The Educational Achievement and Opportunity Gaps in Mexico

Ollin Demian Langle Chimal[a]

[a]University of Vermont, Complex Systems and Data Science, Burlington, Vermont, 05401

This manuscript was compiled on May 4, 2020

Mexico is one of the worst performing countries in the PISA education evaluation program even though the history to fix the lag across the country has led to the implementation of novelty programs such as PROGRESA which introduced the conditional economic subsidies for development. The access to quality education in Mexico, as well as around the World, is greatly correlated to wealth and it's been long studied as one causation of the poverty trap. Using results from the mexican educational evaluation program "PLANEA" we analize the drivers for the achievement level distribution in mathematics and language and their difference to eachother, finding that municipalities with high marginalization degree tend to perform worst in language while low marginalization can be associated to a poorer performance in mathematics. Marginalization is highly correlated to the percentage of indigenous population which suggest that the disparity between achievement levels in language and math in that group could be due the testing and teaching in other than the mother tongue rather than a cognitive implication.

education | opportunity gap | indigenous language | causation

The National Plan for the Learning Evaluation (PLANEA for it's Spanish initials) is part of the Ministry of Public Education (SEP) efforts to evaluate the acedemic performance accross Mexico with the aim for targeted public policies. PLANEA performs several types of test to keep track of academic achievements which has been shown importance (1), the three modalities are a national evaluation, a scholar center evaluation and a diagnostic evaluation, the first two evaluate the academic achievements at the end of both levels of obligatory education, primary (2) and secondary. Unlike it's predecessors such as ENLACE, it evaluates nearly the total amount of schools but only for the diagnostic evaluation on the equivalent of 6 and 9 years of consecutive education, those are called obligatory as the government has the consitutional obligation to provide it to every person in the Country. The track of academic scores has been a major interest of the mexican government since the 1990s where the program PROGRESA (3) and later OPORTUNIDADES (4) (5) which were the first conditional cash transfer programs in the World to be established and they wanted to evaluate their impact in the walfare (6). The focus of this program was to mantain school attainment (7), which is now consider not the best variable to track as there could be presence but no education happening in a school (8). The biggest difference between Mexico's approach and the rest of the region is that Mexico focuses in public education while other countries like Colombia have voucher programs like PACES for children to be educated in private schools (9) (10). The latest test was performed on 2019 accounting for 32,390 schools for a total of 1,015,597 students evaluated on the language part and 1,011,926 on mathematics. This over 1,992 of the 2,457 municipalities in Mexico at that time. The reslts for each school are summarized by the percentage of students in each of the 4 levels of achievement for both areas.

Level	Equivalence
IV	Outstanding
III	Satisfactory
II	Sufficient
I	Insufficient

Table 1. Achievement levels in the PLANEA test

In order to understand how the context affects education other data sources are necessary. There is an extensive literature that reviews the socioeconomic effects on schooling (1). The National Population Council (CONAPO) runs an evaluation of marginalization by municipality every 5 years which is a multidemensional metric that takes four category needs into account; education, dwelling, population distribution and monetary income, the educational part takes into account the percentage of illiterate over the age of 15 people and the percentage of people over 15 that didn't the 6th grade of education. This multidimensional metric stratifies the municipalities into 5 groups; very low, low, medium, high and very high.

Marginalization	Number of municipalities	Number of schools
Very Low	345	13153
Low	498	6199
Medium	514	5708
High	817	6777
Very High	283	2372

Table 2. Number of municipalities and schools by marginalization level. There were 5 schools in municipalities without marginalization information.

The number of municipalities with high marginalization degree exceeds the ones with lower values of it but the number

Significance Statement

The study of education in marginalized areas and the achievement gap compared to developed areas has been studied greatly but little understanding for the causes of it other than nutrition and teacher quality has been made. Here we show that there is a corralation between the gap in the average achievement in language and mathematics and the indigenous population implying a structural disadvantage to the students with mother tongue other than Spanish.

of schools in those are more as we can see from table2.

