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METRICS VALIDATION TO EVALUATE QUALITY IN PUBLIC HIGHER EDUCATION INSTITUTIONS

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ABSTRACT

Introduction: In public higher education, the complexity of evaluating goals to be reached and the uncertainties about metrics adopted by the country hinder the implementation of evaluation processes. **Objective:** To build and validate the content of quality indicators for evaluation of Higher Education Institutions (HEIs). **Method:** Methodological study developed in six stages, in which 10 HEI judges participated, between 2015 and 2018. The Delphi method was employed, and the Content Validity Ratio was calculated, with a value higher or equal to 0.62. A total of 46 indicators were proposed in the following subdimensions: Teaching (16), Research, Extension, Knowledge and Innovation (15), and Management (15). **Results:** Content validity evidence was found for 38 indicators, 11 of which related to structure, 10 to processes, and 17 to results, with the Management subdimension being the one with the lowest CVR values. **Further Considerations**: Validity evidence was found for a matrix of 38 quantitative indicators formulated as mathematical equations, which can be systematically applied to internal institutional evaluations to complement qualitative ones.

Keywords: Organization and Administration. Evaluation Studies as Topic. Indicators. Validation Studies. Higher Education.

INTRODUCTION

Concern about the quality and development of an institutional evaluation culture is currently part of the routine practice of organizations in industry, commerce and services fields.

When it comes to Higher Education (HE), evaluation of institutional quality and performance has become a manifestation of political responsibility, which favors regulations aligned with the interests of society[1]. It gained importance and began to be presented as priority by education authorities, educators and managers in the 1990s following an expanded access to higher education[2,3], especially due to the increasing number of private institutions[3].

HE evaluation, in addition to a methodological procedure, is also a strategic and political activity; therefore, theoretical and ethical aspects need to be taken into account[4]. It aims to improve teaching, research, extension and management and, besides, is being understood as a demand from society in order to guide the choice of reputable and high-ranking national and international institutions[5].

In addition to focusing on monitoring and evaluation, highlight should be given to the formative nature of evaluation processes that promote self-reflection, self-knowledge and learning from the establishment of relations between processes and results[6]. However, evaluating the quality of higher education is a complex task, bearing in mind the multi-dimensionality of the quality construct, as well as the university itself, since many are the roles and activities that they represent, such as teaching, academic programs, research and science support, extension and the general academic environment.

During the historical course of evaluation policies in the country, a fragmented process has evolved to an evaluation system named National Higher Education Evaluation System [*Sistema Nacional de Avaliação da Educação Superior*] – SINAES, which is based on principles and dimensions and founded on internal and external institutional evaluation, as well as on evaluation of courses and of a student's academic performance by means of the National Student Performance Exam [*Exame Nacional de Desempenho dos Estudantes*] – ENADE[7,8].

The process is meticulous and developed in several stages. As for results, in addition to subsidizing regulatory bodies of the Ministry of Education and Culture [*Ministério da Educação e Cultura*] – MEC, and support agencies, it is set

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forth that they should be analyzed within the university for identification of improvement opportunities.

SINAES' evaluation procedures are established according to criteria and indicators formulated as statements to which the evaluator must attribute a concept, in increasing order of excellence, based on a 5-point Likert scale. However, it is possible to observe that indicators represented by equations whose results are expressed as indexes and rates provide a more straight forward interpretation of results, streamlining the decision-making process and continuous monitoring[9].

Thus, the challenge of this research lies in proposing an indicator matrix – in the form of mathematical equations based on criteria adopted in Brazilian models for evaluation of higher education institutions, courses and international accreditation – that allows for intelligibility and comparability and that promotes self-knowledge related to structure, process and result aspects.

Due to distinctions between private and public education organizations as to values and political, social and educational objectives[10], the applicability of the matrix of the indicators presented for validation procedures in this research is aimed at public higher education institutions.

In this sense, the question to guide this study is: Does the quality indicator matrix proposed allow monitoring and evaluating the performance of structure, process and result components in public higher education institutions in the national context?

The importance of disseminating the proactive and formative evaluation culture is what drives this research, which aims to: develop and validate the content of indicators for evaluation of the performance dimension of the quality construct in Brazilian public higher education institutions as to structure, process and result components using evaluation models adopted by the country.

