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POSITION PAPER

EdTech to Reach the Most Marginalised: A Call to Action

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Notes

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Contents

Abbreviations and acronyms

EiE	Education in Emergencies
EMIS	Education Management Information System
ICT	Information Communication Technology
LMICs	Low and middle income countries
LNOB	Leave no one behind
OER	Open Educational Resources
SDG	Sustainable Development Goal
SEND	Special education needs and disabilities
TPD	Teacher professional development
UDL	Universal Design for Learning
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations Children's Emergency Fund

1. Introduction

Low- and middle-income countries (LMICs) have made significant strides in expanding access to education since the early 2000s. Nonetheless, while progress in enrolment has improved, learning rates have stagnated leading to a global learning crisis (↑World Bank, 2018). Without core foundational skills, learners are unlikely to become fully literate or progress further through the education cycle, limiting their life chances. This learning crisis has been compounded by the Covid-19 pandemic in which approximately 1.6 billion learners experienced periods out of school (↑UNICEF, 2020b). While technology was vital in ensuring learning continuity over the pandemic period, the stark differences in technology use and access across and within countries exacerbated long-standing multidimensional and complex inequalities. This was illustrated during the current period of forced remote learning due to the school closures enforced because of Covid-19.

The application of technology in education (EdTech) has the potential to act as a powerful tool in raising the learning opportunities for marginalised learners and stimulating social change.[1] However, research on EdTech — and education research generally — has largely failed to incorporate or evaluate the effects of interventions on diverse groups of learners. Evidence has tended to consider which interventions have been most effective to improve *overall* learning outcomes rather than considering heterogeneity between different groups of learners (↑Alcott & Rose, 2015; ↑Ganimian & Murnane, 2014; ↑Glewwe & Muralidharan, 2015). This causes problems through copy-and-paste solutions — i.e., isomorphic mimicry[2] (↑Pritchett, 2014) — that do not properly assess contextual relevance, feasibility, and equity impacts of interventions, limiting their efficacy.

In recent years, research evaluating what impact different interventions have had on marginalised learners has begun to increase. However, it should be noted that firstly, this has largely focused on certain subsets of marginalised learners compared to others. For instance, there have been a lot more evaluations on what works for girls' education (↑Sperling & Winthrop, 2016; ↑Unterhalter et al., 2014). This has partly been due to the better availability of education data broken down by gender compared to other learner populations. Secondly, research understanding the impact of different EdTech

[1] For further detail see ↑Hennessy et al. (2021).
[2] Isomorphic mimicry is where there is a tendency of governments and donors to mimic other governments' successes, replicating processes, systems, and even products of 'best practice' examples. This can lead to a situation where the intervention in question is less impactful given that differences in context, politics, or capabilities have not been taken into account.

interventions on different marginalised learners is much less documented compared to the education sector more broadly.

It should further be noted that given the politically contentious issue of (in)equity, even where evidence exists, this does not necessarily mean that it will be translated into policies or practice (↑Samman et al., 2021). ↑Sarwar et al. (2021), in their review of government policies focusing on equity in LMICs, found that there was a tendency to focus more on certain marginalised learners (e.g., rural populations) compared to others (e.g., ethnic or religious minorities). This variation appeared to be contingent on whether a focus on specific groups was more politically advantageous in keeping the ruling elite in power (↑Nicolai et al., 2014; ↑Sarwar et al., 2021).[3]

1.1. Purpose of the paper

In this paper, we design and present a framework that can be used to understand and apply equity considerations in EdTech policy and programming decisions. We draw from existing frameworks designed to support policymakers to make education systems more equitable and adapt them to the specific characteristics of EdTech use.

The paper is structured as follows.

1. **Rationale for a position paper on equity.** We summarise the scale of the learning crisis, and how this has disproportionately affected learners from the most marginalised groups. We consider the potential role EdTech plays with regard to the 'leave no one behind' (LNOB) agenda, and an overview of EdTech's limitations.
2. **Existing equitable education frameworks.** We explore existing frameworks relating to education and EdTech and set out how they address how different aspects of education systems need to function in order to improve access to quality education for marginalised groups.
3. **Application of an equity framework for stakeholders working in the EdTech space.** We focus on components of frameworks identified in Section 3 and consider their applicability within the EdTech sphere more specifically. This is the main focus of the paper. We consider evidence of where EdTech has helped strengthen equity for the specific component in question, together with what principles would need to be applied to this area regarding EdTech.

[3] The marginalisation of certain groups are, by definition, due to their deliberate exclusion by the political and economic elite. This, by extension, means they offer very little political capital (↑Samman et al., 2021).

4. **Recommendations.** We conclude with ten recommendations that EdTech stakeholders (e.g., EdTech designers, policymakers and practitioners) need to take into account in order to ensure that EdTech is able to positively impact the access and learning of the most marginalised groups.

2. Rationale for a position paper on EdTech and equity

Since the start of the Covid-19 pandemic, much has been made of the 'new normal' in education, and the prospects of increased digitisation in education provision going forward compared to pre-pandemic levels (↑Pacheco, 2020). With less than ten years to go to meet the United Nations Sustainable Development Goal (SDG) 4 which will not be "met unless met for all" (↑UNESCO, 2015), the importance afforded to technology in delivering quality education must be considered with the most vulnerable in mind. As the evidence from the Covid-19 period illustrates, the ability of marginalised learners to continue with their learning through the use of technology has been severely compromised.

2.1. Why is equity important?

All learners of school-going age have the right to access education: the importance of inclusion is ratified in SDG 4 to "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (↑United Nations Statistics Division, 2020). Education — both access to school and learning — provides economic, health, and social benefits to individuals and their communities (↑Kaffenberger & Pritchett, 2020). These benefits are wide-ranging, with a fair and inclusive education being one of the most powerful levers available to make society more equitable (↑World Bank, 2012). A consideration of equity is thus vital to ensuring these benefits materialise, and all learners have the educational opportunities to survive and thrive.

This commitment to achieving equity requires reducing both inequalities between individual learners (vertical inequality) and between different groups of learners (horizontal inequality) (↑Stuart & Samman, 2017). Key to the LNOB agenda — which is central to all the SDG targets — is prioritising targeted action for the most marginalised learners whom this paper briefly defines in Section 2.1.1.[4]

2.1.1. The learning crisis and those left furthest behind

While there have been significant improvements in increasing access to education for the most marginalised groups since the turn of the millennia, a large proportion of learners are still unable to access school. Before the Covid-19 pandemic, 258 million learners of school-going age were out of school (equivalent to one-sixth of the global school-age population). Learners from

[4] This is commonly referred to as progressive universalism, which we discuss in more detail in Section 4.

marginalised groups made up a disproportionate share of this out-of-school population (↑UNESCO-UIS, 2019). Even for those who do go to school, millions leave without having attained basic skills. In 2019, for instance, 53% of 10-year olds in LMICs were unable to comprehensively read a simple sentence (↑World Bank, 2019, ↑Azevedo, 2020a).

The chance of being in school and learning is significantly dependent on two aspects. The first is a learner's country of residence. In low-income countries, a learner will, on average, be both in school *and* learning for four years compared to 10 years in high-income countries (↑World Bank, 2020). The second aspect is contingent on the marginalisation that a learner may suffer from. The type of disadvantage a school-age child may suffer from varies significantly from country to country. However, low learning outcomes are usually concentrated among the most disadvantaged segments of societies (↑Crouch & Gustafsson, 2018). Disadvantaged groups tend to include women and girls (↑Webb et al., 2020), those based in rural areas (↑Le Nestour et al., 2020); those from low-income households (↑Dreesen et al., 2020); learners with special education needs and disabilities (SEND) (↑Singal et al., 2017; ↑Sæbønes et al., 2015); and refugees and internally displaced groups (↑Katende et al., 2020). The latest Global Education Monitoring Report — with a special focus on inclusion — identifies characteristics commonly associated with disadvantage. These "include[d] gender, remoteness, wealth, disability, ethnicity, language, migration, displacement, incarceration, sexual orientation, gender identity and expression and religion" (↑UNESCO, 2020: p. 6).

Because marginalisation may differ depending on the particular national or subnational context, a vital starting point for decision-makers working in the EdTech space is to identify the particular characteristics of marginalisation in any given context before developing an understanding as to how EdTech can address specific needs (↑Unwin et al., 2020).

2.2. EdTech and how it can support the most marginalised

EdTech Hub has collated evidence on what works for different groups of marginalised learners. During the first few months of the Covid-19 pandemic in 2020, a series of publications on the use and outcome of different technological devices for different marginalised groups were conducted. This included learners living in crisis-affected contexts (↑Ashlee et al., 2020); girls (↑Allier-Gagneur et al., 2020; ↑Naylor & Gorgen, 2020); out-of-school learners (↑Allier-Gagneur & Moss Coflan, 2020); and learners living with disabilities (↑Lynch et al., 2021; ↑Moss Coflan & Kaye, 2020). Key findings for certain marginalised groups included the following.

