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Analysis of the factor structure of the Emotional Fatigue Scale, invariance, and validity based on the relationship with other variables in university professors

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The objective of this study is to analyze the evidence of validity, factorial invariance, and reliability of the Emotional Fatigue Scale in Peruvian university professors. Instrumental and cross-sectional design research was carried out, with the participation of 604 Peruvian university professors from the three regions of the country (Coast, Highlands, and Jungle) and with ages ranging from 21 to 65 years ($M = 44.27$ and $SD = 9.15$), who were selected with the intentional non-probabilistic sampling method. The descriptive analyses of the items were adequate and the polychoric correlation matrix with which the confirmatory factor analysis was performed was adequate. The results show a one-dimensional structure of 9 items, because item 10 had to be eliminated [$\chi^2(27) = 98.7$, $p < 0.001$, $CFI = 0.993$, $RMSEA = 0.067$ y $SRMR = 0.029$]. The resulting factor loads are between 0.57 and 0.93 and the internal consistency is adequate ($\omega = 0.95$). It was also found that the scale presents evidence of invariance according to sex, age, and working hours and of convergent validity with the scales of psychological distress ($r = 0.64$, $p < 0.001$) and life satisfaction ($r = -0.46$, $p < 0.001$). In conclusion, the ECE-PU is a brief measure that has adequate psychometric properties and is useful to assess emotional exhaustion in Peruvian university professors.

KEYWORDS

factor analysis, invariance, reliability, emotional exhaustion, university professors, Peru

1 Introduction

Mental health plays an important role in modern society. This is especially true in workplaces where the teaching profession is practiced, since having an adequate level of mental health is necessary and decisive to improve the quality of education (Maciel et al., 2023). Accordingly, the scientific literature reveals that teaching is a highly

stressful occupation and those who practice it suffer more mental health problems than professionals from other careers (Yang et al., 2019). This fact has been evidenced in studies conducted during the COVID-19 pandemic (Hutchison et al., 2022; Sipeki et al., 2022).

In the higher education field, one of the factors that has been identified as affecting the wellbeing of teachers is emotional exhaustion (Ngalagou et al., 2019). This can be defined as a psychological state, where a decrease in energy, a feeling of emotional and physical exhaustion, as well as a perception of frustration and failure predominate (Barreto and Salazar, 2021). Theoretically, this variable represents one of the main components of Burnout syndrome, which, under the theoretical model of Maslach (1997) is part of the development process of this syndrome. In this case, emotional exhaustion appears first, as a result of the failure to try to modify stress-generating situations. Then, depersonalization appears, which is a defense mechanism built by the individual in the face of the failure of the previous phase; finally, there is the abandonment of personal fulfillment, where the individual believes that his or her work does not merit further efforts (Dominguez Lara, 2019).

Regarding the consequences of living under a state of constant exhaustion, recent research has observed the negative effect that emotional exhaustion can have on university teachers, as shown in a systematic review, which concludes that a high level of emotional exhaustion is associated with lower academic performance and demotivation in students (Madigan and Kim, 2021). This situation can be further aggravated in times of crisis, such as the one developed due to the COVID-19 pandemic, where health concerns, a high workload (Klusmann et al., 2023), poor student behavior, and conflicts with parents were factors that triggered this first phase of Burnout (Baeriswyl et al., 2021).

In the Peruvian context, studies were also carried out that revealed the level of emotional exhaustion experienced by university professors. For example, a study conducted with intensive care teachers found a high percentage of emotional exhaustion (Rivera et al., 2021). In another study carried out with teachers from two medical schools in the Lima Region, 43.5% of participants were affected (Tito et al., 2022) and in another study carried out with basic education teachers in Cusco, 40.3% were affected (Estrada and Gallegos Ramos, 2020). In this regard, the methodology applied in these studies shows the preference for the use of the Maslach Burnout Inventory-MBI (Maslach, 1997), which is an instrument to measure the degree of presence of burnout syndrome, which demonstrates the use of non-specific instruments to assess emotional exhaustion.

This fact reveals that there is a gap in the scientific literature since research evaluations require valid and reliable instruments. Although in Peru there are instruments available to directly measure emotional exhaustion, these have been created for application in the university population; above all, it highlights a test widely used in various studies (Barreto and Salazar, 2021; Prada-Chapoñan et al., 2020; Seperak-Viera et al., 2021), which has been psychometrically explored in different populations of university students (Dominguez Lara, 2019; Dominguez Lara, 2014). Precisely, this measure is characterized by being easy to apply given the brevity of its items, which makes it ideal for generating an adaptation to the population of university professors considering the university academic roles and challenges. Although, of course, a new scale could be designed and validated, it is nevertheless

pertinent to consider the psychometric performance that the Emotional Fatigue Scale (ECE) has achieved, since in the studies carried out it has been possible to evidence adequate indicators of reliability, content-based validity, validity based on internal structure and even validity based on the relationship with other variables. Therefore, the authors of this paper consider it more feasible to make an adaptation based on the ECE, than to build a new scale.

