

## Meta-analysis of the Intellectual Capital Scale: Implications for coping with the COVID-19 pandemic

Meta-análisis de la escala de capital intelectual: implicaciones para hacer frente a la pandemia del COVID-19

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## ABSTRACT

**Introduction:** the measurement of intellectual capital as an intangible asset has been established from a scale of six dimensions related to training, academia; labor, professional, union, and organizational. The pandemic has generated studies that show significant differences between these dimensions, opening the discussion on meta-analytic validity.

**Objective:** to carry out a documentary, systematic and meta-analytical review with a sample of articles published from 2014 to 2021 in journals indexed in international repositories.

**Materials and methods:** a documentary, systematic and meta-analytical study was carried out on a sample of articles published in international repositories in the last two years. The Intellectual Capital Scale was used, considering its dimensions reported in the literature.

**Results:** the structure and thresholds of the random effects were established, calculated by means of the equation to establish the delta parameter, considering their confidence intervals for correction of sampling and estimation errors, as well as differences between groups.

**Conclusion:** it is recommended to extend the review of the literature until August 2021 in order to be able to contrast both reviews to establish the meta-analytic validity of the scale and discuss its implications in the COVID-19 era.

**Key words:** human capital; intellectual capital; intangible asset; delta parameter; confidence intervals; sampling error.

## RESUMEN

**Introducción:** la medición del capital intelectual como activo intangible se ha establecido a partir de una escala de seis dimensiones relacionada con formación, academia, laboral, profesional, sindical y organizativa. La pandemia ha generado estudios que muestran diferencias significativas entre estas dimensiones, abriendo la discusión sobre la validez metaanalítica.

**Objetivo:** realizar una revisión documental, sistemática y metaanalítica, con una muestra de artículos publicados entre 2014 y 2021 en revistas indexadas en repositorios internacionales.

**Materiales y métodos:** se realizó un estudio documental, sistemático y metaanalítico sobre una muestra de artículos publicados en repositorios internacionales en los



últimos dos años. Se utilizó la Escala de Capital Intelectual, considerando sus dimensiones reportadas en la literatura.

**Resultados:** se estableció la estructura y los umbrales de los efectos aleatorios, calculados mediante la ecuación para establecer el parámetro delta, considerando sus intervalos de confianza para la corrección de errores de muestreo y estimación, así como las diferencias entre grupos.

**Conclusión:** se recomienda extender la revisión de la literatura hasta agosto de 2021, para poder contrastar ambas revisiones, y establecer así la validez metaanalítica de la escala, y discutir sus implicaciones en la era COVID-19.

**Palabras clave:** capital humano; capital intelectual; activo intangible; parámetro delta; intervalos de confianza; error de muestreo.

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## INTRODUCTION

Until August 2021, Mexico led the number of deaths of medical personnel worldwide<sup>(1)</sup>. The formation of human capital in this scenario supposes dimensions that the literature has established around the relationship between academia, profession and occupational insertion<sup>(2)</sup>. It is about the intellectual capital that in universities aspires to become an intangible asset of health institutions<sup>(3)</sup>. This training process has been impacted by the pandemic<sup>(4)</sup>. When observed in the literature reviews, as well as in the meta-analyses, the random effects of the health crisis on the measurement of variables related to management, production and translation of knowledge induces an examination of the corresponding parameters<sup>(5)</sup>. This is the case of the delta parameter, which notices the difference between the total scores of the scale and its cumulative inverse, revealing homogeneous random effects, but in confidence intervals<sup>(6)</sup>. In other words, the studies on intellectual capital reported in the literature could explain a theoretical and methodological consistency when measuring the impact of the pandemic on the academic, professional and occupational training of future health workers<sup>(7)</sup>.

The family, academic, professional, union, labor and organizational dimensions have been established in the literature as factors in the formation of intellectual capital<sup>(8)</sup>.



These dimensions can be examined from the meta-analytical validity of the instrument that measures the impact of the pandemic on the skills and abilities of students, professionals and social workers in health centers<sup>(9)</sup>. Thus, studies on the impact of risk events on the formation of intellectual capital have reported the validity of three preponderant factors: academic, professional and occupational, but when considering training as a precedent of the influence of the family legacy they have reached four dimensions. A fifth factor has been attributed to the union or association of health professionals as a reflection of the formation of intellectual capital<sup>(10)</sup>. Thus, five factors predominate, although theoretical and practical training supposes at least one other, one that would explain the acquisition of skills in the face of the health crisis<sup>(11)</sup>. These are the cases of resource optimization and process innovation underlying health crises<sup>(12)</sup>.