The impact of the circumstances on the achievement levels can be seen in figures 1 and 2 which are very similar but let us see different trends in the data. Figure 1 shows the effect of the school being in a certain level of marginalization on distribution of the student's percentage given the type of school, on the other hand figure 2 depicts the effect of the school type on the levels of marginalization which has been discussed in (11) and conditioned to gender in (12). On the first one something very important emerges on the language test, the median over type of schools is somewhat preserved over all marginalization levels but for the very high one and this effect is not equally extreme for the mathematics test, is important to analyze this with statistical rigor. The second figure shows an equally interesting but unsurprising result, regardless of the marginalization level private schools' students perform better on the test.

Because of the aggregated format in which the data is released it is not possible to have a unique target variable, instead we have the distributions of the percentage of students by school that falls inside a certain level group, thus we have 4 variables of interest.

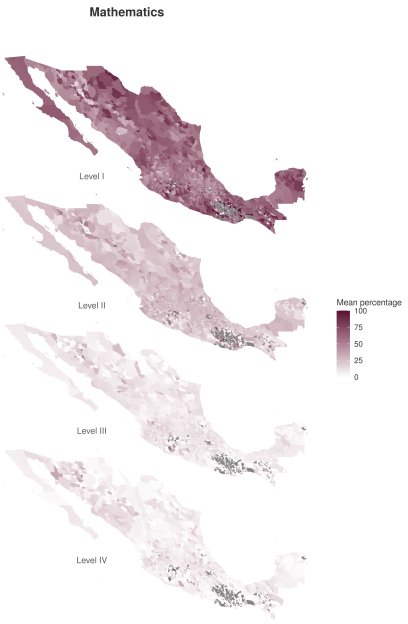

Fig. 3. Choropleth map for the mean percentage of students by achievement levels of the mathematics part of the PLANEA test.

The figure 3 shows the geographical distribution of the mean percentage of students by municipality with scores equivalent to each achievement level. The number of students with insufficient grades greatly exceeds those on the other mark groups. This map also let us see that most of the municipalities without data are in Oaxaca where the indigenous population is high. The zone with higher mean values of achievement is the north-west region, specifically Sonora and Sinaloa.

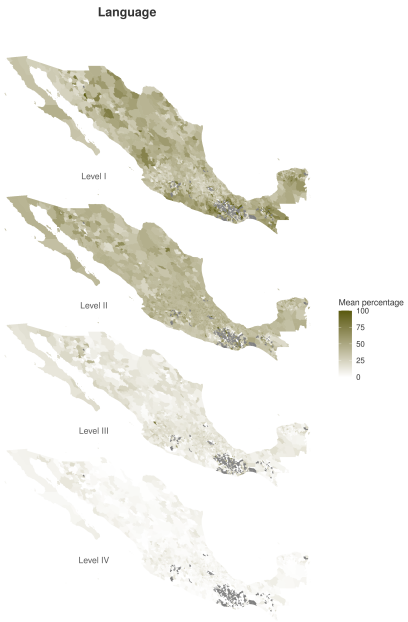

Fig. 4. Choropleth map for the mean percentage of students by achievement levels of the language part of the PLANEA test.

On the other hand figure 4 shows that the distributions for the language part of the test are quite different from those for mathematics. This subject-matter shows that even though the distribution is still skewed towards the lower levels, the difference between the I and II groups is dimnished compared to the one in figure 3 with 6.1% of the students compared to 8.5% in mathematics, in the case of the level I groups the mean values are 37.8% in language and 56.8% in mathematics. This means that less students fail badly in the language tasks but also less students excel.