Given that the measurement of emotional exhaustion in the Peruvian university context is limited, there is a need for an instrument to assess emotional fatigue in Peruvian university teachers; therefore, the objective of this is to analyze the factorial structure of the Emotional Fatigue, Invariance, and Validity Scale based on the relationship with other variables in university professors.

2 Materials and methods

2.1 Design

Framed within an instrumental and cross-sectional design, given that a measurement scale was evaluated and validated taking into account its psychometric properties (validity and reliability) at a single point in time (Ato et al., 2013).

2.2 Participants

A total of 604 Peruvian university professors from the three regions of the country (Coast, Highlands, and Jungle) participated in the study, 357 were men (59.1%), whose ages ranged from 21 to 65 years (Mean = 44.27 years and SD = 9.15), where 89.4% worked in private universities and 85.8% taught at the undergraduate level. In addition, 43.2% worked full time, and 78.6% were contract employees. Finally, 56.8% lived in the coastal region of Peru, while 39.3% lived in the highlands. These university professors were selected through the Coast Region of Peru. Through non-probabilistic sampling of an intentional type.

2.3 Instrument design

Emotional Fatigue Scale (ECE; Ramos et al., 2005) and validated in the Peruvian university population by Dominguez Lara (2019). In the present study, ECE was adapted for university teachers, considering the roles and challenges. It is composed of 10 items with Likert-type answer options: 1 = Rarely, 2 = Rarely, 3 = Sometimes, 4 = Frequently, and 5 = Always.

Life Satisfaction Scale (SWLS; Diener et al., 1985). Validated in Peruvian older adults by Caycho-Rodríguez et al. (2018). The SWLS assesses life satisfaction and is composed of 5 items with five Likert-type response options where 1 = disagree and 5 = agree.

Kessler Psychological Distress Scale (K6; Kessler et al., 2003), has been validated in the Peruvian context by Dominguez-Lara and Alarcón-Parco (2020). This scale is made up of 6 items with Likert-type response options, whose values range from 0 (at no time) to 4 (all the time).

2.4 Procedure

The research was approved by the ethics committee of the Graduate School of the Universidad Peruana Unión with reference 2024-CE-EPG-00214. Considering the progressive return to face-to-face classes, a virtual questionnaire was designed through Google Forms. The link was shared through social networks such as Facebook and WhatsApp. In the first section, informed consent was presented, the objective of the study and emphasizing that participation was voluntary and anonymous.

2.5 Data analysis

Initially, content validity was examined using Aiken's V coefficient (considering values ≥ 0.70 as significant), calculated from the scores assigned by four experts (Ventura-León, 2022). For the confirmatory factor analysis, the ordinal nature of the items was considered by calculating the polychoric correlation matrix. The estimator used was the weighted least squares with adjusted mean and variance (WLSMV), a recommended procedure for ordinal variables (Beauducel and Herzberg, 2006; Gana and Broc, 2019). The overall evaluation of the fit of the model was obtained with the comparative fit index (CFI), the mean square error of approximation (RMSEA), and the standardized residual root square mean (SRMR). CFI values > 0.90 are interpreted as favorable evidence of fit to the model (Bentler, 1990), as well as $RMSEA < 0.080$ (MacCallum et al., 1996) and $SRMR < 0.080$ (Browne and Cudeck, 1992). For the measuring invariance analysis and in consideration of the ordinal nature of the items, the recommendations of Wu and Estabrook (2016) and Svetina et al. (2020) were followed for the analysis of invariance for ordinal variables. Thus, three restrictive models were evaluated hierarchically between the groups according to gender, age group, and working hours, these being the configural, threshold, and threshold and loading invariance, all of them tested using the WLSMV estimator for ordinal data. In addition, for measurement invariance testing, a set of criteria was evaluated, consisting of changing $CFI < 0.010$, $RMSEA < 0.015$, or $SRMR < 0.005$ (Chen, 2007). Finally, for the reliability analysis, the internal consistency method with the omega coefficient (ω) was considered, considering values greater than 0.70. The statistical analysis was carried out using the "R" version 4.2.2 program, specifically with the "lavaan" library in its version 0.6-13 (Rosseel, 2012).

