



unesco

Institute for Statistics
Global Alliance to
Monitor Learning

Global Alliance
To Monitor Learning

WG/GAML/2

PROPOSED USE OF SCIENCE PROFICIENCY AS A PROXY FOR SDG 4.1.1 IN READING

18 October 2021

Background

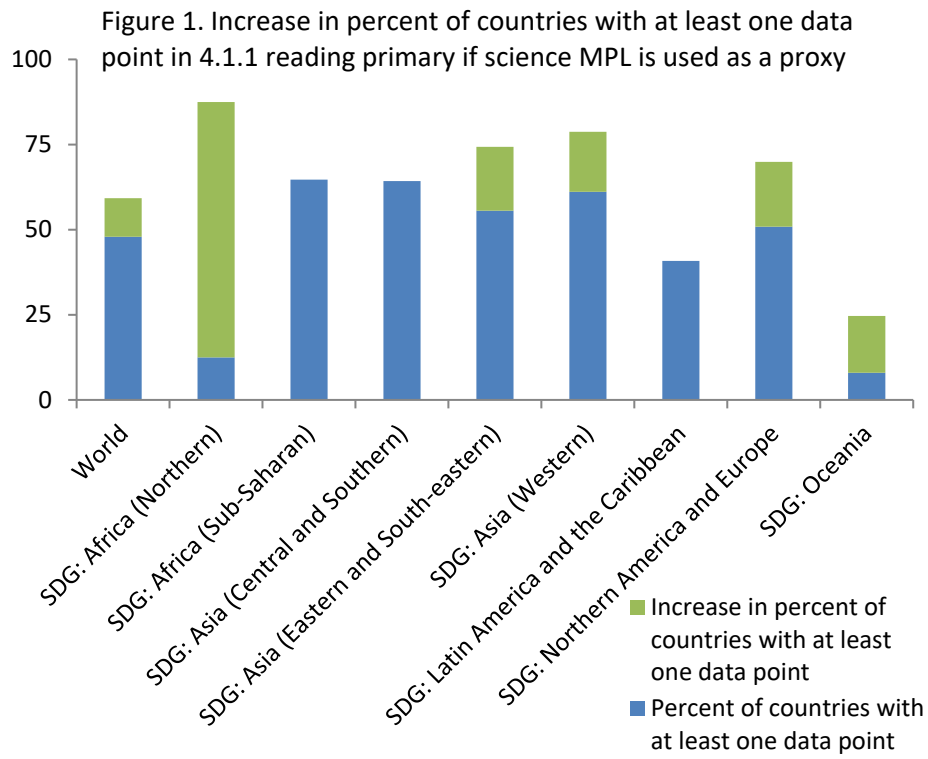
The possibility of using a proxy variable for the percent of students achieving minimum proficiency in reading at the end-of-primary and lower secondary levels (SDG 4.1.1) is motivated by the following two points:

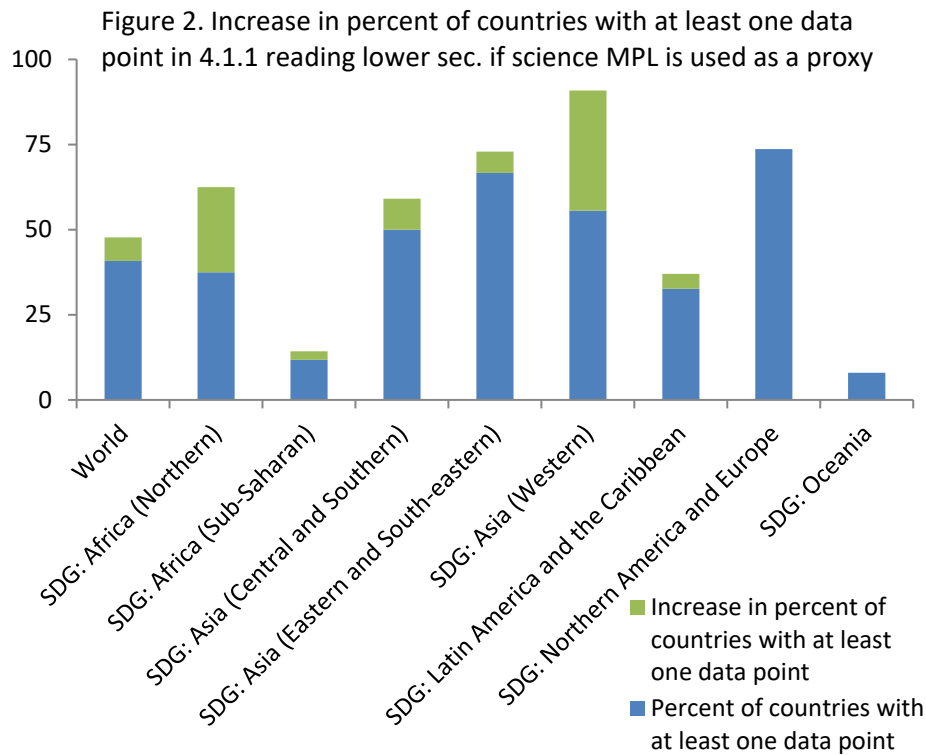
1. **Reduced coverage:** SDG 4.1.1 relies on international student assessments which typically include measures of reading proficiency except for TIMSS which only measures math and science achievement. A number of countries have participated in TIMSS at the 4th grade level or at the 8th grade level but have not participated in PIRLS or PISA, respectively resulting in a lack of reading data for these countries. If the TIMSS science proficiency level can be used as a proxy for reading, then this would increase the number of countries with reading data points.
2. **Science as a proxy for learning poverty:** The UIS and World Bank have developed an indicator of learning poverty which measures the proportion of students either deprived of schooling or deprived of learning in school. Reading proficiency is used at the measure of learning in recognition of the need for reading skills both to learn throughout progression in school and to succeed in other topics including mathematics and science. The learning poverty measure faces the same constraint as SDG 4.1.1: there is number of countries with TIMSS data but no corresponding reading data from another assessment. As a result, learning poverty uses the proportion of students achieving minimum proficiency in science as a proxy for reading in part because science achievement relies on reading proficiency to succeed.

