Are Functional and Critical Digital Skills Distinct?

Evidence from Set Bifactor-ESEM Using the yDSI Among Students

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Structure of the Study

- Theoretical foundation
- Research gap & problem
- Methodological approach
- Data & measurement design
- Model comparison & results
- Interpretation & implications

Research question

Are functional and critical digital skills

- Distinct ?
- Interconnected ?
- or distinct yet interconnected ?

Aim

- Model digital competence structure
- Assess whether functional and critical skills are distinct yet interconnected

Objectives

- ✓ Compare some competing models
- ✓ Evaluate functional and critical skill structure
- ✓ Identify distinct, interconnected, or combined patterns

Digital competence

(Theoretical background)

Multidimensional construct (DigComp, yDSI)

Hierarchical (general + specific sub-constructs)

Functional (operational, task-oriented) + **Critical** (evaluative, reflective, harm mitigating)

Theory suggests

Distinct but related layers **(Helsper et al., 2020; Polizzi, 2025; Samianego, 2024)**

The importance of this study

- Digital competence is essential for future-ready education and meaningful participation in society.
- A methodological gap exists

The problem

Current assessments often fail to capture that gap

Skills often treated as a single construct.

The imbalance between functional and critical skills is overlooked in current assessment approaches !!!

Why this study matters?

FOE priority: **evidence-based digital education design**

Inadequate models 

- ✓ **Weak assessment validity**
- ✓ **Unbalanced curricula**
- ✓ **Limited critical development**

Methodological Problem

- CFA inflates correlations
- ESEM allows construct-relevant multidimensionality
- Bifactor-CFA [general + specific factors (- interfactor correlation)]
- Bifactor ESEM [general + specific factor (+ interfactor correlation)]
- Full Bifactor ESEM (blurs set distinction)

Meta-analytic evidence indicates that bifactor-ESEM models generally yield superior fit and more defensible parameters for complex educational constructs (Gegenfurtner, 2022)

The measurement architecture of digital skills aligns with **Set bifactor-ESEM** (Morin et al., 2016)

general digital competence + interacting **domain specific + set-specific variance**

Advantages

- Captures multidimensionality
- Separates global competence
- Retains dual set structure

Ideal for heterogeneous item sets; clearly separating overarching competence from domain-specific dimensions; Preserves theoretical boundaries; Bifactor ESEM models consistently show superior fit and more reliable parameter estimates for educational constructs that are both general and domain specific.

Youth Digital Skills Indicator (yDSI, Helsper et al., 2020)

- Multiple digital domains
- Functional + Critical items
- Complementary measurement

Method

Study Procedure

Sample: 603 university students

(M_{age} = 22.1; 69.3% female)

Instrument: Short yDSI

Mixed item formats (behavioral vs. knowledge)

24 functional items (4 domains; 6-point Likert)

9 critical items (3 domains, 4 categories, knowledge-based)

Analysis:

Mplus 8.11

WLSMV estimator

Eight competing models tested

Power: Sample size closely matched SEM requirements (target ≈ 630; power = .80; effect size = .15).

Model comparison

- **Models included: CFA, ESEM and bifactor variants**
- **Fit evaluation:** χ^2, **CFI**, **TLI**, **RMSEA**, and **SRMR** using standard cutoffs.
- **Decision criteria:** Model fit interpreted holistically, given χ^2 sensitivity to sample size

Fit criteria + model estimated parameters' accuracy

Model fit evaluation

	Models	χ^2	df	RMSEA	90% CI	CFI	TLI	SRMR
M1	Full ICM-CFA	1362.968	474	.056	.052 .059	.986	.984	.044
M2	Full ESEM	716.867	318	.046	.041 .050	.994	.990	.021
M3	Full Bifactor-CFA	1426.246	462	.059	.055 .062	.985	.983	.043
M4	Full Bifactor-ESEM	621.322	292	.043	.039 .048	.995	.991	.019
M5	Set ICM-CFA 2 order	1317.458	487	.053	.050 .057	.987	.986	.045
M6	Set ESEM	940.023	402	.047	.043 .051	.992	.989	.025
M7	Set Bifactor-CFA	1482.861	482	.059	.055 .062	.984	.983	.051
M8	Set Bifactor-ESEM	729.468	368	.040	.036 .045	.994	.992	.022

Note. χ^2 - Chi-square; df - degrees of freedom; TLI - Tucker-Lewis Index; CFI - Comparative Fit Index; RMSEA - Root Mean Square Error of Approximation [90%CI]; SRMR - Standardized Root Mean Square Residual

Main results

Set bifactor ESEM showed the best overall fit

Outperformed:

