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Large Type Fit Indices of Mathematics Adult Learners: A Covariance Structure Model

Olusegun Ayodele ADELODUN[1*],Titilola Olakunjo OBILADE[2]， Olushina Olawale AWE[2]
1. Institute of Education, Obafemi Awolowo University, Ile-Ife. Nigeria
2. Department of Mathematics, Obafemi Awolowo University, Ile-Ife. Nigeria
Corresponding Author: adelodun@oauife.edu.ng；segunadelodun@yahoo.com

Abstract
Fit is the ability of a model to reproduce the data in the variance-covariance matrix form. A good fitting model is one that is reasonably consistent with the data and doesn't require respecification and also its measurement model is required before estimating paths in a covariance structure model. A baseline model of four constructs together with a combination of none, one, two, three or four additional constructs was constructed with latent variables: educational performance, socio-economic label, self concept and parental authority using dichotomous digits 0 or 1 for each additional construct. We considered 16 progressively nested models starting with baseline model using the mathematics adult learners data from the modeling sample and employing some large fit indexes which are commonly used (*NFI, NNFI, CFI, GFI, PGFI*, among others) Usluel, *et al.* (2008) to test the fitness of the model. The measures of model fit based on results from analysis of the covariance structure model are presented
Keywords: Fit Indices; Structural Equation Modeling; Bernoulli Digits; Latent Constructs; Educational Performance

1. Introduction

A good fitting model is one that is reasonably consistent with the data and so does not require respecification and also its measurement model is required before estimating paths in a structural model (Stevens, 2009). Tanaka (1993), Malsh, *et al.* (2004), and others distinguish between several types of fit indices: *absolute fit indices*, *relative fit indices*, *parsimony fit indices*, and those based on the *noncentrality* parameter.

There are several fit indices that fall into the category of *absolute indices*, including the Goodness-of-fit index (GFI), the adjusted goodness of fit index (AGFI), χ^2 / df ratio, Hoelter's CN ("critical N"), Akaike's Information Criterion (AIC), the Bayesian Information Criterion (BIC), the Expected Cross-validation Index (ECVI), the root mean square residual (RMR), and the standardized root mean square residual (SRMR).

Relative fit indices compare a chi-square for the model tested to one from a so-called *null model* (also called a "baseline" model or "independence" model). There are several *relative fit indices*, including Bollen's Incremental Fit Index (IFI), the Tucker-Lewis Index (TLI), Bentler-Bonett Nonnormed Fit Index (BBNFI), and the Bentler-Bonett Normed Fit Index (NFI).

A number of *parsimonious fit indices* was developed (which are adjustments of most of the relative fit indices) include PGFI (based on the GFI), PNFI (based on the NFI), PNFI2 (based on Bollen's IFI), PCFI (based on the CFI mentioned below).

Noncentrality-based indices include the Root Mean Square Error of Approximation (RMSEA), Bentler's Comparative Fit Index (CFI), McDonald and Marsh's Relative Noncentrality Index (RNI), and McDonald's Centrality Index (CI).

Considerable controversy has flared up concerning fit indices recently. Some researchers do not believe that fit indices add anything to the analysis (e.g., Barrett, 2007) and only the chi square should be interpreted. The worry is that fit indices allow researchers to claim that a mis-specified model is not a bad model. Others (e.g., Hayduk, Cummings, Boadu, Pazderka-Robinson, & Boulianne, 2007) argue that cutoffs for a fit index can be misleading and subject to misuse. Most analysts believe in the value of fit indices, but caution against strict reliance on cutoffs.

Also problematic is the "cherry picking" a fit index. That is, computing a many fit indices and picking the one index that allows you to make the point that you want to make. If you decide not to report a popular index (e.g., the TLI or the RMSEA), you need to give a good reason why you are not.

Kenny, Kaniskan, and McCoach (2011) have also argued that fit indices should not even be computed for small degrees of freedom models. Rather for these models, the researcher should locate the source of specification error.

In this paper, we shall consider the fit indices such as *NFI, NNFI, CFI, GFI, PGFI, AGFI, PNFI* and *IFI* with large values considered indicators of good fit to educational performance model with adult mathematics learners as our subjects.

