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PREPRINT

Using Technology to Improve Education for Marginalised Girls

Lessons in implementation from the Girls' Education Challenge

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Abstract

This article presents the findings of an in-depth study on the implementation of six EdTech-supported projects within the UK Government Foreign, Commonwealth and Development Office (FCDO)'s Girls' Education Challenge portfolio, which aims to improve education for the world's most marginalised girls. Using primary key informant interviews and secondary data from sampled projects, the study identifies the core components related to the implementation of EdTech within the sampled projects: evidence-informed design and delivery; building and maintaining relationships across and between stakeholders; comprehensive and continuous training and capacity development; and situating EdTech within a broader holistic model that prioritises gender inclusion to optimise implementation for marginalised girls. In doing so, the study provides key lessons for optimising the future implementation of EdTech for marginalised girls.

Keywords

Educational technology, Girls' Education, Programme Implementation, Covid-19

1. Introduction

Providing equitable access to quality education for girls is a well-documented significant challenge, and an agreed priority within the international education donor community. The use of technology within education may offer alternative means for girls to access and make progress in education. Though more evidence is needed regarding the most effective uses of technology for girls' education (Dahya, 2016), a small number of studies have considered the impact of EdTech solutions specifically on girls in low- and middle-income countries (LMICs). In their rapid evidence review, Webb et al. (2020) found that access to technology in education is often disproportionately more empowering for girls and women than for boys and men (see also Ferreira, 2017; Khan & Ghadially, 2010). Pitchford, Chigeda & Hubber (2019) also found that EdTech may be useful for mitigating gender differences in attainment. However, there is an ongoing and complex set of digital divides in LMICs, which are often rooted in cultural gender bias (GSMA, 2021; Price, 2020 Steeves & Kwami, 2017 as cited in Webb et al., 2020), meaning that girls often have comparatively less

access to digital devices. In such contexts, technology stands to exacerbate access and equity issues for girls' education (Basavaraja & Sampath Kumar, 2017; Damani et al., 2021).

This mixed picture of the impact of EdTech on girls' education is also observed in available evidence from the recent Covid-19 pandemic and associated widespread school closures, which instigated a rapid proliferation of EdTech use to support remote learning in LMICs and beyond. Evidence is steadily building to suggest that inequality of access to education for girls intensified during the Covid-19 pandemic, arguably in large part due to the increased reliance on technology for learning access (Aslam et al., 2021; Crompton et al., 2021). However, other evidence suggests that levels of participation in remote learning were higher in some contexts for girls than they were for boys (e.g., Young Lives, 2020).

There has been some engagement with aspects of implementation as part of broader discussions in the literature, all of which point to the importance of tailoring EdTech implementation to support successful outcomes for marginalised girls. Existing literature argues that, when developing and delivering EdTech interventions, infrastructural limitations must be carefully considered (Allier-Gagneur et al. 2020), interventions must be contextually appropriate and applied according to sound pedagogical principles (Tauson & Stannard, 2018), and equity must be foregrounded (Crompton et al., 2021). However, there is an enduring lack of studies dedicated to examining the implementation processes that feed into the effective delivery of EdTech interventions for girls in LMICs. Given that available empirical evidence from the broader literature indicates that quality of implementation in education has a statistically significant impact on outcomes (Moir, 2018; Outhwaite, Gulliford, & Pitchford, 2019; Wijekumar, Meyer, & Lei, 2013) and that implementation affects intervention outcomes in numerous and varying ways (Durlak & DuPre, 2008), there is, therefore, a pressing need for further research in this area.

In response to this gap in the literature, this article presents the findings from a study examining the implementing factors that have facilitated the effective delivery of EdTech interventions and contributed to successful outcomes in six projects within the Girl's Education Challenge's (GEC)

portfolio of programmes. The GEC[1] is the UK Government Foreign, Commonwealth and Development Office's flagship investment in girls' education, which was established to address barriers to quality education for marginalised girls. The study addresses two main research questions:

RQ1: What are the key factors relating to the implementation of EdTech interventions within GEC programmes that have facilitated successful implementation and intervention outcomes for marginalised girls?

RQ2: What lessons relating to the implementation of successful EdTech interventions within the GEC can be harnessed to optimise the implementation of future programmes for marginalised girls?

3. Analytical approach and methodology

The following section outlines the analytical approach adopted for the study, as well as the methods used. The study uses a "multifaceted approach" to researching implementation (Century & Cassata, 2016, p. 182), combining information from project designers, implementers and other experts with a review of programme documentation and reports. The analytical approach and methodology have therefore been designed in a way that "recogni[ses] and account[s] for complexity rather than reducing it" (Century & Cassata, 2016., p. 203).

3.1. Analytical approach

The analytical approach to this study was developed using key concepts from implementation research. Following Century & Cassata (2016), the approach is divided into two interrelated parts: (i) characteristics of the innovation – i.e., conceptualising and describing each innovation, and (ii) influential factors – i.e., identifying and organising the "contexts, conditions and characteristics that influence innovation enactment" (2016, p. 181). To examine these key influential factors, the study uses Fixsen et al.'s (2005) concept of 'core components for implementation' for evidence-based

[1] The GEC aims to improve the educational opportunities for up to 1.6 million marginalised girls, working in 17 countries across Africa and Asia. The first phase of the GEC ran from 2012 to 2017, and the GEC is now in its second phase (2017–2025). See https://girlseducationchallenge.org/about/ for more information.

programmes, which was developed based on a systematic synthesis of the implementation science literature. These core components do not exist in isolation, however. They interact with both organisational components and external influencing factors to produce implementation outcomes (Fixsen et al., 2005). It is also well-established across the literature in implementation science that implementation should be considered as a 'stage-based process' (Albers & Pattuwage 2017) rather than an event, with an understanding that, while overlapping, the different stages of an intervention have their own dynamics and factors that facilitate or hinder successful implementation. Based on these aspects of implementation science theory, an analytical framework was developed (see Table 1) to provide a structure for the organisation of implementation data for this study.