METHOD

This is a methodological research for elaboration and validation of instruments that aims to solve concrete daily life problems[11].

The theoretical framework adopted comprehended six stages[12], namely:

I- Conceptual structure establishment – Delimitation, for the purposes in the present research, of the performance dimension belonging to the quality construct, with the latter being operationalized by means of variables, indicators and indexes, which correspond to the way an organization behaves with efficiency and performance in mind[13].

II- Definition of instrument objectives – Evaluation of structure, process and result aspects from the Donabedian evaluation model for public higher education institutions, within the performance dimension of the quality construct, for the following subdimensions: 1- Teaching, 2- Research, Extension, Knowledge and Innovation, and 3- Management[14].

III- Building of the items for each indicator as well as of the response scales – The indicators were developed through relevant literature review based on models for evaluation of: higher education institutions (HEIs), courses, international course accreditation, the guidelines of the 2010-2020 National Education Plan, the 2012-2015 Multiannual Plan, and the experience of professors and technicians from a public university in the state of Paraná with expertise in institutional evaluation. This phase comprehended the development, analysis and judgement of the 103 indicators formulated as mathematical equations, with their datasheet being organized as follows for each indicator: descriptor, foundation, calculation equation, data source, evaluation criteria and sample, evaluating their content and attributes. Six specialists participated (professors and technicians); they had positions in provostship, directorship and management.

IV- Item selection and organization – Considering the agreement percentage ($\geq 80\%$)[12] and with the judges' contributions, 60 indicators were excluded as they were not deemed relevant to the evaluation of the performance dimension of the quality construct for public higher education institutions, which is in line with the recommendation of limiting the

number of metrics in order to not compromise the operationalization and continuity of the evaluation procedure[15].

V- Instrument structuration – In this stage, which took place between October 2016 and December 2017, all 46 indicators were restructured in the subdimensions[14] as follows: Teaching – 16 indicators; Research, Extension, Knowledge and Innovation – 15 indicators; and Management – 15 indicators; with 14 structure, 15 process and 17 result indicators, according to the Donabedian evaluation model (Figure 1).

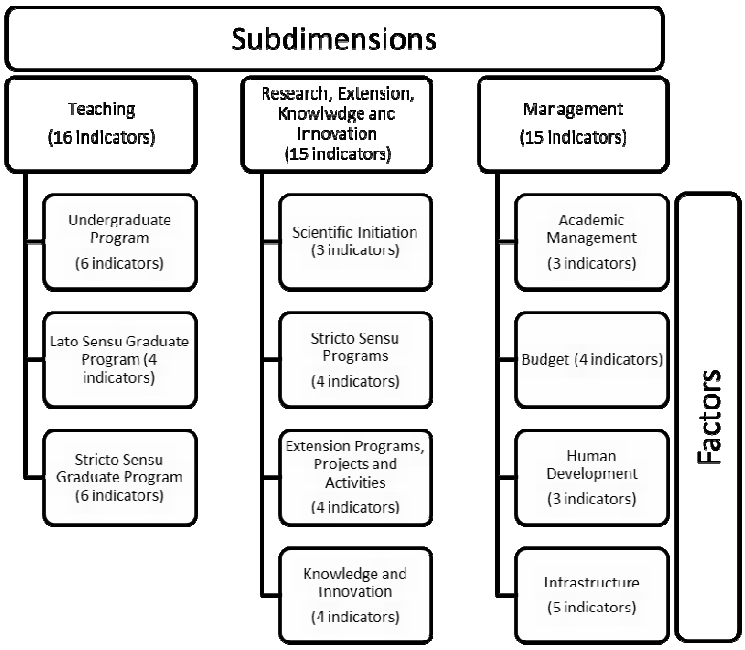

Figure 1. Representation of subdimensions, factors and number of indicators proposed for quality evaluation of public higher education institutions, São Paulo, SP, 2015-2016.
Source: The authors.

VI- Content Validity – Content validation was performed by experts in teaching, management and HE evaluation through the Delphi method, which is based on confidentiality and employed so consensus can be reached among specialists in a certain field of knowledge[16].