It's important to note that as both test weren't performed one after the other, the number of students who took them is not the same, we have the information of 1,012,267 students for the mathematical part and 1,016,087 in the language counterpart. The data contains a column about if the percentage of students present in the test are a representative sample of the school, but the documentation neglects to explain the methodology and by manual inspection we found that is not only based on the percentage of students present as there are different cut-offs for different schools and test part, then, as we don't have the information to asume this as valide we kept those school where the percentage in both tests were more than the 50%. Then the number of students evaluated in language was reduced to 1,008,233 and to 1,004,766. Still it contains above a million records for both. Now the number of schools kept is 31,554 in 1,988 municipalities.

Achievement difference between language and mathematics

When evaluating the academic performance by regions we usually see one-to-one comparisons between them for the same subject-matters but the difference of achivements on them could give us valuable information about the structure of the educational planning.

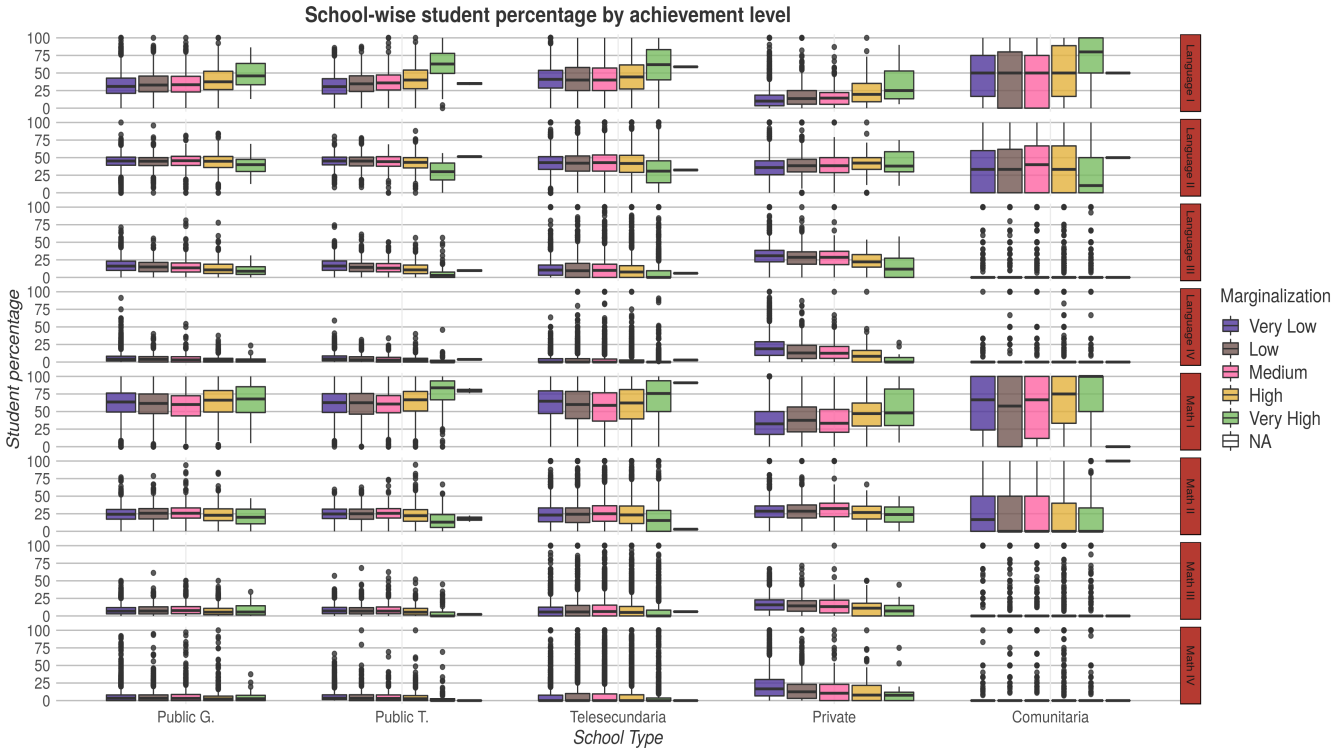

Fig. 1. Distribution of student percentage of a school in each achievement level grouped by marginalization index and school type.