<table>
<tr><th colspan="4">Influential factors at the different phases of implementation for GEC projects</th></tr>
<tr><td>Exploration and preparation (the design and planning phase of the project)</td><td>Implementation (the phase during which the original programming was implemented)</td><td>Covid-19-adapted implementation (the period of school closures during which the intervention was adapted)</td><td>Sustainability (planned or actual implementation of EdTech activities beyond the project's completion)</td></tr>
<tr><td colspan="4">Core implementation components
What were the key implementing components related to the EdTech element(s) of the project during the given phase of implementation?</td></tr>
<tr><td colspan="4">Organisational components
What were the key organisational components affecting the EdTech intervention during the given phase of implementation?</td></tr>
<tr><td colspan="4">External influencing factors
What were the key external influencing factors that affected delivery during the given phase of implementation?</td></tr>
</table>

Table 1: Analytical framework of influential factors in implementation

3.2. Project selection

A shortlist of projects to include within the study was developed based on emerging findings from the GEC's Value for Money (VfM) report on EdTech within the GEC (Shah & Sidhu, 2023), with a specific focus on programmes that were identified through the VfM analysis as providing 'good' or

'promising' value for money.[2] The study follows a 'positive deviance' approach to sampling (UNICEF, 2022) by exploring how specific GEC programmes managed to overcome complex problems inherent to administering EdTech interventions for marginalised girls to produce successful outcomes (McKay, 2017). Out of seven projects approached, six responded positively. The final list of projects included in the study is shown in Table 2 below.

Name of project[3]	Lead organisation	Location	Dates active
The Discovery Project 2 (DP2)	Impact(Ed)	Kenya, Ghana, Nigeria	Apr 2017–Dec 2020
GEARR-ing Up for Success After School (GEARR)	Promoting Equality in African Schools (PEAS)	Uganda	Apr 2017–June 2021
Inclusive Education in Kenya's Lake Region (IE)	Leonard Cheshire	Kenya	April 2017–Mar 2022
iMlango Transitions (IMlango)	Avanti Communications	Kenya	Apr 2017–June 2021
Making Ghanaian Girls Great! (MG3)	Plan International	Ghana	May 2017–Jan 2022
Let Our Girls Succeed – Wasichana Wetu Wafaulu (WWW)	Education Development Trust (EDT)	Kenya	May 2017–Mar 2023

[2] Cost-effectiveness is addressed in the GEC portfolio via a primarily qualitative comparison of the relative VfM of the different types of interventions by Shah & Sidhu (2023). This assessment considers cost as it relates to FCDO spending and reflects an explicit emphasis on contextualised, rather than comparable costs and outcomes.

[3] The bracketed term is how the project is referred to throughout the report.

Table 2. GEC Projects included within the study

3.3. Research methods and data analysis

The study used a multi-method approach, combining primary and secondary data sources to address the research questions. The study drew on two main secondary data sources for the sampled projects, including:

1. GEC project and portfolio documentation related to technology for the sampled projects.
2. GEC baseline, midline, and endline evaluations for the sampled projects.[4]

All project documents were reviewed, with relevant data extracted and organised according to the study's analytical framework. Following the document review, primary qualitative data collection was conducted for the six selected projects, which included:

1. Semi-structured interviews with stakeholders from five GEC projects
2. A focus group discussion (FGD) with four stakeholders from the IE project[5]
3. An FGD with nine key informants from the GEC portfolio level and a follow-up interview with one portfolio-level staff member

Informed consent was obtained for all interviews and FGDs, which took place remotely, using GoogleMeet. Primary data was cleaned, organised according to the analytical framework, and systematically coded to establish sub-themes within the data, which were then grouped into broader cross-cutting themes.

This analysis and contribution to the conversation on the implementation of EdTech for marginalised girls reflect a holistic and primarily qualitative assessment of the implementation factors driving successful outcomes, supplemented with quantitative data where available. While providing significant insight and learnings, the unique contexts of the individual projects, as well as the context of adaptations being made due to the Covid-19 pandemic, mean that caution should be exercised when it comes

[4] All of these are publicly available via the GEC website (https://girlseducationchallenge.org/). Links to specific documents are also included within the Bibliography section of this paper

[5] An FGD was carried out for this project at the request of the project.

to external application or generalisability of the learning presented in this study.

4. Effective EdTech innovations within the GEC: characteristics and outcomes

In order to frame and contextualise the subsequent cross-project analysis of core components in the implementation of the sampled projects, it is important to first describe the projects and the EdTech innovations within them, as well as the availability and strength of evidence related to their effectiveness. The following table (Table 3) details the key characteristics of the specific EdTech innovations within each project, covering both the original project programming (where applicable) and adaptations made to the projects to support distance learning during the Covid-19 pandemic. Along with this, the headline outcomes for each project are provided from midline (ML) and endline (EL) evaluations to give an indication of the impact that each project had overall. This data relates to the impact of projects as a whole, including both technology-based and non-technology-based components, and is primarily focused on learning and transition. In addition, the table details the VfM rating for the project's EdTech components as determined by Shah & Sidhu's (2023) recent analysis of the VfM of EdTech across the GEC.[6]

Name of Project	Core innovation components	Headline outcomes and VfM rating
DP2	Original EdTech programming: Media centres in schools equipped with smart TVs and DVD players, educational video content, including life skills (through the *My Better World* series – MBW), literacy and numeracy, and other subject content; TV broadcast distribution	Outcomes: Large positive impacts on girls' learning found via learning assessments in Nigeria and Wajir (Kenya) at midline. No learning assessment data available from endline, but teachers reported improved performance and learning

[6] While projects were selected for inclusion in this study because of their relative effectiveness and VfM within the GEC, it is important to acknowledge that very limited quantitative data is available from projects that can isolate and causally link EdTech components to specific outcomes. It is also important to note that because of Covid-19, most projects were unable to carry out their endline evaluations as planned, and there is therefore a lack of standardised learning assessment data that speaks to overall learning outcomes.

