	.052				
3rd Moment	.164**	.073			
4nd Moment	.108**	.177**	.171**		
General profile attention	.550**	.530**	.573**	.682**	

*Sig $\alpha \leq 0.05$ **Sig $\alpha \leq 0.01$

Table 4 T test for independent samples in the comparison of class periods and students' general profile of attention, according to the sports practiced in PE classes

	Individual sports	SD	Team sports	SD	Sig.	d-Cohen effect-size (95% IC)
1st Moment	3.76	1.25	3.96	1.17	.035*	0.165 (− 0.151–0.482)
2nd Moment	4.07	1.30	4.17	0.99	.30	0.087 (− 0.229–0.403)
3rd Moment	4.12	1.19	4.18	1.11	.58	0.052 (− 0.264–0.368)
4nd Moment	3.57	1.39	3.85	1.55	.019*	0.19 (− 0.126–0.507)
General profile attention	3.88	0.74	4.04	0.72	.008**	0.219 (− 0.098–0.536)

*Sig $\alpha \leq 0.05$ **Sig $\alpha \leq 0.01$

4 Discussion

The first objective of the present study was to validate the Atest-EF questionnaire, in the context of Physical Education, through the confirmatory factorial analysis. Given that each new application of a measuring instrument represents a contribution to improving the theoretical value of the research domain, this study extends the set of knowledge, confirming the validity of the Atest-EF instrument in a research as well as through improved knowledge of how to assist physical education teachers to understand the oscillation of attention focus and the overall profile of student attention in physical education classes. The results of the confirmatory factorial analysis revealed a structure of four items, grouped in a factor proposed to evaluate the attention of the students in the physical education class, evidencing a good adjustment to the data. The construct of the general profile of attention showed good psychometric properties, namely in what several authors advise (Nunnally 1978; Bentler 1995; Byrne 2010; Schumacker and Lomax 2010; Browne and Cudeck 1993; Hu and Bentler 1999), presenting Atest-EF in this study as a reliable instrument for evaluating students' attention in physical education classes.

The second objective was to characterize the attentional focus and the attentional profile of the students during the physical education class. This study confirms that the focus of attention is mainly on task attention and attention to information (internal focus), and this data has gone to meet the studies of Petrica (2003) and Santos et al. (2009), which found profiles similar to those of our study. Other investigations also sought to find strategies for enhancing the orientation, whose effect was the focus of the subject for the effects of the movement (internal attentional focus), noting that this orientation was beneficial for learning, studies such as those conducted in golf by Brocken et al. (2016), in gymnastics by Abdollahipour et al. (2015) and at the dart launch by Lohse et al. (2014), Tse and Ginneken (2017).

Concerning the parts of the class, we highlight the main part, where the students of the team sports show more attention to the task and attention to the behaviour, these data are in agreement with those of Park et al. (2015), which emphasize the importance of attention focused on the task for sports of open competences, such as collective sports, instead of attention to information. It should be noted that in all modalities, there are higher percentage values of affective attention in the final part of the class than in the rest of the class, but still with little expressive values.

We could observe some similar traits between the general attention profile of individual and collective modalities. However, we noticed that in these results the students, evaluated during the practice of the individual modalities, are mainly with attention, to the task and attention to the behaviour (internal attentional focus) at the beginning and end of the class, than the students of basketball and soccer. These data differ from the investigations carried out by Perkos et al. (2002), Zachry et al. (2005) and Reeves et al. (2007), who affirm that focusing attention externally during the acquisition of a collective skill favours its effectiveness and generalization. However, some authors have rejected the hypothesis of the superior effect of the external focus on the internal in activities such as swimming (Pasetto et al. 2011) or in soccer players (Uehara et al. 2008).

5 Conclusion

It's possible to conclude that the Portuguese version of the Atest-EF Questionnaire can be used with confidence and reliability, in the evaluation of students' attention during physical education classes. The students differ significantly in the attention at the beginning and end of the physical education classes according to the theme addressed in them, as well as evidence of a higher general attention profile in classes of collective modalities.

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