



EdTech for Improved Learning Outcomes for Primary and Secondary Students in Kenya

March 2022

Marta PERICH PALLARUELO
Maty NGOM
Oliver WALKER

LSE - Sochin Research Institute

Reach out to info@sochininstitute.org for inquiries.

Table of Content

| | |
|--|------------------|
| <i>Acknowledgments.....</i> | <i>3</i> |
| <i>Executive Summary.....</i> | <i>4</i> |
| <i>Introduction.....</i> | <i>5</i> |
| <i>Literature Review</i> | <i>6</i> |
| <i>Research Methodology.....</i> | <i>15</i> |
| <i>Findings and Discussion.....</i> | <i>18</i> |
| <i>Recommendations</i> | <i>30</i> |
| <i>Research Limitations.....</i> | <i>36</i> |
| <i>Ethical Considerations</i> | <i>37</i> |
| <i>Conclusion</i> | <i>38</i> |
| <i>Appendix.....</i> | <i>39</i> |
| <i>Bibliography.....</i> | <i>42</i> |

Acknowledgments

The authors are particularly thankful to the respondents who gave key informant interviews. They provided significant technical insights and helped the research with relevant context. We wish to thank the following (listed in alphabetical order):

- Gerald Muriuki, Data scientist and co-founder of Africa Data School, Kenya;
- Muturi Njeri, Learning Experience Designer based, Kenya;
- Quim Sabrià, Co-founder & CEO of EdPuzzle, Inc., United States; and
- Suraj Shah, Lead, Regional Centre for Innovative Teaching and Learning at Mastercard Foundation, Kenya.

We would also like to thank the Nairobi-based Sochin Research Institute and especially:

- Dr. Rosa S. Ko, President;
- Noah W. Miller, Director.

The authors appreciate their trust, their support, and their numerous insights in all stages of the research process.

Executive Summary

Education Technology, or EdTech, refers to any Information and Communication Technology (ICT) application that aims to improve education (Escueta et al, 2017). In 2018, the Kenyan government introduced Kenya's National Education Sector Strategic Plan to set out priorities for the next four years. This included the integration of ICT at all levels of education.

According to the literature, technology can expand access to quality education by facilitating the communication between teachers, students and families and overcome the constraints to access to higher education-related with disabilities or work. It can also be used to increase the effectiveness of the decision-making apparatus within countries and increase performance by targeting the right behaviours. However, EdTech can also foster inequalities. In Kenya, structural factors that affect the equity environment of EdTech include economic constraints, lack of available physical infrastructure, internet connectivity and mobile coverage, negative attitudes and perceptions towards EdTech, gender-based educational gaps, and ethnic inequalities.

Thus, for successful EdTech interventions, governments need to figure out how to effectively distribute resources to support learning within a country. Early literature focuses on the role of funding in improving learning outcomes. While many articles find positive impacts, most literature argues that access to schooling itself does not cause learning. Since then, scholars have tried to expand the definition of the term "resources", most notably Grubb (2009), who divides resources within the education sector into four main categories: simple, compound, complex and abstract.

Hence, this research paper aims to understand how EdTech can most effectively coordinate with researchers, policymakers, teachers, parents and students whilst identifying opportunities for improved EdTech-related practices in Kenya.

Given the resource constraints of the project in terms of the duration as well as the authors being based in London, much of the research consisted of a detailed literature review of the academic and grey literature surrounding the topic. The methods for data collection included desk-based research and key informant interviews. Additionally, three case studies were written to provide contextual information and exemplify the analytical frameworks used in this paper.

The findings regarding the role of EdTech in improving learning outcomes through resource allocation present a surprising finding: a self-reinforcing reciprocal relationship between EdTech and the factors that enhance it. While EdTech interventions require a specific range of factors to be successful, these same factors can be strengthened through EdTech interventions. Therefore, EdTech cannot be simply regarded as a cause or a consequence of these factors, but must be interlinked between them through self-reinforcing mechanisms. Among these factors, three have been particularly highlighted during our research process: community building, accountability, and resource allocation.

Hence, the authors put forth the following recommendations: investing in different types of resources by building Edtech interventions in stages; developing a clear accountability structure in the educational interventions; utilising EdTech as a tool to increase accountability for: teachers, schools, and decision-makers; tailoring interventions towards the needs of local contexts; remote coaching and community meetings, and finally community-level information campaigns.

Introduction

EdTech is often championed by contemporary literature as an efficient, cost-effective solution to plugging learning, retention, teacher training and socio-economic equity gaps in developing countries (Rodriguez-Segura, 2021).

However, empirical results in recent times have been mixed. Furthermore, the capacity of EdTech to create an equitable learning environment has been questioned by policymakers and academics alike in the context of developing countries, due to how the education systems dealt with the far-reaching effects of the COVID-19 pandemic. Hence, this research paper aims to understand how EdTech can most effectively coordinate with researchers, policymakers, teachers, parents, and students whilst identifying opportunities for improved EdTech-related practices throughout the country.

Followingly, the research project will investigate how **EdTech can be utilised to improve the resource allocation process within the public education sector to enhance learning outcomes** and **what structural factors affect the equity environment of EdTech in Kenya?**

Literature Review

1. How can EdTech be utilised for an improved resource allocation process within the public education sector to improve learning outcomes?

1.1. Resource allocation in the public education sector and academic achievement

In recent years, countries around the world have sought to find innovative solutions to improve the education sector. Kenya is no exception. Education remains one of the most effective ways to address societal inequality, and successful resource allocation processes can provide higher quality education and learning opportunities. In this sense, governments need to figure out how to effectively distribute and leverage resources to support learning within a country (Grubb, 2009).

The relationship between resource allocation and academic achievement has been a prolonged debate amongst politicians and scholars alike. Indeed, the debate focuses heavily on the effectiveness of invested resources on educational outcomes. Early literature such as Hanushek (2008) focused on the role of funding in improving learning outcomes. The study finds that, on average, school expenditure and achievement show a strongly positive affiliation, though the strength of the relationship disappears when controlling for differences in family backgrounds. More recent research finds that aggregate measures of per-pupil spending are positively associated with improved or higher student outcomes (Baker, 2016).

Nonetheless, the funding discourse has extended beyond monetary matters, evolving to include other types of resources within the sector, namely, time and human capital. Indeed, Cohen et al. (2003) argue that access to schooling itself does not cause learning. He highlights that the way resources are used can either facilitate and/or inhibit teaching and/or learning which then affects academic performance (Kang, 2021). In this sense, “dollar bills do not educate children. Teachers with particular instructional approaches, principals capable of instructional leadership, schools with supportive climates, and many other resources do” (Grubb, 2009).

In early research, resources from the education sector mainly referred to funding. Studies such as the one from Hanushek (2008) focused on the role of spending to improve educational outcomes. Since then, scholars have started to distance themselves from the concept of “resources equal funding” and expanded the definition of the term “**resources**”, most notably from Grubb (2009), who divides resources within the education sector into four main categories: simple, compound, complex and abstract.

Simple resources are those that are components of funding and per-pupil spending such as materials costs, teacher salaries, teacher-pupil ratios, teacher training, etc. **Compound resources** include teachers’ experiences, time or staff and students’ development. **Complex resources include** innovative teaching practices, shifting more towards balanced pedagogies, building a constructivist curriculum or teacher’s sense of efficacy and control. **Abstract resources** include stability, positive school climate, school attendance rate, curricular coherence, or quality of the relationship between teachers and students (Grubb, 2009).

To effectively improve learning outcomes for students, interventions must affect **multiple categories of resources**, at different levels. For example, poorer schools in rural areas need more than simple resources (better salaries, more teachers, more books, etc.) to increase their learning outcomes and achieve a higher quality of education (ibid, 2009).

Resources allocation in education thus goes beyond funding distribution. It examines “the ways in which those dollars are translated into actions that address educational goals at various educational levels.” For this reason, not only should leaders be concerned with the number of resources invested within the sector, but they should also study how these investments translate into **improved learning outcomes for the students** (Lynch, 2011).

1.2. The learning outcomes in the 21st century

This paper uses the UN guidelines to answer questions regarding the precise nature of desired learning outcomes for students. Of the 17 established Sustainable Development Goals (SDGs), SDG 4, which aims to “**ensure inclusive and equitable quality education and promote lifelong learning opportunities for all**” (UN, 2016), holds the most relevance to this study.

“Quality education” has been defined by the UN as “foster(ing) creativity and knowledge and ensur(ing) the acquisition of the foundational skills of literacy and numeracy as well as analytical, problem-solving and other high-level cognitive, interpersonal and social skills. It also develops the skills, values and attitudes that enable citizens to lead healthy and fulfilled lives, make informed decisions and respond to local and global challenges” (UNESCO, 2015).

1.3. Definition of EdTech

EdTech, the short form for “Education Technology”, refers to any **ICT application that aims to improve education** (Escueta et al, 2017) and has, during the last decades, played a growing role in peoples’ lives. Technology can expand access to quality education by facilitating the communication between teachers, students and families and by overcoming the constraints to access to higher education-related with disabilities or work (ibid., 2017). Moreover, it can help create a more engaging, inclusive and individualised learning experience (Education Technology, 2021). However, EdTech can also foster inequalities. Indeed, not everyone has technology or internet access. For instance, 98% of United States’ high-income households have a computer, but only 67% of low-income households do. Therefore, as will be described below, EdTech has the potential both to reduce and increase inequalities (Escueta et al, 2017). The effect EdTech has on inequality and the practices that best allow for its successful implementation is analysed below.