Name of Project	Core innovation components	Headline outcomes and VfM rating
	of MBW; TPD delivered through Cell-Ed platform to basic phones. Covid-19 adaptations: Library of educational content for national educational TV programming across the 3 implementing countries; MBW series was adapted for radio in Wajir, Kenya, and Kano, Nigeria; English and mathematics courses for cohort girls through Cell-Ed platform, accessed through caregivers' phones; distribution of learner packs in Ghana.	for girls. Internal monitoring also showed significant learning gains post-midline in Ghana and Nigeria (not measured in Kenya). Evidence that girls' clubs and MBW supported positive change in self-efficacy and life skills at endline. VfM rating: **Good VfM** – driven by the project's reach and impact during the Covid-19 pandemic.
GEARR	Original EdTech programming: None. Covid-19 adaptations: Phone call-based support (telephone trees); radio lessons broadcast at the district level; SMS messaging (including a pilot of an SMS learning tool); paper-based learning packs.	Outcomes: Learning assessment data at midline not relevant to present study. No learning assessment or exam data available at endline but self-reported improvements in learning linked to radio (girls), SMS (boys and girls) and telephone calls (boys). VfM rating: **Promising VfM** – Low cost-per-beneficiary ratios for EdTech components, but limited by lack of learning assessment data to understand impact.
IE	Original programming (Assistive Technology and Innovation Project (ATIP) emerged as a subproject within the IE project in Jan 2019): Distribution of Orbit Readers (for note-taking in braille) to schools for visually impaired learners;	Outcomes: Girls with disabilities improved their literacy and numeracy scores between mid- and endline and students maintained learning improvements throughout

Name of Project	Core innovation components	Headline outcomes and VfM rating
	distribution of laptops with assistive Clicker 8 (a multisensory tool for dyslexic learners) and Dolphin Supernova (screen magnification and braille support) software packages; online training for teachers and other stakeholders on the devices, and software through WhatsApp and Google Meet. Covid-19 adaptations: Distribution of solar radio sets to children with visual impairments and vulnerable households; SMS messaging; phone call-based support; distribution of information packs; local radio programmes on health and well-being.	the Covid-19 period. At midline, there was a statistically significant association between experiencing a successful transition and not having a disability, but by endline this was no longer the case, and both groups transitioned at similar rates. VfM rating: **Promising VfM** – provision of assistive devices was found to be cost-effective relative to specialist schools; Orbit readers provided VfM relative to other devices performing a similar function.
iMlango	Original EdTech programming: High-speed satellite broadband connectivity and IT resources, including school computer labs and projectors; delivery of digital learning content through the iMlango digital portal, including individualised simulated maths tutoring and whole-class maths content (via Maths Whizz), digital learning content for literacy and life skills (via Longhorn); electronic smart cards for digital attendance monitoring. Covid-19 adaptations: Development of an Android app and adaptation of content on the iMlango portal to be accessible through the app; WhatsApp groups between	Outcomes: Project activities led to improved learning outcomes (endline), although Covid-19 school closures were a significant hindering factor and led to learning losses. Learning assessment data not available at mid- or endline. Self-reported evidence of learning gains in literacy and numeracy at endline, although national exam (Kenya Certificate of Primary Education) results showed significant variation across the four counties. VfM rating: **Promising VfM** – lacking VfM in its current

Name of Project	Core innovation components	Headline outcomes and VfM rating
	caregivers and teachers to disseminate distance learning materials.	iteration due to high cost-per-beneficiary driven by internet connection and maintenance, licences for content, and field staff, but a new model is anticipated, which lowers costs substantially.
MG3	Original EdTech programming: Solar-powered and satellite-enabled distance learning infrastructure (projector, modem, computer, solar charger) broadcast from studios in Accra to deliver interactive learning sessions to students, teachers, communities, and government officials. Covid-19 adaptations: Use of project infrastructure to create content for the government's Ghana Learning TV (GLTV), distribution of hardware (TVs and decoders); phone call-based support (learning conversations); radio-based back-to-school campaign.	Outcomes: statistically significant increase in learning outcomes through learning assessments at midline. At endline, exam data showed statistically significant improvements for girls in both maths and English. Statistically significant improvement in transition rates at endline. VfM rating: **Good VfM** – relatively high costs offset by project reach (>3 million children across Ghana) and impact during the Covid-19 pandemic.
WWW	Original EdTech programming: Distribution of tablets and projectors to schools as part of a strategy of integration of ICT for learning in classrooms and digital attendance monitoring. Covid-19 adaptations: Distribution of solar radios; awareness-raising on the Kenya Institute of Curriculum Development (KICD) radio lessons; local radio talk shows to guide caregivers on how to support girls'	Outcomes: Endline findings are not yet available. Covid-19 adaptations were deemed effective by a Rapid Assessment Study commissioned by the project; girls' numeracy and literacy scores showed no loss of learning in numeracy and minimal loss in literacy. VfM rating: **Promising VfM** in relation to Covid-19

Name of Project	Core innovation components	Headline outcomes and VfM rating
	learning at home; sharing of learning materials via coaches and teachers to caregivers through bulk SMS and WhatsApp; distribution of paper-based materials for learning; facilitated community-based learning in small groups.	adaptations, driven by low cost-per-beneficiary of radio component, although data linking radio with outcomes is mixed.

