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ARTICLE

Improving Learning in Low- and Lower-Middle-Income Countries

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Abstract
The current challenge of education systems is learning. Across low-income countries (LICs) and lower-middle-income countries (LMCs), 62 % of 10-year-olds could not read at a minimally sufficient level in 2015. This study provides an overview of recent spending on education and its correlation with learning outcomes. We show that the relationship between education spending and learning is historically weak. From 2000 to 2015, LICs and LMCs increased spending on education in primary schools by ~$137 per student, an 80 % inflation-adjusted increase, with no corresponding change on the average learning outcomes. We then conduct a benefit-cost analysis of candidate interventions that could increase learning at low cost. Two interventions – structured pedagogy and, teaching at the right level, with and without a technology component generate large benefit-cost ratios. If deployed uniformly to reach 90 % of the 467 million students in LICs and LMCs, these interventions would cost on average $18 per student per year or $7.6 billion annually, generating $65 in benefits for every $1 spent. The economic logic behind this finding is that the hard and costly work of getting children into primary schools has mostly been accomplished, leaving open the possibility of learning interventions that improve the efficiency of the existing education system at low cost. Our results show that increasing education expenditure by just 6 % could increase learning by 120 % if directed toward these highly cost-effective interventions.

1. Introduction: Poor learning costs the world $3 trillion per year

An investment in knowledge pays the best interest
– Benjamin Franklin in *Way to Wealth* (1758)

While he is perhaps best known for making the connection between lightning and electricity, for 25 years Benjamin Franklin also published a successful magazine that was focused on financial and life advice for the "common people," as he put it. Called the *Poor Richard's Almanac* and summarized in a 1758 essay entitled *Way to Wealth*, Franklin provided aphorisms and quotes that arguably are still relevant today. The quote above claims that investing in knowledge generates the greatest returns. *Was Benjamin Franklin right?* In this Best Investment Paper, we make the case that "Yes!" Franklin was right although with important caveats: the investments have to work, and they have to be backed by evidence that demonstrates their cost-effectiveness, characteristics that, unfortunately, are not always apparent in education policy. However, when they exist, investments in learning generate some of the highest returns across all sectors of development.

Until the 19th century, formal education was primarily for society's elite, such as royalty, aristocracy, and leaders of religious institutions. Formal education as we know it today began expanding in Central and Eastern Europe during the 19th century (Lee & Lee, 2016). Over the course of the Industrial Revolution and beyond, the share of people above age 15 with at least a basic education rose steadily from less than 20 % in 1800 to above 80 % by 2016 (see Figure 1).

Today, efforts to formally educate populations have spread to every part of the globe. The latter half of the 20th century and the Millennium Development Goal (MDG) era saw a great push to boost primary school enrolment in low- and middle-income countries. In 1970, across developing nations, gross enrolment was 87 % (and only 51 % in low-income countries (LICs)), and now this is over 100 % with gender parity in schooling (World Bank, 2021). As a development initiative, much hope was laid at the feet of education – specifically enrolment, with the assumption that children would automatically learn – to boost the prospects of developing countries and help them grow through a better-educated labor force.

Unfortunately, we have since come to realize that being in school does not guarantee learning. While systematic time-series data on the main SDG goals are sparse, a recent estimate suggests only 1 out of 10 children in LICs are able to read by age 10,[1] despite supposedly having attended school for 2–4 years (Azevedo *et al.*, 2021). In comparison, 9 out of 10 children in high-income countries are able to read by age 10. A different but related measure of learning, the Harmonized Learning Outcomes (HLO), shows a slow improvement in primary school learning from 2000 to 2015 for most developing regions of the world, but the improvement is vastly insufficient to reach high-performing education systems by 2030 or even 2050 (Angrist *et al.*, 2020).

Lack of learning has profound implications for individual productivity and country-wide economic growth as well as development more broadly. Using the relationship that 1 standard deviation[2] (*SD*) improvement in test scores – a common measure of learning – is correlated with a 20 % increase in income (Angrist *et al.*, 2020), exposure to an intervention that boosts test scores by 0.25 *SD* (a high but not extreme result) could increase an individual's future earnings by 5 %. At a country level, a recent study in *Nature* indicates

[1] In LMCs, 45% of children can read by age 10.

[2] Education specialists often use tests to measure learning. Since different tests are used around the world and they have different scoring systems, researchers typically measure improvements from interventions in standard deviations of test scores for comparability. Alternative and related approaches have been suggested such as the Harmonized Learning Outcome (Angrist *et al.,* 2020), the Equivalent Years of Schooling measure (Evans & Yuan, 2019), the Learning Adjusted Years of Schooling measure (Filmer *et al*., 2020), and Learning Poverty (Azevedo *et al.,* 2021).

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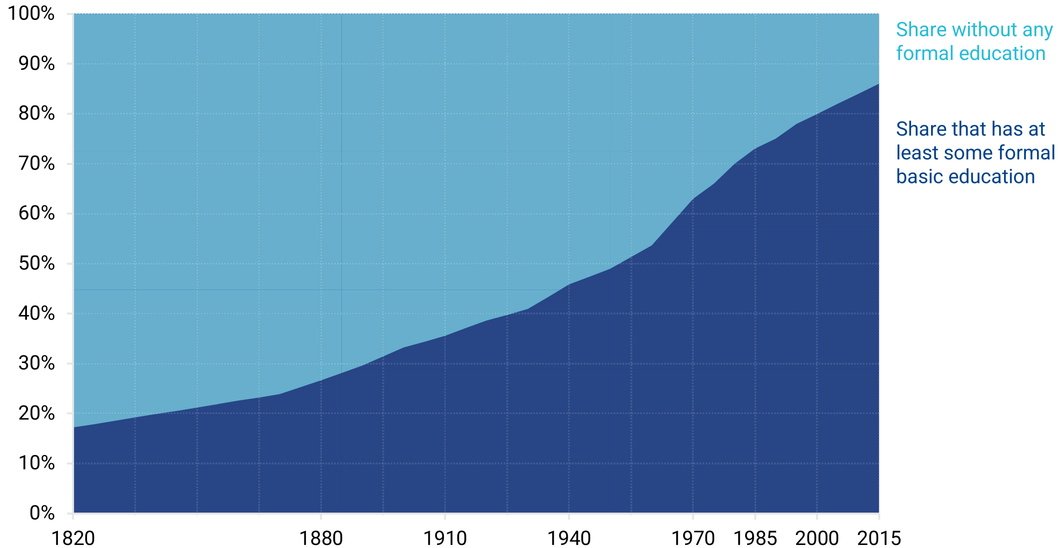

Figure 1. *Share of the World Population older than 15 years with at least a basic education.* Source*: OurWorldInData. Global Education (OECD IIASA, 2016).*

20–50 % of income differences between nations are associated with differences in learning levels (Angrist *et al.*, 2020).

How much does poor learning in primary school cost the world every year? The loss can be approximated by noting that high-performing economies, such as the UK, may generate learning equivalent to 1.2 *SD* of test score improvements per year (Angrist *et al.*, 2020) while Evans and Yuan (2019) show that each year of schooling in LICs or lower-middle-income countries (LMCs) generates 0.15 *SD* of test score improvements. A top school system such as the UK generates eight times as much learning as the typical LIC or LMC system.