Content validity refers to how much a sample of items is representative of the construct of interest and, for this reason, relies on specialists' judgements as there is no statistical test to determine whether the measure comprehends the content or properly represents the construct of interest[17]. The attributes applied to the evaluation of each indicator were: associated, straight forward, relevant, communicable, feasible and accessible; each specialist's answers were registered on a Yes and No dichotomous scale.

In this stage, the sampling universe was composed of professors from public HE institutions with academic or management roles, who were specialists in higher education evaluation and members of Standing Evaluation Commissions, or their equivalents, in their institutions. Sampling was intentional for selecting individuals that knew the topics being studied[11].

The judges were sourced from a list of Brazilian public universities available on e-MEC database of Higher Education Institutions and Courses, at MEC's website (http://emec.mec.gov.br/). A list of 107 public universities was generated, and for selection of the institutions that would participate in the study the following inclusion criteria were adopted: all states with fewer than four public universities; for all states with more than that,

the four main cardinal points (North, South, West and East) were considered, including capital cities and interior towns, and at least one Federal, one State and one Municipal institution.

Thus, 74 institutions were selected; they were contacted by phone in order to inform the contact details of the people responsible for the Standing Evaluation Committees, who were then presented with the objectives and methodology of the research, as well as the participation invitation. The ones who accepted received an e-mail with a link to access the electronic form and the Free Consent Form, with a 30-day period for return. The deadline was extended because only six forms were returned.

The research project was submitted to the Research Ethics Committee and approved – CAAE No 57962416.7.0000.5231.

For data analysis, a scientific strength test for the indicators, or theoretical analysis for the items, was performed by calculating the Content Validity Ratio (CVR), which is a statistical technique to determine whether indicators are useful or not, and whether they can or cannot be maintained in the evaluation instrument[18,19].

The CVR is calculated based on responses from the judge panel with a formula in which Ne corresponds to number of judges that considered the item essential, and N is the number of judges that evaluated the item[18].

$$CVR = \frac{Ne - (N/2)}{N/2}$$

The critical CVR set for the present study was 0.620 based on the judge sample size[18,19]. It was also defined that indicators with CVR ≥ 0.620 would stay, those with CVR between 0.300 and 0.620 would be reformulated according to the specialists' comments and suggestions, and those with CVR ≥ 0.620 would be excluded from the indicator set.

RESULTS

Ten (13.5%) specialists fully answered the questionnaire. As for administrative organization, 10% of the represented universities were municipal, 40% were state and 50% were federal; 10% of them were in the North of Brazil, 40% in the Northeast, 10% in the Midwest, 30% in the Southeast, and 10% in the South. Concerning the judges' profile, 60% were male, 50% were aged above 50, 50% worked in both management and academic affairs, and 50% had over 21 years of professional practice.

Tables 1, 2 and 3 display CVR values for the indicators proposed.

Table 1. Indicator distribution by CVR value, within the Teaching subdimension, São Paulo, SP, 2018.

	Indicators	CVR
Teaching subdimension		
Undergraduate Program factor		
1	Vacancy filling for admittance	0.714
2	Number of students per professor	0.714
3	Number of students per full-time professor	0.543
4	Total dropout rate	0.800
5	Graduates x dropouts index	0.457
6	Course completion rate	0.857
***Lato Sensu* Graduate Program factor**		
7	Vacancy filling for admittance	0.743
8	Total dropout rate	0.771
9	Graduates x dropouts index	0.600
10	Course completion rate	0.829
***Stricto Sensu* Graduate Programfactor**		
11	Vacancy filling for admittance	0.686
12	Total dropout rate	0.771
13	Graduates x dropouts index	0.457
14	Course completion rate	0.886
15	Rate of professors in internationalization process	0.257
16	Rate of graduate students in internalization process	0.343

In the Teaching subdimension, for the Undergraduate Program factor, Indicator 3 had a 0.543 CVR, and, after the suggestions of the judges (J5 and J6), the conformity index was

adjusted to "Comparison with HEI performance, in the Higher Education Census, as well as with the historical series from the last three years."