1.4. Technology-enabled behavioural patterns

Behaviour-altering interventions have been a large area of focus within the literature. Rodriguez-Segura (2021) argues that “**behaviour-shaping incentives**” through technological inputs have the potential to shape systemic issues cost-effectively. However, he highlights that they require a deep knowledge about the constraints to be addressed and a credible theory of change.

Studies by Gaduh et al. (2020) and Duflo et al. (2012) sought to address the high rates of absenteeism in Indonesia and India ($\approx 24\%$ in 2010). The authors put together an intervention

that aimed at providing cameras with timestamps in schools and making teachers frequently take pictures of their students to prove that they were in class. In the intervention, teachers' pay would be reduced if they could not prove their presence. Such mechanisms to change teacher behaviour proved to be successful as they found an increase in student test scores after the intervention. In contrast, an intervention by de Ree et al. (2017) that doubled teacher salaries in Indonesia found no improvement in student learning. In this sense, EdTech could prove to be a valuable tool to increase accountability and performance by targeting the right behaviour.

1.5. EdTech, resource allocation and decision-making in the educational sector

There is extensive literature on the use of EdTech to increase the effectiveness of the decision-making apparatus within countries. In many cases, however, they do not reflect the challenges many governments face in integrating technology to make informed decisions about education policy and systems (Myers et al., 2021).

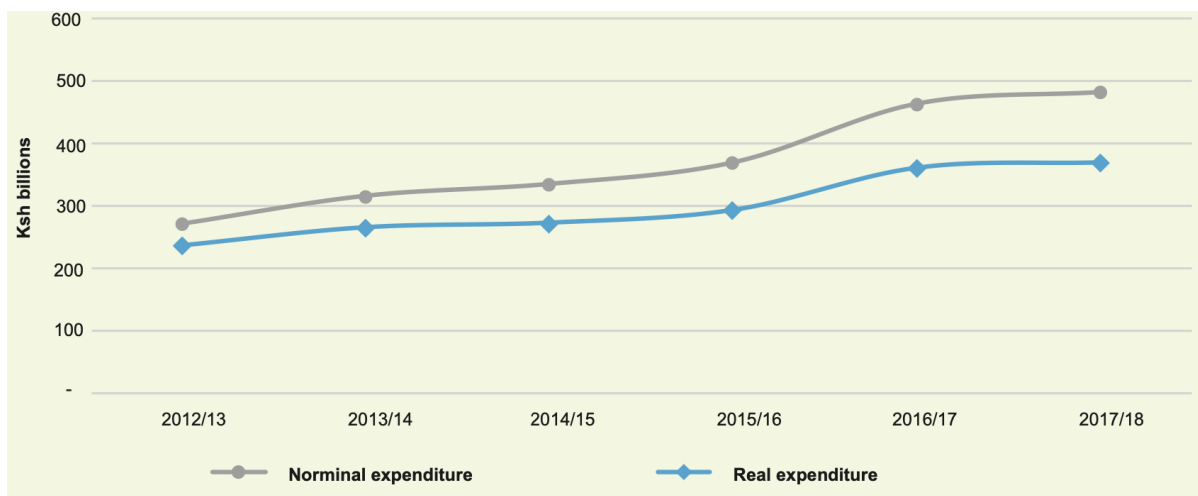
Research by Breiter and Light (2006) studied the role of data for increased accountability and more effective instructional decision-making. Data access allowed decision-makers to allocate resources more effectively in the areas that needed them the most, find which resources were needed in different sectors and target those discrete areas more efficiently. They find that, **by using EdTech to build data and information systems**, decision-makers were able to collect critical information for the development and implementation of schools. These included the real needs of classrooms and educators, teachers' knowledge and practices or instructional strategies. In this sense, EdTech enabled them to build **effective information systems for better school management and improvement**.

Another paper by Rakusin and Bostock (2018) regarding the "Zambia School Gateway" studied the use of EdTech to increase accountability for decision-makers. Through the system, leaders were transformed into administrators and contributed by providing a district-wide view of individual schools' literacy needs for better support where it is most needed. Through their study, Rakusin and Bostoc found a **positive correlation between the tool and data-driven planning for student performance**, finding that the schools that used these tools were twice as likely to be classified amongst the highest performing in terms of literacy outcomes.

1.5. Efficiency and resource allocation in Kenya

Between 2013 and 2018, education sector expenditure expanded by 65.7% from Ksh 251.2 billion in 2013 to Ksh 416 billion in 2017.

Figure 1: Nominal and real education sector spending, 2013/14-2017/18 (Ksh billions base year is 2010)

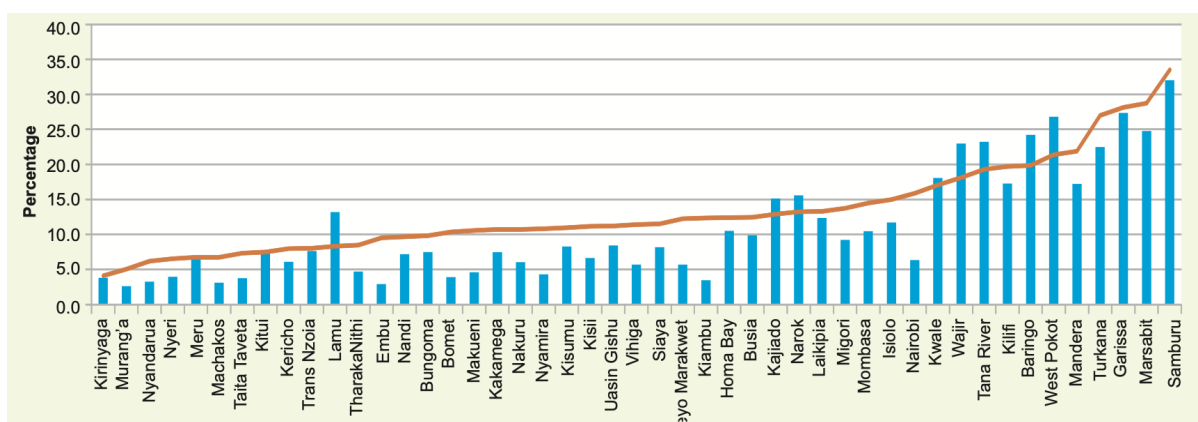


Source: KIPRA (2019)

Nonetheless, there are still some disparities across different counties in terms of per-pupil spending. According to KIPRA (2019), Mombasa County had the highest education spending per capita followed closely by Nairobi. Furthermore, the high per capita spending in Garissa, Mandera and Wajir is synonymous with increasing resource allocation in these counties. The counties with the least per capita spending are Bungoma, West Pokot, Nyandarua, Kwale and Busia counties. Per capita spending tends to be lower in the north, coast, and arid areas. Counties located in these regions have lower enrolment levels and schooling years.

Nonetheless, KIPRA (2019) argued that increased resource allocation does not correlate with increased efficiency. Indeed, counties with higher per capita spending such as Mandera, Garissa, and Wajir have lower years of schooling. The average schooling years was 8.4 years compared to the national average of 12 years.

Figure 2: Proportion of children out of school across counties in 2012 and 2014 (%)



Source: KIPRA (2019)

1.6. EdTech in Kenya

In 2018, the government introduced Kenya's National Education Sector Strategic Plan to set out priorities for the next four years. This included the Integration of "Information and Communication Technology (ICT) at all levels of education" (Ministry of Education, Republic of Kenya, 2018) by:

- "Creating a nationwide e-Education system to support schools;
- Retraining and re-skilling the current workforce on ICT;
- Establishing educational networks for sharing resources and promoting e-learning;
- Facilitating public-private partnerships to mobilise resources for e-learning initiatives." (Myers et al., 2021).

Drivers of EdTech decision-making

In Kenya, the political and economic structures put in place influence the adoption and integration of EdTech intervention at both the micro and macro-level (ibid., 2021). The main drivers include:

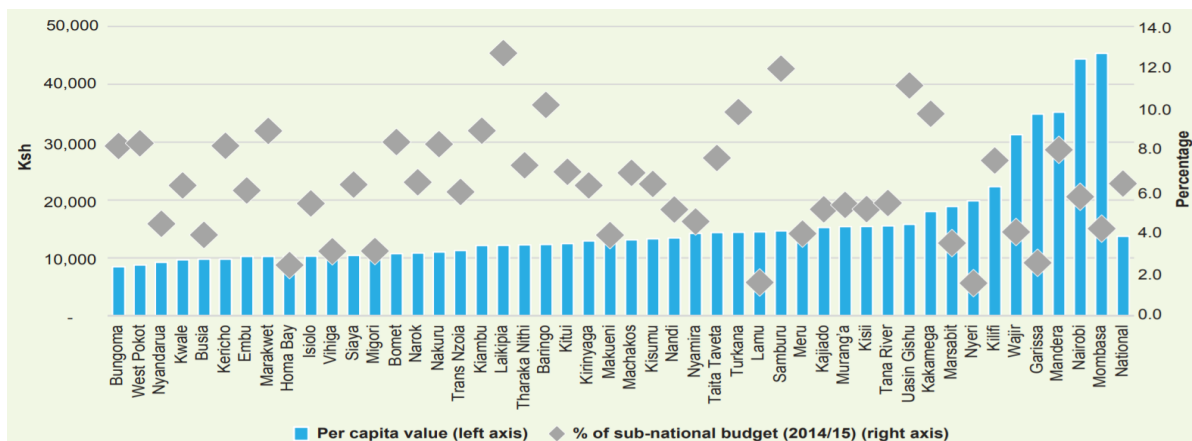
- **Government bodies:** The oversight of EdTech activities is mainly under the Ministry of Education and the Ministry of ICT, together with a large number of autonomous and semi-autonomous commissions, institutes and programs. The government has undertaken a massive decentralisation initiative to increase accountability at the local level (ibid., 2021);
- **NGOs:** NGOs oversee many education initiatives in the country and influence the priorities and agenda of a large number of education programs. While their goals might not necessarily be at odds with the state, they may be isolated from broader policies (ibid., 2021);
- **The Private Tech sector:** A large number of tech start-ups have emerged in Kenya in the past years. The education sector receives much attention from innovators to fulfil the needs of the sector, bridge the gaps in existing education, apply a gender lens to access to quality education, etc. (ibid., 2021).