If this gap – 1.05 *SD* – could be eliminated in LICs and LMCs for one year, it would boost the future incomes of school-age children by 21 %. Given a present value of lifetime income of $30,000 at an 8 % discount rate and 467 million children enrolled in primary school in these countries, the loss is equal to roughly *$3 trillion per year.* Essentially, if all LIC and LMC education systems could rise to the level of the UK then the annual benefit would be equivalent to ~40 % of combined LIC and LMCs' GDPs. Another way to put this is for an average country classified as LIC or LMC, a completely successful education reform could increase that country's wealth at least 40 % before accounting for any spillover or general equilibrium effects. There is, of course, substantial uncertainty in this estimate. For example, the link between learning and incomes has only been empirically established cross-sectionally (and not more robustly, for example, via a randomized control trial with a long-term follow-up) with a relatively wide range around the strength of the relationship (Hanushek & Zhang, 2015; Evans & Yuan, 2019). Nevertheless, this calculation at least provides a plausible order-of-magnitude figure of the income loss from suboptimal learning.

This article sets out the economic case for two highly cost-effective interventions that can partially address this gap:

(i) Structured pedagogy, defined as a *coherent* package of inputs, typically includes textbooks, lesson plans, teacher training, and ongoing coaching of teachers that *work together* to improve in-class teaching, and
(ii) Teaching according to learning levels rather than age or grade (with and without technology).

Overall, the focus of this analysis is on primary education rather than secondary or tertiary levels of education. This is motivated by the fact that returns to education are generally higher at younger ages (Heckman, 2006) and that the unit cost of interventions in primary schools is lower due to higher levels of enrolment. Much of the evidence on interventions to improve learning comes from primary school settings.[3]

The remainder of this article is structured as follows: In the next section, recent experience in the education sector in terms of both learning outcomes and spending is charted out and demonstrates the weak relationship between the two. What the world promised for the SDGs and an estimate of this cost based on historically ineffective approaches is then described. The conclusion is that meeting all the SDGs for education is unfeasible and expensive. In the next section, those interventions that are likely to be most cost-effective are discussed, and using existing reviews, 150 interventions are whittled down to the two most efficient

[3] This is also why we do not focus on early childhood education where the evidence base is substantially smaller than for primary education. However, there are several interventions within the area of early childhood nutrition that have been demonstrated to reduce stunting and improve cognitive ability, yielding excellent BCRs (Hoddinott *et al.,* 2013). These are examined in another paper within the Halftime Best Investment Series.

examined in this study. A cost-benefit analysis of these two interventions is then discussed and finalized with a discussion.

2. The MDG era: Substantial success in boosting access but limited success in improving learning

The MDGs focused on increasing access to primary education, particularly for girls. These aims were achieved to a great degree with primary gross enrollment across the developing world above 100 % in 2015 (World Bank, 2021). The most substantial gains occurred in LICs, which went from 72 to 99 % enrollment. Gender parity in primary schooling was also achieved in 2015 (World Bank, 2021).

The results for learning were less impressive. The Harmonized Learning Outcomes (HLO) database provides information on how countries fared on various standardized tests across time and represents the most comprehensive dataset on learning outcomes globally (Angrist *et al.*, 2020). Focusing on various geographical regions, the results show that in much of the developing world, test scores did not improve substantially between 2000 and 2015 after adjusting for enrolment (see Figure 2). For example, in sub-Saharan Africa, the region with the greatest learning poverty, HLO scores only increased by 1.3 points per year. To put this figure in perspective, it would take another 159 years of improvement at the same pace to reach the level North America (539) had in 2015. Put differently, an average primary school student in sub-Saharan Africa would rank in the bottom 0.6 percentile of all primary students of the same grade in North America.[4]

This lack of progress in learning outcomes (conditional on enrolment) is concerning given the huge resources devoted to improving primary grade education quality in LICs and

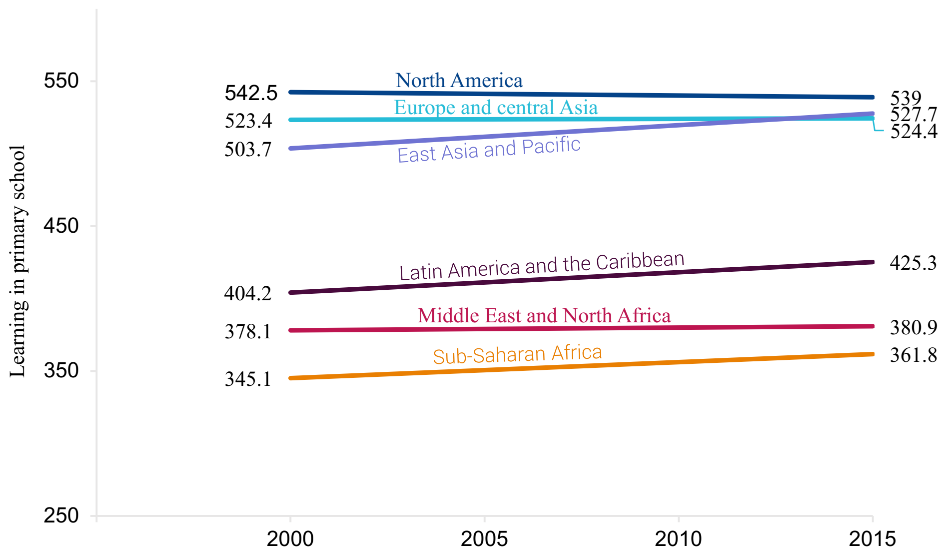

***Figure 2.** Harmonized Learning Outcomes by region, 2000–2015 (primary school).* Source*: Angrist* et al. *(2020).*

[4] This is based on an HLO cross-country standard deviation of 70 (Angrist *et al.*, 2020).

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LMCs across the same period. At the start of the MDG era, we estimated that LICs and LMCs spent $55 billion to keep 324 million children in primary school, at a cost of $170 per student (2020 USD). By 2015, total government spending per student, excluding costs associated with new enrolments, had increased to $307 (2020 USD) or an 80 % increase in spending (see Figure 3).[5] This is based on findings from two reports, the International Commission on Financing Global Education Opportunity (2016) and Al-Samarrai *et al.* (2019).[6]

These large increases in spending have not coincided with increased learning.[7] To understand why these efforts had limited success, it is necessary to consider how this money was spent. Here, data challenges are severe. There is no cross-country database on how education ministries allocate their budgets. Nevertheless, the few pieces of evidence paint a picture that suggests that for many countries, the basic and untested proscription was (and likely remains): *more inputs = better education.*

Prominent country examples of the fallacy that more inputs equal better education come from India and Indonesia, which together enroll a third of all primary school children in LICs and LMCs (UNESCO-UIS, 2021). In India, the Right to Education Act (2009) was heralded as a ground-breaking piece of legislation to address education outcomes in the country. The Act mandates a series of inputs with respect to the availability of schooling, teachers, remedial education and more while being silent on actual outcomes that need to be delivered by one of the world's largest education systems. Inputs to schooling increased (Muralidharan, 2013), with the largest share of funding going toward teachers, both hiring more teachers to reduce pupil-teacher ratios and increasing teacher wages in real terms (Muralidharan, 2013; Bordoloi *et al.*, 2020). However, there has been little to no improvement in learning outcomes. In fact, from 2006 to 2014, the share of children in third grade who could read a first grade text fell from 48 to 40 % (ASER, 2015).

