



Empowering STEM education from within: A call for self-reliance in the Global South

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ABSTRACT

This paper explores the need to develop a practical and contextually relevant STEM education system in the Global South to equip future generations to participate meaningfully in the global economy and to foster inclusive development. Enhancing access to quality STEM education is important, particularly in Africa, where it is estimated that most of the world's new workers in the next 30 years may come from. However, persistent underinvestment in education by many governments in the region continues to undermine progress, making STEM education systems less efficient and more vulnerable to external influence. While international support has played a role in advancing STEM education, this paper critically examines its complexities. Foreign aid can accelerate progress when aligned with national strategies, but it may also come with conditions that compromise local priorities, institutional autonomy and disciplinary balance. This paper argues that the Global South must strategically leverage international support while increasing domestic investment, strengthening national policy frameworks, and preserving a balanced education system that values STEM and the humanities. A more self-reliant and critically engaged approach to foreign aid can help ensure that STEM education serves national development agendas without replicating historical patterns of dependency.

1. Introduction: the state of STEM education in the Global South

A growing number of empirical research show that investment in science, technology, engineering, and mathematics (STEM) education yields measurable developmental and economic returns (Bacovic et al., 2022; Kayan-Fadlelmula et al., 2022; 2023; McDonald, 2016; Mindell and Reynolds, 2023). For example, Hanushek and Woessmann (2020) argue that national performance in mathematics and science predicts GDP (gross domestic product) growth more accurately than schooling years alone. This has significant implications for the Global South, where economic transformation increasingly depends on STEM-related capabilities (Sosale et al., 2023). The African Development Bank (2018) has linked STEM investment to improved innovation, industrial diversification and job creation.

Despite these benefits, empirical data reveal a persistent underinvestment in STEM fields across much of the Global South. According to Schneegans et al. (2021) in a UNESCO report, sub-Saharan Africa spends an average of only 0.51 % of its GDP on research and development (R&D), which is far below the global average of 1.79 %. This underinvestment extends to education systems more broadly. UNICEF (2024)

notes that only 9 out of 49 African countries meet or exceed the internationally recommended benchmark of allocating 20 % of national budgets to education. Thus, countries in the Global South face systemic and structural barriers to implementing effective STEM education strategies. Key among these are limited financial resources, weak digital infrastructure and competing development priorities such as food security and healthcare (Sarpong and Adelekan, 2024). Recurrent costs often consume education budgets, with limited space for capital investment in STEM-specific infrastructure such as laboratories, technology-enhanced classrooms and research centres (UNICEF, 2021).

In contrast, countries strategically investing in STEM education, such as South Korea and Singapore, have witnessed rapid industrialisation and economic mobility. These countries allocated a substantial share of public expenditure to expanding research-intensive universities, strengthening vocational and technical education and fostering public-private research and development ecosystems (OECD, 2023; Poh, 2016). Their experience emphasises the value of STEM education in enabling countries to transition from low-income to high-income status. Moreover, STEM education and research play a central role in responding to contemporary global challenges, including climate

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change, pandemics, food insecurity and rapid urbanisation (Fanzo and Miachon, 2023). These complex problems require the critical thinking, systems analysis and technical competence that robust STEM education can offer (Marginson et al., 2013). While the current funding constraints produce enormous challenges to STEM education in the Global South, they are worsened by deeper historical forces that continue to shape education systems in the Global South.

Colonial legacies shape the educational landscape in the Global South. Many African education systems were initially designed to produce civil servants and clerical workers for colonial administrations, resulting in a historical emphasis on humanities and social sciences (Cloete and Maassen, 2015; Sarpong, 2016). Consequently, while these disciplines are essential for civic development and cultural identity, their disproportionate dominance has left many systems ill-equipped to produce the required number of engineers, technologists and scientists. For example, in sub-Saharan Africa, about 70 % of all higher education enrolments in 2021 were in the humanities, social sciences and business studies, while only about 25 % were in STEM-related fields (African Union Development Agency, 2021).

Moreover, the institutional missions of many African universities continue to prioritise social development goals over technological advancement. As Maassen (2012) observes, there is a prevalent orientation toward poverty alleviation and social justice, which, though important, often marginalises STEM disciplines that require long-term, high-investment strategies. This is reflected in Africa's minimal share of global knowledge production. Despite comprising about 19 % of the world's population (World Population Review, 2025), Africa contributes less than 1 % of global research output (African Union and UNESCO, 2024). This imbalance reflects funding gaps as well as governance and leadership challenges.

For example, Sarpong (2016) conducted a comparative study of the Economics and Physics departments at a flagship Ghanaian university and found that while the Economics department continued to do research and publish using existing data sources and desktop research, the Physics department struggled due to broken or outdated laboratory equipment and little or no funding. Without the minimum necessary infrastructure, STEM disciplines cannot deliver quality research or teaching, resulting in less productivity and suppressed innovation. The same study revealed that weak departmental leadership in Physics failed to secure alternative funding or build partnerships, illustrating that governance and institutional strategy are as critical as funding.