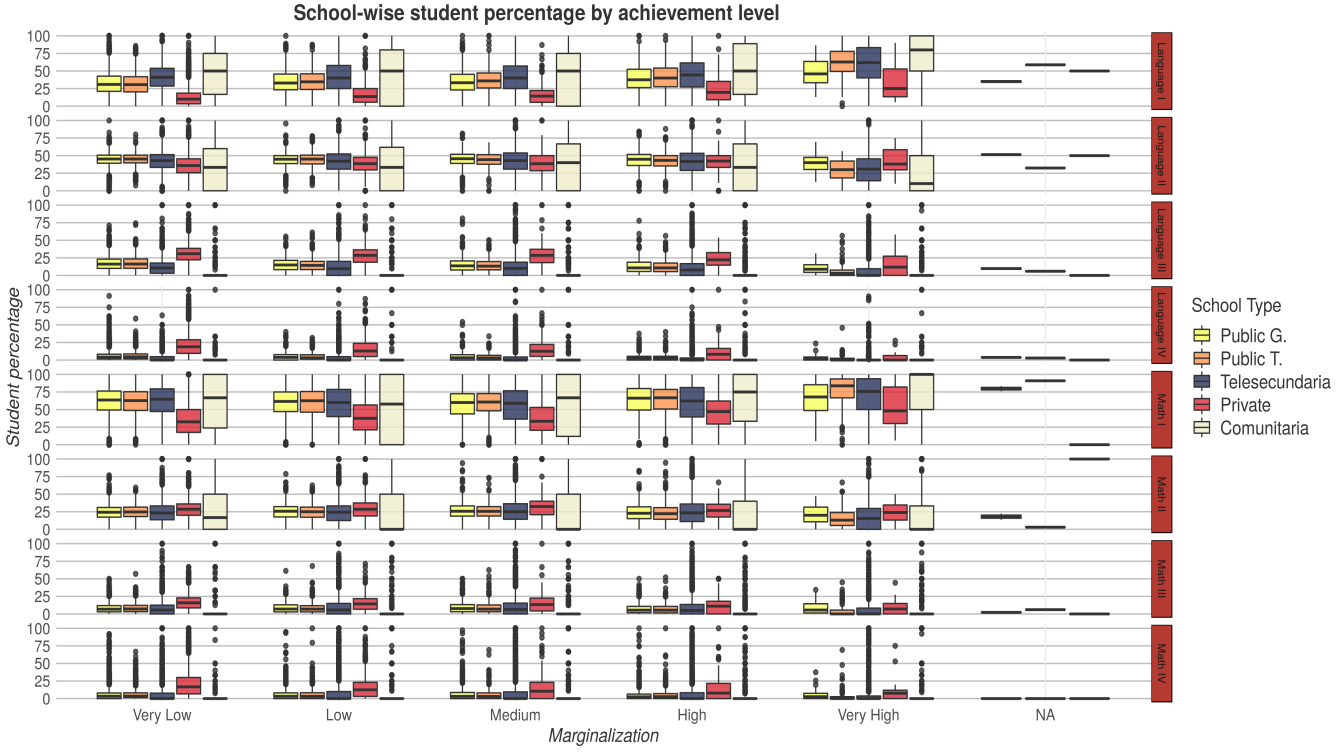

Fig. 2. Distribution of student percentage of a school in each achievement level grouped by school type and marginalization index.

