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# Scale to assess quality of working life in university environment by using item response theory

## Escala para avaliar a qualidade de vida no trabalho em ambiente universitário pela teoria de resposta ao item

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## Abstract

**Purpose:** This study aims to validate Ferreira's (2011) quality of working life (QWL) scale by using item response theory (IRT) and specialists' knowledge to be applied in higher education institutions (HEIs).

**Originality/value:** The paper advances QWL theoretical knowledge by validating a scale to appraise QWL in this specific context using IRT. The scale can be applied in any HEI. Items can be removed or added to adapt the instrument to each institutions' particularities and respond to context change over time. Results can assist decision-makers in identifying critical aspects to be improved, guiding them to allocate resources precisely, and assessing the efficiency of interventions.

**Design/methodology/approach:** With a qualitative and quantitative approach, this exploratory study used the data collected from Klein et al.'s research (2019). The IRT model used to analyze the data was the Graded Response Model. Anchored items were identified to allow the interpretation of the levels on the scale. Specialists were consulted to conduct a qualitative analysis so the scale could reveal the institution's QWL status quo. The scale was applied as a case study in the sample.

**Findings:** The instrument's internal consistency was confirmed, and the results reveal the scale has high reliability. The scale was classified into six cumulative levels. The parameters found demonstrate that the set of items accurately estimates the entire QWL latent trait. Items related to recognition were the aspects with the highest discrimination parameters proving their importance in distinguishing QWL.

**Keywords:** psychometrics, organizational factors, ergonomics, item response theory, higher education institutions

## Resumo

**Objetivo:** Validar a escala de qualidade de vida no trabalho (QVT) proposta por Ferreira (2011), utilizando a teoria de resposta ao item (TRI) e o conhecimento de especialistas para ser aplicada em instituições de ensino superior (IES).

**Originalidade/valor:** O artigo avança no conhecimento sobre QVT ao validar uma escala para avaliar QVT nesse contexto específico utilizando a TRI. A escala pode ser aplicada em qualquer IES. Itens podem ser removidos ou adicionados para adaptar o instrumento às particularidades de cada instituição e responder às mudanças de contexto ao longo do tempo. Os resultados podem ajudar os gestores a identificar os principais aspectos a serem melhorados, orientando-os a alocar recursos com precisão e avaliar a eficácia das intervenções.

**Design/metodologia/abordagem:** Com abordagem qualitativa e quantitativa, este estudo exploratório utilizou os dados coletados na pesquisa de Klein et al. (2019). O modelo de resposta gradual da TRI foi utilizado para analisar os dados. Itens âncora foram identificados para representarem os níveis da escala. Especialistas foram consultados para interpretar qualitativamente os níveis para que a escala pudesse revelar o status quo da QVT da instituição. A escala foi aplicada como um estudo de caso na amostra.

**Resultados:** Os resultados confirmaram a consistência interna do instrumento e a alta confiabilidade da escala que foi classificada em seis níveis cumulativos. Os parâmetros encontrados demonstram que o conjunto de itens é preciso para estimar todo o traço latente. Itens relacionados ao reconhecimento obtiveram maiores parâmetros de discriminação, comprovando influência significativa na QVT.

**Palavras-chave:** psicométrica, fatores organizacionais, ergonomia, teoria da resposta ao item, instituições de ensino superior

## INTRODUCTION

Definitions of quality of working life (QWL) vary from one person to another, organizational context, and industry sector (Qudah et al., 2019) and over time. The most used models are described by Walton (1973), Hackman and Oldham (1975), Westley (1979), and Nadler and Lawler (1983). The QWL dimensions that an organization will use have to be appropriate and useful, considering the workers' needs and expectations, the nature of the work to be done, and the kind of work environment the organization has (Bagtasos, 2011).

According to Walton (1973), QWL is seen as one of the central issues both for research on the quality of human experience in work organizations and in action programs that seek to improve that experience. The information gained from assessing employees' QWL can be utilized by employers to determine what appropriate action might be taken to enhance general QWL or specific aspects of this (Edwards et al., 2009). Based on an understanding of employees' various needs and their QWL experiences, management can identify the strategic gap (if any) in the organization and take further necessary actions to improve the QWL of employees (Bora et al., 2015).

Unlike many other engineering disciplines, human factors are extremely sensitive to context (Moray, 1994). To Hendrick and Kleiner (2002), the primary focus of macro-ergonomics is to design work systems that are compatible with an organization's sociotechnical system characteristics and then to ensure that micro-ergonomic elements are designed to harmonize with overall work system structure and processes. Therefore, the assessment and identification of the key factors that influence QWL in a given context can guide decision-makers to be more assertive in their projects.

A QWL program must be constantly evaluated to correct errors and make continuous improvements, but this practice is unusual in the public sector (Klein et al., 2019). Other authors from the performance measurement field agree on the updating, life cycle, and continuous improvement of the systems (Bititci et al., 2012; Bourne et al., 2000). When employees realize that management is making a sincere effort to improve employee safety, health, and work-life quality, especially when they see those things happening through ergonomic improvements, it usually will lead to increased employee commitment to the organization (Hendrick, 2003).

In addition, HEIs in the public sphere have been under pressure from society to bring their productivity closer to the standards found in the private sector (Cislaghi & Luz Filho, 2006). Ramstad (2009) mentions the

reciprocity between QWL and productivity and points out that it can be difficult to maintain good productivity growth without a favorable development in the QWL – and conversely. Studies observed that QWL influences performance directly or indirectly (Layer et al., 2009; Lee et al., 2007; Singh & Maini, 2020).