Table 3: Overview of core EdTech components and outcomes across sampled projects

Table 3 above demonstrates the diversity of EdTech components and activities implemented across the sampled projects, as well as some variation related to the strength of outcomes and VfM. However, to different extents and using a range of metrics, projects generally demonstrated positive associations between EdTech components, learning and transition outcomes for marginalised girls, and VfM. The cross-project thematic findings on implementation, which follow this section, focus on the influential factors (the 'how' and 'why') behind the relative successes of these EdTech-supported projects.

5. Cross-project thematic findings on implementation

This section presents a cross-cutting discussion of the influential factors – i.e., the "contexts, conditions and characteristics" (Century & Cassata 2016, p. 181) that influenced EdTech implementation across the sampled projects and that were identified as contributing to the effective use of EdTech in improving learning for marginalised girls. These themes are:

1. Evidence-informed design and delivery
2. Building and maintaining relationships across and between stakeholders
3. Comprehensive and continuous training and capacity development

4. Situating technology within a broader holistic model that prioritises gender inclusion to optimise implementation for marginalised girls.

Detailed sub-themes and findings related to all these aspects are presented in the subsections below.

5.1. Evidence-informed design and delivery

5.1.1. Assessment of existing infrastructure, capacity, and context

There was a strong, perceived need across projects to clearly understand the infrastructural context in which they would be operating, and to plan EdTech interventions accordingly. This included mapping existing infrastructure within schools (DP2, WWW), exploring government plans for device and infrastructure provision (DP2), and gathering data on the physical infrastructure of schools (iMlango). DP2 foregrounded sustainability considerations when selecting devices for video content diffusion; TVs and DVDs were ultimately chosen as they were "the most usable and sustainable, and easy to resource locally" (DP2 project staff member). Relatedly, infrastructure and connectivity were identified by participants as key external factors affecting implementation; the pre-existence of reliable infrastructure and connectivity was either identified as a facilitating factor (DP2, MG3, IE, WWW), or the lack thereof as a hindering factor (iMlango, MG3, DP2, WWW).

In the design of their Covid-19 responses, projects (DP2, GEARR, IE) also noted that gathering evidence related to infrastructure and context was crucial to ensuring that EdTech components were contextually appropriate and designed to reach the most marginalised end-user. For example, GEARR gathered evidence on the reach and cost of different technology options and based their design choices on this data. In contrast, the dangers of not having strong data to inform the design of the Covid-19 response was highlighted by iMlango. Project staff described how they were working from inaccurate data on the number of households with smartphones, which was projected to be much higher than it actually was. As a result, they pooled all of their resources into the development of an app which ultimately saw very low uptake among students.

There were also references to assessing school leadership quality (iMlango) and teacher capacity (DP2) during the design phase. Though a less

prominent element of evidence-building across the sampled projects, the project completion report for DP2 suggested that "a deeper assessment of teacher professional development and learner needs at the outset would better enable more immediate tailoring of content to each context."

5.1.2. Consulting community, centring their views and needs

Taking a contextual, community-informed approach to evidence building in the project design phase emerged as a key implementing factor in some programmes. On the content side, DP2 engaged in what they described as "human-centred content design" for their *My Better World* video series. This approach involved gathering young people in the intervention countries together to feed into the initial story design and to review the scripts and the rough-cut animatics to make sure they were contextually relevant. One project staff member felt that this was one of the key reasons why the popularity and uptake of *My Better World* far surpassed expectations.

On the programming side, the importance of detailed needs assessments to reach the most marginalised girls was emphasised in the GEC's VfM analysis as one of the drivers of value for money in EdTech. This is highlighted through projects' approaches to hardware distribution during Covid-19 school closures. MG3, IE and WWW all referred to using data in order to appropriately target limited resources for hardware distribution to the most marginalised students during the Covid-19 pandemic. For example, MG3 carried out a mapping exercise to determine which students within their cohort did not have access to TVs or decoders within their households and targeted the provision of this hardware, prioritising children with disabilities, girls at risk of drop-out, and households with multiple MG3 students (MG3 project staff member).

5.1.3. Feeding internal and/or external knowledge and experience into design

Interview data suggested that lessons from organisations' prior experience had fed into the design and implementation of GEC-T. DP2 staff explained that their extensive experience of using educational media as a tool for classroom learning over many years and LMICs had been crucial when designing their GEC programme. One iMlango interviewee extolled the importance of having partners with significant educational expertise in order to drive a holistic approach to EdTech, while an IE interviewee

emphasised the importance of engaging partners with lived experience (and therefore profound knowledge) of disabilities: “Edit Micro [IE Implementing Partner] employs people with visual impairments to run the Dolphin Supernova [software], so they really understand their requirements and the reality on the ground.”

As one of the few projects that did not include EdTech before the Covid-19 pandemic or have prior organisational experience with EdTech, the use of external evidence in the development of GEARR’s Covid-19 response was considered crucial. All GEARR interviewees emphasised that the choice of EdTech components was based on a range of externally sourced literature on distance or out-of-school learning for at-risk groups or those affected by similar contexts, such as the 2014–16 Ebola outbreak in West Africa. Reviewing literature and evidence on an ongoing basis as it was emerging during the Covid-19 pandemic was also an important component of GEARR’s evidence-based approach. Alongside this was more informal information-gathering, including speaking to other organisations about their plans and sharing content.