Regarding indicators 5, 9 and 13 of the Undergraduate and *Lato Sensu* and *Stricto Sensu* Graduate Programs factors, CVR values were, respectively, 0.457, 0.600 and 0.457. The specialists' comments (J5, J6, J8, J9) addressed the inaccuracy of the indicator, in view of the series of facts related to undergraduate and graduate course dropout.

Thus, this indicator was repurposed so the different attributes that compose the dropout construct could be measured separately, namely: cancellation, with drawal, total suspension, external transfer and dismissal for completion time overdue.

As for indicators 15 and 16, the CVR was 0.257 and 0.043, respectively, which would mean their exclusion, but, due to their importance in the globalized world context, the choice was to consider the judges' suggestions (J4, J7, J10) of better defining and delimiting the term internationalization, as well as using it for the Centers and HEIs (J6).

In this sense, the numerator of indicator calculations was readjusted based on the 14 evaluation areas of the Coordination for the Improvement of Higher Education Personnel [*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*], CAPES, which were grouped into two actions: student and professor mobility (active and passive) and international cooperation (academic, scientific and technological)[20].

Table 2. Indicator distribution by CVR value, within the Research, Extension, Knowledge and Innovation subdimension, São Paulo, SP, 2018.

	Indicators	CVR
Research, Extension, Knowledge and Innovation subdimension		
Scientific Initiation factor		
17	Rate of professors participating in research projects	0.771
18	Rate of students participating in research projects	0.657
19	Rate of hours dedicated to research projects	0.200
***StrictoSensu* Programs Factor**		
20	Rank of Master's/PhD programs	0.886
21	Faculty publishing rate	0.457
22	Rate of dissertations defended and approved in master's programs	0.571
23	Rate of theses defended and approved in PhD programs	0.543
Extension Programs, Projects and Activities factor		
24	Number of extension activities for community integration	0.343
25	Rate of students with extension scholarships	0.457
26	Rate of professors engaged in extension activities	0.457
27	Rate of students engaged in extension activities	0.771
Knowledge and Innovation factor		
28	Number of incubated companies	0.771
29	Rate of approved innovation projects	0.800
30	Rate of executed innovation projects	0.829
31	Rate of registered patents	0.543

About the indicators in Table 2, within the *Stricto Sensu* Programs subdimension, indicator 21 obtained a 0.457 CVR. After comments by J6 and J10, the indicator was reformulated in order to detect the concentration of publications per professor and segment them by *Quails* Capes stratum, with the calculation being adjusted to the following equation:

$$\frac{\sum \text{of articles published per stratum – professor 1} + \sum \text{of articles published per stratum – professor 2} + \ldots + \sum \text{of articles published per stratum – professor n}}{\text{Number of professors in the program}}$$

The CVRs of indicators 22 and 23 were 0.571 and 0.543, respectively. Judge J6 suggested setting the conformity index at 100%, which was accepted.

In the Extension Programs, Projects and Activities factor, indicator 24 had 0.343 of CVR. Comments (J5, J6, J7) referred to the inaccuracy of the descriptor, which was then repurposed to delimit which extension activities would be considered, whether courses, events, production and publishing, and service provision, as well as the eight thematic areas of the extension activity: health, education, labor, environment,

communication, human rights and justice, production technology, and culture[21].

Indicator 25 had a CVR of 0.457 but was excluded due to change suggested by J6, which is included in indicator 27.

For indicator 26, the CVR was 0.457. The judges' comments (J6, J7, J10) suggested improving the definition of the term extension, which was applied also to indicators 24 and 26 as: academic practices of educative, cultural and scientific nature aimed at the community's needs that articulate teaching and research by means of programs, projects, courses, events and service provision[22].

For the Knowledge and Innovation factor, the CVR of indicator 31 was 0.543. Specialist J6 recommended better defining the items to be considered in the calculation; thus, the evaluation included brands, cultivars, industrial design, geographical indication, trade secret, traditional knowledge, and integrated circuit topography[23].

Table 3. Indicator distribution by CVR value, within the Management subdimension, São Paulo, SP, 2018.