Therefore, the successful and effective usage of EdTech will rely on the exploitation of these linkages and partnerships and the involvement of the entire ecosystem in Kenya.

1.7. County-specific EdTech initiatives in Kenya

First, and as mentioned before, Mombasa and Nairobi counties have the **highest education spending** per capita, and Garissa, Mandera and Wajir also have a high resource allocation regarding education. On the other hand, Bungoma, West Pokot, Nyandarua, Kwale and Busia are the counties with the **least** per capita spending in education (UNICEF, 2018).

Figure 3: Education spending by county (per capita and as a % of the sub-national budget for 2016/17)



Source: KIPRA (2019)

Nairobi County, apart from being one of the highest spenders in education, is home to Kenyatta University, which leads **EdTech research** through its Educational Communication and Technology Department. Along these lines, Moi University - in Uasin Gishu county - is the university with the second-highest number of EdTech publications (Myers et al, 2021). Therefore, we may infer that these two counties are quite familiar with EdTech practices.

On the other hand, both Meru and Kitui counties have a smaller tradition in EdTech. First, Meru county's schools still have a **low investment in ICT** - especially because of the high costs of computer hardware and software - which complicates the incorporation of EdTech in education (Bariu, 2020). Conversely, laptops are available in Kitui county, but **internet connectivity** is low, so the computers are only used to store school records, teacher plans or examinations but not to deliver classes (Mwendwa, 2017). Kisii county has had some contact with ICT education through a **pilot project** to promote Kiswahili by the Ministry of Education of Kenya and the New Partnership for Africa Development. This project concluded that teachers are quite open to integrating ICT into their teaching. However, because textbooks are still predominant in the educational practices of this county, more **training** is needed to achieve quality ICT practices (Omariba et al., 2016).

Regarding **formal school enrolment**, West Pokot, Garissa and Samburu counties have the lowest enrolment rates of the country, caused because of the low literacy in families, early marriages, or long distances to schools (KIPRA, 2019).

Regarding girl's school enrolment, Baringo, Bomet, Bungoma, Busia, Embu, Kirinyaga, Kisumu, Laikipia, Makueni, Mandera, Meru, Mombasa, Nandi, Taita Taveta and Tana River counties have a higher percentage of girls out of school than boys.

comes to exploiting the benefits of EdTech interventions. When assessing Kiambu County's ICT infrastructure, Nchunge et al. (2012) emphasised how a lack of connectivity/network infrastructure hinders full access to internet resources, e-mail use and resource sharing in schools in Kenya. Low levels of technological penetration and infrastructural deficiencies hinder the familiarity with the platforms on which EdTech tools are deployed, and hence obstruct the effectiveness of an otherwise well-designed intervention (Rodriguez-Segura, 2021). Oulo (2013) found that, in Bondo District, Kenya, only 33 per cent of rural respondents indicated computers existed in their schools, whereas 100 per cent of urban respondents admitted that they had computers, exemplifying the scale of the regional infrastructure disparities.

Unlike internet penetration, mobile coverage is relatively high across the globe - Kenya possesses a coverage of 98 per cent (Myers et al., 2021). This suggests successful mobile-based EdTech intervention such as in Jere-Folotiya et al. (2014) and Aker & Ksoll (2019) which helped increase the literacy rates in Zambian and Nigerian schools, respectively, may be better suited to correct structural equity issues within the Kenyan education context.

Socio-structural factors also play a key role in the equity environment of EdTech in Kenya. **Attitudes and perceptions towards EdTech**, both within and outside of classrooms, can influence technology adoption, as negative perceptions discourage teachers from putting EdTech into use (Miima et al., 2013). Teachers' ability to adapt to delivering education remotely varies greatly intra-regionally within developing nations (Pena-Lopez, 2016). For example, Kiptalam & Rodrigues (2010b) illustrated that most teachers required to implement EdTech in their classrooms had low levels of digital literacy and have not received any training related to using digital devices in classrooms. This renders attitudes towards education a problem of equity as technological know-how is borne from the confidence, skills and experiences gained from spending time with different forms of software and hardware (Miima et al., 2013) which differs along the rural-urban continuum and across ethnic (Poggiali, 2017) and gendered lines (Kenya SchoolNet, 2003). Furthermore, Bishop (1989) and Maina (2003) argued that Kenyan schools have categorically failed to integrate local cultural values into the curriculum. However, empirical evidence of county-level cultural variations and their influence on EdTech is hard to come by, with most evidence anecdotal in nature.

A second potential socio-structural issue affecting the equity environment of EdTech in developing countries are **gender-based educational gaps**. In 11 schools located from Nairobi to the Rift Valley areas, Kiptalam & Rodrigues (2010a) found that girls used computers at a far lower rate than boys both inside and outside of school. Delving deeper into why technology usage rates differ, Kenya SchoolNet (2003) revealed girls schools have 30 per cent fewer computers than boys schools, whilst Kiptalam & Rodrigues (2010a) show only 41 per cent of girls compared to 89 per cent of boys possessed regular internet access. Such disparity is quantified in and out of school context by Wims & Lawler (2007), who reported that 30 per cent of girls were able to access computers out of school for educational purposes compared to 50 per cent of boys. These findings suggest more gender-based considerations must be taken to provide equitable access to EdTech in Kenya.

Alwy & Schech (2004), Kramon & Posner (2016) and Li (2017) put **ethnic inequalities** at the forefront of analyses of educational development in Kenya. They believe, in terms of schooling infrastructure and resources, relatively small, clearly defined ethnic communities have amassed

an edge over the remainder of the national population. Using Gross Enrolment Ratios and the number of schools and qualified teachers, Alwy & Schech (2004) showed substantial differences in educational opportunity and resources between students from the Kenyan provinces where the ruling elite have originated, past and present. Using Kenyan Demographic and Health Survey data, Li (2017) confirmed that having a co-ethnic president is expected to improve the likelihood of completing primary education. Kramon & Posner (2016) further corroborated these findings. However, interestingly, more recent research compiled by Simson & Green (2020) posits that there is **no solid evidence of ethnic favouritism** in elementary or secondary education in Kenya. Instead, the country's largest ethnic groups are undergoing a process of educational convergence. They claim the existing studies that produce evidence of ethnic disparities rely on problematic assumptions with educational fault lines not mapping neatly onto the main political divides in Kenyan party politics. Thus, whether ethno-regional variations in schooling infrastructure and resources are likely to be a key factor in the equitable provision of EdTech remains undetermined.

Research Methodology

Given the resource constraints of the project in terms of the duration as well as the authors being based in London, much of the research consisted of a detailed literature review of the academic literature. The extensive review of Kenyan and international literature was instrumental in forming the research questions at the onset of the project.

In order to produce a focused research paper, the authors decided to narrow the scope of research questions that could be adequately addressed through the applied research methodology. This paper is structured around two questions:

1. How can EdTech be utilised for an improved resource allocation process within the public education sector to improve learning outcomes?
2. What structural factors in Kenya affect the equity environment of EdTech?

1. Data collection

The methods for data collection include desk-based research and key informant interviews. The desk-based research enabled the gathering of data for the literature review as well as for the case studies. The review also included an examination of relevant quantitative data, up-to-date surveys about the educational environment in Kenya as well as news articles and reports from the development community at large. Finally, three case studies were written to provide contextual information and exemplify the analytical frameworks used in this paper. This was to understand what factors would lead to a successful intervention in the Kenyan context, what barriers must be overcome and what could be improved for further efficiency. Furthermore, these cases were included to provide benchmarking and recommendations that could work in the Kenyan context.

In order to obtain relevant context to the research questions, the research team also conducted Key Informant Interviews (KIIs) with three Kenya based respondents and worked closely with the Nairobi-based Sochin Research Institute. A fourth KII was conducted with an EdTech professional based in the United States. The key informant interviews were used to collect data from experts in EdTech and Digitization, whether in or outside Kenya, to get a view of the EdTech landscape in the country, gauge the structural factors that inhibit the deployment of successful EdTech interventions in Kenya as well as get an understanding of the factors that would enhance the effectiveness of EdTech project in improving learning outcomes in the country.

All experts were chosen for their expertise in the EdTech sector and the selection process ensured that they represented different perspectives. While the experts are acknowledged earlier, their responses are anonymised to maintain their confidentiality in the findings and discussion section of this paper. Additional key informants were identified and contacted through, due to availability issues, it was impossible to conduct interviews before the project's completion date.

The interviewees gave semi-structured interviews that enabled the authors to verify the information collected online about Kenya, get additional insights on details the authors could not get through desk-based research, and get recommendations from experts in the field. Each

interviewee was given a sample of six questions (Appendix 1) to guide them through the discussion. All of the interviews were conducted over Zoom.

Respective interviewees were contacted both by the Sochin Research Institute and research team members' personal contacts.