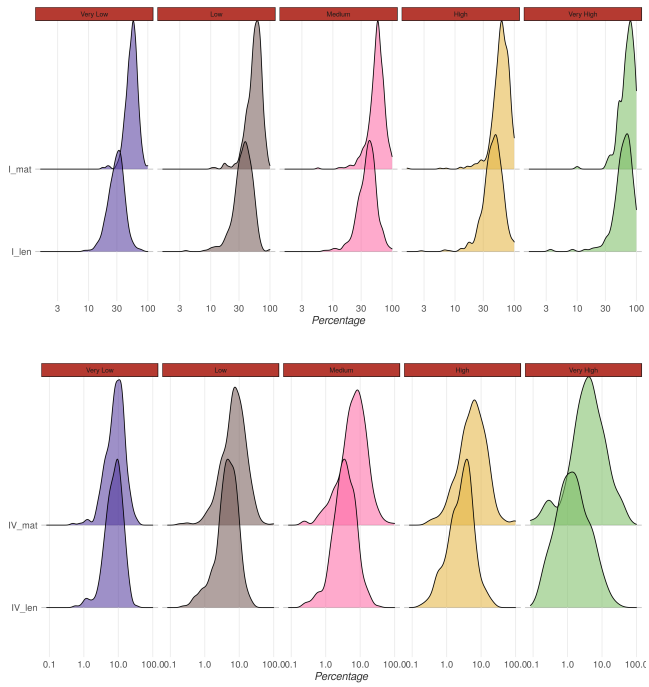

Fig. 5. Distribution density in log10 scale of the percentage of students by municipality in the lowest and highest achievement level.

The PLANEA program tests for two different areas of cognitive development and in a completely equal disadvantage we should expect to see the same correlation between same level of achievements between the both of them but figure 5 shows that the log distribution of the percentage of students in the level one groups are different for the very low marginalization level (p-value: 2.58e-8, two sided F-test) while they are the same for very the very high one (p-value: 6.70e-1, two sided F-test). As the hypothesis is that the gap is the same in every municipality, i.e. we have the same disadvantage for both test parts, we used a F-test to compare the variances of the two samples and see how good of a fit is one for the other. For the level IV group we conclude that for the very low marginalization municipalities the log distributions are the same (p-value: 6.44e-1, two sided F-test) while for the very high marginalization it's inconclusive depending on the significance threshold (p-value: 7.73e-2, two sided F-test). Visual inspection of figure 5 shows that there is indeed a difference. In particular for the language part of the test the municipalities with a very low marginalization level more students' percentage have an insufficient mathematical performance in the test than they do on the language areas but that difference vanishes on the very marginalized ones where they perform as poorly. On the level IV this behaviour is reversed, municipalities with low marginalization that do well in one do it too on the other but as marginalization increases less percentage of students with outstanding performance in mathematics excels in language too.

The previous results suggests that there is a non-cognitive variable associated with the gap between the parts of the test. The overall performance difference is usually explained by the inaccessibility to schools or quality education (13) (14), working children, parent meritocracy (15) (16) (17), lack of nutritious food **???** (18), absent educators (8), lack of estimulation outside the academic environment (19) (20), etc., but all of these account for the same in both parts of the test and there should be an enviromental variable that explains this pattern of children in unfavored conditions which can affect their later entrance to a school with standardize admision test and poor integration (21) (22).

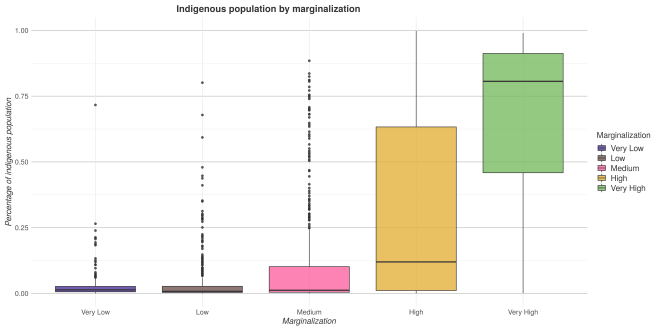

Fig. 6. Distribution of indigenous population by marginalization level.

Being Mexico the large multicultural country that is, it's important to understand the drivers of this phenomena as the integration of all the nations inside the country is not yet achieved and the unlike other developing countries such as Malasya (23), inequality between groups is very large. Using the intercensal survey gathered by the National Population Council (CONAPO) and the National Comission for the Development of Indigenous Peoples (CDI) we were able to cross the information of percentage of people that speaks an indigenous language and the variables that make up the multidimensional definition of poverty and marginalization in Mexico which have been studied in the relationship between schools and inequality (24) (25). Figure 6 depicts that the most marginalized areas in Mexico have a high concentration of indigenous people and therefore a social explanation of why this lag of language development is happening in those regions (26) (27) (28) .