Due to this specificity and mutability, several ways of appraising QWL are found in the literature. In Brazil, Ferreira developed a QWL inventory assessment (Ferreira, 2009) and a scale (Ferreira, 2011) based on 2,105 respondents from different organizations using the classical test theory to analyze the data.

Regarding higher education institutions (HEIs), some scales (Both et al., 2006; Reis Júnior, 2008; Timossi et al., 2009) and instruments (Edwards et al., 2009; Freitas & De Souza, 2009; Klein et al., 2019; Petroski, 2005; Pizzio & Klein, 2015) were developed to measure and classify QWL. However, the fact that none created a scale to assess QWL without distinction of position in this specific context highlights the need to increase theoretical knowledge and justifies the present study.

Given the QWL characteristics mentioned and the necessity to follow a life cycle and continuous improvement, the item response theory (IRT) was used as a research method in this study to develop another scale, using Ferreira's inventory items (2011), to assess the QWL of the employees in HEIs. To Reise et al. (2005), IRT is a collection of mathematical models and statistical methods that are used to: 1. analyze items and scales; 2. create and administer psychological measures; and 3. measure individuals on psychological constructs (e.g., depression). IRT is a non-linear modeling technique based on probability theory, which assesses the functioning of scale items in relation to the measurement of a target trait (Hambleton et al., 1991). Although classical test theory (CTT) has served test development well over several decades, IRT has rapidly become mainstream as the theoretical basis for measurement (Embretson & Reise, 2000). CTT places more emphasis on the scale's composite score (Huang et al., 2017) while the IRT disregards the total test scores, as the conclusions do not depend on it but on each item (Andrade et al., 2000; Bortolotti et al., 2013). Hauck Filho et al. (2014) compared the performance of seven statistical models and concluded that IRT models yield the most reliable latent trait estimates.

Therefore, the objective of this study was to validate Ferreira's (2011) QWL scale by using the IRT and specialists' knowledge to access and monitor the QWL in higher education institutions.

## METHODS

### QWL items and data collection

The present exploratory study was carried out on data collected from Klein et al.'s (2019) survey research in which the CTT was used to analyze the data. These authors applied 56 items from Ferreira's (2009) QWL inventory to assess the parameters. A five-point Likert scale was used in which respondents could express their opinions as follows: 0 – "Completely disagree", 1 – "Partially disagree", 2 – "Indifferent", 3 – "Partially agree", and 4 – "Completely agree".

A total of 474 employees from a HEI in Brazil responded to the questionnaire (gender: 50.8% male and 49.2% female; age: 25.9% from 18 to 30, 44.9% from 31 to 40, 20.5% from 41 to 50 and 8.6% above 50; education degree: 4.4% high school, 17.1% bachelor's, 31.1% specialization, 18.8% master's and 28.7% doctorate) (Klein et al., 2019). Regarding the sample size in IRT analysis, it doesn't have to be "random" or "stratified random" (Embretson & Reise, 2000). Notwithstanding, Edelen and Reeve (2007) suggest that the ideal is to have respondents in all possible response categories for a set of items to be precisely estimated on the different scale levels.

### Data analysis

The IRT was used as a resource to support the validation of Ferreira's (2009) measure to the HEIs' context. The procedures to analyze the data were performed using RStudio software version 3.6.1. Data analysis involved re-categorization of inverted items, frequency analysis, factor analysis, marginal reliability calculations, estimation of item parameters, item characteristic curve (ICC), test information, creation and description of the IRT scale, and respondent's score calculation.

Some items (1, 8, 9, 12, 13, 14, 25, 26, 28, 41, 42, 47, and 54) have a conceptual sense opposite to the others, so agreeing with any of them would worsen QWL. Thus, it was necessary to re-categorize the responses of these inverted items to standardize their meanings according to the scale adopted.

Frequency analysis was carried out to check if there were enough respondents to estimate each response category precisely.

A full-information factor analysis was performed using the "mirt" (multidimensional item response theory) package developed by Chalmers (2012). De Ayala (2009) suggests this analysis is an alternative to check the dimen-

sionality of the instrument, that is, to identify the number of factors involved. Through this analysis, the factor loads of each item could be obtained. The present study adopted, as the exclusion criterion, items with a factor load  $< 0.3$ , once they have no relevance for the measurement of the latent trait, according to Hair et al. (2010).

The instrument's internal consistency was analyzed using marginal reliability calculation specific to IRT. The marginal reliability is similar to the Cronbach alpha used in CTT (Vincenzi et al., 2018). It was suggested by Green et al. (1984) and is computed as a function of the variance of the estimated scores and the average of the expected error variance (Sireci et al., 1991).

The parameters of the items were obtained using the metric (0.1) due to the computational ease, in which zero is the mean and 1 is the standard error. The IRT model considered was the graded response model (GRM) developed by Samejima (1969), and the estimation of the parameters of the items was performed by using the maximum marginal likelihood method (Bock & Aitkin, 1981). The GRM is a cumulative model and assumes there is an order among the response categories of each item. Thus, the probability ( $P_{i,k}^+(\theta)$ ) of an individual  $j$  with ability  $\theta_j$  to choose the category  $k_i$  (0, 1, 2, ... $m_i$ ) or a higher one of item  $i$  is given by:

$$P_{i,k}^+(\theta) = \frac{1}{1 + e^{-a_i(\theta_j - b_{i,k})}}$$

in which:

$\theta_j$  = latent trait of the  $j$ -th individual;

$a_i$  = discrimination parameter of item  $i$ . It represents the capacity of an item to distinguish respondents at different levels of the latent trait. The higher the value of this parameter, the better the item and discrimination among individuals at different latent trait levels (Vincenzi et al., 2018);

$b_{i,k}$  = parameter of location or difficulty of the  $k$ -th category of item  $i$  represented on the same scale as the latent trait. An individual will need to have a higher level of the trait to endorse a more difficult item (Reise et al., 2005), so  $b_{i0} \leq b_{i1} \leq b_{i2} \dots \leq b_{iki}$ . In the present study, the items have five categories of responses (Likert) and, therefore, four parameters of location ( $b_{i,0}$ ,  $b_{i,1}$ ,  $b_{i,2}$  and  $b_{i,3}$ ).