2. The Models

Let *pqsr denotes a baseline model of four constructs together with a combination of none, one, two, three or four additional constructs; where * indicates the latent variables: educational performance, socio-economic label, self concept and parental authority. The variables p, q, r, s denote Bernoulli or dichotomous digits 0 (if excluded) or 1 (if included) for each additional construct, that is

$$p = \begin{cases} 1, & \text{if latent variable CIRCUM is included} \\ 0, & \text{otherwise} \end{cases};$$

$$q = \begin{cases} 1, & \text{if latent variable TRAINENV is included} \\ 0, & \text{otherwise} \end{cases};$$

$$r = \begin{cases} 1, & \text{if latent variable HEALT is included} \\ 0, & \text{otherwise} \end{cases}; \text{ and}$$

$$s = \begin{cases} 1, & \text{if latent variable SEC is included} \\ 0, & \text{otherwise} \end{cases}.$$

Note that: CIRCUM represents circumstances;
TRAINENV represents training environment;
HEALT represents health characteristic; and
SEC represents socio-economic characteristic.

We shall consider some 16 progressively nested models using the data from model sample as enumerated in Table 1. It varies from the baseline model *0000 to the ultimate model *1111.

Table 1: Coding for Models by included Latent Constructs

Code Name	Latent Constructs
***0000**	educational performance, socio-economic label, self concept and parental authority
***1000**	educational performance, socio-economic label, self concept, parental authority and circumstances
***0100**	educational performance, socio-economic label, self concept, parental authority and training environment
***0010**	educational performance, socio-economic label, self concept, parental authority and health characteristic.
***0001**	educational performance, socio-economic label, self concept, parental authority and socio-economic characteristic.
***1100**	educational performance, socio-economic label, self concept, parental authority, circumstances and training environment
***1010**	educational performance, socio-economic label, self concept, parental authority, circumstances and health characteristic.
***1001**	educational performance, socio-economic label, self concept, parental authority, circumstances and socio-economic characteristic.
***0110**	educational performance, socio-economic label, self concept, parental authority, training environment and health characteristic.
***0101**	educational performance, socio-economic label, self concept, parental authority, training environment and socio-economic characteristic.
***0011**	educational performance, socio-economic label, self concept, parental authority, health characteristic and socio-economic characteristic.
***1110**	educational performance, socio-economic label, self concept, parental authority, circumstances, training environment and health characteristics.
***1101**	educational performance, socio-economic label, self concept, parental authority, circumstances, training environment, and socio-economic characteristic.
***1011**	educational performance, socio-economic label, self concept, parental authority circumstances, health characteristic and socio-economic characteristic.
***0111**	educational performance, socio-economic label, self concept, parental authority, training environment, health characteristic and socio-economic characteristic.
***1111**	educational performance, socio-economic label, self concept, parental authority, circumstances, training environment, health characteristic and socio-economic characteristic.

3. Goodness-of-fit Statistics on Modeling Sample

Having considered some 16 progressively nested models starting with model *0000 using the data from the modeling sample, we shall now employ some fit indexes which are commonly used in the literature (such as *NFI, NNFI, CFI, GFI, PGFI*, among others) to test the fitness of the model.

As the values in Table 2 reveal, the fit indexes of the models are included in the values which are acknowledged in the literature (Usluel *etal*, 2008). The commonly used measures of model fit, based on results from analysis of the structural model, are summarized in Table 2. According to Usluel, *etal* (2008), the commonly used measures of large type model fit indexes, based on results from analysis of the structural model, are summarized in Table 2. In practice, *NFI, NNFI, CFI, GFI, PGFI* greater than 0.9, an *AGFI* greater than 0.8, and *PNFI* and *IFI* with large values are considered indicators of good fit.