3 Results

The ECE-PU is an adapted version of the ECE, the evaluation of four experts was favorable ($V > 0.80$), indicating that all the items are relevant, representative, and clear (Table 1). Therefore, the ECE-PU reports evidence of content-based validity.

Before the structural analysis, the descriptive results and the matrix of polychoric correlations of the items were obtained as shown in Table 2. In this one, the intercorrelations are between the values of 0.46 and 0.85.

For the results of the confirmatory factor analysis, the one-dimensional structure of the instrument was evaluated, finding

an inadequate fit. $\chi^2(35) = 196.3$, $p < 0.001$, $CFI = 0.986$, $RMSEA = 0.089$ y $SRMR = 0.035$. Thus, an initial respecification is carried out, allowing the covariance of the errors of items 9 and 10, and then that of removing item 10, "I lack time and I feel overwhelmed by work". The last alternative is to remove the aforementioned item, thus obtaining an adequate adjustment, $\chi^2(27) = 98.7$, $p < 0.001$, $CFI = 0.993$, $RMSEA = 0.067$ y $SRMR = 0.029$. These results can be visualized in Table 3.

The resulting factor loads are between 0.57 and 0.93 and this is visualized in Table 4. The result of internal consistency in this one-dimensional configuration is $\omega = 0.95$.

In the measurement invariance analysis, the fit for the two sex-determined groups was initially evaluated, then they were put together to estimate and evaluate the first level of invariance. Configurational invariance resulted in an acceptable fit, $\chi^2(54) = 132.4$, $p < 0.001$, $CFI = 0.993$, $RMSEA = 0.071$, $SRMR = 0.035$, continuing with the levels of invariance proposed and observing that the criteria for changes in the CFI, RMSEA, and SRMR were met (Chen, 2007). In the same way, the invariance analyses of the measurement according to age group and working day were also carried out, obtaining adequate values in the differences of the adjustment indices, and confirming the equivalence up to the suggested level of equal loading and thresholds for ordinal variables. These results can be visualized in Table 5.

Finally, as evidence of validity based on the relationship with other variables, convergent validity was evaluated, having significant correlations between emotional fatigue scores and psychological distress, $r = 0.64$, $p < 0.001$, and Life satisfaction, $r = -0.46$, $p < 0.001$.

4 Discussion

Previous literature has shown that one of the mental health problems that frequently affects university teachers is emotional exhaustion (Estrada and Gallegos Ramos, 2020; Rivera et al., 2021; Tito et al., 2022); Therefore, it is important to have measurement instruments for its detection, which are easy to use and interpret, and which also have corroborated psychometric properties. In this context, the purpose of this research was to analyze the internal structure, factorial invariance, and validity based on the relationship with other variables of the Emotional Fatigue Scale in Peruvian university professors (ECE-PU).

For validity based on internal structure, through the TFA, evidence was obtained in favor of a unifactorial model, with acceptable fit indices and factor loads, which also shows excellent reliability. Although these findings cannot be contrasted with studies carried out on samples of university teachers, they are consistent with the results obtained in research that evaluated the psychometric properties of ECE in its original version, aimed at university students (Auné et al., 2021; Dominguez-Lara et al., 2018, 2021; Fontana, 2011; González Ramírez and Landero Hernández, 2007; González-Rivera et al., 2022; Martínez-Líbano et al., 2022; Moreta-Herrera et al., 2022). However, it should be noted that to achieve adequate adjustment rates, it was necessary to eliminate item 10 ("I lack time and feel overwhelmed by work"). This decision was made despite the fact that the analysis of modification

TABLE 1 Aiken's V for the evaluation of the relevance, representativeness, and clarity of the items of the scale.