- **For learners with SEND —** EdTech holds the potential to improve educational access in the form of assistive devices to remove barriers that traditionally prevent learners from benefiting from the curriculum (↑Moss Coflan & Kaye, 2020; ↑UNESCO, 2020).
- **For girls —** When barriers are removed — and female learners are given better access to technology — girls are likely to respond with a higher level of engagement. Technology has been found to be disproportionately more empowering for girls than boys (↑Webb et al., 2020).
- **For learners in refugee and displaced settings** — Technology can support learners and teachers by linking them to local and global support and training networks (↑Ashlee et al., 2020).
- **For out-of-school learners, and other learners from lower-income or rural households**. Evidence shows that using low-tech solutions — such as radio (↑Damani & Mitchell, 2020), television (↑Watson & McIntyre, 2020), messaging (↑Jordan & Mitchell, 2020) and tech-enabled personalised learning (↑Major & Francis, 2020) — can help support learning outcomes

Technology has the potential to support marginalised learners through various processes and policies within education systems. This can manifest through EdTech contributions towards pedagogy and teaching practices, content provision, skills development, assessment, and monitoring and evaluation systems (↑Unwin et al., 2020).

2.3. What are the limitations of EdTech in reaching the most marginalised?

Section 2.2 summarised the potential benefits EdTech can offer in being able to reach marginalised groups — and in some cases has already done so. However, unless stakeholders are committed to delivering EdTech with equity considerations taken into account, the default position of EdTech will be to exacerbate rather than reduce existing inequalities. This is the case owing to the manner in which EdTech devices are created, distributed and used, which serves to reproduce and reaffirm the specific inequalities within a given context (↑Unwin et al., 2020; ↑Wagner, 2016). Inequality is hardwired into EdTech's design and distribution. For instance, the majority of people and organisations that build the EdTech tools supplied to LMICs currently originate in high-income countries. This can often mean that the context within which specific marginalised groups reside are not factored into the technological design. This highlights how a more concerted effort to address the specific

and diverse needs of marginalised learners needs to be purposefully factored in when considering what role, if any, technology can play in supporting access to quality education.

As the experience from the Covid-19 pandemic has demonstrated, EdTech's role in reaching the most marginalised groups cannot be assured. The global school closures in response to the pandemic affected in-person lessons for approximately 1.6 billion learners, with a shift towards distance education (↑Azevedo, 2020b; ↑Miks & McIlwaine, 2020). The result was that those with access to internet connectivity and digital learning resources experienced greater levels of learning continuity compared to those without (↑Unwin et al., 2020). At its peak, 31% of school-age learners globally could not be reached at all by either digital or broadcasted learning programmes (↑UNICEF, 2020a).

Access issues were particularly pronounced for low-income countries where just 6% of children and adolescents had internet access, compared with 87% in high-income countries (↑UNICEF, 2020b). Within countries, household data illustrated the significant inequities between regions, wealth groups, and urban and rural settings in accessing technological devices and infrastructure needed for learning (↑UNICEF, 2020b). The gendered digital divide — already prevalent before the Covid-19 pandemic (↑Yeba, 2012) — was further exposed during the Covid-19 pandemic as it prohibited the ability of many girls to continue learning remotely (↑Acosta & Evans, 2020; ↑Webb et al., 2020; ↑Wenham et al., 2020).

While access to EdTech devices and infrastructure by marginalised groups was what elicited the most attention during the Covid-19 pandemic, it was not the only reason why EdTech ineffectively contributed to education continuity for these groups during the school closures. ↑Crompton et al. (2021) noted that the following factors also limited the effectiveness of EdTech for marginalised groups: the relative lack of freedom afforded to certain groups e.g., girls in using EdTech devices compared to others; illiteracy in using these devices; design of educational applications excluding marginalised voices; and the inability of EdTech to deliver the curriculum in an inclusive way. Household survey data from sub-Saharan Africa, for instance, found that in six of the eight sub-Saharan African countries surveyed, the proportion of girls possessing information communication technology (ICT) skills was half that for boys in the majority of countries (↑Amaro et al., 2020). Studies before Covid-19 also support this finding with the ability to use technology appearing to be contingent on the learner's socio-economic status (↑Adam, 2020), digital literacy skills (↑OECD, 2007), and parents' competency in being able to use technology (↑Trucano, 2016).

The potential limitations of EdTech for the most marginalised reinforce the need for an equity-based lens through which to approach decision-making. As such, Section 3 explores existing frameworks that focus on equity in education.

3. Existing equitable education frameworks

There are multiple factors that can contribute to, or result in, unequal access to education and learning for different marginalised groups. These factors define how education systems operate at different levels, and how they often reproduce wider social inequalities and norms. To be able to move from inequitable education systems to those which are equitable, we need to understand each of these factors in relation to different education systems.

3.1. Key drivers of (in)equitable education systems

A great deal of research has attempted to identify what factors drive exclusion, and where in the education system these may occur (↑Varkey Foundation, no date). Nancy Fraser's work (↑Fraser & Honneth, 2003),[5] additionally, has been used by educationalists to investigate what the drivers of exclusion are, and the transformative change needed to allay structural issues causing inequality. These drivers are redistribution, recognition, and representation (↑Power, 2012):

- **Redistribution** — Distributive injustices may arise when structural issues generate class inequalities for certain groups.
- **Recognition** — Hierarchical patterns of cultural value may generate inequality for particular groups.
- **Representation** — Political injustices may arise when certain groups are not accorded an equal voice in political decision-making processes.

Inequity itself is systemic of broader social structure imbalances, economic power struggles, and/or cultural beliefs (↑Omoeva, 2017). Across different country contexts, both technical and political drivers of exclusion often work to reinforce one another and, therefore, need to be considered holistically. An example of this relates to the absence of data on a given population, which may stem both from the capacity constraints in collecting data, and which may be reinforced by an unwillingness of stakeholders to collect data on them (↑Sarwar et al., 2021).

What must be acknowledged, therefore, are that factors which drive (in)equity can be deliberate, driven by how different institutions (both formal and informal) respond to different marginalised groups. It is important to understand these structural parameters of (in)equity; how these manifest

[5] While this model is not education-specific, it does help to bring together key structural issues that contribute to the marginalisation of specific groups of learners in failing to access quality education.

themselves in education systems; and the extent to which they potentially contribute to the marginalisation of certain groups in accessing quality education. A context-specific understanding of inequity within a given education system can offer more meaningful and long-lasting solutions than those that rely on technical solutions alone (see ↑Booth, 2012; ↑Booth, 2015; ↑Fritz et al., 2014; ↑Menocal, 2014).

3.2. Existing frameworks for improving equity within education systems

A number of studies have explored what factors have allowed some countries to more effectively address inequalities compared to others. ↑Arauco et al. (2014) discuss the important role of social movements in successfully changing the 'rules of the game' in addressing intersecting inequalities in seven LMICs across different continents. ↑Sarwar et al. (2021), in a study of 38 countries, document how factors including the political environment, legal aspects of school provision, school- and household-level strategies enabled greater access to quality learning for groups traditionally left behind.

In response to the centrality of the LNOB within the SDG agenda, a number of frameworks have emerged, which set out an evidence-based approach to how education systems can become more equitable. Within the literature considered, areas that significantly overlap in terms of how different components of education systems can most effectively reach marginalised groups, to ensure their access to quality education, include the following.

1. *Legislation or policies which are explicit in their commitment towards marginalised groups* (↑Arauco et al., 2014; ↑Greenhill, 2017; ↑Rose et al., 2020; ↑UNESCO, 2017a; ↑Wodon, 2016). An extension of this commitment includes better representation of marginalised groups in political positions (↑Arauco et al., 2014; ↑Rose et al., 2020).

2. *Education system capacity to produce evidence that is sufficiently disaggregated by different marginalised groups* (↑Greenhill, 2017; ↑Rose et al., 2020; ↑UNICEF, 2019b; ↑Wodon, 2016). Making disaggregated data available more widely would aid evidence-informed decision-making. Another effective strategy would be the generation of evidence specifically relating to what works for the most marginalised groups.

3. *Pedagogical approaches including being gender- and learner-focused approaches, and ensuring teaching is directed at the appropriate level of the learner* (↑UNICEF, 2019b; ↑Wodon, 2016).

4. *Ensuring that the curriculum and assessment systems are designed to respond effectively to all learners*. This means ensuring that they are

inclusive, representative, and relevant to the linguistic and cultural context of each and every learner (↑Wodon, 2016; ↑UNESCO, 2017a; ↑UNICEF, 2019b).