Table 2: Summary Statistics of Large Type Fit Indexes on Modeling Sample

Fit Index	**NFI**	**NNFI**	**PNFI**	**CFI**	**IFI**	**GFI**	**AGFI**	**PGFI**
Ideal Value	**≥ 0.90**	**≥ 0.90**	**Large value**	**≥ 0.90**	**Large value**	**≥ 0.90**	**≥ 0.80**	**≥ 0.90**
Model *0000	0.89	0.86	0.59	0.91	0.91	0.97	0.94	0.53
Model *1000	0.87	0.87^{+}	0.69^{+}	0.90	0.90	0.95	0.93	0.67^{+}
Model *0100	0.89^{+}	0.87^{+}	0.61	0.91^{+}	0.91^{+}	0.97^{+}	0.95^{+}	0.56
Model *0010	0.87	0.84	0.59	0.89	0.89	0.96	0.94	0.56
Model *0001	0.76	0.71	0.58	0.78	0.79	0.94	0.91	0.62
Model *1100	0.86^{+}	0.87^{+}	0.70^{+}	0.90^{+}	0.90^{+}	0.95	0.94^{+}	0.69
Model *1010	0.84	0.85	0.68	0.88	0.88	0.95	0.93	0.69
Model *1001	0.81	0.82	0.68	0.85	0.85	0.94	0.92	0.72^{+}
Model *0110	0.85	0.84	0.62	0.88	0.88	0.96^{+}	0.94^{+}	0.60
Model *0101	0.80	0.79	0.63	0.84	0.84	0.95	0.93	0.66
Model *0011	0.79	0.78	0.62	0.83	0.83	0.95	0.92	0.65
Model *1110	0.83^{+}	0.84^{+}	0.69^{+}	0.87^{+}	0.87^{+}	0.94	0.92	0.71
Model *1101	0.81	0.83	0.69^{+}	0.86	0.86	0.94	0.93^{+}	0.73^{+}
Model *1011	0.80	0.81	0.68	0.84	0.84	0.94	0.92	0.73^{+}
Model *0111	0.79	0.79	0.63	0.83	0.83	0.95^{+}	0.92	0.67
Model *1111	0.79	0.81	0.67	0.84	0.84	0.93	0.92	0.73

"+" indication of good fit model

where

NFI - Normed Fit Index
NNFI - Non-Normed Fit Index
PNFI - Parsimony Normed Fit Index
CFI - Comparative Fit Index
IFI - Incremental Fit Index
GFI - Goodness of Fit Index
AGFI - Adjusted Goodness of Fit Index
PGFI - Parsimony Goodness of Fit Index

Table 2 reveals that models *0100, *1100 and *1110 have values very close to 0.90 which indicate good model fitting compared with other competing models for *NFI.* Similarly, models *1000, *0100, *1100 and *1110 have values close to the ideal value compared with other competing models for *NNFI.* Models *1000, *1100, *1110 and *1101 have large values compared with other competing models for *PNFI.* Moreso, models *0100, *1100 and *1110 have values close to the recommended value compared with other competing models for *CFI.*

For *IFI*, models *0100, *1100, and *1110 have close values to the recommended value compared with other competing models. Models *0100, *0110 and *0111 have close values to the recommended value with other competing models for *GFI.* For *AGFI*, models *0100, *1100, *0110 and *1101 have values greater than the recommended value compared with other competing models. Finally, models *1000, *1001, *1101 and *1011 have close values to the recommended value with other competing models for *PGFI.*

4. Conclusion

We have considered some 16 progressively nested models for educational performance on large type fit indices of mathematics adult learners.

References

Barrett, P. (2007), "Structural Equation Modelling: Adjudging Model Fit," *Personality and Individual Differences, 42*, 815–824.

Hayduk, L., Cummings, G.G., Boadu, K., Pazderka-Robinson, H., and Boulianne, S. (2007), "Testing! Testing! One, Two, Three – Testing the Theory in Structural Equation Models!," *Personality and Individual Differences, 42*, 841-50.
Kenny, D.A., Kaniskan, B., and McCoach, D.B. (2011), "*The Performance of RMSEA in Models with Small Degrees of Freedom*," Unpublished paper, University of Connecticut.
Tanaka, J.S. (1993), "Multifaceted Conceptions of Fit in Structural Equation Models," In K.A. Bollen, & J.S. Long (eds.), *Testing Structural Equation Models.* Newbury Park, CA: Sage.
Marsh, H.W., Hau, K-T., and Wen, Z. (2004), "In Search of Golden Rules: Comment on Hypothesis-Testing Approaches to Setting Cutoff Values for Fit Indexes and Dangers of Overgeneralizing Hu and Bentler's (1999) Findings," *Structural Equation Modeling, 11*, 320-341.
Stevens, J.P. (2009), "Applied Multivariate Statistics for the Social Sciences," (5th Edn) Routledge: Taylor & Francis Group, New York.
Usluel, Y.K., Askar, P. and Bas, T. (2008), "A Structural Equation Model for ICT Usage in Higher Education," *Educational Technology & Society*, 11 (2), 262-273.

Contact Information(for hard copies)

Olusegun Ayodele Adelodun (Ph.D)
Institute of Education,
Obafemi Awolowo University, Ile-Ife. Nigeria
E-mail: *adelodun@oauife.edu.ng*