Causality of the achievement levels

Understanding the mechanisms by which a phenomena occurs is the the most important part for program planning or any type of public policy directed to tackle an specific problem and while descriptive statistics can yield important findings the use of inferential statistics is crucial to extract any conclusions about a certain population and advance into policy treatments (29). Then in order to understand what specific variables have an impact on the test scores we performed a causality analysis which is regularely used in education programs (30). The variables we used were illiteracy, percentage of adult population without elementary school, percentage of people living under 2 minimum wages a month, percentage of dirt floors in houses, municipalities with less than 5 thousand population, percentage of houses without electricity access, percentage of houses without sewage, percentage of houses without clean water access, percentage of overcrowding, school shift, school type and schools by square km in the municipality. After a feature simple feature selection process we only kept the eight less correlated ones and use a Hybrid Hybrid Parents & Children (H2PC)(31) algorithm to learn the structure of

the directed acyclic graphs and then used the DAG structure to do a regression analysis.

After learning the DAG structure for the language scores we find that the I and IV groups share most of their parents, the intersection and their values of the fitted regression analysis for the group I is school type (-0.063), school shift (0.048), school density (-0.045) and overcrowding (0.005) with $\sigma = 0.28$. The only non categorical one with a positive relation is density, thus the more schools per area less failures in language tasks. The shared regression parameters for the group IV are school type (0.082), school shift (-0.049), school density (0.038) and overcrowding (-0.007) with $\sigma = 0.32$. The signed are reversed with respect to the ones from group I which is expected as they are the extreme values. It is interesting that no indigenous population variable were directly linked to them and even on the other extreme of the leaves.

In the case of the mathematics task both levels share the same parents, the regression values for the level I are school shift (0.021), school type (-0.056), overcrowding (0.001) and percentage of indigenous language speakers (-0.068) on the other hand for the level IV group we have school shift (-0.033), school type (0.094), overcrowding (-0.003) and percentage of indigenous language speakers (0.173). Again we have the parameters' signs shifted but interestingly they also are with respect of the same achievement level groups for the language task. Surprisingly the percentage of indigenous language speakers appears as a parent for both of them when it wasn't for the language ones.

Conclusions

We have shown that there is a difference between the PLANEA test scores between the language and mathematics part of it for the students in the most marginalized areas compared to the least ones. This cannot be explained by common approaches to understand the educative lag as they account for an overall achievement without acknowledging the different groups' scores for different subject-matters. We presented that this difference does exist and is significant and translates into a disadvantage in language education for the most marginalized areas where it happen to be more densely populated by indigenous communities. This communities often times doesn't have Spanish as their first languanguage. There have been efforts for incorporating the original languages into public education but as the admission test as well as this type of evaluations such as PLANEA and PISA are made in Spanish, the people in those areas have a clear handicap compared to less marginalized areas. This is in top of the rest of structural skewness in the access to quality education and nutritious food, not to mention the problem of working children and the generalized violence in Mexican rural areas. We can't stress enough that we are not proposing that education should have a structural change towards colonialist education but there is a need for better opportunities that can close not only this but the rest of opportunity gaps, and this research aims to acknowledge a problematic that should be fixed. We also showed that school type is causal of the test scores as well as the school density. We didn't find with this approach a direct parent/child relationship between the language scores and the indigenous population, further work on this is needed.

ACKNOWLEDGMENTS. I want to recognize the work of every community teacher whose labor for clossening the gap and work for children's wellness and rights has inspired this work. Also to all of those who collect and share information.

1. Brunello G, Checchi D (2007) Does school tracking affect equality of opportunity? New international evidence. *Economic Policy* 22(52):781–861.