The item discrimination ( $a$ ) parameters and location for each response category ( $b_{i,0}$ ,  $b_{i,1}$ ,  $b_{i,2}$  and  $b_{i,3}$ ) were estimated, and their respective standard



errors were calculated. An item with a high discrimination value is a better indicator of the latent trait than an item with a lower discrimination value (Van der Linden & Hambleton, 1997).

Based on the discrimination and location parameters, the item characteristic curve (ICC) was obtained. The area of ICC above the  $\theta$  axis represents the amount of information provided by a specific item across the entire continuum of the latent trait of interest (Huang et al., 2017), in this study being QWL. The shape of an ICC describes how the change in the latent trait level is related to the one in the probability of a specific response (Bortolotti et al., 2013). Therefore, the categories of responses present in the ICC should not overlap one another so that they are really expressing the threshold between the different levels on the QWL scale.

Test information and measurement error lines of the QWL instrument were generated. The test information is the sum of the information provided by each item that comprises it (Vincenzi et al., 2018). It quantifies for each level of latent trait how well a set of items is able to accurately estimate the latent trait (Zickar & Broadfoot, 2009). The measurement error is estimated by the inverse of the square root of the test information. In this study, we considered that the test provides desired estimative precision when the measurement error was  $\leq 0.40$ .

To help the association between the items and the levels on the QWL scale, the accumulated probabilities of each item were calculated, and, subsequently, classification by anchor levels was performed, which are characterized by sets of items called anchor items. For an item to be considered an anchor at a certain anchor level in this study, it must be answered positively by at least 60% of the respondents with this latent trait level, and the discrimination parameter ( $a$ ) must be  $\geq 1.0$ .

To facilitate the interpretation and the use of the scale, a linear transformation was performed based on the IRT principle of invariance. Thus, the scale was built with a metric of (100, 10), which is mean 100 and standard deviation 10.

After the parameters of the items are estimated in the same metric, it is possible to compare the QWL of individuals with each other. However, this comparison does not have any practical significance in practical terms. This reason justifies the use of IRT to create a different QWL scale. To develop a scale, it is necessary to validate the criteria. According to DeVellis (2016), criterion validity is often assessed by a correlation between the measure being validated (QWL, for example) and the criterion that is expected to be related (e.g., some behavior).

For criterion validity, four QWL specialists were consulted to conduct a qualitative interpretation aiming to give meaning to the levels on the scale so; the scale could reveal a diagnosis (*status quo*) of the institution's current QWL. First, a meeting was held to define the nomenclature to be given to the levels. It was decided to be: 1. poor; 2. somewhat satisfactory; 3. satisfactory; 4. good; very good, and; 5. excellent. Thereby, specialists were asked to indicate from which anchor level the QWL could be considered as the nomenclature elaborated.

After the scale was interpreted, the respondents' scores were calculated. Unlike questionnaires that use CTT, the score generated by IRT is not obtained by adding points for each item. The IRT estimates the parameter  $\theta$  (ability) for each respondent, considering the parameters of each item and the answer presented by the respondent. Moreover, with IRT, we are able to make predictive statements about respondents' performance as well as examine the tenability of the model *vis-à-vis* the data (De Ayala, 2009). With the scores obtained, the workers were ranked and classified within the IRT QWL scale.

## RESULTS

Frequency analysis revealed that there was not enough information, at least 20 responses, to estimate most of the items' response categories  $b_{i,0}$ ,  $b_{i,1}$ ,  $b_{i,2}$  and  $b_{i,3}$ . For this reason, categories 0 (completely disagree), 1 (partially disagree), and 2 (indifferent) were grouped and coded as 0. Categories 3 (partially agree) and 4 (completely agree) remained separate and were coded as 1 and 2, respectively. Another frequency analysis was done and the results obtained were adequate to gauge each of the new response categories precisely.

The full-information factor analysis indicated that 4 of the 56 items (6, 16, 28, and 47) had factor loadings  $< 0.3$  and were removed from the analysis. A new analysis was performed with the 52 remaining items and revealed that 35.8% of the latent trait information was related to a dominant factor. This result allowed the use of a unidimensional IRT model, according to Reckase (1979).

The marginal reliability coefficient obtained was 0.95. It is unitless and bounded by 0 and 1 (De Ayala, 2009). This result proves the average accuracy across the continuum, and this value reveals that the scale has high reliability.

Table 1 presents the items descriptions and the results obtained by the process of calibration of the 52 items. Discrimination parameters ranged from 0.54 to 2.58, indicating that all items have satisfactory discrimination power. Location parameters varied between -2.17 and 4.50, showing that the scale is capable of assessing workers from no QWL to the highest QWL levels.