The COVID-19 global pandemic further exposed the disparity in global scientific capacity. While countries with robust STEM infrastructures were able to develop, test and distribute vaccines rapidly, many in the Global South were left dependent on international donations (United Nations, 2021). This vulnerability highlights the necessity of building domestic scientific ecosystems and confirms that STEM is not a luxury but a national security imperative.

Despite the importance of STEM and the need for more investment, we also argue that it is crucial to recognise the role of the humanities and social sciences in shaping ethical, inclusive and contextually relevant development. These disciplines contribute to critical thinking, cultural literacy and ethical reasoning, which are indispensable competencies in an age of rapid technological change (Sarpong, 2025). Without the balancing influence of the arts and humanities, an overly technocratic focus on STEM risks producing technically skilled graduates who lack the moral and historical awareness to comprehensively address societal challenges. A holistic education model that integrates STEM with the humanities offers a more sustainable path forward. This approach aligns with calls for "STEAM" education (Science, Technology, Engineering, Arts, and Mathematics), which emphasises the relevance of interdisciplinary thinking in fostering innovation, creativity and social responsibility (Yakman and Lee, 2012). Also, we argue that the overreliance on donor funding should be critically reassessed. While international aid can be supportive, it must not dictate national priorities. The Global South countries must assert ownership over their

education strategies and use external support to complement, rather than substitute, domestic efforts.

The paper is structured as follows. It begins by providing a historical overview of the education system in the Global South, with particular emphasis on its initial design as a mechanism for producing human resources to serve colonial administrative needs. The second section critically examines the politics of donor funding by exploring the complexities of external aid and proposing strategies through which countries in the Global South can mobilise and manage domestic resources more effectively to enhance educational investment. The paper concludes by reimagining STEM education as a strategic driver for sustainable development in the Global South. It is important to acknowledge that this paper draws on statistical data from international organisations such as the World Bank, United Nations, UNICEF and UNESCO to support its arguments. While the paper argues for greater self-reliance in the Global South, using these data sources underlines the continued significance of such international bodies in advancing educational development across the region.

2. Colonial legacies, donor politics and the strategic role of STEM

The evolution of the modern university has been interpreted through various frameworks. Castells (2001) identifies four essential functions: promoting ideology, selecting elites, generating new knowledge and training a skilled labour force. Trow (1970) distinguishes between autonomous functions, such as transmitting high culture and producing knowledge, and popular functions, like democratising access and serving broader societal needs. While these models are rooted in the historical orientation of Europe and North America, they require critical reinterpretation in postcolonial Global South contexts, where higher education institutions were forged within colonial designs and not indigenous aspirations.

The university was historically established to serve colonial objectives in the Global South, particularly in Africa. As Castells (2001) argues, its primary purpose was to train an administrative elite loyal to colonial and, later, postcolonial regimes. Despite global shifts toward massification, higher education in Africa remains relatively elitist. The current participation rate in sub-Saharan Africa is about 9 %, well below the global average of about 40 % (UNESCO, 2022; World Bank, 2025a, 2025b), pointing to deep-rooted inequalities in educational access and opportunity.

Following independence, African leaders like Dr Kwame Nkrumah of Ghana envisioned universities as engines of self-determination (Sarpong et al., 2020). However, their ability to achieve this mandate was constrained by weak institutional capacity and the legacy of colonial underdevelopment (Cloete and Maassen, 2015). Consequently, universities expanded primarily in the humanities and social sciences – fields viewed as less resource-intensive and more aligned with civil service demands – while STEM disciplines were often underprioritised (Bunting et al., 2015; Sarpong, 2016).

Today, the challenges that inhibit the growth of STEM education in Africa are both structural and financial. Despite the growing global recognition that STEM capabilities are vital for innovation, productivity and economic transformation, public investment in higher education remains consistently below global benchmarks. The average African government allocates approximately 3.7 % of GDP to education, which is lower than the global average of 4.5 %, and only a fraction of this is directed towards STEM education (World Bank and UNESCO, 2024).

In this vacuum, donor agencies and international bodies have emerged as key actors in shaping STEM education across Africa. While such partnerships usually help fill financial and infrastructural gaps, they also present strategic and epistemic risks. As Gornitzka and Maassen (2000) observe, funding mechanisms serve as instruments of governance. When donors provide funds, they often condition their support on policy reforms or programming aligned with their own

institutional logics. This dynamic can lead to “projectification” of research (Midler, 1995), where academics become implementers of externally designed agendas rather than originators of locally relevant knowledge (Sarpong et al., 2020). This issue is more notable in STEM disciplines, where funding opportunities can lure universities to adopt curricula or pursue research areas that are more aligned with global trends than national development needs (Sarpong, 2022a).