2. Heyneman SP, Loxley WA (1983) The effect of primary-school quality on academic achievement across twenty-nine high- and low-income countries. *American Journal of Sociology* 88(6):1162–1194.

3. Schultz TP (2004) School subsidies for the poor: Evaluating the Mexican Progresa poverty program. *Journal of Development Economics* 74(1):199–250.

4. Parker SW, Todd PE (2017) Conditional cash transfers: The case of progresa/oportunidades. *Journal of Economic Literature* 55(3):866–915.

5. Angelucci M, Attanasio O (2013) The demand for food of poor urban Mexican households: Understanding policy impacts using structural models. *American Economic Journal: Economic Policy* 5(1):146–178.

6. Skoufias, Emmanuel (2005) *PROGRESA and Its Impacts on the Welfare*.

7. Galindo-Rueda F, Vignoles A (2005) The declining relative importance of ability in predicting educational attainment. *Journal of Human Resources* 40(2):335–353.

8. Chaudhury N, Hammer J, Kremer M, Muralidharan K, Rogers FH (2006) Missing in action: Teacher and health worker absence in developing countries. *Journal of Economic Perspectives* 20(1):91–116.

9. Angrist J, Bettinger E, Kremer M (2006) Long-term educational consequences of secondary school vouchers: Evidence from administrative records in Colombia. *American Economic Review* 96(3):847–862.

10. Lamarche C (2011) Measuring the incentives to learn in Colombia using new quantile regression approaches. *Journal of Development Economics* 96(2):278–288.

11. Chmielewski AK (2019) The Global Increase in the Socioeconomic Achievement Gap, 1964 to 2015. *American Sociological Review* 84(3):517–544.

12. Golsteyn BH, Schils T (2014) Gender gaps in primary school achievement: A decomposition into endowments and returns to IQ and non-cognitive factors. *Economics of Education Review* 41:176–187.

13. Alon S (2009) The evolution of class inequality in higher

11(1):65–86.

17. Duncan GJ, Morris P a, Rodrigues C (2011) Does Money Really Matter? *Development Psychology* 47(5):1263–1279.

18. Attanasio O, Di Maro V, Lechene V, Phillips D (2013) Welfare consequences of food prices increases: Evidence from rural Mexico. *Journal of Development Economics* 104:136–151.

19. Alexander KL, Entwisle DR, Olson LS (2007) Lasting consequences of the summer learning gap. *American Sociological Review* 72(2):167–180.

20. Mare RD (1980) Social background and school continuation decisions. *Journal of the American Statistical Association* 75(370):295–305.

21. Reardon SF, Portilla XA (2016) Recent Trends in Income, Racial, and Ethnic School Readiness Gaps at Kindergarten Entry. *AERA Open* 2(3):233285841665734.

22. Valenzuela JP, Bellei C, Ríos D de los (2014) Socioeconomic school segregation in a market-oriented educational system. The case of Chile. *Journal of Education Policy* 29(2):217–241.

23. Saw GK (2016) Patterns and trends in achievement gaps in Malaysian Secondary Schools (1999–2011): gender, ethnicity, and socioeconomic status. *Educational Research for Policy and Practice* 15(1):41–54.

24. Downey DB, Condron DJ (2016) Fifty Years since the Coleman Report: Rethinking the Relationship between Schools and Inequality. *Sociology of Education* 89(3):207–220.

25. Werfhorst HG van de (2018) Early tracking and socioeconomic inequality in academic achievement: Studying reforms in nine countries. *Research in Social Stratification and Mobility* 58:22–32.

26. Reinke L (2004) Globalisation and local indigenous education in Mexico. *International Review of Education* 50(5-6):483–496.

27. Despagne C (2013) Indigenous Education in Mexico: Indigenous Students' Voices. *Diaspora, Indigenous, and Minority Education* 7(2):114–129.