2. Data analysis

To extract the information, the interviews were recorded on Zoom, after the consent of the interviewees, and they were then transcribed later. Notes were also taken during the interviews. The interviews were then inputted into the software Scribie which allowed a full transcription of the interviews. Then, the authors each read over the transcripts while listening to the interviews to correct mistakes and make the transcripts more readable.

A thematic analysis has been used to analyse the qualitative data from the interviews. The methodology for this type of content analysis was used for the interviews to identify recurring themes, relationships, or factors that could be relevant for this research. This is a commonly used qualitative analysis method that focuses on the content of participants' statements: identifying, analysing and reporting patterns within data (Barret and al., 2018). Consequently, the goal was to find a relationship between the different variables.

Therefore, data-driven codes were created to organise the data and give it meaning. After the data had been coded and recorded for consistency, the authors tried to find which codes were related, what information recurred and what generally seemed to be the most important (Braun & Clarke, 2006). This was done through a code book that can be found in Appendix 2. Finally, after all the themes had been identified, the following thematic mindmap (Figure 5) was built to visualise all the themes and relate them with each other. Although this research paper does not include any quantitative analysis, the mindmap below posits that the 'Impact of EdTech on Learning Outcomes' is the independent variable while 'Community Building', 'Education Resources', "Government Policy", 'Accountability' and 'County Factors' could be potential dependent variables. When writing the findings and discussion, relevant quotes from the interviewees were used to highlight the major themes and possible contradictions (Barret, Bennet & Helmich, 2018).

Figure 5: EdTech in Kenya Mindmap



Based on all of those links and interconnections, a relationship between the different variables has been derived and thus answers to our research question have been found.

Findings and Discussion

The findings regarding the role of EdTech in improving learning outcomes through resource allocation present a surprising finding: a self-reinforcing reciprocal relationship between EdTech and the factors that enhance it. While EdTech interventions require a specific range of factors to be successful, these same factors can be strengthened through EdTech interventions. Therefore, EdTech cannot be simply regarded as a cause or a consequence of these factors, but must be interlinked between them through self-reinforcing mechanisms. Among these factors, three have been particularly highlighted during our research process: community building, accountability, and resource allocation.

*a) **Community building***

In terms of community building, connecting people who work within the EdTech community from all nodes of the production and consumption chain to share resources and insights and to then combine them into the decision-making process was a theme commonly referenced throughout the interview process. Interviewee 4 emphasised the role synergy plays between the ministry staff, teachers and parents, and their need to work together closely to deliver education to students. Communication channels forged by meet-ups between all stakeholders in the EdTech system are required to build a sense of community and common purpose which in turn increases the effectiveness of EdTech solutions in their given environment. Interviewee 2 echoed this sentiment, highlighting the value of speeding up ideas and “brainstorming processes” in developing the Kenyan EdTech industry efficiently and equitably. He contended the fragmentedness of the Kenyan EdTech system has contributed to its inconsistent and unequal successes in its implementation across the country.

A further theme frequented within the interview process concerning community building was the critical role parents play in the deliverance of EdTech interventions in the Kenyan context, and how variations in parental inclusion can lead to inequalities in the education systems.

“People talk about a public-private partnership, I would say in education you add another P, the 4th P is Parents” - Interviewee 3

We found Kenyan children are unlikely to study at home effectively without the support of adults or older siblings. Interviewee 2 further clarified that in the absence of parental support, it is unlikely girls will get the opportunity to reap the full benefits of EdTech. This structural issue of parental support depends on the gender progressiveness of parents within the given county the EdTech intervention is being implemented. Interviewee 3 highlighted how parental support is more likely to be absent in Kenya’s rural counties.

Shifting attitudes and mindsets towards education-related technology at the community level proved to be a topic of significance for interviewees 2 and 3. They found it is important to help teachers learn how to use technology and how to use it for planning, instruction and assessment.

Furthermore,

“mind-shifts are required around the cultural nuances regarding the importance of education for girls” - Interviewee 3 at the community level both for teachers and parents, without which EdTech will

remain as a “male-driven, masculine environment” - **Interviewee 2**

Interviewee 3 went on to reference the cultural nuances of how attitudes towards gender roles can influence the equity environment of EdTech:

“Girls tend to be given the role of looking after younger ones or the family and tend to the families income etc. And the other one is stereotyping and it comes from women themselves. We have found mothers themselves have told girls that no you shouldn't be doing sciences this is all you need to do. And it kind of comes back into that cycle of these things need to be broken and girls need to be able to dream and understand that the sky's the limit”. - Interviewee 3

Girls were 20 per cent more likely to be unable to benefit from an EdTech intervention due to lack of access (USAWA, 2020) whilst children of school-going age in female-headed households were 1.3 per cent more likely to be out of school than their male-headed counterparts (ibid., 2021). Without addressing these structural inequalities along gendered lines, the veracity of the claim that “EdTech can improve learning outcomes within Kenya in an equitable manner” will remain a topic of debate. This gendered imbalance of technology access does not just apply at the student level. More male teachers are trained in digital literacy than female teachers (USAWA, 2020), exemplifying how attitudes towards technology must be addressed not just at the student level but on a community-wide basis.

b) Accountability

As has been mentioned, corruption and the lack of accountability is a structural factor that hinders the equity environment of EdTech.

“We have corruption issues. These are heavy, these are big issues here” – Interviewee 1

“I can see how some of it [a mismatch between reported spending and actual spending] might have to do with corruption and misappropriation of funds. I can see that happening in education” – Interviewee 2

For this reason - and as it will be mentioned later - it is important that transparency is at the core of each EdTech programme. For instance, the Tusome program was successful precisely because it adopted accountability mechanisms. Amongst its key strong points, all actors were sharing the same understanding of the program - which created feelings of collaborative accountability – all the stakeholders knew about the program’s purpose and processes, all the documents were made public, and each role was clearly defined. All these measures helped develop a clear accountability structure (Kaye, 2020), which made this EdTech intervention successful.

However, interestingly EdTech can also be used to increase accountability. Therefore, EdTech and accountability interact in a self-reinforcing way: accountability is needed for EdTech to work, and EdTech can help increase accountability. Regarding the latter, EdTech can reduce corruption and increase accountability through three different ways: increasing teachers’ accountability, increasing parents’ pressure for school accountability and increasing decision-makers’ accountability at the school management and government level.

Regarding the teachers’ job, EdTech can be used as a tool to track teachers efficiently and

improve their job performance. In particular, EdTech can help reduce the huge issue of teacher absence, which is very common in Kenya, and which decreases educational effectiveness. As a result of the possibilities that EdTech offers, data about teacher absenteeism can be made available; therefore, school performance can be highly improved (Kremer et al, 2013). Moreover, EdTech can be a useful tool to increase teachers' accountability by helping them understand their students' performance. EdTech, due to its ability to store data online, can provide data for teachers on their students' learning process. These data can help teachers know which students need more support (World Bank, 2017).

Moreover, EdTech can be a successful tool to enhance accountability within families and teachers, especially to strengthen school-parent communication. Educational apps enable parents to communicate more frequently with the school. That creates, on the one hand, a possibility for them to become more involved with their children's education by having regular meetings with the teacher or checking what their children work on (Jordan and Mitchell, 2020). On the other hand, EdTech can be a pathway to demand improvements in the school or teacher, thanks to the closer communication that is created between parents and teachers (Hennessy et al, 2021).

Finally, EdTech can increase decision-makers' accountability. Thanks to the data EdTech can provide, decision-makers can allocate resources more effectively and collect critical information for better management of their schools (Breiter and Light, 2006).

c) Resource allocation

Types of resources

The Kenyan government has tried to determine the most effective way to distribute resources within the education sectors to provide universal primary education for its citizens. Successful allocation of resources within the public education sector allows access to higher quality education, learning opportunities and better curricula design.

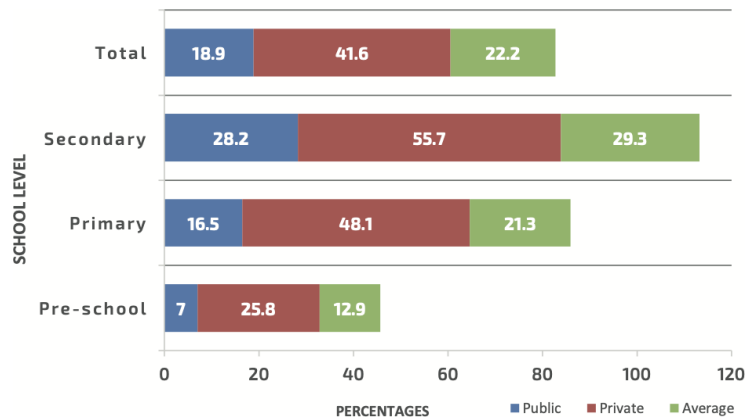
From the KIIs conducted for this study, the participants highlighted different kinds of resources that are needed for successful EdTech interventions as well as ways in which EdTech can improve the allocation of these types of resources for increased accessibility and quality of education in Kenya. Additionally, the USAWA (2020) report "Are Our Children Learning?" provided data on the status of remote-learning among School-going Children in Kenya during the Covid-19 crisis. For the sake of clarity, we divided the resources mentioned into the different categories of resources highlighted by Grubb (2009).

1. Simple resources

Many of the interviewees argued that simple resources are a necessary basis for EdTech interventions. The type of resources highlighted were funding, basic infrastructure such as internet and electricity, teachers' salaries, materials (computer labs). This is in reaction to the large inequalities found in Kenya in terms of access to basic education infrastructure. Indeed, according to the USAWA Agenda, on average, 22 out of 100 children have access to digital

learning (USAWA Agenda, 2020). The higher the level of education, the more likely the children have access to digital learning; nonetheless, the numbers are still very low with the highest number being 29 out of 100 children in secondary schools for public schools (Figure 6).