Another piece of education reform occurred in Indonesia in 2005. This reform, called the Teacher Law, required teachers to pass a nonstringent certification process that then provided them with double their base salary (Ree *et al.*, 2018). Because of this reform and the fulfillment in 2009 of a constitutional commitment to spend 20 % of the national budget on education, the education budget in Indonesia doubled in real terms between 2000 and 2012, with two-thirds of the money being used on teachers (World Bank, 2013). The increase in salary had no discernible impact on children's learning as measured by test scores (Ree *et al.*, 2018).

This brief synopsis has focused on teachers, but similar statements can be made about other inputs provided in isolation such as teacher training unconnected to classroom pedagogy and more textbooks and laptops (World Bank, 2020). Together, these provide

[5] For the most part, this may be explained by increases in the real incomes of teachers. A move from $170 to $307 corresponds to an annual growth rate of 4%, which while large, has been met or exceeded by many developing countries over the period (we thank Paul Glewwe for pointing this out). Nevertheless, while this increase in spending may be an artifact of teacher salaries keeping up with general growth in wages overall, there has not been a proportionate increase in education quality.

[6] Specifically, in 2015, the government contribution to education was $96 per student in LICs, $359 per student in LMCs, and $1159 per student in upper-middle-income countries (International Commission on Financing Global Education Opportunity, 2016). These figures represent 148%, 89%, and 84% increases in spending from 1998 (Al-Samarrai *et al.*, 2019), indicating large increases of education budgets over the MDG period. Al-Samarrai *et al.* (2019) further decompose increases into access versus quality and find that LICs spent 66% on access and 34% on quality while LMCs spent 30% on access versus 70% on quality.

[7] This finding is supported by Al-Samarrai *et al.* (2019) who report that from 1991 to 2017, every 10% increase in education funding led to only 0.8% increase in learning-adjusted years of schooling across developing countries.

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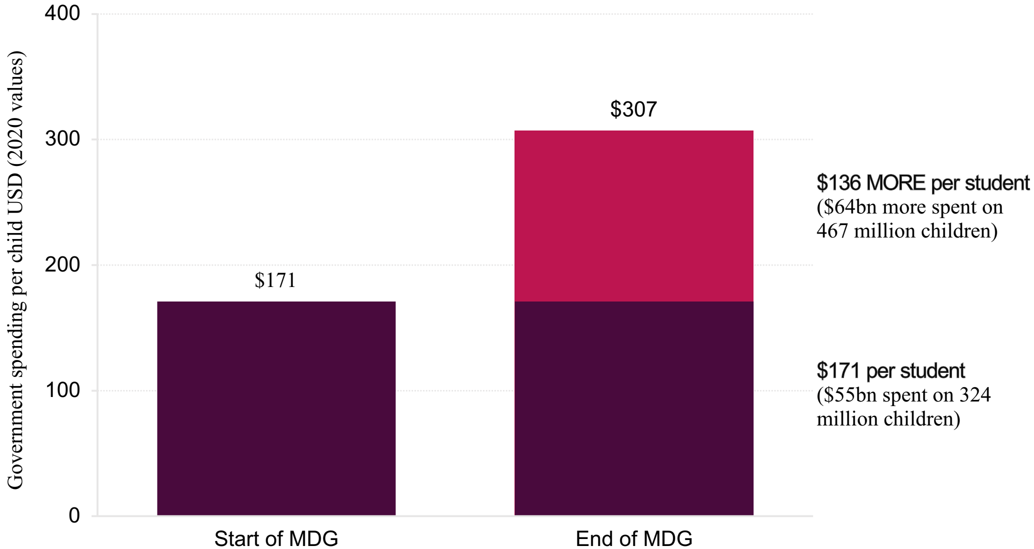

Figure 3. *Increase in government spending per primary student across MDG era, LICs and LMCs (Breakdown by LICs and LMCs: LICs spent $39 per child on 42 million enrolments in 1998. By 2015, they spent an extra $30 per child more on 101 million enrolments. LMCs spent $190 per child on 283 million enrolments. By 2015, they spent an extra $165 more on 368 million enrolments).* Source*: Authors' calculations.*

insight as to why the challenge of learning has not yet been addressed. For LICs, the focus so far has been on access: 70 % of extra spending was directed toward this aim (Al-Samarrai *et al.,* 2019). For lower- and upper-middle-income countries the main problem has been inefficient spending, with an outsized focus on more inputs. This is not entirely the fault of policymakers. Scientific understanding of "what works" in education is relatively new, with education randomized control trials proliferating only from roughly 2005 (Connolly *et al.*, 2018).[8] This work has questioned the efficiency of some norms in education such as organizing by age and providing more inputs in isolation as effective learning strategies. As we will demonstrate, inputs are important, but they cannot be provided in isolation. Instead, they need to be provided within the context of an intervention or program that demonstrates with evidence how the inputs together improve learning.[9]

The SDGs cover multiple education aims – many cannot be implemented effectively, and if we continue with existing approaches, boosting learning will be costly to execute and is unlikely to succeed.

The SDGs include a myriad of education aims, including:

(i) Universal primary and secondary education leading to relevant learning outcomes.
(ii) Early childhood education and preprimary education.
(iii) Vocational, technical, and university education.
(iv) Relevant skills for work.
(v) Equal access to women and the vulnerable, including persons with disabilities, indigenous peoples, and children in vulnerable situations.
(vi) Universal youth literacy.
(vii) Education for sustainable development and global citizenship.
(viii) Education facilities that are child, disability, and gender-sensitive.
(ix) Substantial expansion globally of the number of scholarships available to developing countries.
(x) Substantial increase of the supply of qualified teachers, including international cooperation for teacher training in developing countries.

In the lead up to the ratification of the SDGs, Copenhagen Consensus conducted a rapid analysis of the preliminary goals and targets of the Open Working Group, the party responsible for crafting the SDGs. In this analysis, most of the proposed interventions were considered only fair or poor in terms of effectiveness (Lomborg, 2015). Since then, a substantial body of evidence has been generated showing how certain interventions can increase learning at low cost (Angrist *et al*., 2020; World Bank, 2020), motivating the focus on learning outcomes in this article.

Despite the many different goals for education, it is likely that given existing trends, the vast number of extra resources for education in the SDG era will be spent on more inputs in isolation. For example, the International Commission on Financing Global Education Opportunity (2016) provides one estimate of the extra funding required and mostly allocates

[8] This is not to assert that randomized control trials are the only legitimate source of understanding regarding what "works" in education or any other sector with, for example, quasi-experimental studies also providing useful information about the causal impacts of interventions. Here we are merely pointing out that knowledge generated by rigorous evaluations has increased substantially in the last 15 years.

[9] In contrast, evidence from the United States indicates that substantial funding increases for schools that began in the 1970s lead to increased school quality, and improved education and labor market outcomes for students (Jackson *et al.*, 2015).