ECE	ECE-PU	Relevance		Representativeness		Clarity	
		V	IC 95%	V	IC 95%	IC 95%	IC 95%
1. Los exámenes me producen una tensión excesiva.	1. Mi trabajo me produce una tensión excesiva.	0.92	0.68–0.98	0.83	0.58–0.95	1	0.80–1
2. Creo que me esfuerzo mucho para lo poco que consigo.	2. Creo que me esfuerzo mucho para lo poco que recibo a cambio.	1	0.80–1	1	0.80–1	1	0.80–1
3. Me siento bajo de ánimo, como triste, sin motivo aparente.	3. Me siento bajo de ánimo, como triste, sin motivo aparente.	1	0.80–1	1	0.80–1	1	0.80–1
4. Hay días que no duermo bien a causa del estudio.	4. Hay días que no duermo bien a causa de mi trabajo.	1	0.80–1	1	0.80–1	1	0.80–1
5. Tengo dolor de cabeza y otras molestias que afectan a mi rendimiento académico.	5. Tengo dolor de cabeza y otras molestias que afectan a mi desempeño como docente.	1	0.80–1	1	0.80–1	1	0.80–1
6. Hay días que noto más la fatiga y me falta energía para concentrarme.	6. Hay días que noto más la fatiga y me falta energía para concentrarme.	1	0.80–1	1	0.80–1	1	0.80–1
7. Me siento emocionalmente agotado por mis estudios.	7. Me siento emocionalmente agotado por mi trabajo.	1	0.80–1	1	0.80–1	1	0.80–1
8. Me siento cansado al final de la jornada de estudio.	8. Me siento cansado al final de la jornada laboral.	1	0.80–1	1	0.80–1	1	0.80–1
9. Estudiar pensando en los exámenes me produce estrés.	9. Pensar en mis pendientes laborales me produce estrés.	1	0.80–1	1	0.80–1	1	0.80–1
10. Me falta tiempo y me siento desbordado por los estudios.	10. Me falta tiempo y me siento desbordado por el trabajo.	1	0.80–1	1	0.80–1	1	0.80–1

TABLE 2 Descriptive and polychoral correlations of the items of the scale.

Variables	M	DE	g1	g2	1	2	3	4	5	6	7	8	9	10
Item 1	2.2	1.0	0.4	−0.6	–									
Item 2	2.3	1.1	0.5	−0.5	0.47	–								
Item 3	1.5	0.8	1.8	3.3	0.65	0.49	–							
Item 4	1.8	1.0	1.0	0.2	0.63	0.46	0.69	–						
Item 5	1.5	0.9	1.7	2.1	0.68	0.46	0.77	0.76	–					
Item 6	1.7	0.9	1.3	0.9	0.69	0.46	0.74	0.72	0.83	–				
Item 7	1.6	0.9	1.5	1.8	0.72	0.53	0.71	0.75	0.84	0.85	–			
Item 8	2.2	1.1	0.6	−0.6	0.61	0.47	0.58	0.66	0.65	0.73	0.77	–		
Item 9	2.0	1.1	0.8	−0.3	0.66	0.46	0.65	0.64	0.68	0.72	0.74	0.73	–	
Item 10	2.0	1.0	0.9	0.0	0.69	0.51	0.63	0.68	0.68	0.76	0.79	0.74	0.82	–

indices suggested allowing covariance between the errors of items 9 (*“Thinking about my pending work causes me stress”*) and 10 (*“I don’t have enough time and I feel overwhelmed by work”*), which is justified considering both aspects of relevance and representativeness of the content of the items and methodological aspects. Thus, item 10 refers to two indicators of the construct at the same time, the perception of lack of time and the feeling of being overwhelmed, which is problematic in any measurement process and introduces an ambiguity that can compromise the clarity of the construct. On the other hand, including the correlation between residuals in the factorial model without theoretical support becomes a methodological artifact to improve the fit that does not help to understand the construct (Dominguez-Lara, 2019) and, furthermore, compromises the parsimony and validity of the model.

TABLE 3 Goodness-of-fit indices of the original model and two alternative models for the study scale.

Model	χ^2	Gl	CFI	RMSEA	SRMR
Original model	196.3***	35	0.986	0.089	0.035
Covariation item errors 9 y 10	131.7***	34	0.992	0.070	0.031
Without the item 10	98.7***	27	0.993	0.067	0.029

CFI, Comparative Adjustment Index; RMSEA, mean square error of approximation; SRMR, standardized root mean square residual. *** $p < 0.001$.

On the other hand, it has been shown that the unifactorial structure is invariant according to sex, age group, and working hours, so it is possible to use the version of the ECE for university teachers to identify differences between the groups

TABLE 4 Factor loadings of the standardized solution of the confirmatory factor analysis for the final model.

Item	Factor loading
01. Mi trabajo me produce una tensión excesiva.	0.78
02. Creo que me esfuerzo mucho para lo poco que recibo a cambio.	0.57
03. Me siento bajo de ánimo, como triste, sin motivo aparente.	0.81
04. Hay días que no duermo bien a causa de mi trabajo.	0.82
05. Tengo dolor de cabeza y otras molestias que afectan a mi desempeño como docente.	0.90
06. Hay días que noto más la fatiga y me falta energía para concentrarme.	0.91
07. Me siento emocionalmente agotado por mi trabajo.	0.93
08. Me siento cansado al final de la jornada laboral.	0.81
09. Pensar en mis pendientes laborales me produce estrés.	0.81

TABLE 5 Measurement invariance of the final model regarding gender, age group, and working hours.