28. López-Gopar ME (2007) Beyond the Alienating Alphabetic Literacy: Multilit[illegible] Indigenous Education in Mexico. *Diaspora, Indigenous, and Minority Education* 1(3):159–174.

29. Scott SL, Ip EH (2002) Empirical bayes and item-clustering effects in a latent variable hierarchical model: A case study from the national assessment of educational progress. *Journal of the*

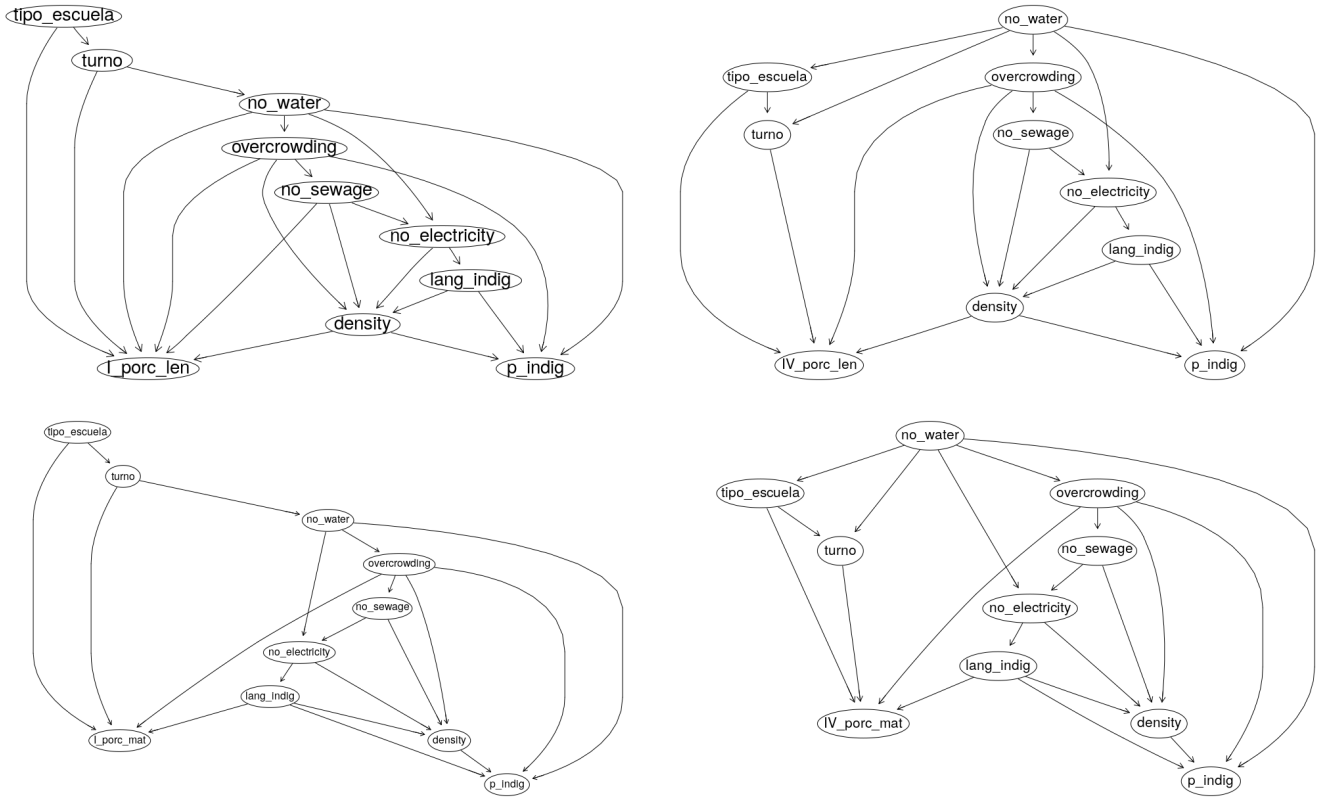

Fig. 7. DAG structure for causality of the extreme groups (I and IV) for the language (above) and mathematics (below) tasks in the PLANEA test.