5.1.4. Ongoing, multi-layered monitoring and evaluation as a driver for productive adaptations

Having strong, multilayered monitoring and evaluation (M&E) processes was seen across all sampled projects to be critical to effective implementation, both during normal programming and during the Covid-19 school closures. The methods, tools, and target of this monitoring were diverse, with some use of more innovative, technology-enabled monitoring alongside other, more conventional forms of M&E. M&E practices included regular assessments and school visits by local staff to observe implementation and gather feedback (iMlango, WWW, IE), and to assess the condition of technological devices (IE); monitoring of EdTech-supported teaching and lesson observations by project staff (iMlango, MG3, WWW) and Ministry of Education (MoE) staff (WWW); opportunities for teachers to provide feedback through teacher cluster meetings (WWW); regular face-to-face check-ins with head teachers (MG3).

Having the scope for productive adaptations based on this M&E data was considered key to improving implementation throughout the project cycle. Indeed, there were countless examples within project documents and interviews of adaptations made based on M&E data, both before and

during the Covid-19 pandemic. Some project staff (IE, WWW, iMlango) referred specifically to the intentional embedding of iterative, agile approaches to implementation within their projects. The cumulative impact of these adaptations on outcomes for iMlango was reported to be significant, with one staff member asserting that through the use of continuous data to drive "intelligent course correction", they were able to make a further 87% improvement in learning yields over two years. The GEC's VfM analysis also identified the ability to make adaptations based on flexibility and real-time monitoring as an important driver of VfM in EdTech. But while iMlango staff were extremely positive about the potential for EdTech to provide continuous, real-time student progress data to feed into adaptations, one staff member was equally emphatic about the value of having locally embedded staff to ensure that this data is interpreted correctly: "You can misinterpret data alone, but people on the ground could give the stories behind the data."

Having clear and tangible evidence on the impact of activities was also identified by DP2 as key to ensuring sustainability at the system level. The "ability to demonstrate the success of project activities tangibly with a clear vision of how these activities present an added value over and above what is already occurring in schools" was stated to be critical to government buy-in and sustaining project activities (DP2 Endline Evaluation).

5.2. Building and maintaining relationships across and between stakeholders

5.2.1. Engaging with government at all levels for impact and sustainability

The DP2 Endline Report found that, alongside the ability of the project to demonstrate proof of their EdTech concept, "systematic efforts to engage government at different levels" were crucial to successful implementation. According to the Endline Evaluation, the project developed a close working relationship with the Nigerian government, which led to shared sustainability planning and the take-over of the project's Accelerated Learning Programme activity by the State Universal Basic Education Board.

The particular importance of working closely with the MoE at the local level was highlighted in the DP2 Project Completion Report; these relationships were reported to "cultivate ownership, ensure coordinated and

collaborative implementation, and increase prospects for long-term sustainability." For the DP2 project, this was achieved through regular meetings with district teams to report on progress, work through challenges, and agree on plans going forward, as well as participation in project training, monitoring, and support for schools. One MG3 staff member also described the importance of the 'several rounds' of face-to-face engagement that they undertook with DEOs to ensure buy-in at the district level. In parallel, an iMlango project staff member identified a lack of MoE involvement at all levels as a key gap in their project implementation, adding that, in hindsight, they should have provided regular updates to local MoE staff to improve local government buy-in.

Existing strong relationships between GEC projects and the national government emerged as key to maximising projects' impact and influence during the Covid-19 pandemic; as a result of these relationships, these projects were engaged as key partners in national Covid-19 education responses (MG3, DP2). MG3's experience during the pandemic also demonstrates how strong relationships between Gender Equality and Social Inclusion-focused (GESI) projects like MG3 and national governments can enhance the potential for EdTech to boost systemic inclusivity. One portfolio staff member highlighted how MG3's policy of incorporating sign language interpretation in their TV shows during the pandemic has since been adopted as standard practice by the government's distance learning agency (CENDLOS).

5.2.2. Community engagement in EdTech implementation

> "For many years we talked about a three-legged stool [in EdTech] – everybody gets excited about the tech, but then it's like, what is the content and what training is going with it? But really, the fourth leg is the community engagement – how are the families and the local community engaged? Are they excited about what's happening and know what's going on?" (DP2 project staff member)

As illustrated by the above quote, the importance of community engagement emerged as a key theme in project staff interviews. Interviewees noted a focus on building relationships with various community stakeholders such as school leaders, teachers, PTAs, and

broader community members as part of project preparation (MG3, DP2).[7] With regard to teacher buy-in, situating the EdTech components within the wider learning context (IE) and framing the EdTech as an enhancement to their teaching rather than an additional burden (MG3) or something that was going to replace teachers (iMlango) were reported by interviewees as key to building trust with teachers. One DP2 staff member also emphasised the benefits of entering communities with "a listening ear and immense degree of humility" and building relationships on that basis. Finally, two projects (iMlango, DP2) described the usefulness of processes established during the preparation phase to establish schools' formal commitment to the project; DP2 drew up memorandums of understanding (MoUs) with schools to ensure the upkeep, security, and sustainability of technological equipment.