5. *Whole-system approaches, which emphasise the importance of engagement with a wide range of stakeholders*. These include sectors beyond education; parts of the system which sit outside formal the education sector (e.g., informal or unformal education sectors); and end-users (i.e., teachers and learners) to better understand the needs of marginalised groups, so as to respond with the most effective solutions (↑Rose et al., 2020; ↑Wodon, 2016).

6. *Providing more resources (both human and financial) better targeted towards the most marginalised learners*, together with ensuring that cost-sharing arrangements remove financial barriers for the most marginalised learners (↑Greenhill, 2017; ↑Rose et al., 2020; ↑UNESCO, 2017a; ↑Wodon, 2016).

A review of EdTech-specific guides and frameworks (↑ADB, 2017; ↑CITE, 2018; ↑DfE, 2019; ↑Trucano, 2016; ↑Wagner et al., 2005) reveal that while equity is mentioned in all of these frameworks, the extent to which it was a central focus differed. A further risk included equity becoming a buzzword rather than how EdTech should be applied in relation to policy, and what impact it can have on marginalised groups. The *Principles for Digital Development* is another useful resource. The nine principles provide a set of guidelines as to how to integrate best practices to tech-based international development and cooperation programmes (↑Principles for Digital Development, no date). While they do not directly reference equity, the principles are useful when thinking about EdTech and marginalised learners. ↑Unwin et al., 2020), in response to the Covid-19 pandemic, provided a guidance note on how EdTech could be tailored in a way that addresses equity issues. This guidance overlaps with those identified above in education frameworks more generally.

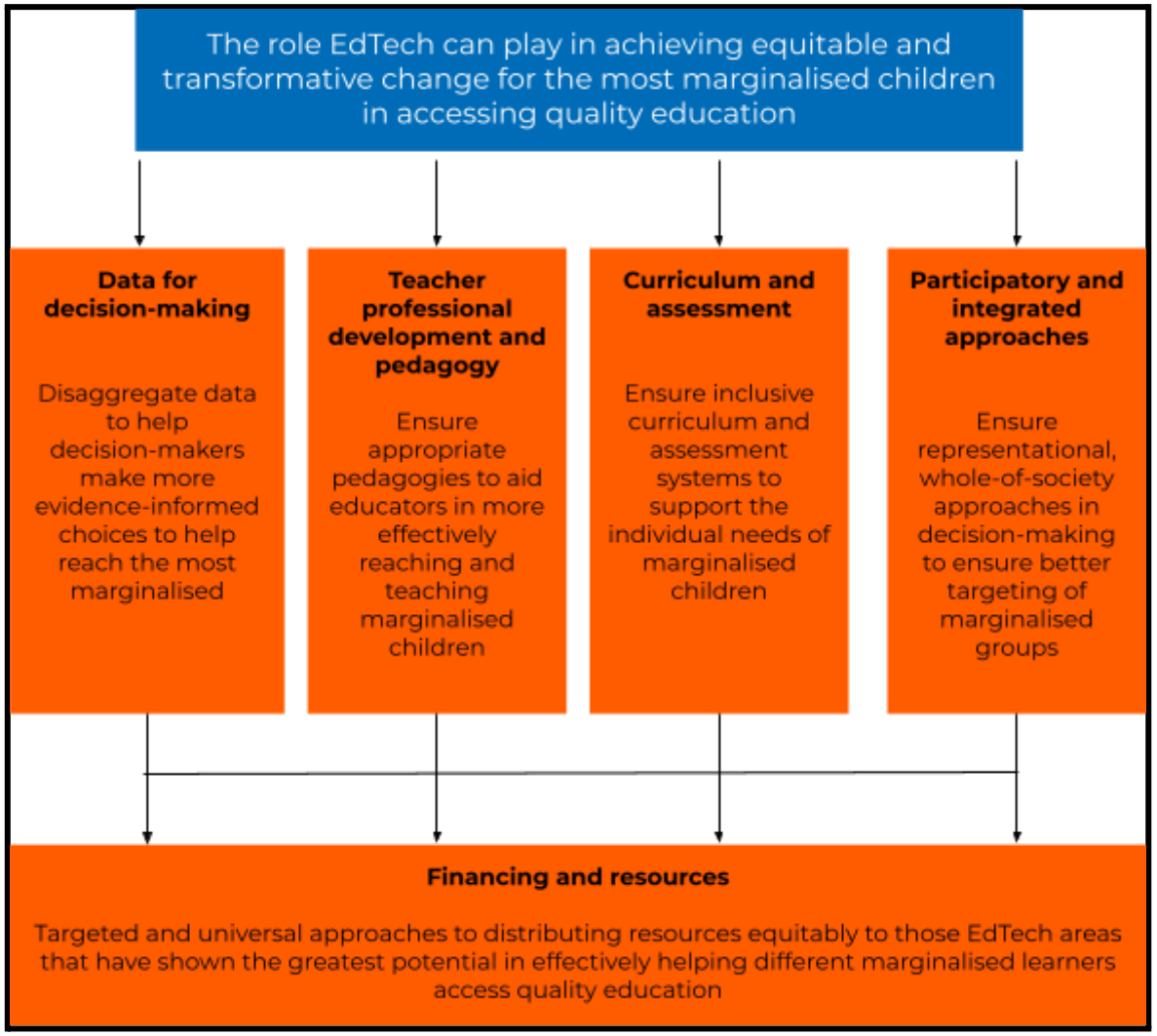
The above discussion has synthesised some of the main ways in which education — and, by extension, EdTech — systems can become more equitable. If applied effectively, targeting these areas of EdTech systems can potentially offer the transformational change advocated for by Fraser (redistribution, representation, and recognition) discussed in Section 3.1. Excluding legislation and policies (Point 1 above), this paper focuses on the remaining five areas and considers these in relation to EdTech systems. We group these according to the following five categories:

1. Data for decision-making

2. Teacher professional development and pedagogy

3. Curriculum and assessment
4. Participatory and integrated approaches
5. Finance and resources (see Figure 1)

Figure 1: *Transformative building blocks needed to improve the learning outcomes for the most marginalised learners.*



4. Building more equitable education systems using EdTech

This section explores a selection of the parameters discussed in Section 3, which are most relevant to how EdTech can contribute to reaching the most marginalised groups. As was discussed in Section 2.3, unless EdTech is deliberately designed and delivered in a way that takes into account marginalised groups, it could exacerbate existing inequalities. As the experience from the Covid-19 pandemic has demonstrated, EdTech's role in reaching the most marginalised groups cannot be assured.

The following discussion considers how different parts of education systems discussed in Section 3.2 can be operationalised so as to achieve more equitable EdTech systems.

Each of the focus areas is summarised according to the following.

- How the focus area needs to be applied to strengthen equity within education systems more generally.
- What existing evidence suggests about the contribution EdTech can make towards making this particular area of the education system more equitable.
- How this focus area within EdTech systems must be addressed to ensure greater equity in aiding marginalised groups greater access to quality education.
- Political economy considerations to understand the extent to which decisions relating to this particular area of focus can allow the EdTech ecosystem to address issues relating to equity.

4.1. Data for decision-making

Disaggregated data of different population groups can capture information to assist decision-makers in monitoring educational progress for those most at risk of falling behind (↑Rose et al., 2020). How education data is collected, analysed, and disseminated are all areas that can impact issues relating to equity. Deciding what data to collect needs to be considered alongside what we mean by equity and inclusion to "measure what we value, rather than value what we can measure" (↑Ainscow et al., 2003, as cited in ↑UNESCO, 2017a: p. 21). A strategy for equity needs to be guided by the variety of issues in a given context (↑Wodon, 2016). Such an approach can help provide a platform to ensure a "consistent and deliberate application of an equity lens" throughout

programme and policy design, implementation, and evaluation (↑Omoeva, 2017, p. 11).

Two areas of data generation addressed in the following sections which can impact equity and inclusion relate firstly to monitoring, and secondly to evaluation and feedback.

4.1.1. How can technology capture data on marginalised learners?

Digital data and monitoring

In recent years, progress has been made on data disaggregation and global organisations acknowledge the important role this has played in addressing inequity and discrimination throughout education systems (↑UNICEF, 2019c). Nonetheless, much is lacking in terms of assessing the impact of this on learning outcomes (↑Omoeva, 2017). In addition, the issue of the weak capacity of countries in being able to collect education data — particularly in relation to marginalised groups — can significantly impact progress on learning for these groups (↑World Bank, 2018). Substantial progress is needed to improve education data collection that allows decision-makers to accurately understand and address the needs of marginalised learners.

Examples of where technology has contributed to more thorough data collection processes follow.

Many education systems in LMICs have moved (or at least this is the plan) to facilitate data collection processes through digitising data collection with the aid of technological devices. Examples of this include collecting data through using tablets in Sierra Leone (↑Namit & Mai, 2019), or cloud-based data systems as in Malawi, Rwanda, and Senegal (↑Koomar & Blest, 2020).