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this to "business-as-usual approaches": higher salaries for teachers, lower pupil-teacher ratios, and expanding inputs, which given the evidence, are unlikely to make much of a difference to learning levels. Specifically, they suggest that by 2030, an extra \$116, \$246, and \$1035 more is required per child for LIC, LMCs, and upper-middle-income countries, respectively. These represent, on average, an 83 % increase in spending on 2015 levels and based on current enrollment, would require an additional \$330 billion per year by 2030. In the next section, evidence is provided on how the global community can increase learning levels at a much lower cost, requiring only \$7.6 billion more per year above existing spending per child.

3. An overview of interventions to address learning: Which are the most cost-effective?

Doing a complete overview of the effectiveness of education initiatives is a challenging task given the proliferation of studies over the last 10 years. As a starting point, we take the cost-effectiveness review of 150 interventions in global education (Angrist *et al.*, 2020).[10] This was a background article for the Global Education Evidence Advisory Panel, an expert group convened to recommend interventions to improve learning in developing countries (World Bank, 2020). The panel, consisting of leading academics and practitioners in education that included Nobel Laureate Abhijit Banerjee, Yidan Prize winner Rukmini Banerji, and former Peruvian Minister of Education, Jaime Saavedra, categorized various interventions into four groupings: great buys, good buys, promising but low evidence, and bad buys. We also refer to previous cost-benefit analyses conducted by the Copenhagen Consensus Center as part of its global and country-level prioritization exercises.

With this in mind, the first takeaway from the review by Angrist *et al.* (2020) is that nearly half of the interventions show no effectiveness whatsoever. These interventions focus mostly on providing inputs alone, cash transfers,[11] and generic teacher training. This finding broadly reinforces the results from Al-Samarrai *et al.* (2019). The Panel categorized these interventions as "bad buys." *One clear recommendation is for governments to not adopt these ineffective policies and redirect funding toward more effective policies if their focus is on improving learning.*

The Global Education Evidence Advisory Panel recommended only one intervention as a "great buy" based on the benefits, costs, and quality of education, specifically context-relevant information that shifts people's beliefs about the benefits of education or the quality of schooling being provided.[12] An example of this was the provision of basic statistical information to parents about the wage impacts of more schooling in Madagascar (Nguyen, 2008).

[10] While 150 appears substantial, it is relatively small given the diversity of the field and myriad approaches. Moreover, a focus on cost-effectiveness naturally limits the universe of potential interventions for consideration to those where cost data is available. The implication is that we may have missed a highly effective intervention (this is a challenge for all education policymakers, not just this article). Nevertheless, it represents a starting point on which to focus the conversation on cost-effectiveness.

[11] Cash transfers were not considered effective for improving learning. However, they have been demonstrated to be effective at achieving other development aims such as increasing enrolment or reducing poverty (Sulaiman *et al.,* 2016; Bastagli *et al.,* 2019).

[12] As this article was about to go to press, The Global Education Advisory Panel released an updated document (World Bank, 2023). The panel now recommends three "great buys," its highest ranking of cost-efficiency. The three interventions are (i) Providing information on the benefits, costs, and quality of education, (ii) Supporting teachers with structured pedagogy, and (iii) Targeting teaching instruction by learning level, not grade (in or out of school).

The Panel also recommended the following interventions as “good buys”: structured lesson plans with linked materials and ongoing monitoring, coaching, and training of teachers (structured pedagogy); target teaching instruction by learning level, not grade (in or out of school); reduced travel times to schools (through school construction or bicycle transfers); giving merit-based scholarships to disadvantaged children and youth; using software that adapts to the learning level of the child (where hardware is already in schools) and preprimary education (ages 3–5).

Interventions categorized as “promising but low evidence” were the following: early childhood stimulation programs (for ages 0–2) that targeted parents, teacher accountability and incentive reforms, and community involvement in school management. Although there is less evidence for these educational interventions, preliminary findings showed they are highly cost-effective.

Following the recommendations of the Panel, we screened out the “bad buys” and the “promising but low evidence buys” from further consideration. We also screened out preprimary education because a recent review of BCRs for expanding preprimary learning indicates BCRs of 1.5–7.8 at discount rates of 5 % or higher (Horton & Black, 2017). While respectable, the BCRs for these interventions are substantially lower than the BCRs of the interventions recommended in this article.[13]

Last, we folded in “software that adapts to the learning level of the child” as a technology variant of “teaching instruction by learning level” as per the framing of Angrist *et al.* (2020).[14]

This leaves four interventions remaining from the Global Education Evidence Advisory Panel list of great and good buys:

(i) providing information about the benefits, costs, and quality of education,
(ii) structured pedagogy with ongoing monitoring and coaching of teachers,
(iii) teaching according to learning level (with and without technology), and
(iv) reducing travel times to schools as well as giving merit-based scholarships to disadvantaged children and youth.

While these were all considered cost-effective by the Panel, in deciding their recommendations, the Panel only examined *program costs* per unit of learning gain (in this case, learning-adjusted years of schooling or LAYS). It appears they did not include all flow-on costs to education systems and students, particularly the costs associated with increased enrolment. These costs include the direct costs of schooling incurred by education systems

[13] As an additional check, we conducted a scenario analysis to see what impact on learning would be required to generate an excellent BCR, or BCR above 15. Horton and Black (2017) note a cost of $341 per child per year (reported in the original paper as $300 per child in 2012 USD, which has been inflated using GDP deflators to 2020 USD) for preprimary learning in lower-middle-income countries. For this to achieve a BCR of 15, the boost to income from exposure to preschool would have to equal 23% at an 8% discount rate. This boost to income is not supported by any academic evidence of which we are aware. The only evidence potentially supporting this is from Gertler *et al.* (2014) who found an increase of 25% to earnings from a two-year program that trained parents in offering psycho-social stimulation for children aged 9–24 months in Jamaica. However, this is not the same as preschool learning and was classified as promising with low evidence by the Education Advisory Panel.

[14] Some may disagree with this framing since the interventions appear very different with respect to implementation. However, we chose to group both together since they are based on the same theory of change, namely, increasing the individualized nature of learning, and are likely to be substitutes rather than complements. Moreover, there is a relatively large body of literature that supports the learning impacts from adaptive software with 18 studies identified in Rodriguez-Segura (2020).

that expand as enrolments increase. Alternatively, if education systems do not expand inputs (teachers and buildings) then the costs are borne by students who experience higher pupil-teacher ratios and potentially having to learn outdoors. For older children, there is also the opportunity cost of enrolment. We argue that conducting a cost-benefit analysis using this lens alters the calculus for interventions where the benefit is predominantly an increase in enrolment.

In this case, two interventions with a focus on increasing enrolment, these being reducing travel time to school and merit-based scholarships, will incur nontrivial flow-on costs beyond the program costs of providing these interventions. For example, a cost-benefit analysis on providing bicycles to girls in Rajasthan notes that extra schooling costs and opportunity cost of enrolment outweigh the cost of the bicycle by a factor of 2.3 (Mithal, 2018). This leads to a BCR of 6.6 at an 8 % discount rate, which is a good but not excellent return on investment.[15]

A cost-benefit analysis of merit-based scholarships would represent, at best, the average return to schooling for the grade that the scholarship is being given. This is because the costs of such an intervention would be the direct and opportunity costs of schooling, while the benefits would be estimated by the increase in lifetime earnings from that year of schooling. This is the classic formulation of returns to education. The scholarship would be treated as a transfer. The BCRs from interventions designed to increase years of schooling are typically between 3 and 15 (see Appendix).