Nevertheless, not all donor engagement is detrimental. When designed with mutual accountability and local ownership, international partnerships can significantly enhance African STEM ecosystems. Successful models include the African Centres of Excellence (ACE) initiative, established in 2014 and funded by the World Bank, which supports regional research centres in water management, data science and health. The World Bank has helped establish 80 centres across 20 African countries, many of which focus on STEM disciplines. Evaluations show that ACE projects have improved graduate programmes, increased female participation in STEM and facilitated cross-border academic collaboration (World Bank, 2025c). These successes, however, underline a point that the real benefits of donor funding are unsealed when African institutions assert agency in shaping their development pathways. Governments and universities must articulate their own strategic visions for higher education and negotiate funding agreements that reinforce, rather than displace, these priorities (Sarpong et al., 2020). This requires stronger internal governance, greater transparency in financial management, and the cultivation of alternative funding streams, including university-industry linkages and innovation hubs (Sarpong, 2023a, 2022b).

3. Navigating the politics of donor funding in STEM education

Donor funding from international financial institutions and bilateral agencies is vital in shaping educational and developmental priorities across the Global South. While such funding can serve as a vital resource for countries with constrained national budgets, it often comes with conditions that introduce both opportunities and constraints (Cavanagh and Mander, 2003).

Historically, development aid from institutions like the World Bank and the International Monetary Fund (IMF) has been tied to structural adjustment programmes (SAPs), which are policies that require budgetary constraints, liberalisation and public sector reform in exchange for financial assistance (Abouharb and Cingraneli, 2006). Though these programmes are often justified as pathways to macro-economic stability, their effects on social sectors have been widely criticised (Sarpong et al., 2020). Education, in particular, has frequently faced budget reductions under SAP regimes. For instance, between 1980 and 2000, average education spending as a share of GDP declined in many Global South countries implementing SAPs (Alexander, 2001; Ismi, 2004).

A more recent example is Ghana, which, following the economic fallout of the COVID-19 pandemic, restructured its bonds to secure a \$3 billion IMF bailout in 2023. The resulting restraint measures triggered public sector budget cuts, including in education, which adversely affected access, quality and long-term workforce development (Abotebuno Akolgo, 2023). Similarly, Pakistan’s 2023 IMF agreement required spending cuts that significantly impacted allocations to various sectors, including education and health. This prompted public disapproval and concern over the deterioration of essential services (Tricontinental, 2023). Such examples raise fundamental questions about the trade-offs of donor-dependent development. Can pursuing short-term financial liquidity legitimately justify the long-term erosion of human capital investment, especially in fields like STEM?

Crucially, this reliance on external funding often gives donors undue influence over curricula, research agendas and institutional governance (Sarpong, 2021). Donor priorities, shaped by the political, economic and strategic interests of donor countries, may not reflect the socio-economic needs of recipient countries (Mosley, 1995; Sarpong et al., 2020). This is

particularly problematic in STEM, where imported models may fail to account for local contexts, which may lead to contradictions, unsustainable practices and minimal innovation grounded in indigenous knowledge systems (Choo and Sarpong, 2024).

Furthermore, this top-down model can undermine academic autonomy and erode local capacities. When funding is conditional on implementing externally designed programmes, universities may become conduits for foreign policy goals rather than engines of national development (Aronowitz and Giroux, 2000; Cloete and Maassen, 2015). Over time, this may weaken internal governance structures, cause entrenched dependency and reinforce epistemic neocolonialism.

To enable Global South countries to improve their STEM education, they need to reduce their dependence on external donor agency funding or negotiate the terms of such funding to avoid infringement on academic autonomy from external donors. Also, governments of the Global South must be willing to invest more of their GDP into STEM education. Though the outcome may not be witnessed now, a country that invests more in education can reap many benefits, including economic growth, social and political stability, reduced poverty and improved health (Sarpong and Adelekan, 2024). The Global North countries are where they are now in part – as other factors like historical context, resource extraction and geopolitical power dynamics also played significant roles; see Nisenfeld (2022) – due to the bold steps and sacrifices they made in the past to invest in STEM education as the backbone of the economy (Mudaly and Chirikure, 2023). It is not too late for the Global South countries to take a similar step by investing substantially in STEM education. This step will undoubtedly come with challenges, but effective leadership can help navigate them for a prosperous future.

However, even as STEM is promoted as the engine of economic transformation, there is a growing risk that the Global South may replicate the technocratic models of the Global North, which is increasingly prioritising economic utility over humanistic inquiry (Sarpong, 2025). Recent education reforms have significantly reduced funding for the arts, humanities and social sciences in countries such as Japan, New Zealand, the UK and the Netherlands. Japan’s 2015 directive to reduce humanities programmes in over 50 national universities aimed to realign higher education with industrial demands (Blakemore, 2015). Likewise, the UK and New Zealand have restructured research funding in favour of STEM disciplines, often to the detriment of the social sciences and humanities (O’Hara, 2025; New Zealand Government, 2024; Sarpong, 2025).