	Indicators	CVR
Management subdimension		
Academic Management factor		
32	Teaching degree rate	0.771
33	Faculty workload rate in relation to type of institutional affiliation	0.229
Budget factor		
34	Funding expenses	0.286
35	Investment expenses	0.286
36	Average undergraduate course cost	0.286
37	Average undergraduate student cost	0.343
Human Development factor		
38	Rate of vacancies not filled by professors/university agents	0.486
39	Absenteeism rate	0.086
40	Qualification rate	0.543
Infrastructure factor		
41	Classroom square meters per student	0.686
42	Auditorium square meters per student	0.543
43	Number of available restrooms	0.686
44	Size of basic bibliographic collection	0.829
45	Size of complementary bibliographic collection	0.686
46	Specialized journal subscriptions	0.457

It is possible to see that, in the Management subdimension, of the four indicators that compose the Budget factor, three were excluded for having a CVR of 0.286 (34, 35, 36), with Indicator 37, "Average undergraduate student cost", remaining, which presented a CVR of 0.343.

The specialists' comments (J2, J3, J4, J6) evidenced the need to improve the description of the indicator by defining cost units and detailing the formula. However, indicator 37 alone would not be representative of the Budget factor, so the choice was to exclude it.

For the Human Development factor, the CVR of indicator 38 was 0.486. Although there were no suggestions as to how to improve it, the choice was to reformulate its title to read "Faculty vacancy rate" in order to better delimit the object of interest.

The CVR of indicator 40 was 0.543, and there was no suggestion on the judges' end. However, it was maintained, because concern about a professor's qualification also derives from its direct relationship with education quality.

As for the Infrastructure factor, indicator 42, with a CVR of 0.543, was excluded after J6 argued that it was irrelevant, just as indicator 46 (0.457 CVR), for which there was also no improvement suggestions from the judges.

DISCUSSION

The data presented show that the subdimensions and factors were appraised differently among the judges. The indicators with the highest number of contributions from the specialists were those related to

complex themes, such as dropout evaluation (5, 9, 13), internationalization (15,16), faculty publishing (21), and extension (26).

Comparing the findings shown in Tables 1 to 3, it is possible to observe that the lowest CVR values were found for the Management subdimension, especially for the Budget factor (0.3000 CVR), which suggests a relationship with the fact that this specific field of knowledge was not yet part of the evaluation dimensions instituted by the country and was therefore not perceived as relevant by the evaluators; however, further studies need to be conducted in order to elucidate this fact.

All of the specialists' recommendations were accepted, and indicators with CVRs inferior to 0.300 were excluded, in addition to indicators 37, 42 and 46. Because there was no disagreement between the judges, the indicator matrix did not require a new validation stage.

At the end of the content validation procedures, 38 indicators showed validity evidence, of which 11 evaluated structure aspects, 10, process aspects, and 17, result aspects. Among those, 15 referred to the Teaching subdimension, 14, to Research, Extension, Knowledge and Innovation, and 8, to Management[14].

In higher education, as well as throughout the organization of service provision, seeking a greater efficiency in processes and actions is crucial. Evaluation is a tool that instrumentalizes managers and aims at the excellence of education quality[6,9].

Evaluating should not be limited to measuring results with control in mind, but rather formatively subsidizing opportunities for individuals to look at themselves in a reflexive way, establishing relations between structures, processes and results, which helps with the decision-making process[6].

During the conduction of this research, a difficulty commonly found in measurement instrument validation studies appeared, which spans the methodological path itself to culminate in the judges' evaluation procedures, with the number of specialists being a limitation in this study, although the amount of 10 judges meets the literature recommendation[24].

Another limitation involves the indicators selected. The intention was not to exhaust all variables in the Performance dimension of the higher superior quality construct. It was to propose a number of relevant indicators to evaluate structure, process and result aspects that are valid as to their content, that are simple to apply and whose results are easy to comprehend, considering that they are formulated as mathematical equations with results expressed as indexes and rates for monitoring and control of institutional self-evaluation processes.

As for the scale type used in this study, implementing the dichotomous scale is deemed to be an advance for quality metrics validation. Four-point Likert-type scales are commonly used in studies of such nature[12]; however, the dichotomous scale is an alternative to ensure greater asymmetry between response positivity and negativity[24], without impacting reliability[25].