Last, we consider the overall evidence base and impact of including costs of increased enrolment for the Panel's lone "great buy," providing information on the benefits of schooling. Angrist *et al.* (2020), in their review, note only two studies with cost-effectiveness data for this intervention (Nguyen, 2008; Jensen, 2010), each with very different cost-effectiveness outcomes. Nguyen (2008) generates a cost per learning-adjusted-year of schooling (LAYS) at 150 per $100 while Jensen (2010) provides close to zero LAYS per $100 (see Figure 2 in Angrist *et al.,* 2020). In the course of reviewing an earlier draft of this article, one reviewer pointed out that Nguyen (2008) was not yet published and recommended we remove this article from the evidence base. That leaves just one paper with cost-effectiveness data.

However, additional papers have estimated impacts (though not with costs). As reported by Angrist *et al.* (2020), the average value of these is 0.08 LAYS. While moderate in size in line with typical effects in education around 0.1 *SD* (Evans & Yuan, 2022) it can be reasonably inferred to have a high return because the cost of providing information is very low.

This is where the importance of considering nonprogram costs becomes apparent. In the studies supporting this intervention, as cited by the Global Education Evidence Advisory Panel (World Bank, 2020), implementation of this intervention either increased enrolment by as much as 4.5 percentage points (Nguyen, 2008; Jensen 2010; Andrabi *et al.,* 2017; Gallego *et al.*, 2018) or compelled parents to choose more expensive schools (Neilson *et al.*, 2019). Given the modest impact and unaccounted costs, is the benefit-cost ratio (BCR) large enough to warrant inclusion in the recommended package? To assess this, we modeled the

[15] This is not to say that increasing enrolment for girls or disadvantaged peoples should not be done. However, this analysis makes explicit any potential trade-offs for favoring increased enrolment over improving learning for those already enrolled. It is important to note that providing interventions that improve learning also benefits girls or disadvantaged groups that are already enrolled in school.

full costs and benefits of the intervention, including flow-on costs, estimating a BCR that was large (21) but significantly lower than the eventual BCR for the recommended package. Therefore, this intervention was also removed, although education ministries may want to consider implementing this as a next step after the recommended package since the BCR is still high.

That means that of 150 possible interventions, it is likely that these two are the very best:

(i) *Structured pedagogy*, defined as a *coherent* package of inputs, typically textbooks, lesson plans, and teacher training and coaching that *work together* to improve in-class teaching.
(ii) *Teaching according to learning level rather than age or grade.* This can be accomplished by technology that adapts to children's learning level, or where this is not feasible (e.g., budget is unavailable for the sizeable upfront investment) by deploying "teaching-at-the-right level" as developed by the nongovernmental organization Pratham.[16]

Of note is that there is evidence that these two interventions can be delivered at scale with government involvement (Stern *et al.*, 2021), thus addressing a key challenge of the recommendations derived from randomized controlled trials of pilots and relatively small samples. These recommendations are therefore not merely academic in nature but are also supported by real-world success stories across Africa and South Asia.

Copenhagen Consensus has conducted multiple cost-benefit analyses on these and other interventions to improve learning as part of its global and country-level prioritization exercises. The results of these analyses are summarized in Table 1 and reinforce the broad findings of the Global Education Evidence Advisory Panel.

Copenhagen Consensus "Traffic Light" Rating System

During the Copenhagen Consensus' Post-2015 Consensus project, an Eminent Panel that included two Nobel Laureates devised a "traffic light" rating system to categorize interventions based on their BCR.

The traffic light system has five categories:

→ Excellent – BCR ≥ 15
→ Good – 5 ≥ BCR > 15
→ Fair – 1 ≥ BCR > 5
→ Poor – BCR < 1
→ Uncertain – BCR not known

As a general rule, Excellent interventions correspond to the top 20th percentile of interventions, while the median intervention usually has a Fair rating. Copenhagen Consensus has used this traffic light system to classify priority targets and the interventions of the Open Working Group, the Indian government, the African Union, the Malawian National Planning Commission, and the Ugandan government.

[16] To be clear, teaching at the right level is a general pedagogical technique and not necessarily linked to a specific organization's approach.

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Table 1. *Findings from previous Copenhagen Consensus Studies*

Intervention	BCR evidence
Providing information on schooling	Excellent Information campaign on benefits of schooling, Copenhagen Consensus III BCR = 732 N.B. This did not include flow on effects from learning and was based on Nguyen (2008)
Using software that adapts to the learning level of the child	Excellent Rajasthan (BCR = 62) Andhra Pradesh (BCR = 74) Malawi (BCR = 106)
Structured pedagogy in the form of structured lesson plans with linked student materials, teacher professional development, and monitoring	Excellent Malawi (BCR = 22)
Targeted instruction (teaching at the right level)	Excellent or Good Rajasthan (BCR = 35) Andhra Pradesh (BCR = 32) Bangladesh (BCR = 12) Haiti (BCR = 9) Ghana (BCR = 8)
Well-structured incentives for teachers/teacher accountability	Uncertain Rajasthan (BCR = 19.5) Bangladesh (BCR = 1+) Post-2015 (BCR = 4)
Health and nutrition to improve access and learning (e.g., school feeding)	Fair or Good School Feeding Ghana (BCR = 4.8) Nutrition (2nd Copenhagen Consensus 2012, BCR = 3.5) School Feeding (Malawi BCR = 10) Deworming (2nd Copenhagen Consensus, BCR = 3.5)
Teach in local language	Teach in Creole (Haiti BCR = 8)
Generic inputs to schooling in isolation (more teachers and teaching assistants, training and incentives for teachers, free uniforms)	Mostly poor or fair More laptops (Bangladesh, BCR <1) Improve school management (Bangladesh, BCR > 1) Business as usual inputs (Bangladesh, <1) Generic teacher training (Rajasthan, AP BCR = 1, Haiti = 6) Increase number of teachers (Rajasthan, AP, BCR = 5, Malawi = 1.2) Free school uniforms (Haiti, BCR = 3) Classroom construction (Malawi, BCR = 2.2)

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4. Cost-benefit analysis

4.1 General Parameters

The cost-benefit analysis considers a representative 8-year-old in a LIC or LMC. The student is exposed to the intervention and achieves increased learning, as measured in *SD* improvements in test scores, highlighted in recent reviews of investments to improve learning in lower-middle-income countries (LMCs; Evans & Yuan, 2019; Rodriguez-Segura, 2020). This increased learning leads to a 20 % boost[17] to counterfactual income per SD improvement following Angrist *et al*., (2020). Projected income is a function of GDP per capita that varies as countries become wealthier (see Appendix for estimation methodology). Individuals are assumed to work from age 18 to 64. The discount rate is 8 %. For the main results, we report findings from a rollout in a typical LIC or LMC. In the Appendix, we report additional scenarios including for upper-middle-income countries and using other discount rates.

There is the potential for substantial complexity in modeling the education pathways of an 8-year-old who receives the intervention versus one who does not. Key modeling considerations include the years of exposure to the intervention, the impact of learning on the probability of dropout in the years following the intervention, and the cumulative effect of these impacts (learning and years of schooling) on eventual school attainment.