These developments reflect a global trend that mistakenly equates national development solely with technological innovation. However, the effectiveness of STEM-based solutions is significantly contingent on their social relevance, ethical grounding and cultural embeddedness (Sarpong, 2025). As Universities New Zealand (2024) noted in its critique of the recent Marsden fund cut to the humanities and social sciences by the New Zealand government, transformative innovation demands not only technical expertise but also social insight and ethical reflection. These capacities are developed through the humanities and social sciences.

The Global South must resist the binary of STEM versus non-STEM to avoid an imbalanced education system. Instead, it should pursue a holistic model of education that equips students with the technical skills to build infrastructure and the critical capacities to understand the societies they aim to serve. In doing so, governments can future-proof their development strategies to ensure that technological advancement is not decoupled from values such as equity, sustainability and justice. This bold step may necessitate a reduced reliance on external funding by the Global South and a strategic, efficient management of domestic resources to foster greater self-reliance.

4. Avoiding the over-reliance on donor funding/foreign aid

As discussed earlier, donor funding has played a vital role in shaping educational systems across the Global South, particularly by promoting

STEM education. While donor funding can facilitate transformation in STEM education, its over-reliance can be detrimental in many ways, including undermining national ownership and local relevance (Sarpong et al., 2020). If the Global South countries are waiting for the Global North to help develop their STEM education, they should be prepared to neglect their arts and humanities and other locally relevant priorities, as donor support may not cover these areas. Donor agencies and international organisations are usually driven by outcomes that can be easily quantified, such as the number of scientists or engineers trained (UNESCO, 2020). This is partly due to increased academic capitalism (Slaughter and Rhoades, 2004) and marketisation in the Global North education systems, where market imperatives and quantifiable returns dominate higher education reforms (Sarpong, 2023b). For reasons like this, we argue that the Global South countries should avoid the over-dependence on donor funding and manage their resources well to cater to their education needs.

The economic disruptions caused by the COVID-19 global pandemic exposed the fragility of donor-dependent models (Ryder, 2020). Even donor countries faced recessionary pressures, shrinking aid budgets and suspending projects. The Trump administration's withdrawal of USAID (United States Agency for International Development) from several African nations since assuming power in 2025 (The White House, 2025) and recent reconfigurations in European and Australasian foreign aid priorities (Wiseman, 2025) are stark reminders of how geopolitical shifts can abruptly cut off vital education funding pipelines.

The unpredictability of external aid underscores the urgency for governments in the Global South to invest in education systems that are sturdy, endogenous and strategically aligned with national development priorities. Some Global South countries have combined external support with substantial national investment and clear policy direction to enhance sustainable STEM education systems.

4.1. Rwanda

Educational reforms in Rwanda offer a convincing example of policy coherence and domestic ownership. While the country receives significant foreign aid, it insists on aligning the funding with national frameworks such as Vision 2020 and Vision 2050 (Keijzer et al., 2020). The government has made STEM education a central pillar of national development, with consistent budget allocations (Sibomana et al., 2025). It has increased its education budget to 5.6 % of GDP as of 2023 (UNICEF, 2023), with growing shares allocated to STEM at both secondary and tertiary levels. The *One Laptop per Child* initiative, launched in 2008 and co-funded by the Rwandan government, has reached about 270,000 students and is embedded within a broader ICT-in-education strategy (Kagame, 2013; Rwanda Basic Education Board, n.d.).

4.2. Ghana

Though Ghana's domestic education spending slightly decreased from 3.27 % to 3.17 % of GDP (UNICEF, 2024), it launched the Free Senior High School policy in 2017 (which is still in operation as at the writing of this paper), primarily funded from national coffers. The Free Senior High School programme supports access to both STEM and non-STEM subjects and has significantly boosted enrolment rates, particularly for girls (Mohammed and Kuyini, 2020). However, Ghana's economic challenges following COVID-19 compelled it to seek the \$3 billion IMF bailout in 2023 (Abotebuno Akolgo, 2023), illustrating the fragile balance between progress and macroeconomic vulnerability.

4.3. Ethiopia

Ethiopia has strategically combined external assistance with a strong domestic commitment to develop a sustainable STEM education system. Guided by national development plans such as the Growth and Transformation Plans (GTP I & II) and the Education Sector Development

Programme (ESDP VI), the government has prioritised STEM to drive industrialisation and economic transformation (Ethiopia Ministry of Education, 2021). Ethiopia allocates about 4.5 % of its GDP to education, with increasing investment in STEM-focused Technical and Vocational Education and Training institutions and public universities (World Bank, 2022). Donor support, particularly from China, the World Bank and UNESCO, has been channelled through national frameworks, reinforcing domestic ownership and long-term sustainability (Endale et al., 2019).