The use of technology for education in emergencies (EiE) is widely documented and highlights EdTech's role in supporting data collection in emergency contexts (↑Ashlee et al., 2020). This includes using technology to help disburse education resources, together with obtaining information on education needs during emergencies (↑Barry & Newby, 2012). In Haiti, for instance, Short Message Service (SMS) and call centres were used to collect data on community needs following the earthquake in 2010 (↑ICTworks, 2012).

Technology has aided *Translators without Borders* to collect additional data through the adaptation or inclusion of additional items on surveys. This has been used to help understand languages spoken by learners, which can be one source of marginalisation (↑Translators Without Borders, no date).

Technology can be used to collect data directly from stakeholders such as learners and parents. In the Democratic Republic of Congo, the *Allô École!*

Initiative designed for use in low-income contexts involved parents and teachers submitting feedback, concerns and suggestions to the Ministry of Education through questionnaires via SMS (short message service) or Interactive Voice Response (IVR) (↑Koomar & Blest, 2020).

Similarly, technology has aided citizen-led movements to collect data. In Kenya, Tanzania, and Uganda mobile phones were used as part of the Uwezo citizen-led assessment that collects data on learning outcomes (↑Koomar & Blest, 2020). In Tajikistan, communities used computers to send collected data on out-of-school learners to inform district-level decision-making (↑Pinnock & Lewis, 2008). ↑Kaye et al., (2020: p. 34) find that citizen-led assessments have the potential to better capture learning data on out-of-school learners — which is traditionally lacking — as they are household- and not school-based.

Data analysis: evaluation and feedback

Equity building is an "inherently iterative, extended, and persistent process" (↑Omoeva, 2017, p. 17). Therefore, initiatives must be adaptive and open to adjustments. Well-functioning data collection and analysis processes should lead to systemic improvements through more effective feedback loops. It must be noted that for technology to lead to more data-driven decision-making, the technical capacity of stakeholders to manage, interpret and apply data needs to also be assessed and supported where necessary (↑Custer et al., 2018). Effective data systems and trained staff can facilitate dynamic and continuous adjustments at different levels of education systems (↑Wodon, 2016). Although this is rarely operationalised (↑Wodon, 2016), examples do exist which demonstrate how providing timely and accurate data to policymakers can result in improved educational outcomes. Examples of where this has been facilitated through the use of technology are detailed below.

Research on the Tusome programme in Kenya demonstrated how learner data collected through tablets led to more timely feedback to teachers on their practice (↑Kaye, 2020). This meant more effective support for teachers, and improvements to teaching methods that led to more equitable outcomes (↑Piper et al., 2018).

In Pakistan, real-time school monitoring through Android applications provided more timely and accurate information to enable evidence-informed decision-making. This was part of a wider tech-based initiative that included collecting geospatial data to identify previously abandoned buildings. It led to over 50,000 learners who had previously been out of school — of whom 72% were girls — being able to access education (↑GPE, 2019).

Digital dashboards have been established in Nigeria through the Addressing Education in Northeast Nigeria (AENN) programme. This is designed to

provide equitable access to basic education for populations displaced by conflict. The dashboards help guide policymakers by providing real-time information on education indicators to support over 200,000 conflict-affected learners through safe, formal and non-formal and accelerated education (↑Koomar & Blest, 2020).

4.1.2. Principles to ensure equitable data systems within EdTech systems

The role of technology in the collection and use of data indicators concerning education would need to take into account the following principles.

EdTech activities involving data must prioritise the safety of learners

Data practices must aim to ensure they "do no harm" (↑UNESCO, 2020, p. 74). Decisions around data — particularly open-source data — must consider what type of data is being collected, how it is being stored and disseminated, and who is using it (↑Principles for Digital Development, no date). This is particularly relevant for marginalised groups who are most at risk, as has been demonstrated by increased online violence toward women and girls during the Covid-19 pandemic (↑UN Women, 2020). In Malaysia and Mongolia, governments have implemented robust data privacy legislation to ensure that individual data can only be used anonymously or in aggregate form (↑UNICEF, 2020c).

Data collection processes utilising technology should incorporate the views of learners and communities

Where possible, these groups should be involved and empowered to take part in decisions relating to data collection activities (↑UNESCO, 2017a; ↑UNESCO, 2020). The example from Tajikistan given in Section 4.1.1 involved working with learners and adults to develop and undertake data collection activities appropriate for the community (↑Pinnock & Lewis, 2008).

Data must be collected to comprehensively review the impact of EdTech interventions

There is a bias within studies to focus on the positive impact of EdTech and this often means "unintended consequences are ignored or simply not looked for" (↑Unwin et al., 2020: p. 86). Only through providing more balanced findings can the field better understand the actual effects on marginalised learners. The negative impact of technology, for example, was almost non-existent in the studies assessed for a review on teacher's use of EdTech in LMICs (↑Hennessy et al., forthcoming).

4.1.3. Political economy considerations

While disaggregated data allows for more effective monitoring around progress concerning equity in any given education system, data collection —

when disaggregated by characteristics relating to marginalisation — can raise several politically sensitive issues. Firstly, the collection of data disaggregated by marginalisation may meet strong resistance from powerful interest groups. This may be due to a fear that making certain groups aware of the inequity they experience through the availability of data will lead to calls from marginalised groups to change the status quo (↑UNESCO, 2020).

Secondly, the collection of data relating to characteristics of nationality, ethnicity, or religion may be perceived as unnecessarily intrusive. Ex-UN rapporteur on extreme poverty, Philip Alston, warned that technology companies can often operate in virtually "human rights free-zones" and that key decisions around digital technologies can ultimately "surveil, target, harass and punish beneficiaries, especially the poorest and most vulnerable among them" (↑Pilkington, 2019). This extends to privacy issues of learners as the use of EdTech to collect data on students can have "profound implications for their privacy, well-being, safety and future prospects" (↑Barrett, 2020: p. 1). As recommended above, governments must, therefore, engage with stakeholders to adopt a more precautionary approach to decisions relating to education data and privacy (↑Unwin et al., 2020).

4.2. Teacher professional development and pedagogy

Teachers are "agents of change" (↑UNESCO, 2020, p. 377) whose attitude towards, understanding of, and experience with diversity is a fundamental aspect of how equity is manifested within education systems (↑UNESCO, 2017a). The Universal Design for Learning (UDL) framework, for instance, advocates using varied teaching approaches in order to make education more inclusive and accessible to learners (↑Rose & Meyer, 2006). Preparation for inclusive teaching can occur during initial training or through continued professional development (↑UNESCO, 2017a). As the general understanding of marginalisation and diversity develops over time — and as learner populations become more diverse — teachers require continued teacher professional development (TPD) on inclusion (↑Donnelly, 2015). Teaching practices in many countries throughout the world, however, remain highly didactic, with rote teaching techniques being widely applied (↑Nag et al., 2014; ↑Unwin et al., 2020). As teachers represent the highest costs to education systems and are potentially the "most powerful resource", the training and development they receive is critical for enhancing inclusive education outcomes (↑UNESCO, 2017a, p. 36)

4.2.1. How can EdTech help with inclusive teaching practices?

There are encouraging signs of shifts in recognising inclusive teaching practices, and the role of EdTech in supporting this. For instance, where the

underlying principles framing the UNESCO *ICT Competency Framework for Teachers* previously focused on economic growth and human capital, the most recent version emphasises the importance of the UDL and inclusive education within teacher development (↑UNESCO, 2018). Nonetheless, a recent systematic review on the use of technology within TPD in LMICs found that few initiatives incorporated approaches specifically addressing the needs of marginalised learners (↑Hennessy et al., forthcoming). Additionally, a systematic review on the use of EdTech for SEND learners in LMICs concluded that teachers seemed to be "left out of the process" and are reluctant to adopt EdTech into their regular teaching practices (↑Lynch et al., 2021: p. 72). Even less research exists around how marginalised teachers themselves are supported in their professional development through the use of EdTech (↑Hennessy et al., forthcoming). However, examples of where technology has been used to support TPD initiatives to help enhance equity are as follows.

A TPD pilot for teachers of blind and low-vision learners in Kenya involved an initial in-person session, followed by virtual TPD. The initiative utilised devices for reading braille, data bundles to enable regular training, and Whatsapp to share teaching resources. The programme reported increased learner engagement and the use of assistive technologies in the classroom. It also highlights the advantages of adopting a blended approach to tech-based TPD initiatives (↑Kweyu & Koszorus, 2021).

In Iraq, technology was used to support TPD in the Domiz Refugee Camp. Teachers used technology to access training resources via a cloud-based server and engaged in communities of learning through sharing knowledge and experiences (↑Dahya, 2016).

Video exemplars provided on mobile devices in the English in Action programme in Bangladesh contributed to a shift from didactic to more learner-centred teaching practices in schools for learners from low socio-economic groups (↑Shohel & Banks, 2012).