Project staff also noted the value of allowing for broader community use of technological devices to increase community buy-in and sense of ownership of EdTech projects (DP2, MG3, iMlango). One DP2 project staff member explained that, in their most rural implementing location (Wajir county), where communities may have had no prior access to TV, they decided to make schools "centres for community viewing" of TV programmes. "It brought the school together [...] and made schools think of creative ways of protecting the equipment, owning the project and ensuring that the project is sustained" (DP2 project staff member). As part of their approach to ensuring teacher and head teacher buy-in, iMlango also provided scope for school staff to access the internet more generally (use for students was restricted to the iMlango portal), with one staff member suggesting that without this, school leadership "would have never allowed the internet in schools."

5.2.3. Multi-actor collaboration and coordination

The effectiveness of robust project management and coordination strategies, both internally between different project staff and when engaging with multiple external providers (e.g., satellite providers), was highlighted as a key aspect of implementation by MG3 project staff. Conversely, iMlango project staff saw ineffective coordination as one of the factors that impeded the successful implementation of their project, with one project staff member noting that, while there was communication

[7] N.B. Some of this relationship-building took place during the first phase of the projects (GEC-1).

between project partners, on-the-ground implementation was very disjointed, and there was no sense of a 'whole project' approach: "We did talk to each other on the project management level, but the reality on the ground was that we were working in silos. We might as well have been separate projects." As a result, staff noted that school actors were susceptible to receiving conflicting instructions from different partners, leading to confusion and compromising trust in the project overall.

The importance of strong coordination with external stakeholders was also emphasised in project documentation from the IE project. By working in close coordination with the government's Educational Assessment and Resource Centres (who are responsible for screening assessments and support planning for children with disabilities), establishing relationships with special schools to provide ongoing support for learners and teachers using Orbit Readers, and involving members of organisations of persons with disabilities, the project was judged to have "demonstrated the value of teamwork, engagement, partnership, networking, or exchange programmes in building the ecosystem to support effective ICT for inclusive education" (IE internal documentation).

5.2.4. The enduring importance of human relationships to support learning with EdTech

In a variety of ways, sampled projects demonstrated that interpersonal relationships were crucial to supporting learning with EdTech. Nowhere was this better evidenced than during the Covid-19 school closures, which exposed the limits of independent, tech-supported study. Research conducted on GEARR's Covid-19 response, as well as the project interviews, highlight the importance of both caregivers' involvement and general human interaction in supporting girls' learning during the pandemic (Damani et al., 2021). Restrictions on movement during the pandemic meant that community embeddedness and existing strong relationships were vital for continued student engagement (MG3, DP2, IE, WWW, GEARR). In the case of WWW, the project came to rely heavily on community health volunteers (CHVs) and community-based remedial teachers (who were familiar and therefore unthreatening to students and families) for maintaining communication with students during closures and following up on their radio learning.

In relation to caregivers, MG3 and WWW project staff members both noted the importance of caregiver support for girls' learning during the pandemic and highlighted its absence within some households, suggesting that this was in many cases linked to caregiver illiteracy, due to which caregivers may have lacked both the inclination and confidence to support their children with learning. Staff from GEARR, iMlango, and WWW also emphasised the significant challenges presented by negative caregiver attitudes, especially during the Covid-19 period. iMlango, WWW, and MG3 staff members noted that given that many students shared devices with their family members, negative caregiver attitudes could often reduce girls' device access and, therefore, their ability to engage in project activities. Significantly, given persisting negative attitudes towards female education in many areas, caregivers reportedly expected girls to prioritise chores over their home learning, reducing their ability to focus on their studies (GEARR, WWW).

For GEARR, WWW and MG3 staff, raising awareness and assisting caregivers to support their children's education during school closures was therefore considered a vital part of their Covid-19 response. In particular, GEARR staff emphasised how regular contact with caregivers (introduced as an adaptation following feedback) was key to assuaging culturally motivated concerns about girls receiving phone calls from teachers, making caregivers more comfortable with this aspect of the projects' Covid-19 response. A community-based group learning initiative implemented by WWW during the pandemic was also seen to be a key mitigator of negative caregiver attitudes towards learning, as it "shielded [girls] from household distractions" (WWW project staff member).

Research conducted on the efficacy of WWW's Covid-19 response also confirms the importance of peer relationships in driving learning during pandemic; according to research conducted by EDT and the EdTech Hub, radio lessons were not associated with higher performance in reading and mathematics *except* where girls listened to the radio in groups (Amenya et al., 2021). WWW project staff elaborated on this, explaining that students were able to complete the assignments set during radio lessons and then discuss answers in their groups, which helped them sustain learning and motivated them to learn. However, it is worth noting that some projects (DP2, iMlango) felt that group learning was not an option during the pandemic due to the health risks involved.

5.3. Comprehensive and continuous training and capacity development

5.3.1. Training multiple stakeholders

School actors were identified as having a strong influence on project engagement and, therefore, overall implementation. iMlango and DP2 project staff members highlighted the importance of projects being backed by supportive head teachers: "the head teacher was the crucial component, hands down every time" (iMlango project staff member). This is likely due to the belief that attitudes from the top of a hierarchical structure such as a school inevitably trickle down and set the tone for the rest of the school community. Relatedly, interviewees underscored the importance of extending training to a variety of project stakeholders other than teaching staff, including head teachers, community members, government officials, project staff, and trainers themselves (DP2, MG3, iMlango). In the case of DP2, project staff reported the success of informally mapping *My Better World* video content to community needs as part of DP2 mentor training – something that had the potential to be transferred to community members themselves (DP2 project completion report). This would not only ensure that content was fully relevant to its viewers but would also enable sustainability beyond the project lifespan. In addition, and also in the interests of sustainability, another DP2 project staff member spoke of the importance of training "MoE and TSC colleagues in the area, so anytime they [went] into the schools they could support and check whether the project is ongoing."