Model invariance	χ^2 (df)	CFI	RMSEA	SRMR	Δ CFI	Δ RMSEA	Δ SRMR
Sexo:							
Configural	132.36 (54)	0.993	0.071	0.035			
Equal thresholds	148.19 (72)	0.994	0.060	0.035	0.001	0.011	0.000
Equal loadings and thresholds	138.11 (80)	0.995	0.050	0.035	0.001	0.010	0.000
Age group:							
Configural	141.8 (81)	0.995	0.062	0.038			
Equal thresholds	169.8 (117)	0.996	0.048	0.038	0.001	0.014	0.000
Equal loadings and thresholds	174.7 (133)	0.997	0.040	0.039	0.001	0.008	0.001
Jornada laboral:							
Configural	134.8 (54)	0.991	0.072	0.036			
Equal thresholds	142.2 (72)	0.992	0.058	0.036	0.001	0.014	0.000
Equal loadings and thresholds	134.6 (80)	0.994	0.048	0.036	0.002	0.010	0.000

The invariance of the final model measurement was evaluated based on comparisons of sex: men ($n = 349$), women ($n = 236$); age group: 21 to 35 years ($n = 116$), 36 to 50 years ($n = 318$), 51 to 65 years ($n = 151$); and work schedule: full-time ($n = 253$), part-time ($n = 332$).

segmented by the aforementioned variables without apparent bias since there is evidence in favor of the equity of this measure. This result is consistent with previous studies that explore the measurement invariance of instruments that measure burnout in teachers (Aboagye et al., 2018) and with the studies by Dominguez-Lara et al. (2018) and Moreta-Herrera et al. (2022), in which it was evidenced that ECE in its version for university students is invariant according to sex.

With validity based on the relationship with other variables, it was found that ECE scores are directly related to a measure of psychological distress and indirectly to a measure of life satisfaction. These results are consistent with the findings of previous literature, which have shown, for example, that burnout has a negative impact on the mental health of university teachers (Jiang et al., 2017) or that, in this same population group, emotional exhaustion plays a mediating role between work-related stress and life satisfaction (Xu and Wang, 2023).

Regarding the practical implications, considering that the measurement of emotional exhaustion in teachers has been limited to the use of a single instrument in particular (Urbina-Garcia, 2020), this research has managed to provide a measurement tool with adequate psychometric properties for the assessment of emotional exhaustion in Peruvian university professors. Therefore,

its use can be useful not only for research purposes but also as a screening measure, so that universities can use the instrument as part of their occupational health policies, to manage the mental health of university teachers, identifying promptly those who need care and support for the maintenance of their psychological health.

Some limitations need to be considered. First, the intentional nature of the sampling limits the generalizability of the results found. In addition, although teachers from the three regions of Peru, the group of teachers from the Selva region was not sufficiently represented. Second, data collection was done online, which could lead to bias and increase measurement error. Thirdly, since a cross-sectional design has been used, it has not been possible to corroborate the stability of the scores, nor examine the fluctuation in emotional exhaustion scores in relation to changes in academic periods. Given these limitations, it is recommended that the psychometric properties of the ECE be evaluated through structured or quota sampling, considering representative samples from the main cities of Peru, as well as including other groups of teachers. In addition, future research should examine reliability and assess measurement invariance according to other relevant characteristics, such as origin.

Given these limitations, it is recommended to evaluate the psychometric properties of ECE for university teachers in

representative samples of the main cities of Peru or to include other groups of teachers, such as teachers of Regular Basic Education, to corroborate the results found. In addition, the examination of reliability through the test-retest method is pending for future research. Finally, it is recommended to corroborate the psychometric properties of the instrument from the perspective of Item Response Theory (IRT), and thus be able to determine the most representative items.

In conclusion, the ECE-PU in its version for university teachers is a one-dimensional, brief, and easy-to-use instrument that has adequate psychometric properties.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Ethics Committee of the Graduate School of the Universidad Peruana Unión. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

RC: Conceptualization, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing. OM-B: Conceptualization, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing. RC-B: Data

curation, Formal Analysis, Investigation, Methodology, Software, Visualization, Writing – review and editing. IC: Data curation, Formal Analysis, Investigation, Validation, Visualization, Writing – review and editing. SL-H: Conceptualization, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review and editing.

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