In Pakistan, female higher education teachers reported that online TPD platforms provide them with greater opportunities to express themselves and participate than the in-person sessions in which they experienced gender-based biases (↑Khan, 2018).

4.2.2. What principles must the EdTech sector follow to ensure inclusive teacher professional development?

Key principles to consider when thinking about EdTech in relation to pedagogy and TPD include the following.

TPD initiatives involving EdTech must be able to develop teachers' competencies for inclusive practice

Fundamental values that need to be considered for developing teacher competencies for inclusive practice include valuing learner diversity, supporting all learners, working with others, and having access to sustained professional development (↑UNESCO, 2017a). The training programme at the Al-Mabarrat Association in Lebanon incorporated these values as teachers were trained on the use of technology in the teaching-learning process for inclusive education. This resulted in more effective teaching practices and enhanced learning outcomes for SEND learners (↑European Agency for Special Needs and Inclusive Education, no date).

EdTech initiatives need to be designed in a way that supports continuous TPD on inclusive education

As understanding of diversity develops, or as learner populations become more diverse, TPD initiatives need to take into account the changes in how to teach marginalised groups most effectively. This can be achieved by using EdTech to empower teachers to enhance their own learning and development (↑Unwin et al., 2020).

Ensure that EdTech tools are designed to be relevant to teachers from marginalised groups

It is paramount that initiatives, which incorporate technology into TPD programmes, do this with teachers coming from marginalised groups in mind. This is fundamental to stimulate more equitable education systems broadly (↑UNESCO, 2020). A key step in this process would be to design tools with the users, (i.e., teachers) (↑Principles for Digital Development, no date). A TPD initiative in the Kakuma Refugee Camp in Kenya, for instance, used data from teachers' Whatsapp-based communities of learning groups to design future teacher training and peer coaching workshops (↑Mendenhall et al., 2018).

4.2.3. Political economy considerations

Creating more equitable education can mean challenging cultural attitudes and systemic practices, including providing more equitable TPD opportunities for marginalised teacher groups and promoting greater diversity in the teaching workforce. Education systems globally, however, do not tend to employ a diverse range of teachers, making it difficult for marginalised learners to relate to and form positive relationships with teachers (↑UNESCO, 2020). Technology can be used to help promote teacher diversity. In Pakistan, for example, a recruitment initiative targeting more female teachers used WhatsApp groups to foster relationship building and facilitate communities of learning (↑GPE, 2019).

A second challenge is that while teachers must be involved in decision-making processes and have their voices empowered, changes to pedagogical approaches often follow top-down approaches (↑Save Our Future, 2020). This is problematic given that it will be teachers' and teacher educators' attitudes and beliefs toward equity that will lead to inclusive practices being adopted (↑UNESCO, 2020). Developing the competencies teachers require to implement inclusive practices requires time, resources, and support (↑UNESCO, 2020). Providing support is needed both internally, at the classroom level, and externally, through engagement with parents, psychologists, and other specialists, as well as creating supportive networks with other teachers (↑UNESCO, 2017a).

4.3. Curriculum and assessment adaptation

Curriculum and assessment are central mechanisms through which the principles of equity and inclusion are enacted within an education system. In many LMICs, however, curricula tend to be irrelevant to local context, overambitious, too fast-paced, promoting contextually irrelevant skills, and delivered in a language of instruction different to that spoken at home (↑UNESCO, 2020).

For education to be inclusive and applicable to marginalised groups, there is a need to be responsive to different needs (↑Save Our Future, 2020; ↑UNESCO, 2020). An inclusive curriculum would be one that "takes into consideration and caters for the diverse needs, previous experiences, interests and personal characteristics of all learners" (↑International Bureau of Education, no date). The relevance, representativeness, and accessibility of a curriculum — in addition to how it is implemented — all play fundamental roles in learners' experiences of education (↑Glatthorn et al., 2019). For the curriculum to be inclusive it should be adaptable to fit the different needs of learners, which means that learners should be actively involved in the learning process (↑UNESCO, 2017a).

Aligned with Fraser's focus on a politics of cultural *recognition* as a means to address social injustices (see Section 3.1), inclusive education needs to go beyond a focus on access, and ensure that pedagogy, curriculum, and assessment practices are aligned to recognise — and work with — learner diversity (↑UNESCO, 2020).

4.3.1. How can EdTech help ensure an equitable curriculum?

The Convention on the Rights of the Child states that "the curriculum must be of direct relevance to the child's social, cultural, environmental, and economic context" (↑UNESCO, 2020, p. 121). The UDL framework promotes the use of

digital technology to create flexible learning environments that can adjust for diverse learning needs and treats differences positively to enable learning for all learners (↑Meyer et al., 2016). EdTech can provide fluidity to enable greater diversity in terms of how and when people learn, including opportunities for alternative pathways to certification (↑Unwin et al., 2020).

A recent systematic review, however, found that greater emphasis on accessibility principles within Open Educational Resources (OERs) is needed (↑Zhang et al., 2020). Moreover, digital resources created outside of a particular context may not be suited to the national curriculum and wider contextual factors (e.g., religious and cultural norms). This highlights the importance of aligning OERs to curricula and vetting resources to be contextually relevant (↑Chandra, 2020).

The following provide examples of how technology has been applied in a way that can enable curriculum adaptation in a way that is inclusive and equitable:

In Eswatini, Go Girls Connect! is a digital adaptation of a previous education initiative, and is delivered to girls via mobiles. The three-year project aims to build digital literacy, together with empowering girls to understand and manage difficult social gender norms (↑Koomar & Blest, 2020).

The DionWired Special Needs project for SEND learners in South Africa enabled teachers to adapt content to learners' needs through the use of a literacy software package (↑Banes et al., 2019). The success of the project led to the model being adopted in a larger-scale pilot for all schools offering South African Sign Language (SASL) in the Western Cape province.

In the Philippines, the eSkwela programme provided a non-formal online curriculum designed for out-of-school learners through an alternative learning system (↑Kamei, 2010). The initiative has enabled remote and blended learning and provided opportunities for participants to enhance literacy and other skills and gain certification to boost future employment prospects.

Language of instruction is a crucial component of how learners engage with the curriculum. It is widely accepted that learning in a child's mother tongue aids learning development and interactivity with families and communities (↑UNESCO, 2016). Yet it has been reported that 40% of learners are not educated in a language they speak or understand (↑UNESCO, 2016). The following examples relate to how technology can support a more equitable approach to the language of instruction:

- Technology can be utilised to reinforce minority languages. In India, for instance, online dictionaries have been developed in collaboration with communities to support Odisha state's multilingual education involving

1,500 primary schools and 21 languages of instruction (↑Panigrahi, 2019; ↑UNICEF, 2019a).

- Language technology solutions can assist speakers of marginalised languages through approaches such as natural-language processing applications to support remote learning (↑Haßler et al., 2021). An initiative in Nigeria, for instance, developed a mobile application to collect multilingual data from voice donors to feed into artificial intelligence-based natural-language processing to support classroom dialogue (↑Agajo et al., 2020).
- The Kenyan government has developed its own sign language and braille to widen access to education for disabled learners (↑Mativu, 2017). This has been incorporated by eKitabu, an educational content provider, which has included Kenyan Sign Language and contextual characters in videos for open access digital storybooks for learners (↑All Children Reading, 2018).

4.3.2. How can EdTech help ensure equitable assessment systems?

Assessment forms the basis of what is taught and of teaching methods and is a fundamental for an inclusive education system (↑UNESCO, 2017a). Assessment that supports inclusive education should be coherent with learning goals and accommodate different learner needs (↑UNESCO, 2020). To that end, there is a need to look beyond standardised tests given that these often focus on a narrow subset of learning which excludes certain learners (↑UNESCO, 2017a). Moreover, high stakes, summative standardised tests can often lead to negative practices, such as rote teaching and learner reassignment. This can negatively impact the most marginalised learners (↑UNESCO, 2017a). Addressing this requires assessing learners — especially the most marginalised — throughout the education cycle to ensure that they are not left behind (↑Laveault & Allal, 2016). However, teachers — particularly in the context of LMICs — are often not well trained to adequately monitor and evaluate learning outcomes, particularly for marginalised learners (↑UNESCO, 2020). There is therefore not only opportunity for EdTech to make assessment fairer — for instance through secure online platforms (↑Unwin et al., 2020) — but also to assist teachers in conducting assessments. Examples using technology to support teachers to undertake assessment include the following.