4.4. Malaysia

Malaysia's persistent strategy of knowledge-driven development is an example of how domestic resource mobilisation can drive STEM advancement. From the 1970s onward, Malaysia invested heavily in public universities, STEM-focused polytechnics, and research grants. As of 2022, Malaysia allocates 3.9 % of its GDP to education, placing it ahead of most countries in the Global South (UNICEF, 2022). These investments were funded primarily through domestic resources and strategic planning, which enabled the country to build a robust education system that supports innovation and cultural preservation (Sarpong et al., 2020).

Key lessons from the experiences of Rwanda, Ghana, Ethiopia and Malaysia highlight several critical considerations for advancing sustainable STEM education in the Global South. They include, but are not limited to, the following:

1. *A clear national vision:* A well-defined and long-term national vision for STEM education is important. Positioning STEM as central to national development helps attract investment, justify sustained public spending and ensure that reforms extend beyond electoral cycles. Institutionalising policies across successive governments enhances continuity and systemic transformation.
2. *Substantial domestic investment:* Robust government funding is crucial alongside external support. Public investment in education demonstrates political commitment, enhances a country's leverage in donor negotiations, supports policy stability and sustains progress during economic disruptions. Long-term sustainability further requires macroeconomic stability, fiscal planning and diversified funding sources.
3. *Strategic donor engagement:* Engaging with donors on equitable terms is crucial. Countries that embed donor contributions within nationally defined development frameworks are better positioned to align aid with local priorities, minimise fragmentation and strengthen domestic ownership, thereby reducing dependency over time.
4. *Inclusive STEM education:* Equity must be a core principle of STEM education policy. Targeted interventions to address gender, regional and socio-economic disparities are critical for broadening participation, building public support and maximising the developmental potential of human capital.

5. Conclusion: rethinking STEM education for sustainable development in the Global South

This paper has argued for a reimagined and self-reliant approach to STEM education in the Global South that strategically aligns with local development priorities while resisting the overinfluence of external actors. It highlights the need to build robust, context-sensitive STEM systems to support inclusive and sustainable growth by examining structural underinvestment, historical legacies and the political economy of foreign aid and donor funding.

Beyond economic and technological advancement, the paper contributes to policy discourse by advocating for a balanced education model that integrates STEM with the humanities. This approach enhances innovation and workforce readiness and as well ensures that education systems cultivate ethical, culturally grounded and critically

informed citizens.

For policymakers, the paper emphasises the need to increase domestic investment in education, strengthen institutional governance and assert national ownership over curriculum and funding priorities. The paper offers scholars a framework for analysing how aid, history and policy intersect to shape educational futures in the Global South.

Finally, empowering STEM education from within while maintaining interdisciplinary breadth can help break cycles of dependency and position the Global South as a knowledge producer in a rapidly changing world.

Author statement

We, the authors, declare that this manuscript is original, has not been published previously, and is not currently being considered for publication elsewhere. All authors have contributed significantly to the work and have read and approved the final manuscript.

CRediT authorship contribution statement

Bezawit Alamirew Wube: Writing – review & editing, Formal analysis, Conceptualization. **Joshua Sarpong:** Writing – review & editing, Writing – original draft, Resources, Formal analysis, Conceptualization.