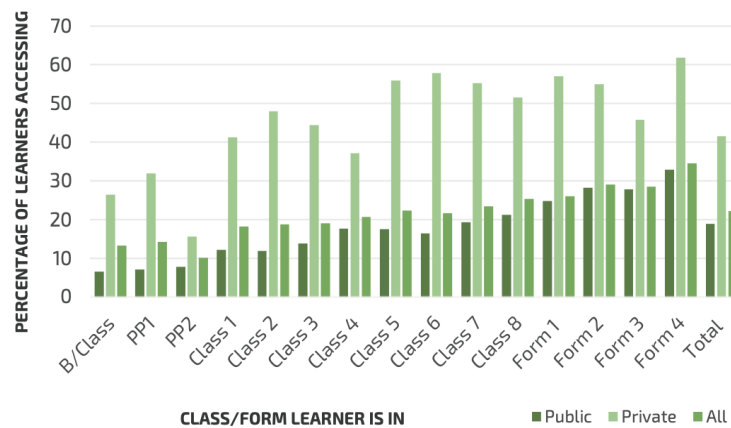
Figure 6: Percentage of learners accessing digital learning by school type and schooling level



Source: USAWA Agenda, 2020

However, beyond being low, these numbers can be misleading as there are significant gaps between public and private schools. In fact, less than 30 per cent of public schools have put in place any measures or have access to the necessary infrastructure to reach children with digital learning material (Figure 7) (USAWA Agenda, 2020).

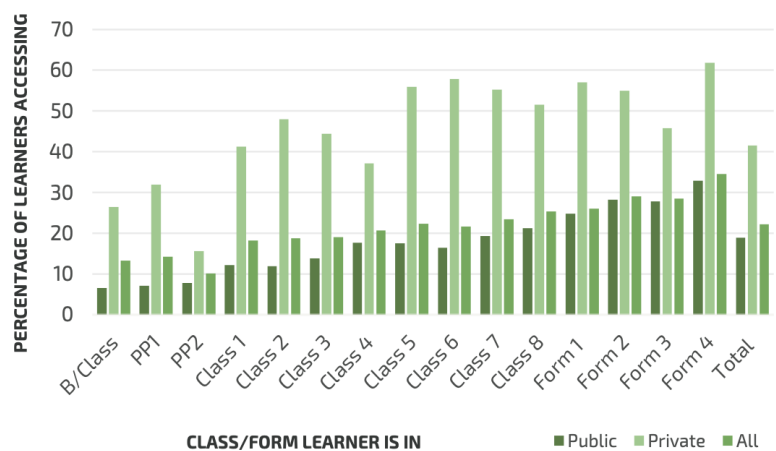
Figure 7: Percentage of public schools that had put in place measures to reach learners remotely



Source: USAWA Agenda, 2020

Access is even lower in the sub-counties where, in public schools, access to remote learning in primary schools averages at about 7 per cent and around 15 per cent in secondary schools (Figure 7).

Figure 7: Percentage of the learners in the public schools in the surveyed sub-counties accessing remote-learning



Source: USAWA Agenda, 2020

Furthermore, the most popular learning platform was WhatsApp which is not categorised as a learning platform (Figure 8).

Figure 8: Platforms used to reach learners by schools

| Platform | Percentage |
|----------|------------|
| Radio | 40.1 |
| TV | 31.3 |
| Email | 4.6 |
| WhatsApp | 73.7 |
| SMS | 33.2 |
| Other | 10.6 |

Consequently, even though the existing literature posits that simple resources are inadequate to enhance learning on their own, the key informant interviews highlighted that these are necessary to initially bridge the gaps between different counties:

“In the Northern part of Kenya, there is not even electricity so talking about EdTech, like during Covid times, they were saying that students should learn online, how do you expect students who is in the forest to be studying...that doesn’t make sense. – Interviewee 1

“You need to invest more in places that are more remote, that don’t have the infrastructure that you need to do in an urban context” – Interviewee 2

“I would focus on hardware, Chromebooks because they are cost-effective and easy to connect with multiple platforms” – Interviewee 4

The USAWA (2020) report highlighted that, when asked what are the biggest challenges they faced in enabling and accessing digital learning, teachers and parents mentioned, respectively:

- Electricity problems: 84 times and 335 times
- Lack of access to smartphones: 72 times and 129 times
- Poverty and Internet connectivity: 65 times and 514 times
- Network connectivity: 49 times and 219 times
- Parental illiteracy: 32 times (teachers)
- Lack of TV, Radio and Computers: respectively 172, 132 and 47 times (parents)

For counties in Kenya that do not even have access to basic infrastructure or proper learning facilities, investment in simple resources is primordial to build a basis upon which EdTech can be added later as an additional layer.

The following case study exemplifies a learning initiative by the Kenyan government that primarily focused on the provision of simple resources. Although the current Jubilee government committed to providing all Standard One students with a laptop when it came to power in 2013, the project has faced immeasurable challenges. Its lack of successful implementation will also be an obstacle in transitioning fully to the Competency-Based-Curriculum that envisions digital literacy as a core competence.

Case Study 1:

The Digital Literacy Programme - A failed project

In 2013, the Coalition of National Alliance, the United Republican Party, the National Rainbow Coalition and the Republican Congress Party announced the Digital Literacy Programme (DLP) to increase literacy among Kenyan school children by equipping them with laptops. The project raised more than USD 270 million to enhance infrastructure, train teachers, distribute laptops and develop online content (Wanzala and Nyamai, 2018). The funding was fully raised through the National treasury (Mugedi, 2016).

Despite the scepticism regarding the government's ability to deliver on this promise, the implementation began in 2016 and roll-out was quickly accelerated. Within six months, the DLP was able to train over 70,000 teachers, digital content was developed for grades 1 and 2 in Kiswahili, English, mathematics, science and social studies, and access to electricity was extended to all but 500 schools within the country (Mariga et al., 2017).

However, this pace quickly halted: the goal of reaching all schools by December 2016 was not achieved. By 2018, only 19,000 schools out of 23,000 had received devices, only 70,000 teachers out of 250,000 have received training, and only just over a third of teachers were using the tablets in the classroom (Wanzala and Nyamai, 2018).

The DLP provides a striking example of the challenges of EdTech in the Kenyan context. Despite its innovative approach to tackling a fundamental problem, the DLP focused mostly on simple resources and did not include any mechanism to increase trust and acceptance. According to Kaye (2020), for innovative tech tools to be integrated into everyday life, three elements need

to be included: trust, accountability, and capacity.

Instead of working with stakeholders to address their specific concerns, the government pursued an intensive, top-down approach that excluded the participation of a wide range of stakeholders. They focused intensely on providing materials with no account for differences in the level of infrastructure available in different regions, the capacity of the professors to integrate ICT into their learning processes, the school climate and social norms dictating technology use, teacher's pain points and the ability of this solution to solve them.

As well, the capacity-building activities were inadequate to realise the programmers' goals. There were no mechanisms to assess the knowledge and skills of the people trained and an insufficient number of days was allocated to training itself (3days).

Finally, the unwillingness of teachers to use the devices was accelerated by the absence of accountability mechanisms. The project distributed more than 1 million devices (KNA1, 2021) which would be a significant amount of the budget. These devices may have never arrived at their destination, or worse, have been stolen (Otieno, 2021). As well, Kaye argues that none of the authorities within the existing accountability structure in the education system at large or within the DLP were mandated to monitor and enforce device use. Therefore, they were unable to achieve the desired outcomes (Kaye, 2020).

2. Compound resources

In terms of compound resources, interviewees put forth the importance of training teachers and allocating their time in an efficient manner to improve learning outcomes. In fact, one interviewee argued that for simple resources to be effective, they need to be supplemented by training to fully take advantage of EdTech interventions:

"I think there's need for training and maybe a collaboration with universities or research institutes that train people who are interested in EdTech to understand different pedagogical approaches and ways to enable learning" – Interviewee 2

"Especially at the beginning, it's important to give them guidance or a professional element to understand how to develop the curriculum, how to use the tools, and start building one unit and then another unit, and then another unit." – Interviewee 4

Teachers in Kenya face major challenges in developing their technical skills and knowledge. Therefore, they find it difficult to support themselves and fully integrate ICTs in their teaching. The teacher our team interviewed recommended that capacity building should be increased for teachers so that the technology will be more accessible to them. They also recommended building awareness among teacher trainers to integrate ICT early in their teaching curricula.

"Specifically, I would give teachers time to develop themselves and their content" – Interviewee 4

In this sense, to effectively improve learning outcomes for students, interventions must affect multiple categories of resources, at different levels. For example, poorer schools in rural areas

need much more than simple resources (better salaries, infrastructure, more computers, tablets etc...) to increase learning outcomes and achieve a higher quality of education.

Finally, in this scenario, EdTech can prove itself a useful tool to facilitate and standardise training for teachers and students. In this sense, initiatives to provide access to online courses for teachers and educators represent an untapped potential to deliver quality and resource-effective education. Nonetheless, the interviewees highlight the importance of practical content, flexible scheduling, interactive activities and rewards and certificates.