The Tangerine open-source software application is an offline tool designed to collect data at the early grade level using low-cost tablets (↑RTI, no date). Tangerine tools provide teachers with the means to conduct formative

assessment in the classroom, together with providing teachers with timely coaching and feedback to support their understanding of individual learners' needs. It has been used in over 60 countries globally, including in Zimbabwe for the *Supporting Adolescent Girls' Education* initiative (↑Thukral et al., 2019)

Adapting to diverse needs, which involves changing the content or format of an assessment and removing barriers impeding completion (↑UNESCO, 2020). Examples of how technology is applied to assist SEND learners to undertake assessments include using computerised administrations and specialised braille keyboards (↑Thurlow, 2013; ↑UNESCO, 2020). Evidence on assessment accommodation, however, remains generally inconclusive (↑Thurlow, 2013).

The Covid-19 pandemic has provided more research on how distance assessment can be achieved, such as using phone-based formative assessments (↑Angrist et al., 2020; ↑Luna-Bazaldua et al., 2021). Recent evidence, nonetheless, suggests that such assessments may not be completely reliable due to factors such as learners receiving assistance from family (↑Crawfurd et al., 2021).

4.3.3. What principles must the EdTech sector follow to ensure inclusive curricula and assessment?

It is crucial that equity fundamentals are promoted through education practices that learners interact with. As such, it is paramount that the following principles involving Edtech and curricula and assessment are considered to support more inclusive practices.

Curricula

- *EdTech needs to enable curriculum flexibility to cater for learner diversity.* Being able to adapt content or language to cater for diversity is essential in addressing marginalised learners' needs. The Let's Read initiative, for example, provides locally-created OERs in over 20 languages across Asia to create greater reading opportunities for learners (↑The Asia Foundation, 2019).
- *Content must be aligned to the national curriculum and ensure it is relevant, representative, and inclusive for the context in question.* It is crucial that EdTech providers engage with local stakeholders to ensure that materials are fit for contextual learning needs.

Assessment

- *EdTech use for assessment needs to be appropriate for the context in which it is being applied.* Assessments need to relate to the curriculum and the language of instruction to enable equitable opportunities for learners. This extends to the utilisation of technology that learners (and teachers) are familiar with (↑Unwin et al., 2020). Tablet-based

assessments on early mathematical skills in Malawi, for instance, were undertaken using instructions provided in the Chichewa language. The learning gains from this initiative were significant and transferred to a paper-and-pencil assessment format (↑Pitchford, 2015).

- *EdTech should enable educators to undertake formative assessments that provide feedback on individual learner needs.* Where possible, the use of EdTech for such purposes should connect to district / national monitoring and evaluation initiatives to provide educators with timely feedback on individual learners. As part of the Tusome project in Kenya, assessments were conducted using tablets that fed information to a cloud-based platform informing decision-making (↑Kaye, 2020).
- *EdTech should be used to remove barriers to ensure that assessment processes accommodate diverse learners' needs.* In Turkey, technology-supported learning and assessment tools were designed in an initiative for hearing-impaired learners. The project enhanced teacher pedagogical practice and led to student learning gains (↑Karal, 2015).

4.3.4. Political economy considerations

Curriculum review and reform are critical processes for addressing equity concerns. National reforms, however, are fairly static processes, typically taking place every seven to ten years (↑Fadel et al., 2015). This has significant implications for revising and updating curricula to be made more inclusive. This is particularly relevant given that understanding around the roots of inequality, and the diverse needs of different marginalised groups evolve (sometimes rapidly) over time.

Similarly, the involvement of marginalised groups both in the development of — and their representation within — educational content can be a politically sensitive issue. In a global analysis of textbook content, for instance, girls and women continue to be under-represented in school curricula (↑Benavot & Jere, 2016). A rare and positive example of where curriculum reform processes engaged with indigenous communities to develop culturally relevant teaching and learning materials comes from the Odisha State of India (↑UNESCO, 2020). Factors that aided this involved communities being actively involved in curriculum design; recruiting teachers fluent in the respective languages; and the formation of a working group involving teachers, linguists, international agencies, anthropologists, and tribal language experts. It is vital that EdTech supports such engagement and does not exacerbate existing exclusionary processes (e.g., through engaging only teachers with access to high-tech digital devices and / or the internet).

4.4. Participatory and integrated approaches

Achieving equity in learning outcomes requires the involvement of stakeholders across the system who may otherwise be excluded from decision-making processes. Otherwise known as a whole-society approach, this entails involving parents, communities and civil society organisations, as well as the private sector in the decision-making process (↑Unwin et al., 2020). When it comes to meeting global commitments on girls' education, for instance, evidence appears to suggest that this is effective when there is an adequate representation of women leaders at every level of government to ensure greater political participation in decision-making, together with changing patriarchal norms and structures (↑Rose et al., 2020). This relates back to the component of *representation* contained in Fraser's model which was discussed in Section 3.1.

As well as approaches that are participatory, for an education system to be truly equitable means working in an integrated way, not just with actors in the formal education sector but also with those working in traditionally under-represented parts of the non-formal and informal education sector. This is due to the multitude of barriers many marginalised groups continue to face in accessing formal education structures. Similarly, engaging with actors and institutions in sectors outside of the education space is crucial in driving the transformational change needed to achieve equity in access and learning. It will also lead to positive spillovers between efforts in different sectors (↑UNICEF, 2019b; ↑Unwin et al., 2020).

4.4.1. How can EdTech enable participatory and integrated approaches?

Evidence of where technology has facilitated participatory and integrated approaches to decision-making is currently available only from small-scale projects. More research is needed to understand the scalability and (cost-)effectiveness of these interventions. Some examples of how technology has supported participatory and integrated efforts are as follows.

In South Africa, social media prompted greater awareness of textbook content in circulation that appeared to blame a sexual assault scenario on the victim. Through parental engagement, Pearson — the textbook supplier responsible for the content — announced it would amend the language immediately (↑Davies, 2016). Similarly, the #FeesMustFall hashtag in South Africa played a crucial role in allowing citizens to express how satisfied they were with education services. It ended up playing a central role in political discourse at a national level (↑UNESCO, 2017a).

EdTech has the potential "to blur lines between formal, informal and nonformal learning" (↑Tauson & Stannard, 2018: p. 55). One way is to provide certification for the learning of marginalised groups who may otherwise have no access to formal education pathways (↑UNESCO, 2012). This may be through blockchain-based certification schemes including digital IDs (↑Unwin et al., 2020). Elsewhere, technology has aided skills development through the use of virtual and augmented platforms. This has provided new opportunities for youth to gain new employment-related skills (↑Unwin et al., 2020).

4.4.2. What principles must the EdTech sector follow to enable integrated and participatory approaches?

The following principles are crucial when considering decision-making processes relating to EdTech interventions that adequately take into account matters relating to greater equity and inclusion.

Technological interventions should be designed with the participation of marginalised learners

To ensure that EdTech can meet the diverse needs of the end-users — particularly those who are marginalised — one of the key elements is "getting to know the people you are designing for through conversation, observation and co-creation" (↑Principles for Digital Development, no date). In Sierra Leone, a good example of this was the success of the Pikin Tok radio show during the Ebola crisis. This involved young people, who were the show's target audience, being active participants of the design process along with other stakeholders, including international experts and government officials from the health and education ministries (↑Barnett et al., 2018). Elsewhere, the eSkwela alternative learning system in the Philippines explicitly incorporated out-of-school youth responses on learning aspirations into the programme design (↑Tan, 2010).

Parental and community involvement is a necessary part of the design process of any technological design

As the experience of Covid-19 has illustrated, parental and community involvement in children's learning is crucial. In a meta-review of EiE interventions, ↑Tauson & Stannard (2018) found that community engagement in the design of technology in the occupied West Bank led to better-designed learning interventions. In Cameroon, the Two Rabbits model was designed for and with the semi-nomadic hunter-gatherer community. It engaged with communities to record interactive, audio pre-school lessons in the local language (↑Plaut et al., 2020).

EdTech must engage with education stakeholders beyond formal education systems

Marginalised learners are most likely to be concentrated among those who are either out of school or in non-formal or informal education settings.

Technology's role must be to link the informal learning process to the formal so that "seamless learning can occur anytime" (↑Khaddage et al., 2016: p. 16). An example of where this has been operationalised is Kenya. Technology enabled girls of secondary school age with intermittent access to education to access formal learning through the use of mobile phones and Google (↑Zelezny-Green, 2014).

A holistic cross-sectoral approach must be administered when planning for the use of digital technology in education

Often, the use of digital technologies in education is led either by the Ministry for ICT or the Ministry of Education. However, this siloed approach can jeopardise many interventions. Firstly, it inadequately deals with the knowledge gaps, which arise in the absence of a holistic approach. Secondly, it risks a disjointed approach to financing — either duplicating or else failing to invest in areas of a programme that assure its efficacy (↑Unwin et al., 2020). Cross-sectoral collaboration is important when it comes to issues concerning equity. As part of the Covid-19 distance education approach, for instance, the South Korean government conducted a national role call to better understand technology availability at home (↑Joynes et al., 2020).