While it abstracts from reality, we choose to model a simpler pathway that provides a cleaner cost-benefit test of an intervention's impact. Specifically, we assume one year exposure to an intervention at 8-years-old and measure the gains against a counterfactual of average primary-level income. The alternative approach of modeling the full education pathway requires the use of additional assumptions (e.g., the probability of continuation being conditional on prior learning) that are not necessarily measured with high precision and for which effects would compound over time. This would generate complexity without necessarily adding any insight into these interventions' effectiveness. Furthermore, many of the studies that provide effect sizes are only measured based on one year of exposure (or less) to an intervention, and long-term impacts are not well known.

Table 2 notes the most important parameters of the analysis and are explained below.

4.2. Structured pedagogy

Structured pedagogy interventions provide a coherent set of inputs that improve pedagogical delivery of the curriculum. The interventions typically include some level of training, as well as ongoing monitoring and coaching for teachers. Evans and Yuan (2019) reviewed 67 effect sizes across 16 studies (mostly of medium to large scale), noting a median value of 0.13 *SD* (range -0.14 to 0.81) improvement drawn from a randomized control trial in Kenya (Jukes *et al*., 2017). The cost of the intervention for LMCs is estimated from the information provided in two papers concerning the same program (Piper *et al*., 2018*a*,*b*). These studies show that the direct costs of the intervention were $8.62[18] (all three

[17] A possible alternative approach is to adopt the findings from Evans and Yuan (2019) who identify in their sample of five developing countries a 37% boost to income per 1 *SD* improvement in test scores. This would almost double the reported BCRs.

[18] Two important observations are worth making about this estimate. The first is that it is the cost for several subjects. Therefore, it differs to teaching according to learning levels, which typically focus on one subject. Second,

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Table 2. *Key parameters*

Intervention	Parameter	Value	Unit	Source
Structured pedagogy	Boost to learning	0.13	SD	Median value as per (Evans & Yuan, 2019)
	Boost to income	2.6	%	Calculation following Angrist *et al*., (2020)
	Cost per student per year	7.75	USD	Piper *et al*. (2018*a*,*b*)
Teaching according to learning levels (with technology)	Boost to learning	0.275	SD	Rodriguez-Segura (2020)
	Boost to income	5.5	%	Calculation following Angrist *et al.,* (2020)
	Cost per student per year	26.64	USD	National Planning Commission of [Malawi] (*2021a*)
Teaching according to learning levels (without technology)	Boost to learning	0.15	SD	Duflo *et al*. (2011); Duflo and Kiessel (2015); Banerji *et al*. (2016)
	Boost to income	3.0	%	Calculation following Angrist *et al.,* (2020)
	Cost per student per year	19.53	USD	Adapted from Dutt *et al.* (2016)

components – teacher training, textbooks, and teaching guides in 2020 USD) and that the intervention was successful due to the presence of periodic monitoring and coaching, including real-time data input from tablets provided to the monitors. For LICs, teacher training and monitoring costs are scaled using the differences in income between LMCs and LICs while teaching guides and textbooks are assumed to cost the same as in LMCs. The cost per student is estimated at $4.95. The weighted average cost across LIC and LMCs is $7.75.

4.3. Teaching according to learning level rather than age or grade

This intervention is typically implemented by taking some part of the school day (around one hour) and grouping children by their learning levels rather than ages. During this time, children are exposed to teaching that is tailored to their learning needs. As noted above, this can be achieved in two manners: with or without technology. Technology approaches may use tablets or computers with adaptive software.[19] The nontechnology approach may use

this cost does not include NGO personnel costs during the pilot studies. We did not include these costs since it is likely in a scaled version that government teachers, not NGOs, would be the primary delivery method. These two factors are countervailing in that the first would increase benefits per cost, while the second would decrease them. We thank Benjamin Piper for pointing this out.

[19] A recent innovation in technology-based teaching at the right level involves using low-tech mobile phones to send targeted messages tailored to learning levels (Hassan *et al*. 2021, Angrist *et al*. 2022, Angrist *et al*. 2023). Much of this new evidence was generated after this cost-benefit analysis was completed. Nevertheless, we note the

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existing teachers with or without teaching assistants or substitute teachers from a specialized organization (such as Pratham in India).

There are at least two pathways in which this approach improves learning for children. First, by experiencing teaching that is more adapted to their level, children are less likely to be left behind and can master the skills and knowledge required for more advanced parts of the curricula. Overall, grouping by level ameliorates the challenge of large pupil-teacher ratios and heterogeneous learning levels in classes. With technology, learning can be adapted to the level of the individual student, with the software mapped to a child's progress. The second pathway of benefit is through improving the actual teaching itself, as teacher quality is often highly variable in LIC and LMC contexts. While they have not fully replaced classroom instruction, technology approaches can standardize the delivery of the curriculum to reflect best practice. Of course, technology comes with challenges, for example, the need to purchase and maintain hardware, the availability of high-quality software, and training existing teachers.

For the technology version of the intervention, we adopt the median boost to test scores (0.275 *SD*) from a review of 18 studies by Rodriguez-Segura (2020) on the use of technology for "self-led learning" (see Table 8 of that paper). The costs of this vary by context, and the median value from the Rodriguez-Segura (2020) review is $15 per student per year. However, this cost may not include a range of expensive set-up costs such as buildings, computers, and electricity. To account for potentially more realistic conditions in any scaled-up program, we adopt the parameters from a recent cost-benefit analysis of expanding tablet-based learning in Malawi, where the existing infrastructure is poor (National Planning Commission [Malawi] 2021*a*).[20] In that example, schools were provided with 60 tablets, a dedicated classroom with solar panels for storing and charging the tablets, and a trainer to assist the teachers on how to use the tablets. The annual cost in a LIC context is estimated at $24.88 per child,[21] and in an LMC context, it is $27.18 per child.[22] The weighted average cost across LIC and LMCs is $26.64.[23] Reporting costs as annualized values partially obscures the substantial initial investments required for buildings, solar panels, and computer hardware. For example, a program for 500 students per year, requires almost $50,000

substantial potential of the mobile phone version of the intervention and suggest this as an avenue for future research, given that a recent multi-country randomized control trial shows that it can deliver up to four years of high quality instruction for only $100 (Angrist et al. 2023).

[20] In 2020, Malawi had only 30% of its road network paved, and only 12.5% of its population had access to electricity (National Planning Commission [Malawi], 2021*b*).

[21] Specifically, one tablet plus ancillary equipment is estimated to cost $336, lasts 4 years, and serves 8.3 children annually; one classroom is estimated to cost $25,410, lasts 20 years, and serves 500 children annually; one solar panel is estimated to cost $1900, lasts 10 years, and serves 500 children per year; one trainer has an annual salary of $1500, serving 14 classrooms of 50 children each. Annual maintenance costs are assumed to equal 10% of purchase costs for the tablet and ancillary equipment. Annual maintenance costs of the building are assumed to be 2% of construction cost (Theunynck, 2009).

[22] This estimate is derived by using the same estimates for LICs but with a trainer cost of $3379, a classroom of 22 students, and no building requirement.