FINAL CONSIDERATIONS

In public higher education, as well as in all organizations, proactive evaluation is of paramount importance as it allows for self-knowledge with the establishment of relations between processes and results, enabling the detection of capabilities and fragilities, which is the basis to planning and management.

The development of this research provided validity evidence for a matrix of 38 quantitative indicators formulated as mathematical equations, which can be systematically used in internal institutional evaluation, complementing qualitative evaluations and subsidizing the identification of improvement potential, and this can be applied to courses, study groups, bodies/centers, with all specificities respected.

It is not about proposing new indicators to evaluate the performance of public higher education institutions; instead, from the evaluation processes instituted in the country, it is about proposing a matrix of indicators considered relevant by a panel of experts for the internal and systematic evaluation of these organizations towards self-knowledge.

Moving forward with methodological procedures for measurement validation, new studies should be developed in order to test the applicability and reliability of the indicators proposed.

VALIDAÇÃO DE MÉTRICAS PARA AVALIAR A QUALIDADE EM INSTITUIÇÕES PÚBLICAS DE ENSINO SUPERIOR

RESUMO

Introdução: No campo da educação superior pública, a complexidade em avaliar o alcance dos objetivos institucionais e as incertezas acerca das métricas adotadas pelo Estado prejudicam a implementação de processos avaliativos. **Objetivo:** Construir e validar o conteúdo de indicadores de qualidade para avaliação de Instituições Públicas de Ensino Superior (IES). **Método:** Estudo metodológico desenvolvido em seis etapas, com a participação de 10 juízes de IES, entre 2015 e 2018. Empregou-se a Técnica Delphi e o cálculo do *Content Validity Ratio*,com valor maior ou igual a 0,62.Foram propostos 46 indicadores nas subdimensões: Ensino (16); Pesquisa, extensão, conhecimento e inovação (15); e Gestão (15). **Resultados:** Constata-se a evidência de validade de conteúdo de 38 indicadores, dos quais 11 de estrutura, 10 de processos e 17 de resultados, sendo a subdimensão Gestão a que obteve menores valores de CVR. **Considerações Finais:** Obtiveram-se evidências de validade de uma matriz de 38 indicadores quantitativos, formulados como equações matemáticas, que podem ser utilizados sistematicamente na avaliação interna institucional, complementando a avaliação qualitativa.

Palavras-chave: Organização e administração. Estudos de Avaliação como Assunto. Indicadores. Estudos de validação. Educação superior.

VALIDACIÓN DE MÉTRICAS PARA EVALUAR LA CALIDAD EN INSTITUCIONES PÚBLICAS DE ENSEÑANZA SUPERIOR

RESUMEN

Introducción: En el ámbito de la educación superior pública, la complejidad para evaluar el alcance de los objetivos institucionales y las incertidumbres acerca de las métricas adoptadas por el Estado perjudican la implementación de procesos de evaluaciones. **Objetivo:** Construir y validar el contenido de indicadores de calidad para la evaluación de Instituciones Públicas de Enseñanza Superior (IES). **Método:** Estudio metodológico desarrollado en seis etapas, con la participación de 10 jueces de IES, entre 2015 y 2018. Se adoptó la Técnica Delphi y el cálculo del *Content Validity Ratio*, con valor mayor o igual a 0,62. Fueron propuestos 46 indicadores en las subdimensiones: Enseñanza (16); Investigación, extensión, conocimiento e innovación (15); y Gestión (15). **Resultados:** Se Constata la evidencia sobre la validez de contenido de 38 indicadores, de los cuales 11 de estructura, 10 de procesos y 17 de resultados, siendo la subdimensión Gestión la que obtuvo menores valores de CVR. **Consideraciones Finales:** Fueron obtenidas evidencias sobre la validez de una matriz de 38 indicadores cuantitativos, formulados como ecuaciones matemáticas, que pueden ser utilizados sistemáticamente en la evaluación interna institucional, complementando la evaluación cualitativa.

Palabras clave: Organización y administración. Estudios de Evaluación como Asunto. Indicadores. Estudios de validación. Educación superior.

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