Traditional CFA

ESEM variants

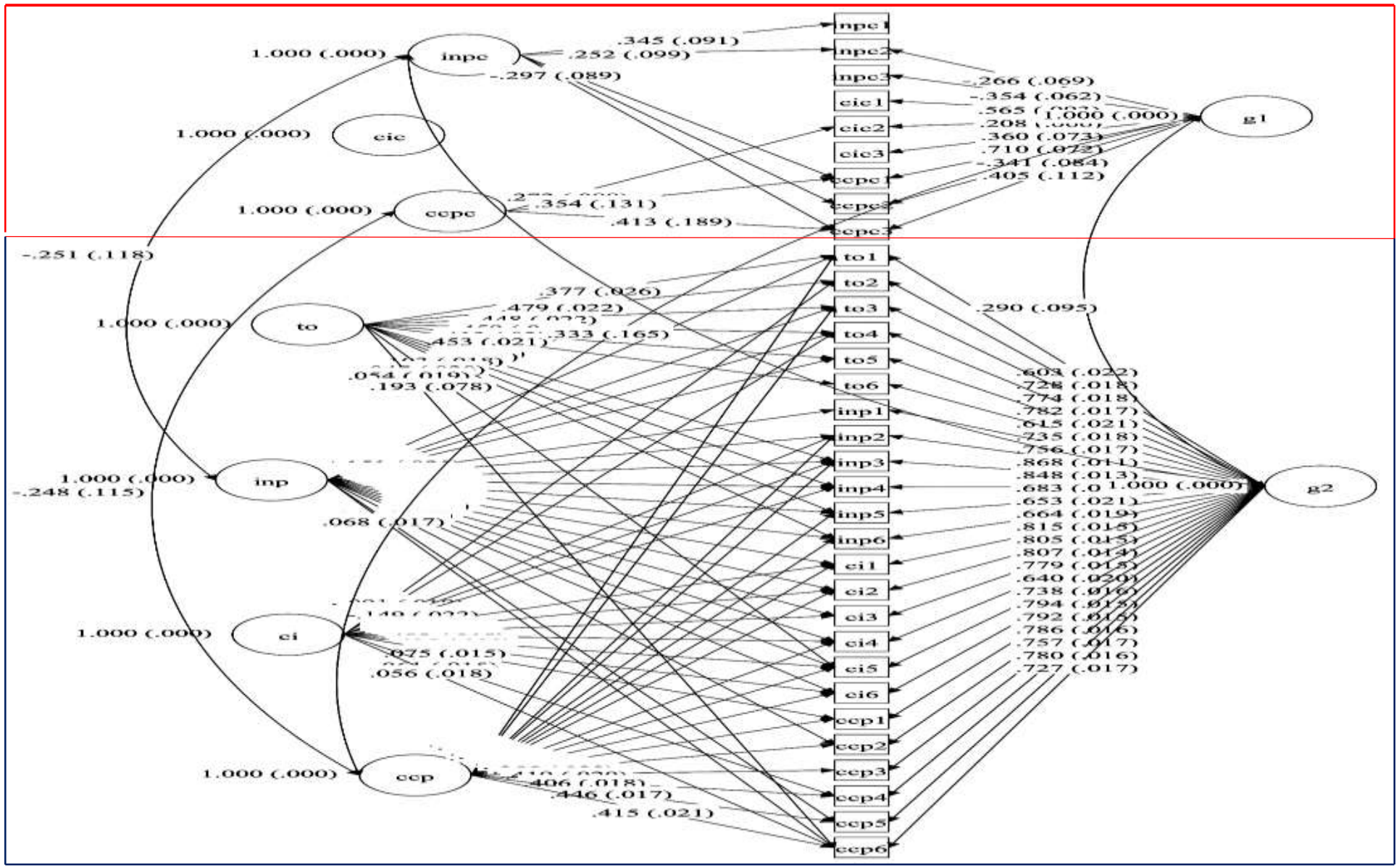
Bifactor variants (incl. Full bifactor ESEM)

Evidence supports a layered model of digital competence (functional + critical skills)

Set bifactor ESEM

Critical

Functional



Distinct structural patterns across domains

Critical digital skills

- Largely unidimensional
- Dominated by a general evaluative factor

Functional digital skills

- Multidimensional

Interconnection

- Set bifactor ESEM revealed low correlations between functional and critical general factors ($r \approx .29–.30$), supporting their weak (statistically significant) relation.
- Set bifactor CFA produced inflated overlap ($r \approx .77$), likely due to restricted zero cross loadings.
- Significant cross set relations emerged only for INP and CCP sub-dimensions.

Conclusion: Set bifactor ESEM provided the **most accurate and theoretically coherent model**, balancing parsimony, interpretability, and structural validity, avoiding inflated factor overlap.

This evidence is supported by:

- ✓ **Domain distinction**: functional and critical domains show different behavioral patterns
- ✓ **Domain interconnection**: a weak but significant association between domain general factors and selected sub-factors
- ✓ **Theoretical validity**: superior model fit, supporting the imposed set-based restrictions

Core insight

- **Functional and critical digital skills are distinct yet interrelated domains**, best captured through a parsimonious Set B-ESEM.
- These findings support **layered assessment models** and **curricula that balance operational proficiency with critical digital judgment.**

Summary

Theory: Confirms digital competence as a layered, multidimensional construct, distinguishing functional (operational) from critical (evaluative) skills.

Measurement: Highlights the need for theory aligned models (e.g., Set bifactor ESEM) to ensure construct validity and interpretability.

Education practice: Digital competence should not be treated as a single construct, but as interconnected multidimensionally and hierarchically structured.

Curriculum design: Develop functional skills early and embed critical skills across disciplines as transversal competences.

Outcome: Supports evidence based curricula that move students from tool use to reflective digital citizenship.

Thank you
for your attention!