Conflicts of interest statement

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References

- Abotebuno Akolgo, I., 2023. Ghana's debt crisis and the political economy of financial dependence in Africa: history repeating itself? *Dev. Change* 54 (5), 1264–1295. <https://doi.org/10.1111/dech.12791>.
- Abouharb, M.R., Cingranelli, D.L., 2006. The human rights effects of World Bank structural adjustment, 1981–2000. *Int. Stud. Q.* 50 (2), 233–262. <https://doi.org/10.1111/j.1468-2478.2006.00401.x>.
- African Development Bank, 2018. Annual development effectiveness, review 2018: “Made in Africa” – Industrialising the continent. African Development Bank Group. (https://www.afdb.org/fileadmin/uploads/afdb/Documents/Development_Effectiveness_Review_2018/ADER_2018_EN.pdf).
- African Union Development Agency. (2021). Rwanda as a model: Improving STEM education curricula in Africa. AUDA-NEPAD. (<https://www.nepad.org/blog/rwanda-model-improving-stem-education-curricula-africa>).
- African Union, UNESCO, (2024). Continental conference: Transforming science, technology, engineering and mathematics in Africa.
- Alexander, N.C., 2001. Paying for education: how the World Bank and the International Monetary Fund influence education in developing countries. *Peabody J. Educ.* 76 (3–4), 285–338. <https://doi.org/10.1080/0161956X.2001.9682002>.
- Aronowitz, S., Giroux, H.A., 2000. The corporate university and the politics of education. *Corp. Educ. Forum* 64 (4), 332–339. <https://doi.org/10.1080/00131720008984778>.
- Bacovic, M., Andrijasevic, Z., Pejovic, B., 2022. STEM education and growth in Europe. *J. Knowl. Econ.* 13 (3), 2348–2371. <https://doi.org/10.1007/s13132-021-00817-7>.
- Blakemore, E., 2015. Japanese Universities Are Shuttering Social Sciences and Humanities Departments. *Smithsonian magazine*. (<https://www.smithsonianmag.com/smart-news/japans-government-asks-all-universities-shutter-humanities-and-social-sciences-departments-180956803/>).
- Bunting, I., Cloete, N., Wah, H.L.K., Nakayiwa-Mayega, F., 2015. Assessing the performance of African flagship universities. In: Cloete, N., Maassen, P., Bailey, T. (Eds.), *Knowledge Production and Contradictory Functions in African Higher Education*. African Minds, Cape Town, pp. 32–60.
- Castells, M., 2001. Universities as dynamic systems of contradictory functions. In: Muller, J., Cloete, N., Badat, S. (Eds.), *Challenges of Globalisation: South African Debates with Manuel Castells*. Maskew Miller Longman, Cape Town, pp. 216–223.
- Cavanagh, J., & Mander, J. (2003). World Bank, IMF turned poor Third World nations into loan addicts. The CCPA Monitor. (<https://www.tru.ca/library/pdf/cavanagh-mander.pdf>).
- Choo, L.W., Sarpong, J., 2024. Guest editorial: considering the global-local relationships in education. *Policy Futures Educ.* 22 (6), 1020–1031. <https://doi.org/10.1177/14782103241278163>.
- Cloete, N., Maassen, P., 2015. Roles of universities and the African context. In: Cloete, N., Maassen, P., Bailey, T. (Eds.), *Knowledge Production and Contradictory Functions in African Higher Education*. African Minds, Cape Town, pp. 1–17.
- Endale, K., Pick, A., Woldehanna, T., 2019. *Financing social protection in Ethiopia: A long-term perspective* (No. 15). OECD Publishing. (https://www.oecd.org/content/dam/oecd/en/publications/reports/2019/02/financing-social-protection-in-ethiopia_a5296afb6/9ce809d8-en.pdf).
- Ethiopia Ministry of Education, 2021. *Education Sector Development Programme VI (ESDP VI)*. Government of Ethiopia, Addis Ababa.
- Fanzo, J., Mlachon, L., 2023. Harnessing the connectivity of climate change, food systems and diets: taking action to improve human and planetary health. *Anthropocene* 42, 100381. <https://doi.org/10.1016/j.ancene.2023.100381>.
- Gornitzka, A., Maassen, P., 2000. Hybrid steering approaches with respect to European higher education. *High. Educ. Policy* 13 (3), 267–285. [https://doi.org/10.1016/S0952-8733\(00\)00012-X](https://doi.org/10.1016/S0952-8733(00)00012-X).
- Hanushek, E.A., Woessmann, L., 2020. Education, knowledge capital, and economic growth. *Econ. Educ.* 171–182. <https://doi.org/10.1016/B978-0-12-815391-8.00014-8>.
- Ismi, A. (2004). Impoverishing a continent: The World Bank and the IMF in Africa. Canadian Centre for Policy Alternatives. (<https://www.policyalternatives.ca/wp-content/uploads/attachments/africa.pdf>).
