Unveiling the key-drivers of Educational Deprivation through Statistical and Complex Network Analysis

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The challenge

• To develop a model for carry on a secondary analysis of a multivariate dataset coming from a large-scale assessment coordinated by UNESCO in 15 Latin American countries.

• To estimate the level of learning of students in Reading, Mathematics and Science at the end of primary education.

• To measure gaps between countries and subpopulation groups, given by socioeconomic status, rurality or type of financing of the school, for unveiling those factors associated with the lack of quality in education across the region.

• Dynamics are modeled at three different levels: Micro (discrete), Meso (continuous and discrete), and Macro (continuous).

Building the Network model
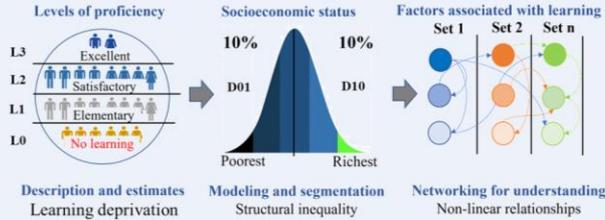
Fig. 1. Three main phases for modelling structure-of-learning-deprivation for carry on complex network and statistical analysis.

Fundamentals

• In the study are considered more than 3 200 s participating schools and more than 134 000 students from third and sixth level of primary education.

• Based on sociological proposals suggesting **Learning deprivation** most be measured in two ways:

1. **Absolut:** every child must develop a minimum level of learning (given by the cut-off point ψ_1)
2. **Relative:** for each student below ψ_1, how deep is the lack of learning, measured as the distance from the score reached by her or him to the cut-off point ψ_1

• An interaction between two variables is represented as an edge that connects two nodes and the scoring representing the student's ability is the weight of the edge.

Micro-level (discrete dynamics)

Modelling interactions between multiple factors that might be related with learning, segmented by subpopulation groups.
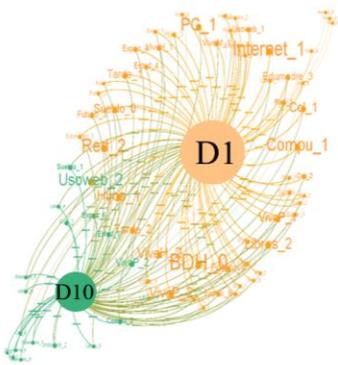

Fig 2. The network shows two local clusters given by socioeconomic groups of students: the poorest (D1, orange) and the richest (D10, green).

It is easy to see that there are so much more variables provoking learning deprivation in the groups of poorest than in the richest students.

Meso-levels (continuous & discrete dynamics)

It is possible to estimate the distribution of the levels of learning and follow the flux from each socioeconomic group for measuring the level of deprivation for each country.
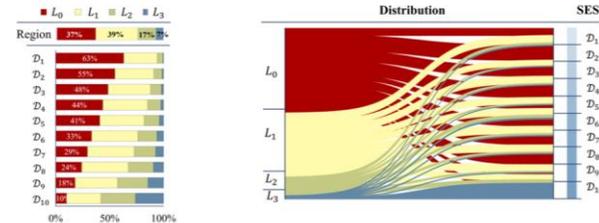

Fig 3. Distribution of levels of achievement among SES deciles.

Fig 4. Relative flows of the distribution of levels of achievement among SES deciles.

And this might be very useful for understanding how structural the problem is in order for developing more accurate evidence-based policies.
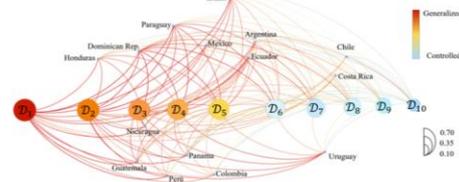

Fig 5. Magnitude of the gaps in each country through odds-ratio $\mathcal{D}_{01}$-$\mathcal{D}_{10}$

Macro-level (continuous dynamics)

Analysing this wide variety of information, it is possible to identify the how deep is the lack of learning and how many students are deprived in each country.

This knowledge allows to governments and policymakers to understand, establish and share educational challenges and goals in a more objective way, as well as to measure and compare improvements at local and regional levels.

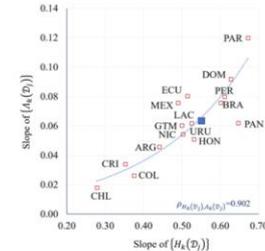#### Levels of learning deprivation in Latin American countries

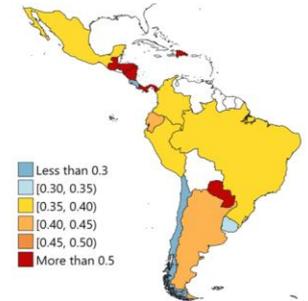**Fig. 6.** Relationship between intensities of absolute and relative deprivation gaps.

Fig. 7. Rate of learning-deprived students in Latin American countries

Network analyzes were carried out by Gephi 0.9.2, statistical estimations with R and Orange and geographical representation with QGIS.