4.4.3. Political economy considerations

An integrated approach to programming EdTech towards supporting marginalised learners would require the support of several stakeholders to provide the financial support needed to execute this (↑Wodon, 2016). Political support is needed not only to ensure support for marginalised populations from multiple sectors but also to ensure the participation of marginalised groups in designing EdTech programmes that directly affect them. The evidence from the wider education literature, however, finds that parental participation is often contingent on perceptions that other stakeholders have of them (↑Barquedano-Lopez et al., 2013). In a study focusing on poor rural districts in Ghana, for instance, ↑Essuman & Akyeampong (2011) found that decision-making power was likely to be concentrated in the hands of more educated community members.

The support of the community for any education intervention, however, is important because it is likely to improve use. For instance, girls tend to benefit more from the use of educational technology compared to their male counterparts (↑Khan & Ghadially, 2010). However, their access to technological devices appears to be negatively affected by attitudinal bias in relation to the ownership and usage of technology (↑Zelezny-Green, 2011). This reflects a need for EdTech designers to adequately anticipate societal norms towards learners who may be traditionally marginalised.

4.5. Finance and resources

Across all country contexts, learners who are the hardest to reach are likely to entail much higher investment needs than those who are not marginalised (↑UNESCO, 2010). There are many potential opportunity costs that policymakers need to take into consideration when making investment decisions that specifically relate to equity. Governments may, for instance, have to decide whether a universal or a targeted approach is adopted given the higher unit cost often associated with approaches targeting marginalised learners (↑Sabates et al., 2020).

To enable more equitable EdTech systems, the mechanisms through which resources are allocated should align with the element of Fraser's model which relates to *redistribution* (see Section 3.1). An approach to enact this would be to implement principles relating to progressive universalism. These provide guiding principles as to how the spending decisions of both national governments and donors can better align to the LNOB agenda through the better targeting of resources to the most marginalised groups. One approach is providing a service for all, together with more targeted attempts to ensure that the most disadvantaged groups do not get left behind. This echoes principles of selectivity within universalism (↑Jacques & Noel, 2021). A second approach offers a more sequenced approach, which targets specific groups first before rolling out a given intervention (↑ODI & UNICEF, 2020).

Among the elements encompassing the progressive universalism approach are those that,

- Ensure that public spending subsidises levels of the education system most likely to be accessed by the most marginalised. For instance, this can be achieved through greater cost-sharing between households and public resources at higher levels of education, given that these levels are accessed by relatively more advantaged groups (↑Zubairi & Rose, 2016; ↑Ilie & Rose, 2018).
- Direct public resources towards parts of the education system outside of formal education to target resources towards learners who cannot access the formal schooling system. The majority of learners accessing non-formal education programmes are also those most likely to come from a marginalised group (↑Unwin et al., 2020).
- Increase and directly target public financial support to reach the most marginalised learners. This could be achieved through a number of mechanisms, including funding formulas, cash transfers, and social protection programmes (↑Garcia-Jaramillo & Miranti, 2015).

Progressive universalism redistributive approaches would need to underpin any decisions relating to EdTech investment. This would involve targeting public resources towards what works effectively for different marginalised groups of learners.

4.5.1. How can technology aid in the more equitable distribution of resources?

Technology has the potential to aid in distributing resources more equitably in a way that reaches the most marginalised. This section discusses two examples in more detail.

EdTech to supplement limited resources (example of teachers)

While EdTech has the potential to play a role in addressing the inequitable allocation of teachers and to support teachers who have to manage large groups of diverse learners, it is important to emphasise that it must be used alongside traditional education interventions to *support* rather than *replace* teachers (↑Save Our Future, 2020). However, structural factors in specific contexts may mean that the unequal distribution of public resources across education systems, which are overwhelmingly spent on teacher salaries, continue to persist. Several studies document how, for instance, the shortage of teachers in education systems in LMICs are often not just about overall shortfalls but also due to deep-rooted structural factors (↑Asim et al., 2017; ↑Béteille, 2009; ↑Zubairi, 2020). To counter this, in some contexts, Edtech is being utilised as a strategy to counter teacher shortages, where these exist.[6] While it is an emerging strategy, there is little evidence on what impact interventions like these have had on learning, for example,

- In China, teacher resistance to taking teaching positions in remote and impoverished parts of the country led to the introduction of Online Classrooms in delivering curriculum content. Learners must physically attend lessons at school where a projector is set up where they can see their teachers and other learners taking part in online lessons (↑Debroy, 2018).[7]

- In Indonesia, the Philippines, and Thailand, the uneven distribution of qualified teachers has contributed to a boom in EdTech devices to aid classroom teaching in contexts where there is a shortage of teachers (↑Watanabe, 2017).

[6] Using similar methods employed by ↑Romero et al. (2017) and ↑Sabates et al. (2020), research could consider the extent to which supplementing schools or classrooms with a shortage of resources with technology leads to additional years of schooling.
[7] This 'high-tech' option may be unfeasible in contexts where remote areas and schools are unlikely to have access to electricity, let alone internet connectivity, and real-time online delivery.

EdTech can provide more information on how resources should be allocated

Accurate data can lead to more effective planning regarding the distribution of public resources. Datasets with equity dimensions are largely limited to outcomes on school participation (see Section 4.1). Data on the way resources are allocated to different groups of learners, schools or geographic areas are less widely reported. For instance, information on teacher deployment, teacher quality, expenditure per learner, or resource allocation per school or learner generally tends to be vastly under-reported.[8] Examples of where technology has aided this are as follows.

In Sierra Leone, a digitised approach to Education Management Information System (EMIS) data — together with poverty and transport data — has been utilised by government officials to distribute textbooks and teachers according to need (↑Namit & Mai, 2019).

The Check My School initiative in the Philippines uses technology as a mechanism to bypass the routine challenges experienced when tracking resources at lower levels of the system (↑Manuel et al., 2019). It has used a blended approach in helping communities monitor textbooks and budget allocations at the school level, among other things. This then creates a feedback loop by combining both on-the-ground community monitoring together with providing 'up-to-date' information through the use of ICT to provide government officials at the Department of Education with the most accurate information (↑Read & Atinc, 2017; ↑Shkabatur, 2012).

Technology proved an important mechanism in helping deliver cash transfers during the Covid-19 pandemic (↑Soon-Shiong et al., 2020). This has been evidenced elsewhere to help target cash resources to vulnerable groups in low-income contexts pre-Covid-19 (↑Datta et al., 2008; ↑Smith et al., 2011). Specifically, regarding education, ↑Sperling and Winthrop (2016) document how the use of mobile phone technology to deliver cash transfers to girls has had a positive impact on school participation. A note of caution must be made, however, on the over-reliance in delivering resources in this way. The gender divide in mobile phone ownership, for instance, may exclude girls from redistribution programmes (↑Bourgault & O'Donnell, 2020).

4.5.2. What principles must the EdTech sector follow to more equitably distribute resources to marginalised learners?

Any investment in EdTech interventions would need to adopt the principles of progressive universalism — discussed at the beginning of Section 4.5 — when

[8] As outlined in Section 4.1.3 this information could be deliberately withheld due to fears that more transparent information on the distribution of resources could create unwanted political pressure to change the status quo.

it comes to financing. The following are among the most important principles of such an approach that relate to EdTech and are worthy of emphasis. Align government and donor spending to EdTech interventions which have been proven to be effective in meeting the complex needs of marginalised learners.

Investments in EdTech would need to incorporate the specific resource needs of different marginalised populations across different contexts and factor these into design processes. A 'one size does *not* fit all' approach to ensure that "digital technologies [are] used in context-specific ways" and "relevant to the specific contexts and needs of the people" (↑Unwin et al., 2020: p. 21) are core principles to achieving equity within EdTech systems.

The design of Edtech interventions must entail minimal additional prohibitive costs for the poorest households and communities

The cost to the end-user and / or the repair and maintenance of technological devices — once distributed — is often inadequately taken into account when designing many EdTech projects (↑Wagner, 2016). In addition, there is little consideration of the user cost, which prohibits continued access to learning software. This raises questions relating to the sustainability of EdTech models (↑Plaut et al., 2020). Tiny Totos — an enterprise working in Nairobi's slums, is a rare exception to the rule and has factored sustainability into its working model. It finances smartphones, as well as cooking equipment that daycare providers use to prepare meals. Revenue is then raised through the sale of meals sold to learners within their care (↑Plaut et al., 2020).