Proposal

The proposal is to use minimum proficiency in 4th grade TIMSS science as a proxy for minimum proficiency in reading at the end of primary and to use minimum proficiency in 8th grade TIMSS science as a proxy for minimum proficiency in reading at lower secondary. The proxies would be applied only to countries that do not have data on the percent of students achieving minimum proficiency in reading for end of primary or lower secondary, respectively; that is, no country would have a data series that includes both actual measures of reading and proxy measures of reading.

Figures 1 and 2 provide an estimate the increase in coverage in 4.1.1 primary and lower secondary reading as a result of using the science MPL proxies. Globally, the percent of countries with at least one data point for 4.1.1 primary reading data would increase from 48 percent to 59 percent. At the lower secondary level, the percent of countries with one data point would increase from 41 percent to 48 percent. Increases vary by SDG region; Northern Africa would see significant increases in coverage at both levels as would Western Asia at the lower secondary level.





Validity analysis

In order to demonstrate with validity of the proposed proxies, the correlation and error between minimum proficiency in reading and the proxies were measured for countries that had data for both data. First, TIMSS and PIRLS were both conducted in 2011 which allows for measuring validity of the proxies for those countries that participated in 4th grade TIMSS and PIRLS (which is conducted at the 4th grade as well). Second, TIMSS and PISA were both conducted in 2015 which allows measurement of validity for those countries that participated in TIMSS 8th grade and PISA (which targets 15 year olds).

Table 1. Validity measures: percent of students achieving minimum proficiency in science and reading are highly correlated

	correlation between proxy and actual indicator	median absolute value of differences between proxy and actual indicator (percentage point)	observatio ns
2011 4 th grade TIMSS science MPL as a proxy for the 2011 PIRLS grade 4 reading minimum proficiency level	0.99	2.53	34
2015 8 th grade TIMSS science MPL as a proxy for 2015 PISA reading MPL	0.90	11	28

To demonstrate the validity, two proxies were constructed. The first was the percent of students that achieved minimum proficiency in 4th grade TIMSS science in 2011 as a proxy for PIRLS reading in 2011, and the second was the percent of students that achieved minimum proficiency level (MPL) in 8th grade TIMSS science in 2015 as a proxy for PISA reading MPL (as defined by GAML) in 2015. Table 1 presents two measures of validity of each proxy: the correlation and the median absolute difference. As a proxy for 2011 PIRLS minimum reading proficiency level, the percent of students achieving minimum proficiency in 4th grade TIMSS science was highly correlated with minimum proficiency in PIRLS. The median absolute difference between these two was 2.5 percentage points which indicates that the difference between the percent of students achieving minimum proficiency between TIMSS 4th grade science and PIRLS reading was less than or equal to 2.5 percentage points in absolute value. 8th grade TIMSS science minimum proficiency was also highly correlated (0.9) with PISA reading minimum proficiency but had a higher median absolute difference of 11 percentage points.

Conclusions

Using TIMSS science as a proxy offers additional data on learning achievement for measuring progress towards SDG 4.1. The proxies are highly correlated with actual reading proficiency; however, there is some difference between the two measures, particularly at the lower-secondary level.