- Kagame, P. (2013). One Laptop per Child contributing to Rwanda's vision. (<https://www.paulkagame.rw/one-laptop-per-child-contributing-to-rwandas-vision/>).
- Kayan-Fadlemlu, F., Sellami, A., Abdelkader, N., Umer, S., 2022. A systematic review of STEM education research in the GCC countries: trends, gaps and barriers. *Int. J. STEM Educ.* 9 (2), 1–24. <https://doi.org/10.1186/s40594-021-00319-7>.
- Keijzer, N., Klingebiel, S., Scholtes, F., 2020. Promoting ownership in a “post-aid effectiveness” world: evidence from Rwanda and Liberia. *Dev. Policy Rev.* 38, O32–O49. <https://doi.org/10.1111/dpr.12469>.
- Maassen, P., 2012. Universities and the effects of external funding: Sub-Saharan Africa and the Nordic countries. In: Nelson, A.R., Wei, I.P. (Eds.), *The global university*. Palgrave Macmillan, New York, NY, pp. 231–254.
- Marginson, S., Tytler, R., Freeman, B., & Roberts, K. (2013). STEM: country comparisons: international comparisons of science, technology, engineering and mathematics (STEM) education. Final report. Australian Council of Learned Academies, Melbourne, Vic. (<https://acola.org/wp-content/uploads/2018/12/saf02-stem-country-comparisons.pdf>).
- McDonald, C.V., 2016. STEM education: a review of the contribution of the disciplines of science, technology, engineering and mathematics. *Sci. Educ. Int.* 27 (4), 530–569. (<https://www.icaseonline.net/sei/december2016/p4.pdf>).
- Midler, C., 1995. Projectification” of the firm: The Renault case. *Scand. J. Manag.* 11 (4), 363–375. [https://doi.org/10.1016/0956-5221\(95\)00035-T](https://doi.org/10.1016/0956-5221(95)00035-T).
- Mindell, D.A., Reynolds, E., 2023. *The Work of the Future: Building Better Jobs in an Age of Intelligent Machines*. MIT Press.
- Mohammed, A.K., Kuyini, A.B., 2020. An evaluation of the Free Senior High School Policy in Ghana. *Camb. J. Educ.* 51 (2), 143–172. <https://doi.org/10.1080/0305764X.2020.1789066>.
- Mosley, P., 1995. *Aid and Power: The World Bank and Policy Based Lending*. Routledge.
- Mudaly, R., Chirikure, T., 2023. STEM education in the Global North and Global South: competition, conformity, and convenient collaborations. *Front. Educ.* 8, 1–13. <https://doi.org/10.3389/feuc.2023.1144399>.
- New Zealand Government. (2024). Marsden Fund refocused for science with a purpose. (<https://www.beehive.govt.nz/release/marsden-fund-refocused-science-purpose>).
- Nisenfeld, H. (2022). How the Global North effects the Global South. (<https://storymaps.arcgis.com/stories/cf2f7c451d8d4b8680a91b96c6b636c2>).
- O'Hara, G. (2025). The UK's academic recession is in full swing. *Financial Times*. (<https://www.ft.com/content/Oec7120a-5b78-43da-8016-0415dca99073>).
- OECD (2023). OECD reviews of innovation policy: Korea 2023. (https://www.oecd.org/en/publications/oecd-reviews-of-innovation-policy-korea-2023_bdcf9685-en.html).
- Poh, L.C., 2016. From research to innovation to enterpriseness: the case of Singapore. *Cornell Univ. INSEAD WIPO Glob. Innov. Index* 133–139. (https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2016-chapter10.pdf).
- Rwanda Basic Education Board (n.d). One Laptop Per Child (OLPC). REB. (<https://www.reb.gov.rw/olpc/>).
- Ryder, G. (2020). COVID-19 has exposed the fragility of our economies. *International Labour Organization*. (<https://www.ilo.org/resource/article/covid-19-has-exposed-fragility-our-economies-0>).
- Sarpong, J. (2016). Analysing research dynamics at the University of Ghana: A case study of the department of economics and the department of physics [Unpublished masters thesis]. Oslo: University of Oslo.
- Sarpong, J. (2021) Research autonomy and “Marketisation” in Higher Education: A Case Study of Two New Zealand Universities. New Zealand: Doctoral thesis, University of Auckland.
- Sarpong, J., 2022b. A university that withstands financial uncertainties in complex times. *Pac. Asian Educ. J.* 33 (1), 119–133.
- Sarpong, J., 2022a. Research and disciplinary differences versus funding allocation in New Zealand's higher education system. *Issues Educ. Res.* 32 (1), 374–393. (<https://www.iier.org.au/iier32/sarpong.pdf>).
- Sarpong, J., 2023a. Reconciling research autonomy and marketisation in New Zealand universities: the idea of strategic entrepreneurialism. *J. Mark. High. Educ.* 1–17. <https://doi.org/10.1080/08841241.2022.2157069>.