Private EdTech stakeholders must be incentivised to invest in, develop for, and serve marginalised groups of learners

The EdTech domain would not develop as rapidly without the private sector.[9] Past experience has shown that a reliance on non-market approaches alone in developing and supplying EdTech have typically ended in failure (↑Wagner, 2016). However, at the same time, private sector companies would "go out of business if they provide educational services to families who cannot pay for them" (↑Unwin et al., 2020: p. 22). Therefore, some form of external public subsidy to ensure EdTech providers incorporate the needs of marginalised learners is needed. During the Covid-19 pandemic, for instance, some governments responded by subsidising internet companies to provide cheaper connectivity (North Macedonia); providing free SIM cards (Kyrgyzstan); or not charging data costs for educational content (Jordan, Paraguay, Rwanda, South Africa) (↑Dreesen et al., 2020)

[9] China stands at odds with this approach and has, more recently, introduced stronger regulatory measures for the USD 100 billion EdTech sector operating in the country. This has effectively banned companies teaching the school curriculum from making profits and has been partly driven by concerns surrounding equity (↑Bloomberg news, 2021).

Provide better evidence on the cost-related long-term returns of EdTech interventions focusing on left-behind groups

Where limited evidence does exist, it suggests the potential of targeted interventions that target disadvantage can yield high economic and social returns (↑Samman et al., 2021). ↑Manuel et al. (2019) found that switching education funding from the best-resourced to worst-resourced districts could achieve efficiency savings of at least 40%. Similarly, ↑Sabates et al. (2020) found that by focusing on marginalised adolescent girls, the Campaign for Female Education (CAMFED) programme achieved greater value for money per dollar spent than it would have had it focused on relatively more advantaged learners. These studies hold valuable lessons for balancing equity considerations with those relating to cost-effectiveness — often seen as diametrically opposed — and suggest that decision-makers need to "mainstream equity in calculations of cost-effectiveness itself" (↑Chuang et al., 2021: p. 16).

4.5.3. Political economy considerations

Investment in tech devices that are context-specific and specific to marginalised users are key to ensuring EdTech aligns with equity objectives. In Section 4.5.2 this paper recommended applying the principles of progressive universalism to achieve this. However, depending on the context, it is important to acknowledge the structural issues which may prevent this goal from being achieved in the immediate term.

Firstly, in certain country contexts resources may be organised to consolidate social, political, and organisational power. For example, since its independence, the way public resources have been distributed in Kenya appear to have been skewed towards those ethnic subgroups who have most strongly supported the patron group in power (↑Hassan, 2020). ↑Sarwar et al. (2021) found that government prioritisation of left-behind groups in LMICs — through technical and financial resources — is strongly influenced by the relative bargaining power of that particular group. ↑Nicolai et al. (2014), furthermore, found that during the recent expansion of free education, rural and remote populations were high up on the policy agenda because their votes were crucial for maintaining electoral bases.

Secondly, the equity objectives stated in Section 4.5.2 need to be reconciled with that of a private sector strategy. Private funding models would typically be about imposing uniform platforms and content so as to reach as large a market as possible (↑Unwin et al., 2020). EdTech developers may, through their default position, develop a mobile application in South Africa focusing on English rather than Xhosa due to greater market potential (↑Rodriguez-Segura, 2020). Similarly, private sector strategies may be driven by the purchasing power parity of the end-user. This would mean targeting richer households,

which would by default exclude the specific needs of the most marginalised groups, or else price them out of the market (↑Rodriguez-Segura, 2020). Lastly, the high, initial fixed costs needed to reach marginalised populations may push investors and / or decision-makers towards investments that are more normative, rather than those based on need. EdTech interventions characterised as 'cost-effective' run the risk of excluding groups of marginalised learners, or else addressing their specific needs (↑Chuang et al., 2021).

5. Recommendations

The experience of learning under Covid-19 has put the spotlight on EdTech and equity. It has reiterated that EdTech decision-makers — be they designers, providers, or implementers — need to adequately disaggregate and design for the end-user population to increase the efficacy of EdTech interventions. As stated by ↑Wagner (2016: p. 11) "[r]ather than implementing projects where there already is a device-friendly infrastructure, trained teachers, and electricity, equity necessitates moving to more challenging terrains."

The main purpose of this paper has been to provide guiding recommendations, which EdTech stakeholders (in particular EdTech designers, policymakers and practitioners) need to implement in order to effectively reach the most marginalised learners. Before presenting these, it is important to acknowledge — as this paper has done throughout — that inequity is a political issue, which will not be addressed by technical solutions alone. As set out under each parameter in Section 4, the political economy factors of different contexts would need to be understood to determine how, and to what extent, the guiding principles can be actionable.

Therefore, as a first step, understanding the context within which an EdTech intervention is being planned is crucial. This would include engaging with context experts and undertaking a political economy analysis that looks at how change has happened, and what has enabled or prevented an agenda relating to different marginalised groups. These factors would help determine the approach needed to move in the direction of the ten recommendations set out below, an approach that is likely to be iterative rather than linear.

The second step would require tracking what stage countries are at in relation to the ten recommendations set out below. These are likely to differ both in terms of context and of different groups of marginalised learners. The approach followed by ↑Trucano (2016) for the Systems Approach for Better Education Results (SABER) ICT framework is worth considering here as it sets out four stages of progress. These are latent, emerging, established and advanced stages of progress. The section below details the following ten recommendations which relate to the five education parameters discussed in Section 3.

5.1. Data and evidence for decision-making

1. **Generate more rigorous evidence on the impact of EdTech which disaggregates data on end-user populations of EdTech.** In order to ensure that decision-makers have complete information on the type of EdTech interventions that meet the specific needs of different

marginalised learners most effectively, future research must properly disaggregate by end-user what the impact of EdTech interventions are considering context, relevance, feasibility, and equity. A database that is able to adequately break down evaluation and meta-evaluations on what EdTech interventions work, and for whom, will be contingent on the availability of disaggregated data.

2. **The use of EdTech to collect and disseminate data must be done by placing equity considerations at its centre.** EdTech data activities need to consider equity and inclusion to understand a multitude of issues including what data is being collected, by whom, for what purpose, and how this relates to and impacts marginalised groups. This involves incorporating the views of stakeholders in data collection and analysis activities. Data privacy is a significant risk, therefore EdTech decision-making must ensure that learners' safety is taken into consideration.

5.2. Teacher professional development and pedagogy

3. **Support and develop teachers' continuous professional development of inclusive education.** To address concerns relating to equity, any EdTech interventions would need to ensure teachers are supported in developing a continuous understanding of teaching marginalised learners. This involves working with teachers to understand their needs and providing support both in the classroom and outside with actors such as parents, psychologists, and peers.

4. **Promote inclusion for teachers from marginalised groups.** Any EdTech initiative must ensure that teachers from marginalised groups are adequately supported in their teaching practices and professional development (e.g., through adapting initiatives for teachers with disabilities). Supporting teacher diversity is both an end in itself and a means to achieving greater equity throughout education systems broadly.

5.3. Curriculum and assessment adaptation

5. **EdTech must be flexible and enable adaptation.** The learning needs of all learners are diverse, plentiful, and change over time. EdTech interventions need to be able to support education systems in effectively catering for the diverse and changing needs of learners (e.g., through content creation or providing learning materials in marginalised languages). EdTech content, nonetheless, needs to be

vetted to ensure adequate alignment with the national curriculum, and relevant, representative, and inclusive content.

6. **EdTech must support formative assessment and enable access to assessment.** EdTech must be applied to support educators to undertake formative assessments — including in classrooms — and connect to district / national monitoring and evaluation initiatives to provide timely feedback on individual learners' needs. EdTech should additionally be used to provide opportunities for adaptation to ensure that assessment processes can accommodate diverse learner needs.

5.4. Participatory and integrated approaches

7. **Democratise EdTech interventions by involving the end-users in the design of any intervention.** A user-centric and participatory design should be used to better reflect the particular needs of the end-user (e.g., particular challenges they may experience or their capacity for usage). This inclusive design would need to give end-users genuine power to make decisions throughout the process, from start to finish. This would enable the technological device or intervention to be designed in a way that ensures maximum impact for the particular needs of those users.

8. **EdTech actors need to work collaboratively both with neglected parts of the education system and other sectors.** Taking a whole-sector approach will benefit the most marginalised learners given that they are more likely to be situated outside of the formal education system. Moreover, they face intersecting disadvantages which require support beyond the education sector. Such an approach will also help with efficiency issues related to technology-related investments.

5.5. Finance and resources

9. **Governments and donors must adopt a progressive universalism approach to present and future funding for the EdTech sector.** Public funders will need to target EdTech funding in a way that prioritises those levels of education where marginalised groups are concentrated, and where the focus is on those technological devices which have demonstrably been shown to have significant impact on the access and learning outcomes of marginalised groups.

10. **Public funders must incentivise the private sector to invest in EdTech products and services that serve marginalised learners effectively.** Partnerships between governments and donors with the private sector

will be important in ensuring that EdTech reaches the most marginalised learners. The private sector can be supported and incentivised through external public subsidies in meeting the costs incurred in targeting marginalised learners. Added to this, the private sector can help governments and donors make available EdTech products suitable for marginalised learners in contexts where they would otherwise be unmet.

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