3. Complex resources

Complex resources cannot be readily bought compared to simple resources. These types of resources were mentioned most often by interviewees. The latter includes practices such as innovative teaching practices, shifting towards more balanced pedagogies, building of constructivist curriculum, etc. The key informants argued that EdTech can increase social learning and teaching and allow teachers to adapt their curricula and remain flexible for their students.

"[...] how you can leverage, EdTech to build a much better planning experience than just providing resources or materials for passing exams." – Interviewee 2

The experts also argued that there are multiple ways of integrating EdTech within the education system that do not explicitly rely on internet measures. Offline resources have the potential to address issues that are too costly or resources intensive to be tackled effectively by the state. EdTech can be used to promote access and participation in schools:

"[...] there are ways that you can integrate things like videos, games, or more interesting resources to make the learning experience just a lot more relevant, a lot more interesting to students, and therefore they are more likely to engage with it, then just sit down and just take notes" – Interviewee 2

This will allow personalised learning by considering local infrastructures and barriers to access to technology as they limit the ability of students to take full advantage of features that facilitate personalised learning.

Therefore, the following case study provides insight into a successful EdTech program in Kenya showcasing the effectiveness of using simple, compound and complex resources, community building for problem-solving and the development of a clear accountability structure.

Case Study 2:

The Tusome Program - an ongoing success story

The Tusome program, "Let's Read" in Kiswahili, was a USD 81 million program funded by the United States Agency for International Development and carried out in partnership with the Kenyan Ministry of Education from 2014 to 2021. It is a program focused on enhancing Kenyan early grade literacy (EGL) quality. It translated to "Let's Read" in Kiswahili and aimed to strengthen EGL in all 23,000 Kenyan public schools for grades 1, 2 and 3. The latter was done through the provision of tablets, new textbooks and material, teacher and civil society training,

training of senior leaders to use the data to identify education gaps. The tablet came with Tangerine, a classroom observation tool created for the program, a digital version of all textbooks, Papaya (a software to help teachers in reading and spelling) and a dashboard of data accessible by County Directors of Education and the central Ministry of Education staff to support evidence-based policy making (Kaye, 2020).

The program's midway evaluation showed a statistically significant increase in EGL in both Kiswahili and English (Freudenberger and Davis, 2017). Other studies have shown that Tangerine allowed an accurate measurement of student performance and enabled policymakers to collect targeted data to adapt to the children's divergent progress (Piper and al., 2016).

Kaye (2020) argues that, compared to the DLP, Tusome was able to successfully integrate trust, accountability and capacity which are at the heart of its success.

Indeed, capacity building was at the core of Tusome which focused on training teachers and providing coaching on the new EGL approaches. It made sure that all actors with the program shared the same understanding of the approaches, which created a feeling of collaborative accountability for children's learning outcomes. The comprehensive training programs allowed for trust to foster trust in Tusome by aligning good practices with local needs through robust communication.

All stakeholders were aware of Tusome's purpose and processes, all documents were made public to increase transparency and each role was clearly defined which developed a clear accountability structure. The use of tablets helped make data more accessible to all stakeholders which provided positive outcomes for policymaking after that. In this sense, these elements created a positive feedback loop which increased outcomes for a wide range of stakeholders within the project.

In this sense, the Kenyan experience shows that there is a large potential for the use of EdTech to strengthen capacity and decision making in the education sector. However, these interventions must be carefully designed to: build system capacity by employing the right resources, build trust between actors, and strengthen accountability processes. The tools must be carefully aligned with the local context to increase responsiveness and acceptance of initiatives for all stakeholders.

4. Abstract resources

Finally, a few interviewees mentioned the use of abstract resources such as curricular coherence and increased teacher-student quality time for improving learning outcomes. In fact, one interviewee highlighted the use of EdTech to reduce the burdens placed upon teachers and to e.g. increase the student access to their teachers:

"I think it can help teachers and help them to reduce the amount of overhead and all the things, 'cause teachers have to do a lot of administrative work and sometimes it reduces how much time they have to actually teach, and it also makes them overly stressed, so I think you can find ways to maybe automate some

of that or do it in a way that's scalable so that teachers just focus on the more human pieces, human elements that our system is not gonna replace or even a robot is not gonna come and do it.” – Interview 2

Beyond that, they highlighted the ability of EdTech to increase curricula coherence across the country and ensure that students get more equitable access to education. For that to be possible, interviewees mentioned the need for adaptation and consideration of local factors, such as languages, to provide successful initiatives:

“[...] think the other layer to it is a localization of the content that's built, or even like the language that you use, if you're building an app” – Interview 2

Therefore, EdTech can be used to support personalised learning and teaching. This would enable target teaching to the learning levels of the student thereby reducing the negative effects of high teacher-learner ratios rampant in Kenya.

Consequently, the relationship between EdTech and resource allocation goes both ways. While different kinds of resources are necessary for EdTech interventions to be successful, EdTech can also act as an input to facilitate the allocation of these resources for improved learning outcomes in primary and secondary education.

It is important that EdTech shows impact when it comes to learning outcomes, as one of the interviewees mentions:

“It is important to understand the impact measure [of a learning intervention], and to create a framework to measure that impact. – Interview 3

The Menttores program has proven to be effective, and its impact has been rigorously quantified. This programme can help us the authors and others with the application of best practices to other contexts.

Case Study 3

The Menttores program in Spain

One successful case study of EdTech in education is the **Menttores** programme (Teach for All Spain, 2022), carried out by the foundation Teach for All Spain. Menttores was a free-of-charge after school tutoring programme, mostly focused on mathematics and socio-emotional skills (motivation, wellbeing, work routines) for pupils from low-income sectors. The online sessions were given by professional mentors and had an innovative online format using digital devices. The programme was carried out online and 378 pupils in the lower secondary school participated.

Apart from helping students, the programme aimed to test the efficiency of the online methodology used. For this reason, a randomised controlled trial was applied by randomly selecting an intervention group and an equivalent control group. The outcomes were measured before and after the program, both for the intervention and control group. The results were extremely positive: the intervention group increased their end-of-year maths grades by 17%, their increased school satisfaction by 7%, their grade repetition decreased by 75% and the

probability of continuing their academic tracks increased by 31%.

According to its leaders, Menttores succeeded because of three main reasons. First, because of the **mentors' selection**. The selection was an extremely well-thought process with different steps (resume filtering, motivation letters, personal interviews) to find competent professionals, not only because of their grades but because of their soft skills too. Moreover, mentors were well paid, which attracted competent people. Another reason for its success was the **mentors' training**. According to its leaders, they received a thorough education in which they learned how to use online education tools, best practices for student engagement through EdTech, and emotional support strategies. Finally, **the use of technology in an accessible way** was a key to the programme's success. Since many students did not have high technical knowledge about technology, Google Workspace, Meet, Classroom and Jamboard were used. Even though these can seem simple methods, children learned how to use technology, which will be key for their future development and career path. Since the programme was implemented in low-income sectors, the Ministry of Education and the Autonomous Communities of Spain purchased or lent devices to the students who did not have a device at home or could not access one at their schools. At the end of the programme, devices were loaned to the educational centre. Therefore, we can extract from this case study that the resources for a successful education technology programme (especially in low-income sectors) should be governed by selecting good teachers, providing good teacher training, and the use of technology in an accessible way.

d) Role of the Government

During the interview process, the authors were able to interact with some emerging EdTech start-ups in Kenya and the United States which gave insights into the role of government in facilitating EdTech adoption. The latter include:

- **Funding and access**: All interviewees argued that the government has more resources at its disposal to fund EdTech initiatives that strengthen the education sector. They have all vouched for a plan to increase infrastructure, investments and increase access for the most marginalised populations.

"If you are able to provide the infrastructure layer whereby as a start-up, I don't have to be thinking how to provide my students laptops or how do I send a stipend for my students for electricity" – Interviewee 1

"[...] education technology projects need to be funded by the government..." – Interviewee 3

- **Oversight and allocation of resources**: The government should be responsible for the oversight and governance of the general education system and define the programs and policies for primary and secondary education.

"[...] the government ideally is meant to create social good, and so they have more incentive to allocate resources and an access to an EdTech better than the private sector even though they are not doing the work." – Interviewee 2

- Support through regulation and policymaking: interviewees emphasised the role of regulatory barriers in inhibiting their ability to provide quality EdTech. They mentioned taxes and compliance with regulatory bodies in terms of curricula which reduces their flexibility. They also highlighted the role of the government in providing regulations and putting together institutions that would support EdTech start-ups and drive the development of the EdTech sector.

“There is one issue we found that the government required...There is a body called NITA [National Industrial Training Authority], there is a body requiring us to be compliant with that, I don't think that makes sense, 'cause one even provides a curriculum, let's say on machine learning today, in the next three months, the industry has moved on from that, like whatever we are teaching in 2021 is already obsolete in 2022.” –

Interviewee 1

“Like this industry is moving quite fast and requiring us to be regulated or requiring us to get approval, to be honest, doesn't make sense there.” – **Interviewee 1**

Beyond the central role of the government, most interviewees stressed the need to involve all stakeholders to build effective solutions:

“I would say it is not just a ministry-led or government-led effort, this needs to be a holistic community, parents, there's a lot of change, manage mind shifts that are required...” – **Interviewee 3**

“Obviously involve the community, understand the community, try to understand the needs of the community... And again, I think organising these meetups for people to talk about their problems and use those meetups to bring solutions to the table and see how they react to different solutions, I think this is a more natural way of doing things.” – **Interviewee 4**

One of our interviewees suggested that apps and conferences with social content are a great way to incentivize professors to identify their pain points and see how well they can be solved with technology (Interviewee 4, 2022).