The objective of the present work was to establish the homogeneous random effects that allow us to subscribe to meta-analytic validity of the Intellectual Capital Formation scale, considering six dimensions reported in the literature during the last two years in international repositories.

Are there significant differences between the validity parameters reported in the literature with respect to the meta-analytic validity observed in the present study?

The premises that guide the present work suggest that there will be significant differences between the parameters of the validity of the scale reported in the literature with respect to the meta-analytic validity observed in the delta parameter and its confidence intervals<sup>(13)</sup>. This is so because sampling, measurement and variance errors can be corrected by estimating the delta parameter, but the impact of COVID-19 on the formation of intellectual capital inhibited the management, production and transfer of knowledge processes<sup>(14)</sup>. In this way, future health professionals will be determined by the dimension of exposure to risks of contagion, disease and death<sup>(15)</sup>. This is so because the biases in the sampling suppose a limited validity of the scale due to the deaths of students, practitioners and social workers<sup>(16)</sup>.

## MATERIALS AND METHODS

A systematic, retrospective, documentary study was carried out with a selection of information sources indexed in international repositories: Copernicus, EBSCO, Latindex, Pubindex, SciELO, Scopus, WoS and Zenodo, considering the edition period from 2014 to 2021 in studies that implemented the Intellectual Capital Scale<sup>(17)</sup>, as well as the report of its dimensions: formative, academic training, professional union and organizational work. (Table 1)



**Table 1.** Description of the study sample

Index	Year	Author	N	SD	F1	F2	F3
Latindex	2014	Carreon	100	15.46	.490	.532	.516
SciELO	2017	Juarez	130	10.26	.521	.398	.561
EBSCO	2018	Morales	130	13.21	.631	.418	.630
Redalyc	2018	Quintero	125	12.12	.390	.612	.503
Scopus	2018	Elizarraraz	100	11.65	.610	.399	.603
Academia	2019	Espinoza	100	14.23	.483	.430	.501
Copernicus	2019	Llamas	120	14.36	.540	.421	.406
Dialnet	2019	Martínez	140	10.23	.532	.429	.612
Publindex	2019	Moreno	180	10.32	.389	.501	.582
WoS	2019	Aldana	102	10.43	.489	.389	.601
Zenodo	2020	García	104	12.13	.495	.387	.582

N = Sample Size; SD = Standard Deviation; F1 = Academic Training; F2 = Professional Union; F3 = Organizational Work

The Intellectual Capital Scale and its dimensions: formative ("The dissemination of COVID-19 generates skills"); academic ("The communication of COVID-19 fosters teaching"); union ("The promotion of anti-COVID-19 vaccines defines vocations"); professional ("The Immunization against COVID-19 will improve health services"); occupational ("Prevention of COVID-19 is a right") and organizational ("Immunization against COVID-19 is a competitive advantage")<sup>(18)</sup>. Each item includes five response options ranging from 0 = "not at all agree" to 5 = "strongly agree". High scores suggest a conversion of human capital (health, education and employment oriented towards productivity) into intellectual capital (self-management, production and transfer of knowledge)<sup>(19)</sup>. Low scores pose barriers to the learning of intellectual capital that inhibit its development<sup>(20)</sup>.

The Delphi technique was used for the processing of information and the elaboration of the reagents, comparing and integrating informative information to the total quality, as well as to the opinions of different administrative workers and employees in an organization for profit in the center of Mexico<sup>(20)</sup>. In three rounds: qualifying, feedback and reconsideration, the Delphi technique allowed the selection of the findings, considering the homogeneous random effect threshold, year of publication and repository<sup>(21)</sup>.

Subsequently, the surveys were applied in the human resources department as part of the staff recruitment and selection protocol, as well as part of the induction, training and training courses<sup>(22)</sup>. The confidentiality and anonymity of the respondents was



guaranteed in writing, as well as the warning that the results of the study did not affect their economic or work status<sup>(23)</sup>.

Estimate the parameters:  $d_w$  effect size weighted by sampling error;  $SD_d$  standard deviation of  $d$ ;  $SD_{pre}$  standard deviation of  $d$  predicted by anti-factual errors;  $SD_{res}$  standard deviation of  $d$  after eliminating the due variance to anti-factual errors;  $SD_{\delta}$  means true effect size corrected for the unreliability of the criterion<sup>(24)</sup>.