**Table 1**

*Item descriptions, estimates of discrimination (a), and location ( $b_1$  e  $b_2$ ) parameters on the scale (0,1) with their respective standard errors and factor loadings*

Item	Item description	Parameters estimates, standard errors (SE), and factor loading (FL)						
		a	SE(a)	$b_1$	SE( $b_1$ )	$b_2$	SE( $b_2$ )	FL
1*	Communication between co-workers is unsatisfactory.	0.65	0.12	1.66	0.31	4.15	0.75	0.36
2	Coexistence in the work environment at the university is harmonious.	1.30	0.13	-1.07	0.12	1.43	0.15	0.61
3	The distribution of tasks is fair.	1.10	0.13	0.40	0.11	2.99	0.33	0.54
4	The practice of recognition contributes to my professional achievement.	0.75	0.10	-1.55	0.24	0.50	0.15	0.40
5	Society recognizes the importance of my work.	1.12	0.12	0.05	0.10	2.13	0.23	0.55
6	Norms for carrying out the tasks are strict.	-	-	-	-	-	-	-
7	Opportunities for professional growth are the same for everyone.	1.32	0.14	0.49	0.10	1.65	0.17	0.61
8*	It is common not to complete initiated work.	0.68	0.13	1.88	0.34	3.93	0.70	0.37
9*	Conflict in the workplace is common.	1.07	0.13	0.40	0.11	2.18	0.25	0.53
10	Access to immediate superiors is easy.	1.32	0.15	-2.09	0.21	-0.59	0.09	0.61
11	There is performance monitoring.	0.54	0.10	0.54	0.20	4.50	0.85	0.30
12*	There are difficulties in superior-subordinate communication.	1.29	0.13	-0.52	0.10	0.55	0.11	0.60
13*	There is a lack of support from superiors for my professional development.	1.73	0.16	-0.16	0.08	0.84	0.10	0.71
14*	Time to take a break is lacking.	0.77	0.11	-0.49	0.15	0.69	0.16	0.41
15	I like the institution where I work.	1.91	0.18	-1.55	0.13	-0.22	0.07	0.75
16	Deadlines are demanded to complete the tasks.	-	-	-	-	-	-	-

(continue)

**Table 1 (continuation)**

*Item descriptions, estimates of discrimination (a), and location ( $b_1$  e  $b_2$ ) parameters on the scale (0,1) with their respective standard errors and factor loadings*

Item	Item description	Parameters estimates, standard errors (SE), and factor loading (FL)						
		a	SE(a)	$b_1$	SE( $b_1$ )	$b_2$	SE( $b_2$ )	FL
17	There is trust among co-workers.	1.34	0.13	-0.55	0.10	1.64	0.16	0.62
18	There are incentives for career growth.	1.74	0.16	-0.24	0.08	1.33	0.12	0.71
19	My co-workers are willing to help me.	1.23	0.12	-1.25	0.14	0.94	0.12	0.58
20	My immediate superior is interested in helping me.	1.64	0.15	-1.17	0.11	0.12	0.08	0.69
21	My working relationship with the immediate superior is cooperative.	1.50	0.14	-1.36	0.13	0.18	0.09	0.66
22	My working relationships with co-workers are harmonious.	1.35	0.14	-2.01	0.19	0.42	0.10	0.62
23	I am free to say what I think about the work.	1.38	0.13	-1.12	0.12	0.73	0.11	0.62
24	At this university, the activities I do are sources of pleasure.	1.45	0.14	-0.91	0.11	1.09	0.12	0.65
25*	Working conditions are precarious.	1.00	0.12	0.11	0.11	1.62	0.20	0.51
26*	Tasks are repetitive.	0.72	0.12	1.32	0.23	3.65	0.58	0.39
27	At the university, I have time to do my job with zeal.	0.94	0.11	-1.45	0.19	1.07	0.16	0.48
28*	At the university, there is a strong demand for results.	-	-	-	-	-	-	-
29	At this university, my dedication to work is recognized.	1.99	0.18	0.00	0.07	1.54	0.13	0.76
30	At this university, results obtained from my work are recognized.	2.06	0.19	-0.04	0.07	1.69	0.13	0.77
31	At this university, I am encouraged by my superior.	1.84	0.17	0.09	0.08	1.22	0.11	0.73
32	At this university, I have free access to higher superiors.	1.24	0.13	-0.70	0.11	0.79	0.12	0.59
33	The university offers opportunities for professional growth.	1.60	0.15	-0.33	0.08	1.19	0.12	0.68
34	Managerial behavior is characterized by dialogue.	2.00	0.18	-0.20	0.07	1.12	0.10	0.76
35	Personal development is a real possibility at the university.	2.11	0.18	-0.20	0.07	1.11	0.10	0.78
36	The physical space to perform my work is satisfactory.	0.95	0.12	-0.01	0.11	1.92	0.24	0.49

(continue)

**Table 1 (conclusion)**

*Item descriptions, estimates of discrimination (a), and location ( $b_1$  e  $b_2$ ) parameters on the scale (0,1) with their respective standard errors and factor loadings*