[23] These values are relatively similar to the "sandbox" costing exercise undertaken by edTech Hub in Malawi. They note a value of "around $30 per year per child," but do not provide any details about how this was estimated (see https://edtechhub.org/scaling-personalised-learning-technology-in-malawi/). In another paper, Piper *et al.* (2016) found higher costs but for a different intervention that assumes an e-reader to student ratio of 1:1, a substantially higher ratio than what we assume here.

Table 3. *Costs, benefits, and BCRs of interventions in LICs and LMCs*

	Cost per student for one year (USD)	Benefit per student (USD)	BCR
Structured pedagogy plus teacher monitoring and coaching	7.75	815	105
Teaching according to learning level rather than age or grade with technology	26.64	1724	65
Teaching according to learning level rather than age or grade without technology	19.53	940	48
Weighted average of interventions (1/3rd split)	17.97	1160	65

to get the program started. Of course, after the initial investments are made, costs are substantially smaller for subsequent cohorts. Governments who cannot easily raise funds for initial investments might find the costs of starting the program prohibitive.

For the intervention without technology, we draw upon studies that have estimated the costs and impacts from "Teaching at the Right Level." Here we assume an effect size of 0.15 *SD* improvement in test scores, which broadly corresponds to the results from large and medium-scale evaluations conducted in Haryana, Kenya, and Ghana (Duflo *et al.*, 2011; Duflo & Kiessel, 2015; Banerjee *et al.*, 2016; Banerji & Chavan, 2020).[24] The reference cost is drawn from Dutt *et al.* (2016) who report an average per child cost of $12.50 in 2013–2014. We also add one teaching assistant with an assumed wage equal to half of the average wage in LMCs and who works for 1/8th of the school year. The total cost is estimated at $23.43 in LMCs (2020 figures). For LICs the estimated cost is $6.89, reflecting differences in income levels and class sizes between LMCs and LICs. The weighted average cost across LIC and LMCs is $19.53 per student.

5. Results

In Table 3, the weighted average results across LIC and LMCs where the largest learning gaps currently lie are presented. The results indicate that all the interventions generate excellent BCRs with Structured Pedagogy having the largest BCR at 105, followed by teaching according to learning level (with technology) at 65, and teaching according to learning level (without technology) with the lowest BCR at 48, although this is still very high compared to many interventions in global development. In the Appendix, a sensitivity analysis of alternative estimates using different parameters is presented. The broad findings remain unchanged.

[24] Other evaluations of the intervention have noted *SD* improvements as large as 0.70 *SD* as well as some cases of project failure where the intervention was effectively not implemented at all (Banerjee *et al.*, 2016; Banerji & Chavan, 2020). A recent paper shows that much of the variation of previous studies was due to two implementation factors (Angrist and Meager, 2023). After accounting for these implementation factors, the results of previous studies appear generalizable across contexts.

6. Discussion and conclusion

The above results show that there are certain interventions that LICs or LMCs can deploy that could significantly boost learning outcomes at relatively little cost, these being structured pedagogy and teaching according to learning levels with and without technology. If these interventions are deployed uniformly[25] to reach the estimated 467 million students in LICs and LMCs (i.e., a 1/3rd split between structured pedagogy and teaching according to learning levels with and without technology), the weighted average cost would be $17.97 per child per year. This represents an increase of just 6 % of the average $326 being spent by education systems already to maintain current levels of enrolment in LIC and LMCs. The interventions would generate learning equivalent to 1.2 more years of standard schooling for every year they are deployed, boosting the incomes of future students by $1,160 (or 4 % of lifetime income).

The economic logic underpinning these results is simply explained: the costly and difficult work of getting children into school has mostly been done. Hundreds of millions of children attend class every school day across developing countries. They gather in schools that have already been built with teachers that are already hired. These costs, while large, will be incurred regardless. Unfortunately, despite these substantial efforts, children are not learning. This article shows that relatively inexpensive innovations to the ways in which education is delivered and teachers instruct can generate substantial gains that outweigh the modest additional costs.

How much would it cost to deliver these interventions at scale? Across both LICs and LMCs, there are an estimated 467 million children in primary school (UIS-UNESCO, 2021). If the global community could scale these interventions uniformly to 90 % of the primary school-going population in these countries, the annual cost would be around *$7.6 billion per year.* This would be substantially less than the $330 billion suggested by the International Commission on Financing Global Education Opportunity (2016) required to reach SDG4 and only 0.16 % of the $4.7 trillion spent by the world on education annually (UNESCO, 2022). The expected benefit in terms of future income would equal *$467 billion per year for an overall BCR of 65.*

There are several limitations to this analysis. First, due to data availability, the focus is only on improving learning in primary school settings. Second, the recommendations are limited by the interventions for which there is existing evidence on costs and benefits. Third, for the BCRs to hold, future expansion of the recommended interventions must meet or exceed the quality of implementation in the studies upon which the BCRs are based. While there are clear challenges in implementing at scale, there is evidence to indicate that structured pedagogy and teaching according to learning levels with and without technology have been deployed successfully (Stern *et al.,* 2021). Last, to monitor progress on whether education systems are indeed improving, extra investment would be required for high-frequency testing. This is outside the scope of this article, but one might argue it is a necessary condition for improving learning.

In summary, it is critical that countries ensure that they do not increase spending per student on inputs alone. These inefficient interventions include extra schools, teachers,

[25] It is an open question whether interventions deployed together would cannibalize potential learning gains or lead to learning synergies. This is a subject of future research within the education space. If there are synergies, the overall BCR would be even higher than what we have presented here.

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books, and laptops. However, this is not to say that education systems should totally ignore inputs altogether. The key phrases in the sentence above are "per student" and "alone." Countries with increasing numbers of children entering the education system, as is common in much of sub-Saharan Africa, will require more spaces to maintain increasing levels of enrolment and keep pupil-teacher ratios reasonable. However, based on the analysis in this article, we recommend that any new spending beyond maintaining levels of enrolment should be directed toward smart approaches that increase learning cost-effectively. More inputs are needed for the two interventions recommended; however, structured pedagogy and teaching according to learning levels with and without technology, when provided together within a framework of interventions, show clear evidence of impact and cost-effectiveness.

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A. Appendix

For completeness, the Copenhagen Consensus Library also includes many benefit-cost analyses on increasing access to education with results generally showing excellent BCRs for preschool, fair or good outcomes for primary and secondary education, and fair outcomes for vocational education.