Proposed proxies

For SDG 4.1.1, two proxies are proposed to increase coverage for reading:

1. Minimum proficiency in science in TIMSS,
2. A modeled estimate of reading proficiency using TIMSS data (and potentially others, methodology to be determined)

Validity analysis

In order to demonstrate with validity of the proposed proxies, the correlation and error between minimum proficiency in reading and the proxies were measured for countries that had data for both data. First, TIMSS and PIRLS were both conducted in 2011 which allows for measuring validity of the proxies for those countries that participated in 4th grade TIMSS and PIRLS (which is conducted at the 4th grade as well). Second, TIMSS and PISA were both conducted in 2015 which allows measurement of validity for those countries that participated in TIMSS 8th grade and PISA (which targets 15 year-olds).

To demonstrate the validity, two proxies were constructed. The first was the percent of students that achieved minimum proficiency in the respective, corresponding TIMSS assessment as proxies for the GAML definition of minimum proficiency using PIRLS and for PISA. The second was a modeled estimate which used the percent of students achieving minimum proficiency in both TIMSS science and TIMSS mathematics. The model was specified as

$$\ln\left(\frac{r_{PIRLS}}{1 - r_{PIRLS}}\right) = \beta_0 + \beta_1 \ln\left(\frac{s_{TIMSS\ g4}}{1 - s_{TIMSS\ g4}}\right) + \beta_2 \ln\left(\frac{m_{TIMSS\ g4}}{1 - m_{TIMSS\ g4}}\right) + u_{PIRLS}$$

and

$$\ln\left(\frac{r_{PISA}}{1 - r_{PISA}}\right) = \beta_0 + \beta_1 \ln\left(\frac{s_{TIMSS\ g8}}{1 - s_{TIMSS\ g8}}\right) + \beta_2 \ln\left(\frac{m_{TIMSS\ g8}}{1 - m_{TIMSS\ g8}}\right) + u_{PISA}$$

where r , s and m denote the proportion of students achieving minimum proficiency in reading, science and mathematics, respectively, with subscripts indicating the source of data and u denoting an error term with subscript indicating the model. Both models were estimated using data for countries that participated in both of the specified international assessments. The modeled estimates were calculated from the predicted values of the dependent variable using the TIMSS data. Note that this model specification was selected for the purposes of this proposal in order to demonstrate the advantages of using a modeled estimate of a proxy; developing a more sophisticated model is possible.

Table 1. Comparing validity measures: science and reading minimum proficiency levels are highly correlated, but modeling using more variables can increase accuracy

	correlation between proxy and actual indicator	median absolute value of differences between proxy and actual indicator (percentage point)	observatio ns
For 2011 PIRLS grade 4 reading minimum proficiency level			
using 2011 TIMSS grade 4 science as a proxy	0.99	2.53	34
using modeled estimates based on 2011 TIMSS grade 4	0.99	0.96	34
For 2015 PISA reading minimum proficiency level			
using 2015 TIMSS grade 8 science as a proxy	0.90	11	28
using modeled estimates based on 2015 TIMSS grade 8	0.88	4.69	28

Table 1 presents two measures of validity of each proxy: the correlation and the median absolute difference. As a proxy for 2011 PIRLS minimum reading proficiency level, the percent of students achieving minimum proficiency in 4th grade TIMSS science was highly correlated with minimum proficiency in PIRLS. The median absolute difference between these two was 2.5 percentage points which indicates that the difference between the percent of students achieving minimum proficiency between TIMSS 4th grade science and PIRLS reading was less than or equal to 2.5 percentage points in absolute value. The modeled estimate for reading had a similar correlation with PIRLS reading but was more accurate in terms of error, having a median absolute difference of just under 1 percentage point. Similar results were found for minimum proficiency in PISA reading. 8th grade TIMSS science minimum proficiency was also highly correlated (0.9) with PISA reading minimum proficiency but had a higher median absolute difference of 11 percentage points. The modeled estimates were slightly less correlated (0.88) but reduced the median absolute difference by more than half, to 4.7 percentage points.

Conclusions

As a proxy for minimum proficiency in reading, minimum proficiency in science is highly correlated. Using a modeled estimate, however, appears to have the potential to increase the accuracy of the proxy particularly as measured by the median absolute difference. The model itself can be more sophisticated than the one used in this demonstration by including more variables in TIMSS (or other available sources) and different functional forms. The disadvantages of using modeled estimates are needed for computation on the part of the UIS and the relatively small number of countries for which both TIMSS and reading proficiency data is available for calibrating the model.