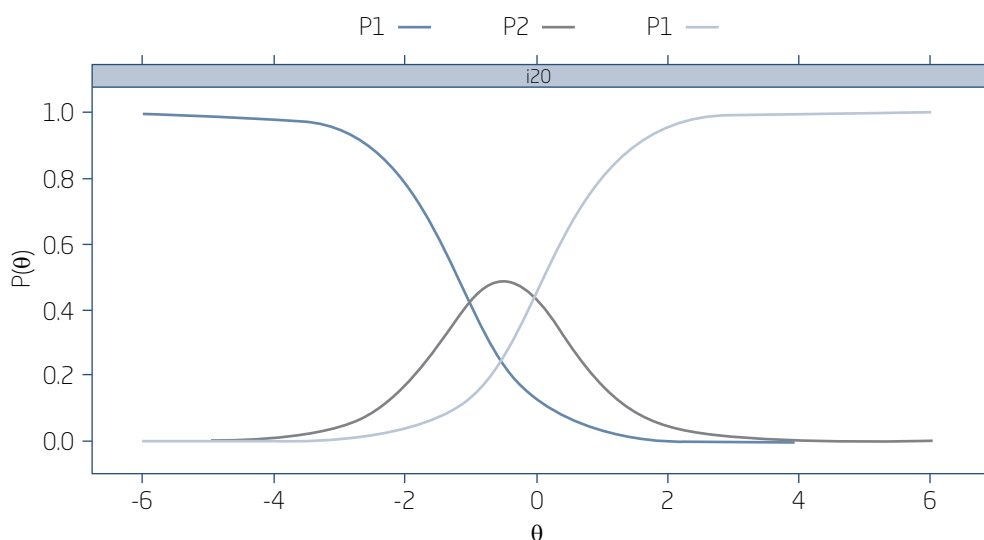
Item	Item description	Parameters estimates, standard errors (SE), and factor loading (FL)						
		a	SE(a)	$b_1$	SE( $b_1$ )	$b_2$	SE( $b_2$ )	FL
37	The workplace is comfortable.	1.13	0.12	-0.35	0.11	1.40	0.16	0.55
38	The room temperature is comfortable.	0.87	0.11	-0.61	0.14	0.89	0.16	0.45
39	The lighting level is sufficient to carry out the activities.	1.08	0.12	-1.22	0.15	0.12	0.10	0.53
40	The workplace is suitable for carrying out tasks.	1.08	0.12	-0.60	0.12	1.17	0.15	0.53
41*	The work I do puts my physical security at risk.	0.67	0.10	-1.17	0.22	-0.06	0.14	0.37
42*	The equipment needed to perform the tasks is precarious.	0.86	0.11	-0.72	0.14	0.98	0.17	0.45
43	The work instruments are sufficient to carry out the tasks.	0.89	0.11	-0.90	0.15	1.44	0.20	0.46
44	Consumables are sufficient.	0.84	0.11	-0.92	0.16	1.17	0.18	0.44
45	Recognition of collective work is an effective practice.	2.39	0.23	0.53	0.07	1.90	0.14	0.81
46	Recognition of individual work is an effective practice.	1.96	0.19	0.60	0.08	2.29	0.19	0.72
47*	The pace of work is excessive.	-	-	-	-	-	-	-
48	The time I spend at the university makes me happy.	1.85	0.16	-0.68	0.09	0.88	0.10	0.76
49	The work I do is useful for society.	1.02	0.13	-2.17	0.26	-0.42	0.11	0.51
50	I can do my job without pressure.	0.87	0.11	-1.43	0.20	1.37	0.20	0.45
51	I can do my job without overloading tasks.	0.75	0.10	-0.79	0.17	2.03	0.29	0.40
52	My work makes me feel good.	2.20	0.18	-0.90	0.09	0.59	0.08	0.79
53	I feel recognized by the institution where I work.	2.58	0.23	0.15	0.07	1.40	0.10	0.83
54*	I have the impression that I do not exist for the institution.	1.68	0.16	-0.15	0.08	0.64	0.09	0.70
55	I have the possibility to be creative in my work.	1.00	0.11	-1.25	0.16	0.96	0.15	0.51
56	I have the freedom to execute the tasks.	1.19	0.12	-1.59	0.17	0.89	0.12	0.57

**Source:** Elaborated by the authors.

(-) items removed from the analysis; \* inverted items.

The graphics containing the IIC were generated. It was noticed that items had none of their response categories overlapping others, proving that grouping the response categories during the frequency analysis was effective. Figure 1 presents the item 20 information curve as an example to show that the thresholds between the response categories are clearly distinguishable. The x-axis represents the latent trait (QWL), and the y-axis represents the probability of a worker choosing a category response for an item in a given level of QWL.

**Figure 1**  
*Item 20 characteristic curve*



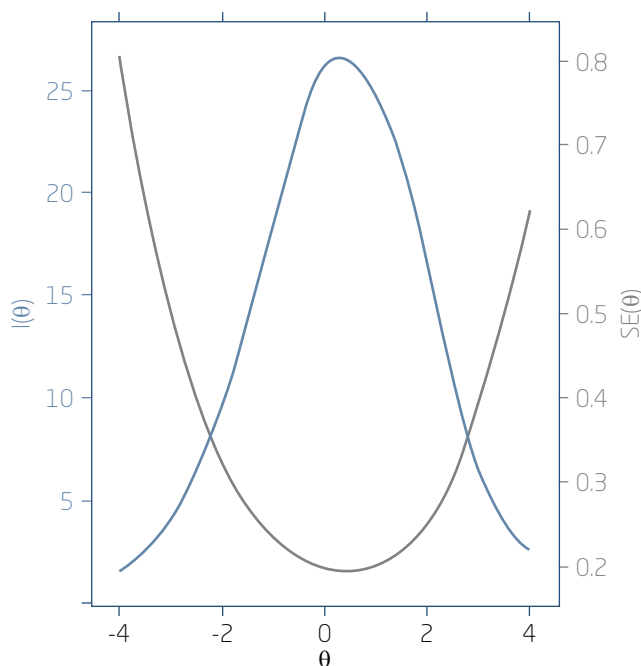
**Source:** Elaborated by the authors.

The lines represent each response category after grouping. Blue: the grouping of completely disagree, partially disagree, and indifferent; pink: partially agree, and green: completely agree.