5.3.2. Training as an ongoing, adaptive, and differentiated process

A common observation among interviewees was that, in order to lead to meaningful EdTech adoption, training cannot be delivered as a one-off exercise; rather, initial input needs to be complemented by a series of follow-up activities to consolidate learning (DP2, IE, WWW, MG3, iMlango). Project staff from IE, MG3, iMlango and DP2 noted the significant value in providing space for teachers to access training materials after training and ask follow-up questions, with interviewees highlighting the benefits of using technology to support this ongoing training. While for IE, MG3 and iMlango, this was done via WhatsApp, DP2 used the Cell-Ed platform, where teachers could review training content and trainers could pick up teachers' questions and respond to them at the next school visit. In a

similar vein, iMlango, IE, and MG3 project staff all noted the importance of virtual peer support groups (via WhatsApp), which enabled teachers to receive support that was relevant to their experience and confidence levels; those struggling with an aspect of technology adoption could appeal to more confident technology users within the network to have their particular problem addressed.

Levels of teacher and school leadership confidence with, and enthusiasm for, EdTech, were reported to be a key factor that could facilitate or hinder the implementation of EdTech components (iMlango, DP2, IE, MG3). iMlango, DP2, and IE staff emphasised that student engagement with EdTech was dependent on individual teachers' enthusiasm and confidence. Both in relation to head teachers and class teachers, enthusiasm for EdTech implementation often correlated with teachers' digital literacy and confidence, which in turn was often related to their age (MG3, iMlango). Older teachers were less likely to be interested, perhaps due to being less familiar and less confident with, or even threatened by, technology in general, while younger teachers "were more open to technology and understood the importance of it – it made all the difference" (iMlango project staff member). In light of these differences, project staff (DP2, IE) indicated that training teachers to integrate EdTech into their practice may be most effective when it is adaptive and individualised to teachers' needs.

Demonstrations and modelling also emerged as a particularly successful way of transferring EdTech knowledge and skills to teachers and other project stakeholders (iMLango, MG3, IE, DP2). In particular, DP2 and iMlango project staff both commented on the utility of identifying more "tech-savvy" teachers to demonstrate how to use EdTech resources to other teachers, with an iMlango staff member adding that this was optimised by immediate opportunities for individual practice following demonstrations.

5.3.3. Focusing on GESI and other training needs alongside training on EdTech integration

While many interviewees focused their comments on efforts to improve teachers' digital literacy and confidence, several also noted the importance of addressing other training needs in parallel with EdTech-specific training. Given the GEC's focus on inclusion, GESI training was unsurprisingly a core training component and crucial for ensuring equitable access to EdTech (MG3, IE, DP2, iMlango). One IE staff member, for example, referred to

asking teachers to study Massive Open Online Courses on how to work with visually impaired students ("just the use of tech says nothing if you don't know how to approach a child with a VI educationally"). For iMlango, GESI training had a direct impact on student access to EdTech; as one staff member explained, "to start with, boys would push to the front [in ICT classes], so [the GESI trainer] taught the teachers to line students up to keep things fair." A similar observation was made during an interview for the iMlango Endline Evaluation: "at the beginning of the project, in most cases, boys were accessing the portal more than girls. In response, gender balance aspects were introduced to lessons, and teachers were encouraged to take more control. This led to greater success in ensuring equal portal access between boys and girls."

Beyond GESI awareness, in one case, it emerged that a lack of subject knowledge was preventing teachers from successfully using EdTech in their classrooms. One iMlango staff member noted that a lack of numeracy skills combined with a lack of confidence with the new technologies had resulted in teachers trying to avoid using the tech, which they felt would further expose their lack of knowledge. The staff member noted that doing extra maths training with the teachers in question subsequently "made a big difference" in terms of increased willingness to use technology in the classroom.

5.4. EdTech as a means, not an end – the importance of situating EdTech

5.4.1. Designing inclusive, contextualised EdTech content within a holistic model

One way in which projects were able to ensure that EdTech was used in the service of inclusion was through gender-sensitive, inclusive, and contextually appropriate content design. GEARR project staff cited examples of how they had designed radio show content to be inclusive and relevant to their marginalised female students during the Covid-19 pandemic. They challenged gender stereotypes by featuring girls in a variety of stereotypically male professions within radio programming, and made girls' after-school aspirations a broadcast focus. Similarly, DP2

subtitled video content and reviewed all content using Wizenoze software[8] to check that it was suitable for students with low literacy levels.

Beyond technology selection and content, project staff (IE, MG3) also noted the importance of delivering EdTech components and accompanying activities as part of a holistic model that views stakeholders as individuals with multiple needs and facets. One MG3 project staff member explained how students who had recently become mothers were invited to come to live lessons "with their babies, and nobody could treat them inappropriately." Other MG3 staff members referred to distance learning sessions being made as accessible to students as possible through the use of local languages, maintaining an informal, non-threatening atmosphere, and providing snacks to ensure that students were not distracted by hunger.

Prioritising alignment with existing education sector plans was also identified by several project staff (MG3, DP2, iMlango, IE), as well as portfolio level staff, as an important way to ensure that EdTech was relevant to the context, supported by stakeholders, and therefore sustainable.