Intervention	BCR evidence
Early childhood stimulation/ preschool	Excellent African Best Buys 2020 (BCR = 36) Bangladesh (BCR = 18.2) Haiti (BCR = 17) Post 2015 Consensus (BCR = 33) Malawi (BCR = 4.8)
Primary or secondary school access	Mostly fair or good Universal primary in Sub-Saharan Africa (Post 2015 Consensus, BCR = 7) Private school subsidies (Haiti, BCR = 2.9, Ghana, BCR = 0.7, 3rd Copenhagen Consensus = 13.5) Conditional cash transfers (2nd Copenhagen Consensus 2012, BCR = 4; 3rd Copenhagen Consensus 2012, BCR = 19.9; Haiti, BCR = 5; Bangladesh = 5) Conditional cash transfers for girls' secondary (Rajasthan, BCR = 2.8, Andhra Pradesh = 4.0, Malawi = 9.2) Bicycle transfers for girls (Raj = 4.5, AP = 11.7) School toilets for girls (Raj = 4.1, Andhra Pradesh = 11.9) Increase secondary school completion (Post-2015, BCR = 4)
Vocational training expansion/ apprenticeships	Mostly fair On-the-job management training (Bangladesh, BCR = 5.4) Apprenticeships (Ghana, BCR = 2.4; Rajasthan = 4.5, Andhra Pradesh = 7.2) Vocational education (Ghana, BCR = 1.2, Bangladesh BCR = <1; Rajasthan = 4; Andhra Pradesh = 16.3)
Other	Civic Education (Haiti, BCR = 4.9)

A.1. Results using alternative parameters

Using a 3 % discount rate

	Cost per student for one year (USD)	Benefit per student (USD)	BCR
Structured pedagogy plus teacher monitoring and coaching	7.75	3004	388
Teaching according to learning level rather than age	—	—	—
With technology	24.87	6355	256
Without technology	19.53	3466	178
Weighted costs/benefits of interventions	17.38	4275	246

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Using a time-variant discount rate, *r* where *r* equals twice the short-term growth rate

	Cost per student for one year (USD)	Benefit per student (USD)	BCR
Structured pedagogy plus teacher monitoring and coaching	7.75	1234	159
Teaching according to learning level rather than age			
With technology	27.47	2611	95
Without technology	19.53	1424	73
Weighted costs/benefits of interventions	18.25	1756	96

Using a 37 % boost to income per 1 *SD* test score improvement

	Cost per student for one year (USD)	Benefit per student (USD)	BCR
Structured pedagogy plus teacher monitoring and coaching	7.75	1487	192
Teaching according to learning level rather than age	—	—	—
With technology	26.64	3146	118
Without technology	19.53	1716	88
Weighted costs/benefits of interventions	17.97	2116	118

Results for upper middle-income countries

	Cost per student for one year (USD)	Benefit per student (USD)	BCR
Structured pedagogy plus teacher monitoring and coaching	21.7	2783	128
Teaching according to learning level rather than age	—	—	—
With technology (50 %)	54.8	5888	107
Without technology (50 %)	78.0	3211	41
Weighted costs/benefits of interventions	51.5	3961	77

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A.2. Description of projected income calculations

One common approach to estimating income for average potential worker is to relate it to GDP per capita.

Let income per average worker in country i in year $t = W_{it}$, where a worker is defined as a person participating in the labor force. Also, let LabshGDP_{it} equal labor's share of GDP in country i in year t, and LFP_{it} equal the labor force participating rate to total population for a country i in year t. Finally, let Y_{it} = GDP per capita in country i in year t. Income as a ratio of GDP per capita in country i in year $t = k_{it}$ can be formulated as:

$$k_{it} = \frac{W_{it}}{Y_{it}} = \alpha + \beta_1 \times \frac{\text{LabshGDP}_{it}}{\text{LFP}_{it}} + \varepsilon_{it}.$$

We observe the value of k using the Penn World Table's estimate for labor's share of GDP by country for 2019 (Feenstra *et al.*, 2015). This estimate includes income from all employment and self-employment. The World Bank provides an estimate for the share of total population participating in the labor force, and GDP per capita (current USD).

The countries with the lowest GPD per capita have the highest value of k on average around 1.4 going down to an average of 1.0 for countries with GDP per capita over $10,000. One explanation for this observation would be that the countries with the lowest GDP per capita in the world have a large share of children not participating in the labor force.

Observing k using the data for 2014 from the previous Penn World Table the relationship is the same. In fact, the estimated parameters for k (Figure 4) only change by 1 %.

We use the above relationship to convert GDP per capita to income per worker:

GDP per capita < 10,000: GDP per capita × (1.4 − 0.000045 × GDP per capita) = income per worker

GDP per capita > 10,000: GDP per capita × 1 = income per worker

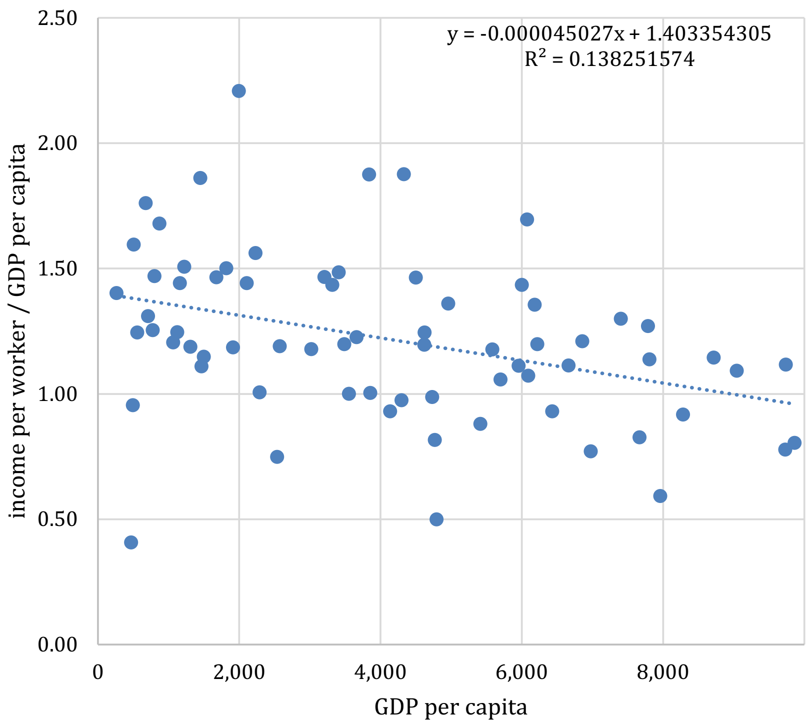

Figure 4. *Relationship between income per worker and GDP per capita for the 70 countries with full data availability and GDP per capita < $10,000 in 2019.*

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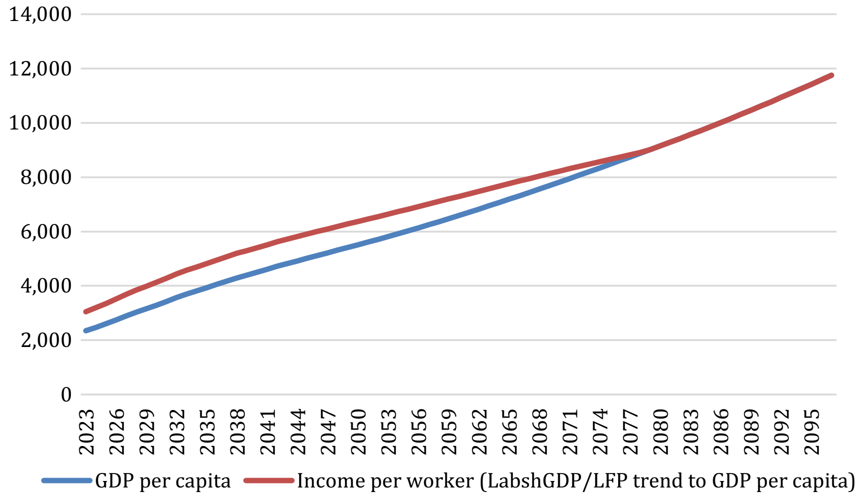

Figure 5. *Average GDP per capita and estimated income per worker for low-income and lower-middle-income countries.*

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