Figure 2 shows the test information curve. It indicates that the test is able to estimate QWL with the desired precision in the interval where the measurement error is  $\leq 0.4$ , which is between -2 and 2.5. Therefore, the set of 52 items covers the entire QWL latent trait (blue line) and shows the reliability and range of the instrument.

**Figure 2**

***Test information and measurement error of the QWL instrument***



*Source:* Elaborated by the authors.

The blue line represents the test information  $I(\theta)$  (vertical axis on the left) along the scale (horizontal axis). The pink line represents the measurement error (vertical axis on the right). It indicates that low values provide a more precise estimative.

Table 2 lists the anchor items in each anchor level after linear transformation to the metric (100,10) obtained by the transformation constants  $\alpha = 10.2849$  and  $\beta = 100.0876$ . It also displays specialists' qualitative interpretation and positioning, which resulted in the QWL scale levels.

The IRT QWL scale allows interpreting the scores of the workers at each level. Table 3 describes each one in detail. Once the IRT QWL scale is cumulative, it is expected that workers in a given QWL level agree with the items in this level as well as the items in the inferior levels. For example, for a worker to be at the level of QWL 95 and 100 (somewhat satisfactory), there is a high probability that they will partially agree with, at least, the items at levels 85 (10, 22, and 49) and 90 (15, 21 and 56).

According to the scale generated, workers start to experience QWL at level 85 "Poor" when they are begging to "partially agree" with the items at this level. No QWL is perceived in levels inferior to 85.

**Table 2**

*The positioning of the anchored items in the anchored levels on the QWL scale considering the item categories*

Anchor levels	85	90	95	100	105	110	115	120	125	130	135
QWL scale	Poor	Somewhat satisfactory		Satisfactory		Good		Very good		Excellent	
	10b <sub>1</sub>	15b <sub>1</sub>	2b <sub>1</sub>	12*b <sub>1</sub>	5b <sub>1</sub>	3b <sub>1</sub>	13*b <sub>2</sub>	2b <sub>2</sub>	5b <sub>2</sub>	9*b <sub>2</sub>	3b <sub>2</sub>
	22b <sub>1</sub>	21b <sub>1</sub>	19b <sub>1</sub>	17b <sub>1</sub>	13*b <sub>1</sub>	7b <sub>1</sub>	19b <sub>2</sub>	18b <sub>2</sub>	7b <sub>2</sub>	46b <sub>2</sub>	
	49b <sub>1</sub>	56b <sub>1</sub>	20b <sub>1</sub>	18b <sub>1</sub>	29b <sub>1</sub>	9*b <sub>1</sub>	23b <sub>2</sub>	29b <sub>2</sub>	17b <sub>2</sub>		
			23b <sub>1</sub>	32b <sub>1</sub>	30b <sub>1</sub>	25*b <sub>1</sub>	24b <sub>2</sub>	30b <sub>2</sub>	25*b <sub>2</sub>		
			24b <sub>1</sub>	33b <sub>1</sub>	34b <sub>1</sub>	45b <sub>1</sub>	31b <sub>2</sub>	37b <sub>2</sub>	45b <sub>2</sub>		
			39b <sub>1</sub>	35b <sub>1</sub>	31b <sub>1</sub>	46b <sub>1</sub>	32b <sub>2</sub>	40b <sub>2</sub>			
			52b <sub>1</sub>	40b <sub>1</sub>	37b <sub>1</sub>	12*b <sub>2</sub>	33b <sub>2</sub>	53b <sub>2</sub>			
			55b <sub>1</sub>	48b <sub>1</sub>	53b <sub>1</sub>	22b <sub>2</sub>	34b <sub>2</sub>				
				10b <sub>2</sub>	54*b <sub>1</sub>	39b <sub>2</sub>	35b <sub>2</sub>				
				15b <sub>2</sub>	20b <sub>2</sub>	52b <sub>2</sub>	48b <sub>2</sub>				
				49b <sup>2</sup>	21b <sub>2</sub>	54*b <sub>2</sub>	55b <sub>2</sub>				
							56b <sub>2</sub>				

Source: Elaborated by the authors.

\* Inverted item.

**Table 3**

*Description of the QWL scale levels and score range based on the response categories of the anchored items*

Level	Description
No QWL 82.5]	At this level, workers have no perceived QWL. They have a high probability of not agreeing with all the items of the instrument. They may partially agree with some items, but their score will likely be lower than 82.5.
Poor (82.5; 92.5]	Workers placed at this level begin to experience QWL. They partially agree to have easy access to the immediate superior, relationships with co-workers are harmonious, the work they do is useful for society, they like the institution where they work, have a cooperative relationship with their immediate superior, and the freedom to execute the tasks.

(continue)