5.4.2. Blending non-tech, low-tech, and higher-tech options

The principle of ensuring maximum inclusivity often led projects to offer a combination of non-technology-based, low-tech and higher-tech options. As one WWW project staff member stated, "the question of equity needs to be at the centre of the design. It needs to be a solution that doesn't cut off those who cannot afford or would struggle with digital literacy." All three GEARR staff reflected that this approach was central to the success of their Covid-19 response, resulting in 95% of PEAS students reportedly being able to access at least one form of support during that period:

> "Those four things [radio, SMS, telephone calls, printed learning packs] meant we had multiple channels to reach our children. We knew that not all kids have phones, not all our kids have access to a radio, or can go pick up a learning pack. But if you have these four channels, then we could split our resources across." (GEARR staff member)

Blending technology-based tools with other tools for learning was also found to carry significant benefits for learning outcomes. According to

[8] See https://www.wizenoze.com/why-wizenoze/ Retrieved on 5 July 2023

Damani et al.'s (2021) analysis of GEARR endline data, when the paper-based learning packs were included in regression analyses, these packs were more 'impactful' on girls' education than all forms of EdTech. In relation to WWW, Amenya et al. (2021) also found that paper-based learning resources were strongly associated with higher learning outcomes, especially for girls attending camps.

Similarly, WWW staff members noted that blending technological elements with non-technology-based tools allowed for the benefits of both components to be maximised. While radio by itself was not considered successful, combining radio broadcasts with paper-based tutorials and consistent feedback from teachers unlocked the learning potential of using radio. Indeed, one iMlango project staff member spoke regretfully about not having followed the same path: "Sometimes going back to basics and doing the easy thing well works better than tech. We'd have been better off printing workbooks and sending them to schools [...] Low-tech is not perfect but more sensible in this case [...]Rural Kenya didn't need a tech solution to Covid." This is reflected in the available data related to the effectiveness of the app during the pandemic; iMlango project staff interviewed unanimously deemed the mobile app ineffective due to its high cost and low uptake, and 77% of students did not use the mobile app at all for learning during school closures according to the endline evaluation (iMlango Endline Evaluation).

6. Conclusion

The above discussion of findings presents a highly nuanced picture of the factors influencing implementation that were highlighted across interviews and project documents. In summary, the main implementation components that influenced effectiveness within the design and preparation phases are:

1. Evidence-led design that incorporates needs assessments, assessments of existing infrastructure, capacity, and policy environment in the development of context-appropriate EdTech activities.
2. GESI-informed project design that accounts for the most marginalised end-user.

3. A holistic programme design that adopts EdTech as a means rather than an end.
4. Relationship-building between project and different stakeholders in preparation for the roll-out of EdTech activities to improve prospects for buy-in at different levels.
5. Capacity development of different stakeholders on both EdTech and, where necessary, broader skills development with particular emphasis on gender-responsive and inclusive pedagogies.

The main implementation components that influenced effectiveness within the implementation phase are:

1. Strong, multilayered M&E across the project cycle, which feeds into productive adaptations.
2. Ongoing training of stakeholders across the project cycle to consolidate and develop learning, which should be adaptive and differentiated to address specific challenges.
3. Maintenance of strong relationships with different stakeholders to ensure ongoing buy-in and support.

Core organisational factors driving effective implementation are:

1. Pre-existing organisational knowledge and expertise of both EdTech and education programming to feed into project design, and, where this is not present, an organisational culture of openness to learn and draw from the knowledge of others in the establishment of new EdTech activities, even during fast-moving periods of a crisis like the Covid-19 pandemic.
2. Cultures of strong coordination and robust project management to allow for effective communication across project staff and partners.
3. Organisational flexibility and willingness to adapt and iterate throughout the project cycle in response to challenges highlighted through M&E and cross-stakeholder communication.

Effective implementation was also, in part, driven by a deep understanding of relevant external factors (from infrastructure to socio-political context), established through evidence-building and M&E, and designing and adapting activities on the basis of this knowledge, as well as the aforementioned organisational flexibility and adaptability in the face of new or unforeseen external factors (including Covid-19).

Findings from this study also provide several insights relating to good practice in implementation that improve prospects for sustainability, which include:

1. Alignment of EdTech projects with education sector plans and priorities.
2. Relationship building and maintenance with key stakeholders from the community level to the national level, fostering buy-in and creating a sense of partnership.
3. Evidence building to provide proof of concept for governments to increase chances of post-project uptake and financing.

While these findings are inevitably specific to the projects from which they emerge, they have the potential to be highly relevant to all those seeking to implement EdTech in a manner that is likely to have a positive impact on the learning of marginalised girls. While providing tailored and sector-specific learning, they also align in varying ways with existing broader literature within implementation research (Albers & Pattuwage, 2017;Fixsen et al., 2005), as well as literature on EdTech for girls in LMICs (Allier-Gagneur et al., 2020; Crompton et al., 2021; Tauson and Stannard, 2018). In light of this, it is recommended that EdTech project designers and implementers working in similar contexts consider the above elements in the development and enactment of projects using EdTech to improve education for marginalised girls and within marginalised communities. Donors should prioritise funding for projects that are designed in a way that incorporates these core implementation components and are led by experienced organisations with demonstrable cultures of strong coordination, project management, and flexibility.

Finally, while the study details useful evidence from the sampled projects in relation to the prospects for sustainability of EdTech components and activities within education interventions that are donor-funded and

time-limited, the scope for studying the longer-term sustainability of EdTech activities for marginalised girls in low-income countries remains limited by a lack of data on what happens to ongoing implementation once external funding is no longer available. This lack of data or institutional knowledge is largely related to the nature of the funding cycle in these types of donor-funded projects. Since the sustainability of positive change is key to determining the long-term success of a project, this represents a significant and enduring gap in the evidence on EdTech in LMICs, which this study has not been able to address. Donors should therefore consider providing a small amount of long-tail funding to implementing organisations for the monitoring of independent implementation after project closure to develop a clearer understanding of the factors that feed into long-term effectiveness.

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