Recommendations

1. Invest in Different Types of Resources: Build EdTech Interventions in Stages

In order to leverage the synergies between EdTech and resource allocation, it is necessary to invest in different types of resources. Successful EdTech interventions for improved quality and equity of education in Kenya rely on a mix of simple, compound, complex and abstract resources. However, it may be difficult for the government to invest in all these resources at once. In this case, the authors propose to invest and build resilient EdTech interventions incrementally:

Stage 1: Screening and investment in simple resources

The first stage of the intervention would be to conduct an analysis of the status quo in different counties in Kenya. The purpose of this analysis would be to understand the availability of basic infrastructure and map out needs for the education sector. For investments to be more equitable between the different counties, the authors propose an analysis based on the following factors:

- Existence and accessibility of basic school infrastructure: functioning buildings, classrooms, available and qualified teachers;
- Access to electricity;
- Access to the phone network and the internet;
- Availability of hardware and software;
- Type of hardware and software available;
- Teacher's absenteeism; and
- Teacher's incentives: salaries, bonuses, vacation, social protection.

Gaining access to such information will facilitate the allocation of resources to different counties based on their needs. This will allow for a more equitable distribution of resources and ensure that counties, such as the ones in Northern Kenya, are not left behind in the process.

Next, the recording of such information will allow the government and its partners to identify the basic infrastructure that must be provided as a first layer for EdTech interventions. While investing in such simple resources is not an end in itself, as all our interviewees highlighted, it is necessary to build the foundation upon which EdTech projects will be built. At the beginning of the process, the authors suggest concentrating these resources on the school buildings, rather than trying to achieve the complex goal of providing computers and Wi-Fi access for all children and all homes.

Beyond target data collection and investments at the county level, the government can also conduct specific interventions within counties with big inequalities. They could, for instance, target poorer neighbourhoods in counties such as Nairobi where, in total, students have very good access to basic infrastructure but where large inequalities can still be found between different neighbourhoods. Some poorer neighbourhoods even find themselves in a situation akin to that of the rural areas in terms of access to infrastructure.

This process will nonetheless require putting together a clear accountability structure to minimise the effects of corruption.

Stage 2: Invest in compound & complex resources

After providing the basic infrastructure layer, the next step is to invest in compound and complex resources. Infrastructure itself, as seen in the literature and the findings from our research, is insufficient to improve learning outcomes. Consequently, it is essential to supplement the necessary hardware and surrounding infrastructure to use technological devices with the following:

- **Teacher training:** When implementing EdTech interventions, especially in rural areas, it will be essential for the teachers to act as facilitators. As the technology cannot completely erase the role of the professor, it will be essential for them to be trained. The following list is not exhaustive but presents examples of the possible content of such training programs:
 - How to use the devices;
 - How to solve simple technical problems with devices;
 - How to effectively integrate the devices in the classroom for a better learning experience;
 - How to use the device effectively to lessen the burden of administrative tasks such as grading or peer-reviewing; and
 - How to introduce systems that will allow students to engage with each other in a holistic manner.

The Tusome case study provides an example of an adequate training methodology. The training must be done in collaboration with the teachers themselves. The trainers must constantly interact with the teachers to understand their pain points and tailor the training accordingly. They should also facilitate interactions between the teachers. This will enable teachers to share their expertise. Creating this sense of teamwork and belonging will increase their motivation as well as their willingness to collaborate within the program.

- **Building a constructivist curriculum in technology in mind:** Beyond teacher training, actors must collaborate at different levels to build a curriculum that will integrate the technology while fulfilling the needs of the students in that particular setting. Especially for primary and secondary education, such innovative teaching practices can allow the professors to have a more balanced pedagogical approach to learning. While government bodies set general agendas and goals to be reached in the education system, at the school levels, educators and professors must set up an agenda with specific goals to be reached within each program. This agenda must be put together with the use of technology in mind. The following questions can serve as a baseline to think about how technology can be incorporated while building new curricula:
 - How can technology facilitate the attainment of [said goals]?
 - How can technology be integrated to increase [said goals]?
 - How can it ease the burden of teachers and educators?
 - Are any goals technologically focused?
 - How can technology increase the learning experience of students?

- How can it be used to tailor learning to achieve [said outcomes]?

Stage 3: Abstract resources: localization of EdTech content

This step within the implementation program is not the most pressing or essential. However, investing in these resources could be the reason for the success or failure of the adoption of EdTech programs in different regions. One of the main structural factors to the use of EdTech for improved learning outcomes is its incompatibility with local contexts. In this sense, for successful implementation of EdTech interventions, the government and its partners must invest in resources for the localisation of content. Such measures could include:

- **Use of local languages in programs and curricula:** Use a mix of English and Kiswahili for general content. Then at the county level, they may have the option to include other popular local languages as well.
- **Use of local individuals on cover pages:** Representation matters. As Kenya is ethnically diverse, implementers of EdTech interventions might find it useful to develop content to which students can relate by using people that look like them.
- **Use culturally relevant mentions as examples:** When developing certain programs, it might be useful to mention things such as dress code, festivals, or specific holidays that are culturally relevant in the context in which the EdTech intervention is implemented. It could be a text to read, the variable in a mathematical formula, an example for a grammar rule, etc.

By investing in these resources at different stages, the success of such EdTech projects will create ripple effects that affect resource allocation in turn. For instance, investing in EdTech as a complementary resource to decrease administrative burdens will increase the availability of compound resources such as teachers' time and experience or complex resources such as teachers' sense of efficacy and control. More specifically, the use of automated systems for grading and peer review can allow teachers to increase the quality time they have with their students by reducing the amount of stress and time they spend on administrative work (Interviewee 2, 2022).

By spending more time with students, teachers can better identify their pain points and tailor learning in ways that would ultimately improve their learning experience.

One important point to mention is that this ripple effect can only be created if there are incentives for teachers and educators to redirect the resources they are able to save because of EdTech. In this regard, it is imperative to develop a clear accountability structure to make sure that these resources are allocated to improve learning outcomes accordingly.

2. Develop a Clear Accountability Structure in the Educational Interventions

To do this, transparency must be at the core of each EdTech program. Some of the accountability and transparency mechanisms that have been found successful in other educational programs are the following:

- Explaining clearly to the participants the **program's purpose and processes**;
- Clearly defining the **role and tasks of each participant**;
- Sharing the **goals and understanding of the program** with all the participants; and
- Making all the **documents of the intervention public**.

3. Utilise EdTech as a Tool to Increase Accountability in the Education Sector

As it was previously mentioned, the use of EdTech can be used precisely to increase accountability in the education sector. Some of the areas in which accountability can be increased are the following:

- **Teachers' job:** EdTech can be used to track teachers' absenteeism and to improve their performance with students. Some of the recommendations our team suggests for that are the following:
 - Utilise EdTech to collect data on teachers' absenteeism.
 - Use EdTech tools to track students' performance, thanks to activities and corrections online, or homework records. That can help teachers understand which students need more support and therefore improve their performance.
 - Divide classes into small groups who work with an online task. EdTech can sometimes be a substitute for teachers' presence. Therefore, teachers can offer more individualised support to children, one-to-one meetings, or work with smaller cohorts.
- **Parents' pressure for school accountability:** EdTech can be used to strengthen school-parent communication since educational apps open new channels of communication - sometimes even more informal- between parents and teachers. This results in two positive outcomes that reinforce each other: first, parents are more involved in their children's education. Second, thanks to their involvement, they will value their children's education more. That will make them more willing to demand improvements to the school. Our team suggests the following actions:
 - Utilise the EdTech tools mentioned above (activities online, or homework records) to make parents see their students' work. That will make them more involved in their children's education.
 - Use EdTech apps to increase school-parent communication, through online messages and other communication channels.
 - Use feedback online forms to ask for parents' opinions. That will incentivise them to demand improvements and render the school accountable.
 - **Decision-makers' accountability:** the data that EdTech provides can help decision-makers to allocate resources more effectively and collect critical information for better management of their schools.

4. Community-building Solutions

For EdTech in Kenya to be successful and equitable, one cannot simply focus on the benefits accrued by a single stakeholder, i.e. students, teachers, parents, etc. Instead, key stakeholders must be considered in tandem as a singular integrated community.

The evidence from this study has shown that simply bypassing the considerations of teachers and failing to engage and amalgamating them with new technologies will not lead to a sustained and equitable learning improvement for students.

Because teachers are central to the learning process in technology-rich environments (World Bank, 2021) they cannot be left out of any decision-making and implementation processes. As a result, while implementing EdTech interventions in Kenya, it is crucial to look at teacher competence frameworks, teacher networks, and communities of innovative teachers to help empower the national cohort of teachers.

The lack of community-building within the application of EdTech interventions has proven to be one of the deeper structural issues surrounding EdTech across the developing world (Rodrigues-Segura, 2021). Through looking at successful examples of how such policy deficiencies have been tackled we can produce recommendations as to how to reduce the negative impacts on equity propagated by imperfect EdTech interventions.

4.1. Tailoring Interventions Towards the Needs of Local Contexts

For instance, one option could be to deliver expert content through pre-recorded lessons tailored to local contexts. Beg et al. (2019) used such intervention solutions to replace regular class time and to give teachers the tools to review the content of classroom videos through multiple-choice testing. Applied to the Kenyan context, by consulting the teaching communities on a regional-specific basis and case-by-case basis, it is possible to use technology to bring education to more remote and rural Kenyan counties and/or schools with generally weaker performing teachers. Additionally, Näslund-Hadley et al. (2014) showed that interventions with a higher degree of community-level local adaptations can be successful for improving mathematic achievements. For Paraguayan pre-schoolers, Maths was taught bilingually in Spanish and Guaraní to mimic local teaching conditions. Applied to Kenya, ensuring interventions are not just taught in Swahili but in the local languages too should enable EdTech to become immersed within the community and help build an inclusive system in which all stakeholders can benefit.