**Table 3 (continuation)**

**Description of the QWL scale levels and score range based on the response categories of the anchored items**

Level	Description
Somewhat satisfactory (92.5; 102.5]	Besides the characteristics of the previous level, since it is a cumulative scale, this level identifies workers who partially agree that coexistence in the work environment is harmonious, co-workers and immediate superior are willing to help, they are free to say what they think about work, the activities they do are sources of pleasure, lighting level is sufficient, their work makes them feel good, they can be creative, there are no difficulties in superior-subordinate communication, there is trust among co-workers, there are incentives for career growth, they have free access to higher superiors, the university offers opportunities for professional growth, personal development is a real possibility, the workplace is suitable for carrying out tasks and the time they spend at the university make them happy. This is the first level in which workers begin to agree with some items completely. They completely agree that they have easy access to the immediate superior, they like the institution where they work, and the work they do is useful for society.
Satisfactory (102.5; 107.5]	Added to the features of the previous items, workers in this level partially agree that society recognizes their work, superiors support their professional development, dedication to work is recognized, results obtained from their work are recognized, managerial behavior is characterized by dialogue, they are encouraged by their superiors, the workplace is comfortable, they feel recognized by the institution, and have the impression that they exist for it. They completely agree that the immediate superior is willing to help and that the working relationship with the immediate superior is cooperative.
Good (107.5; 117.5]	In addition to the items above, workers partially agree that distribution of tasks is fair, opportunities for professional growth are the same for everyone, conflict in the workplace is not common, working conditions are not precarious, and recognition of collective and individual work is an effective practice. They completely agree that there are no difficulties in superior-subordinate communication, relationships with co-workers are harmonious, lighting level is sufficient, their work makes them feel good, they have the impression that they exist for the institution, superiors support their professional development, co-workers are willing to help, they are free to say what they think about work, the activities they do are sources of pleasure, they are encouraged by their superiors, have free access to higher superiors, the university offers opportunities for professional growth, managerial behavior is characterized by dialogue, personal development is a real possibility, the time they spend at the university make them happy, they can be creative, and they have the freedom to execute the tasks.
Very good (117.5; 127.5]	From this level on, workers are expected to, at least, partially agree with all the items. In addition, they completely agree that coexistence in the work environment is harmonious, there are incentives for career growth, dedication to work is recognized, as well as the results obtained from it, the workplace is comfortable and suitable for carrying out the tasks, they feel recognized by the institution, society recognizes the importance of their work, opportunities for professional growth are the same for everyone, there is trust among co-workers, working conditions are not precarious, and recognition of collective work is an effective practice.

(continue)

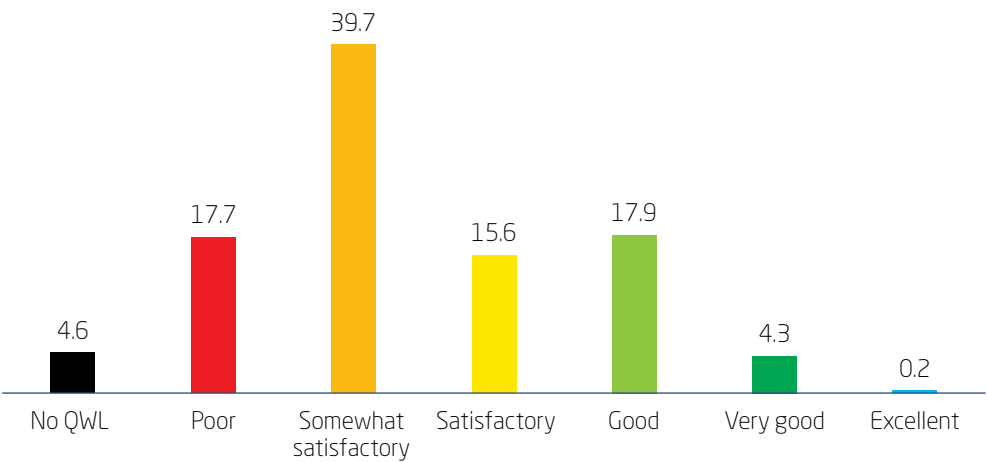
**Table 3 (conclusion)**  
*Description of the QWL scale levels and score range based on the response categories of the anchored items*

Level	Description
Excellent (127.5;	Additionally to the previous items, workers in this level completely agree that conflict in the workplace is not common, recognition of individual work is an effective practice, and distribution of tasks is fair.

Source: Elaborated by the authors.

Figure 3 shows the classification of the respondents in each level according to their scores. It can be seen that most workers from this sample (39.7%) are in the “somewhat satisfactory” level, and only 0.2% are in the “excellent” level.

**Figure 3**  
*Percentage of workers in each level of QWL*



Source: Elaborated by the authors.

## DISCUSSION

The present study used the GRM to construct and interpret the QWL scale. According to Porter (1961), one of the most useful systems for the psychologist is the grouping of motives or needs according to a hierarchy of prepotency. This theory has been devoted especially to the seminal studies of Maslow (1943, 1981). As in the GRM, the hierarchy of needs states that

there are primary needs that must have been fulfilled first before the individual seeks to achieve the higher ones. This is one advantage of the scales created by using IRT.

The results obtained from the factor analysis allowed the use of the IRT one-dimensional model to measure QWL precisely and develop a reliable scale. Two fundamental assumptions of unidimensional IRT models are that a single trait determines how people respond to items and that those items are locally independent (Cella et al., 2007). The IRT criteria for selecting items emphasize unidimensionality and are more rigorous and stricter than is the case with CTT (Schwartz et al., 2020).

Items 6, 16, 28, and 47 were removed from the analysis because they had a factor load  $< 0.3$ . It means they may be related to another dimension. In contrast, other items can be tested to be included in the instrument. This process is possible due to one advantage of the IRT. That is, once the scale is built, new items can be inserted on the same scale using a technique called equalization described by (Kolen & Brennan, 2004). This procedure may be useful to suit the instrument to each institutions' particularities better. Ergonomics/human factors conceptualize any system of interest as existing within a boundary and thus a defined context, having inputs and outputs which may connect in many to many mappings (Wilson, 2014).

Equalization can also be used to be responsive to the mutable characteristic of QWL. According to Hendrick (1988), many environmental characteristics are dynamic and often unpredictable in a university environment. Whatever aspects may have been considered as related to an excellent level of QWL today may not be the same ones tomorrow.