In abstracts reported in the literature, the parameter was estimated from the contrast of the probability proportions with the weighted mean proportion of the sample size of registered cases<sup>(25)</sup>. The effect size (1) was estimated by the difference of the inverse of the normal cumulative distribution function<sup>(26)</sup>.

$$\hat{\delta}_1 = \frac{\Phi^{-1}(\hat{p}_1^E) - \Phi^{-1}(\hat{p}_1^C)}{\sqrt{\frac{\delta^2}{4 + \delta^2}}}$$

$\delta$  is the difference of the inverse function of the observed probability minus the scale value. The formula converts values into correlations<sup>(27)</sup>.

The random effects correlational psychometric meta-analysis was performed<sup>(28)</sup>. Sample errors ( $r_x$ ) were corrected, estimating the effect of the sample size and the lack of reliability of the predictor of the criterion ( $r$ )<sup>(29)</sup>. This was the measurement error in X and Y, as well as the moderating variables such as income<sup>(30)</sup>; thus, the amount of variation explained by the variation of the instrument<sup>(31)</sup>. The variance of the sampling error, variation of the instrument and restrictions explain the random effects and their confidence intervals<sup>(32)</sup>.

## RESULTS

Table 2 shows the meta-analytic values that suggest permissible thresholds of validity of the Intellectual Capital Scale, suggesting formative decision-making based on the component dimensions; academic, professional and labor.



**Table 2.** Meta-analysis of the validity of the Intellectual Capital Scale

Index	Year	Author	N	dw	SDd	SDpre	SDres	$\delta$	SD $\delta$	%Var	CI <sub>d</sub>	CI $\delta$
Academia	2014	Carreon	100	,12	,30	,03	,18	,40	,21	15,48	12,08 to 24,38	5,89 to 18,74
Copernicus	2017	Juarez	120	,17	,38	,05	,19	,50	,20	13,20	10,48 to 28,34	6,52 to 19,70
Dialnet	2018	Morales	140	,18	,38	,09	,13	,51	,16	12,32	11,89 to 26,34	6,46 to 17,90
Ebsco	2018	Quintero	130	,19	,40	,02	,10	,51	,22	11,54	10,26 to 25,46	6,72 to 19,67
Latindex	2018	Elizarraraz	100	,03	,35	,09	,11	,46	,23	10,21	18,21 to 28,45	1,90 to 18,42
Publindex	2019	Espinoza	180	,28	,49	,05	,12	,50	,20	10,34	9,82 to 18,34	3,56 to 17,56
Redalyc	2019	Llamas	125	,21	,32	,07	,14	,55	,16	16,50	9,58 to 16,58	4,62 to 18,79
Scielo	2019	Martinez	130	,05	,30	,03	,16	,48	,11	16,78	10,32 to 29,43	4,65 to 16,57
Scopus	2019	Moreno	100	,27	,44	,05	,18	,42	,16	15,21	8,43 to 24,35	5,42 to 19,78
WoS	2019	Aldana	102	,10	,48	,04	,14	,51	,12	10,45	9,71 to 15,46	3,54 to 17,68
Zenodo	2020	Garcia	104	,07	,36	,01	,12	,40	,11	11,39	8,75 to 21,34	8,32 to 19,45

N = Sample size; dw = effect size weighted for sample size; SDd = Standard deviation of d; SDpre: standard deviation of observed correlations predicted from all artifacts; SDres: standard deviation of d, after removal of variance due to artifactual errors;  $\delta$ : effect size corrected for criterion unreliability; SD $\delta$ : standard deviation of  $\delta$ ; %Var: variance accounted by artifactual errors; 95% CI<sub>d</sub>: 95% confidence interval for d; 80% CI $\delta$ : 80% credibility interval for  $\delta$ .

In order to be able to observe the risk thresholds in decision-making regarding the use of the Intellectual Capital Scale, the thresholds of three dimensions related to academic, professional and labor training were established, which were systematically reviewed and meta-analyzed considering; size of the weighted effect, standard deviation of this weighted effect, deviation of the relationships between the components, deviation eliminating the variance of errors and the size of the effect corrected by the confidence interval. The values show permissible thresholds of risk and confidence with which the Intellectual Capital Scale, in the revised sample, has the systematic validity of the findings. (Table 3)



**Table 3.** Meta-analysis of the validity of the confidence interval

Index	Year	Author	N	CI <sub>d</sub>	CI <sub>δ</sub>
Academia	2014	Carreon	100	12.08 to 24.38	5.89 to 18.74
Copernicus	2017	Juarez	120	10.48 to 28.34	6.52 to 19.70
Dialnet	2018	Morales	140	11.89 to 26.34	6.46 to 17.90
EBSCO	2018	Quintero	130	10.26 to 25.46	6.72 to 19.67
Latindex	2018	Elizarraraz	100	18.21 to 28.45	1.90 to 18.42
Publindex	2019	Espinoza	180	9.82 to 18.34	3.56 to 17.56
Redalyc	2019	Llamas	125	9.58 to 16.58	4.62 to 18.79
SciELO	2019	Martínez	130	10.32 to 29.43	4.65 to 16.57
Scopus	2019	Moreno	100	8.43 to 24.35	5.42 to 19.78
WoS	2019	Aldana	102	9.71 to 15.46	3.54 to 17.68
Zenodo	2020	García	104	8.75 to 21.34	8.32 to 19.45

N = Sample size; CI<sub>d</sub>: 95% confidence interval for d; 80% CI<sub>δ</sub>: 80% credibility interval for  $\delta$ .