- Sarpong, J., 2023b. Performance funding and the academic profession: a New Zealand case study. *High. Educ. Skills WorkBased Learn.* 13 (3), 502–514. <https://doi.org/10.1108/HESWBL-12-2022-0288>.
- Sarpong, J., 2025. Funding Cut for the Humanities in Neoliberal Higher Education Systems: A Case of New Zealand's Marsden Fund. *N. Z. J. Educ. Stud.* 1–14. <https://doi.org/10.1007/s40841-025-00388-0>.
- Sarpong, J., Adelekan, T., 2024. Globalisation and education equity: the impact of neoliberalism on universities' mission. *Policy Futures Educ.* 22 (6), 1114–1129. <https://doi.org/10.1177/14782103231184657>.
- Sarpong, J., Sturm, SR, Gunn, C., 2020. A university beyond aid: the challenge to the academic freedom and success of Ghanaian universities of over-reliance on donor funding. In: Sengupta, E, Blessinger, P (Eds.), *Teaching and Learning Practices for Academic Freedom: Innovations in Higher Education Teaching and Learning*. Bingley: Emerald, pp. 145–162. <https://doi.org/10.1108/S2055-36412020000034013>.
- Schneegans, S., Lewis, J., Straza, T. (Eds.), 2021. *UNESCO Science Report: the Race Against Time for Smarter Development – Executive Summary*. UNESCO Publishing, Paris.
- Sibomana, A., Bizimana, E., Havugiyaremye, L., Ndokoye, P., 2025. Impact of educational policies and reforms on human capital development in Rwanda. *Int. J. Chang. Educ.* 1–9. <https://doi.org/10.47852/bonviewJCE52023747>.
- Slaughter, S., Rhoades, G., 2004. *Academic Capitalism and the New Economy: Markets, State and Higher Education*. Johns Hopkins University Press, Baltimore, MD.
- Sosale, S., Harrison, G.M., Tognatta, N., Nakata, S., 2023. *Engendering Access to STEM Education and Careers in South Asia*. World Bank Publications.
- The White House (2025). *Reevaluating and realigning United States foreign aid*. (<https://www.whitehouse.gov/presidential-actions/2025/01/reevaluating-and-realigning-united-states-foreign-aid/>).
- Tricontinental (2023). *How the International Monetary Fund Is Squeezing Pakistan*. Dossier, Number 69.
- Trow, M., 1970. Reflections on the transition from mass to universal higher education. *Daedalus* 99 (1), 1–42. (<https://www.jstor.org/stable/20023931>).
- UNESCO (2020). *Education for sustainable development: A roadmap. Transforming Our World: The 2030 Agenda for Sustainable Development A/RES/70/1*, available online at <https://doi.org/10.54675/YFRE1448>.
- UNESCO (2022). *Higher education figures at a glance. UNESCO World Higher Education Conference*. (https://uis.unesco.org/sites/default/files/documents/f_unesco_1015_brochure_web_en.pdf).
- UNICEF, 2021. *Analysis of education spending in the West and Central Africa region: A policy brief for ministers of education and finance*. UNICEF, Dakar.
- UNICEF (2022). *Malaysia: Country office annual report 2022*. (<https://www.unicef.org/media/136776/file/Malaysia-2022-COAR.pdf>).
- UNICEF (2023). *Education budget brief: Investing in children's education in Rwanda 2023/24*.
- UNICEF (2024). *Ahead of the day of the African child, UNICEF says African governments still not spending what they need to secure quality education for the continent's children*. (<https://www.unicef.org/esa/press-releases/ahead-day-african-child-unicef-says-african-governments-still-not-spending-what-they>).
- United Nations. (2021). *Decrying Covid-19 Vaccine Inequity, Speakers in General Assembly Call for Rich Nations to Share Surplus Doses, Patent Waivers Allowing Production in Low-Income Countries*. (<https://press.un.org/en/2021/ga12367.doc.htm>).
- Universities New Zealand (2024). *Statement on cuts to Marsden Funds for Humanities and Social Sciences*. (<https://www.universitiesnz.ac.nz/latest-news-and-publications/statement-cuts-marsden-funds-humanities-and-social-sciences>).
- Wiseman, D. (2025). *Why is there a growing divide between Australia's defence and foreign aid?* (<https://www.rnz.co.nz/news/pacific/559012/why-is-there-a-growing-divide-between-australia-s-defence-and-foreign-aid>).
- World Bank, 2022. *Ethiopia - Education Sector Public Expenditure and Institutional Review (PEIR): Analysis of Equity, Efficiency, Effectiveness, Adequacy, and Sustainability of Public Spending and Institutional Arrangements in the Education Sector*. World Bank Group, Washington, D.C.
- World Bank (2025a). *Tertiary education*. (<https://www.worldbank.org/en/topic/tertiaryeducation#1>).
- World Bank (2025b). *School enrollment, tertiary (% gross)*. (https://data.worldbank.org/indicator/SE.TER.ENRR?name_desc=false).
- World Bank (2025c). *The African Centres of Excellence: 10 Years of Innovation and Impact*. (<https://www.worldbank.org/en/news/immersive-story/2025/05/13/the-african-centers-of-excellence-10-years-of-innovation-and-impact>).
- World Population Review (2025). *Population by continent*. (<https://worldpopulationreview.com/continents>).
- Yakman, G., Lee, H., 2012. Exploring the exemplary STEAM education in the US as a practical educational framework for Korea. *J. Korean Assoc. Sci. Educ.* 32 (6), 1072–1086. <https://doi.org/10.14697/jkase.2012.32.6.1072>.
- World Bank & UNESCO (2024). *Education Finance Watch 2023: Special edition for the African Union Year of Education 2024*. <https://thedocs.worldbank.org/en/doc/70f42d39bab0a849b36b2de4208a35e1-0140022024/original/EFW2023-Africa-edition.pdf>.