The items with higher values of discrimination parameters are "I feel recognized by the institution where I work" and "Recognition of collective work is an effective practice." This finding reveals that recognition plays an important role in distinguishing workers' QWL. Many studies Ferreira (2011), Mohan and Kanta (2013), Nadler and Lawler (1983), Qudah et al. (2019), Saraji and Dargahi (2006), and Warr et al. (1979) have shown the relevance of recognition in improving QWL and motivation, according to the seminal works of Maslow (1943) and Herzberg et al. (1959).

Based on the scale generated, workers begin to notice QWL at the level 85 "Poor." Workers in this level partially agree that they have harmonious relationships with co-workers. Hassan and Lapok (2014) affirm that interpersonal relations are one of the most influential factors on QWL. Interpersonal conflicts with co-workers contribute to increased stress levels (Bora et al., 2015). Also, at this level, workers feel that their work is useful for

society. Walton (1973) mentioned that the social relevance of work life is one of the major conceptual categories relating to QWL. Cherns (1976) corroborates this finding and states that employees should be provided with tasks that have social relevance to life. In contrast, organizations that are seen to be acting in a socially irresponsible manner will cause increasing numbers of employees to depreciate the value of their work and careers, which in turn affects worker self-esteem (Walton, 1973).

Level “Somewhat satisfactory” reveals aspects related to incentives for career growth which is also associated with QWL by Hassan and Lapok (2014) and Walton (1973), Raj Adhikari and Gautam (2010). Workers at this level tend to like the institution where they work. Chan and Wyatt (2007) cited that employees perceive their QWL positively if they are satisfied with their work and organization.

Simmons and Swanberg (2009) verified that low supervisor support was associated with depressive symptoms. According to Beh and Rose (2007), conflict relations with managers can cause dissatisfaction. Correspondingly, to achieve the “Satisfactory” level on the IRT QWL, workers have a high probability to completely agree that they have a cooperative relationship with the immediate superior who is willing to help. It demonstrates that connection with the superior is fundamental to a satisfactory QWL.

Workers at the “Good” level feel the liberty to execute the tasks, be creative, and give their opinion. Freedom to structure work tasks, prioritization of tasks, and time management all contribute to a more flexible job which should lead to higher levels of QWL (Aketch et al., 2012). These findings corroborate Sirgy et al. (2001), who identified seven major needs of employees, and one of them is related to creativity at work.

A comfortable and appropriate workplace and recognition are key indicators in the “Very Good” level. Previous studies suggest that an agreeable workplace can effectively contribute to job satisfaction (Kalleberg, 1977; Rosser, 2004; Singh & Maini, 2020). Recognition of collective work, the results obtained by the institution, and recognition of the importance of work by society are the different types of this aspect that respondents experience if they are placed in this level. Sirgy et al. (2001) identified that recognition and appreciation of work with the organization, as esteem, must be required to acquire QWL. According to Cherns (1976), to promote quality of life, workers should perform quality work that provides recognition.

One characteristic pertinent to the “Excellent” level that differs from the level below is that recognition is focused on the individual. According to Beh and Rose (2007), job enrichment theory, which began with the pioneering

work of Herzberg et al. (1959), suggests that jobs should be redesigned for increased challenge and responsibility and opportunities for advancement, personal growth, and recognition.

It means that to reach the top of the scale, individual work is recognized most of the time. Workers first must have the appropriate environment and resources available (aspects from the lower levels) to perform their tasks well. This way, they can deliver meaningful results and, consequently, be recognized and experience the top aspect on the QWL scale. This relationship reinforces that QWL is a cumulative latent trait and that the IRT Gradual Response Model developed by Samejima (1969) is appropriate to provide parameters to measure it.

The results obtained from the application of the scale as a case study classified each respondent in a QWL level and revealed that most of them were at the “somewhat satisfactory” level. These findings highlight relevant aspects that need to be improved. The easiest way to establish credibility with management is to identify those obvious deficiencies where relatively inexpensive improvements can have a quick cost-benefit payoff (Hendrick, 2003). In this sample, a QWL program focusing on providing the requirements to the employees to achieve the aspects related to the level above (satisfactory), such as encouraging cooperative relationship with the immediate superior, will have a higher probability to be more effective. Also, identifying each employee’s QWL level enables decision-makers to be more precise when providing individual or the-same-QWL-level-group specific interventions for them to rise to the next level.

## CONCLUSION

By using IRT, this research confirmed that Ferreira’s (2009) instrument is reliable to measure QWL in HEIs. It was possible to validate an IRT QWL scale to reveal the *status quo* of institutions’ workers QWL. Its interpretation allows decision-makers to identify key aspects necessary to be improved. It assists them in better allocating resources (human or material), guiding intervention programs, and avoiding waste in issues that will not enhance QWL significantly. In addition, by doing this, directly or indirectly, the performance of an individual or a sector of work may be optimized.

With the IRT QWL scale, it is possible to make comparisons: 1. between workers; 2. between institutions and; 3. longitudinal. Each kind of comparison can express different practical and useful information. Comparisons among workers may reveal micro-ergonomic details such as what kind of

job, what position, or what department investments should be addressed. This way, dealing with its specificities, intervention may be more precise. The result obtained by comparing institutions can be used by the government or regulatory agencies to state norms demanding a minimum level of QWL considered acceptable. Moreover, longitudinal comparison can show if QWL has increased or decreased over the years. Furthermore, it can demonstrate if an ergonomic intervention program was efficient or not.

Ultimately, to improve QWL requires a shift to a more proactive health promotion approach rather than a reactive program. The results obtained from the application of the scale are able to advocate strategies that can help in making work more pleasant and enhancing the employees' performance.

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