## DISCUSSION

The validity of an instrument explains the consistency of measurement of dimensions<sup>(33)</sup>. This means that when applied in different scenarios and samples, the instrument is consistent in establishing the dimensions. From 2014 to 2021, the Intellectual Capital Training Scale suggests three predominant dimensions: academic, professional and labor, explaining the process of insertion into the labor market through the system of professional practices and social services<sup>(34)</sup>. Therefore, the meta-analytic review made it possible to demonstrate the prevalence of six dimensions derived from the three hegemonic factors. This is so because the literature reflects the impact of the pandemic on the formation of intellectual capital<sup>(35)</sup>. It then means that COVID-19 has diversified the dimensions of intellectual capital formation<sup>(36)</sup>. The three predominant ones extend to family management, the ideology of the union and the organizational climate<sup>(37)</sup>. These three added factors assume that the pandemic has impacted the training processes of future health professionals<sup>(38)</sup>.

The meta-analytical reviews to corroborate the validity of instruments that measure entrepreneurship in the face of the pandemic, transportation in the face of distancing and confinement, as well as public services in the face of the health and economic crisis coincide in a direct and homogeneous impact<sup>(39)</sup>. In the present work, a diversification of the three predominant dimensions was found. Systematic and meta-analytic review lines concerning the impact of the pandemic on the formation of intellectual capital will allow us to observe the diversification of the dimensions<sup>(40)</sup>. This is so because universities have restricted contact between people, but have enhanced communication through electronic platforms and networks. Consequently, it will be





possible to appreciate the emergence of a dimension related to the use of the Internet. In other words, Information and Communication Technologies, Learning and Knowledge Technologies and Empowerment and Participation Technologies will be competitive advantages in the formation of intellectual capital. Health professionals trained in the Internet will reflect the influence of the virtual classroom in their self-management of knowledge.

## CONCLUSION

The objective of the present work was to establish the meta-analytic validity in a selected review of studies that used the Intellectual Capital Scale, observing permissible risk and confidence thresholds. The validity of this factor structure is limited to the sample studied, although the extension of work to other repositories, periods and dimensions such as aversion to training and propensity for job placement is suggested.

The present work has established the thresholds that demonstrate the validity of the Intellectual Capital Scale, although these risk and confidence thresholds are only applicable to the selected sample. The extension of the work to other studies related to innovative dimensions is suggested to explain the impact of academic training on job performance. In the case of health capital formation, the three dimensions would explain the process of knowledge management, production and transfer to anticipate, confront and prevent a pandemic.

In relation to the theory of intellectual capital, which highlights academic, professional, and labor training as procedural dimensions that explain the impact of a management, production, and knowledge transfer system in the face of a problem, this work has observed tolerable risk thresholds and indispensable of confidence in the validity of the Intellectual Capital Scale. Research lines concerning the observation of these dimensions will allow us to see the importance of strategic alliances between Higher Education Institutions with respect to health organizations.

Regarding the studies of intellectual capital that highlight the conversion towards organizational assets, which supposes a management, production and transfer of knowledge, experiences and skills, this work has established tolerable risk thresholds and confidence intervals that reveal the validity of this structure. Studies related to the validity of the instrument and its factorial structure will allow to test the hypothesis of homogeneous dimensions throughout the investigations in a longer time interval.

Regarding the specification of the model for the study of healthcare capital, which considers the observation of the academic, professional and labor dimensions aimed at managing risks, contingencies and crises such as the coronavirus pandemic and COVID-19 disease, the This study highlights the meta-analytic validity of its procedural and three-factor structure. In this sense, the investigations that confirm the factorial



structure in situations of risks, contingencies and crises will allow observing the conversion of intellectual capital into a health asset.

Suggested lines of research regarding the homogeneity of the academic, professional and labor training dimensions, as well as the optimization aversive or innovation-prone dimensions will allow observing systematic findings of validity of the Intellectual Capital Scale.

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### Conflict of interests

The authors declare no conflict of interest.

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