4.2. Remote Coaching and Community Meetings

Remote coaching and meetings might be utilised to increase communication and link parents and teachers participating in the EdTech community. For example, in Wolf et al. (2018)'s study in Ghana, the authors used technology as part of a larger treatment arm aimed at getting parents more involved in the intervention. By opening direct communication channels between stakeholders and better ensuring parental support is maintained by including them in any decision-making processes, this type of intervention would address the critical role parents play in the deliverance of EdTech interventions in the Kenyan context, and how variations in parental inclusion can lead to inequalities in the education systems.

4.3. Community-level Information Campaigns

Undoubtedly, a clearer understanding is needed of the factors that affect potential gender disparities within EdTech, both at home and in school environments in Kenya. Although this study singled out “attitudes and perceptions” as the main reinforcing mechanism of uneven gendered stereotyping within EdTech communities, a lack of knowledge of the specific nodes through which gender imbalances are reinforced reduces the capacity to implement targeted recommendations to rectify these forms of structural inequalities. Instead, EdTech could be used more generally to provide community-level information campaigns to expose the potential of educational technologies to liberate not just women but the population as a whole. Furthermore, it could be used to provide educational resources that promote the safe use of digital technologies, teaching women and girls how to address safety issues, increasing their resilience to outside pressures, and protect themselves in a digital environment - thus creating a community-level support network which enables EdTech to benefit Kenyans more inclusively and equitably.

Research Limitations

The research design for this study presents several **limitations**:

- Due to the recent interest in the topic of EdTech in developing countries, the literature is quite scarce and the data is limited. The **limited amount of research** on the topic made the study rely on grey literature for the evaluation of EdTech interventions in the country.
- As the team only used **secondary data** and existing literature, the authors are aware that the findings are susceptible to the limitations of the research designs from the data sources which may include selection bias from interviews.
- The **focus on Kenya** limits the generalizability of our findings to other developing countries.
- The **sample size (4) for the key informant interviews** provides a limited basis to demonstrate the validity of the findings. Therefore, the team supplemented them with three case studies and secondary data from reports to provide a wider pool from which to extract the findings.
- There is **potential for bias from interviewees**, especially regarding their relationship with the government or their opinion on measures such as compliance and taxation which may affect the businesses they are operating. To control for those, the team tried to gear the questions solely towards their areas of expertise. In terms of government regulations, the team wanted to understand the impact of those directly on the individuals which here would require the interviewees to narrate their own experiences.
- Findings are susceptible to **selection bias from interviewers** as the interviewees were not randomly selected and were carefully chosen due to their expertise in certain sectors.
- The **use of software to transcribe the interviews** could cause some information to be omitted. The software does not always transcribe everything fully and accurately which may cause people to misunderstand certain terms and expressions and therefore convey a completely different message. To control for this, each interview was recorded and team members read over the transcriptions and corrected any mistakes made by the software.
- Finally, the obvious limitations of thematic analysis through coding are that the **codes come from subjective interpretations of the data** and the categories may not be appropriate for the study. Thus, for this research, codes and themes emerged from discussions between different team members on the appropriateness of the data collected.

Ethical Considerations

The research design for this study also presents some **ethical issues, especially because of the interviews conducted:**

- During the process of interviews, and although we did ask for voluntary participation, there is a possibility that this **consent was not genuine**. It is possible the interviewees felt the need to please students from a prestigious university.
- We made sure to explain the purpose and benefits of participating in the interviews to have informed consent. However, due to **language or ethical barriers**, that may not have been as clearly understood.
- **Anonymity and confidentiality:** Although the anonymity has been preserved about the contributions of each interviewee, we have provided their names and occupations. They have consented to this.
- **Power relations:** We are fully aware that the research has been done from a Global North country to a Global South one, which may have implied some hidden power dynamics.
- **Plagiarism:** We have ensured that our work is free of plagiarism and that we have correctly referenced it.

Conclusion

As we have shown in this research report, EdTech presents multiple advantages to foster the education sector in Kenya: Better resource allocation in decision-making positions, the improvement of learning outcomes, or better communication between teachers, students and families. However, EdTech interventions need to be well planned and implemented to create substantial change and overcome the structural factors that the Kenyan education sector has.

It is important to note that we have found a reciprocal relationship between EdTech and the factors that enhance it. While EdTech interventions require the abovementioned factors to be successful, these same factors can be strengthened through EdTech interventions. Therefore, we believe EdTech cannot be simply regarded as a cause or a consequence of these factors but must be interlinked between them through self-reinforcing mechanisms.

To this extent, the authors recommend:

- 1) Implement the EdTech interventions in three stages, where different types of resources are used. In the first stage, there should be an investment in simple resources (hardware and software, Wi-Fi connection, electricity, etc.). We suggest starting by providing the schools - and not the particular homes - with these resources.
- 2) Invest in a combination of compound and complex resources (teacher training, and a constructivist curriculum that integrates technology).
- 3) Invest in abstract resources, such as the use of local tools (language, curricula, etc.).

The investment in resources needs to be paired with accountability mechanisms to ensure the viability of the project. To do that, we suggest planning an accountability structure, where all participants understand the goals of EdTech in education and its implementation. EdTech can also help ensure this accountability by reducing teacher absenteeism, creating more opportunities for parents and teachers to interact with each other, allowing teachers to interact with students in smaller groups, and improving decision-makers' access to information.

Finally, it is crucial to involve the whole community in the EdTech intervention. Students, teachers, parents and other education agents need to be involved as an integrated community. Involving the community as a whole will ensure that the requirements on the local level are listened to, and therefore that the interventions are tailored to their real needs. Moreover, EdTech can also be used to decrease gender inequalities in local communities, when providing girls educational resources that promote the use of digital technologies.

To sum up, the authors believe that if these three factors are considered in the implementation of programmes, EdTech could be a strong tool to successfully overcome the structural factors in the Kenyan education sector and provide a more quality and equitable education for all.

Appendix

Appendix 1: Key Informant Interviews initial guiding questions

1. Apart from funding, what type of resources do you think would be most effective to enhance the quality of EdTech in Kenya.
2. Do you believe ethnicity influences the equity environment of EdTech, if so how?
3. What do you think explains the mismatch between government reported numbers of spending in the education sector in certain counties compared to actual spending
4. What would you recommend for better resource allocation in the Kenyan education sector?
5. What is the role of culture in the adoption of education-related technologies?
6. What would you recommend for better resource allocation in the Kenya Education sector?
7. What would you recommend to decrease inequalities in Kenya resulting from the adoption of EdTech?

Appendix 2: Key Informant Interviews Preliminary Coding Book

I. Themes and Sub-Themes/Keywords

1. Community Building

- a. Connecting people who work in EdTech to share resources and insights
- b. Building a network
- c. Meeting like-minded people
- d. Including parents in EdTech decision making process
- e. Shifting mindsets/attitudes towards technology
- f. Stressing the importance of EdTech to females
- g. Removing community-level barriers to EdTech
- h. Community-level subsidies
- i. Include communities and different stakeholders in EdTech decision making process

2. Learning

- a. Social learning
- b. Active learning
- c. Learning outcomes

3. Government

- a. Discrepancy in budgets and spending rates in some counties
- b. Lack of data
- c. Corruption
- d. Access problems
- e. Representative access to computers
- f. Lack of initiatives and failed laptop project
- g. Making money from education
- h. Better positioned than the private sector to allocate resources

- i. Meant to create social good
- j. Accountability
- k. Need to invest in more remote places that don't have e.g. Internet access
- l. Provide basic infrastructure layer

4. Engagement of Students through EdTech

- a. Design better learning experience
- b. Videos
- c. Games

5. EdTech use

- a. Complement teachers, so they have time for other duties
- b. Peer review for grading

6. Culture

- a. Gender gap in access to technology (Kakuma refugee camp hosts many people from Sudan and Ethiopia))
- b. Localization of content
- c. Use of language
- d. Institutional culture influences adoption rate of EdTech
- e. Infrastructure not distributed equally affects adoption culture
- f. School culture doesn't support the use of computer labs
- g. Tech is destructive and doesn't help learning

7. Reducing inequalities

- a. Better infrastructure
- b. Changing mindsets and attitudes
- c. Provide job opportunities in EdTech
- d. Closing gaps between public and private schools
- e. Closing gaps between different counties

8. Resources

- a. Funding

9. Technology

- a. EdTech initiatives are by the private sector
- b. Use of renewable energy to power technology in remote areas

10. Training

- a. Quality of learning
- b. Lack of education background of EdTech Founders
- c. Lack of knowledge of how learning works
- d. Lack of collaboration between EdTech firms and universities or research firms
- e. Lack of knowledge about pedagogical approaches

11. National exams

- a. EdTech is for passing the exams and not learning

12. Mentorship

- a. Lack of access to mentors

13. Ethnicity

- a. Access to infrastructure
- b. Access to income

14. Rural and urban debate

- a. Nairobi
- b. Income inequality
- c. Private schools

15. Constraints of the emerging EdTech private sector

- a. Difficulty in the collection of payments - no adapted platform for other African countries
- b. Lack of infrastructure
- c. Ability to pay
- d. Digital tax
- e. NITA compliance in an industry that is constantly changing

II. Cases (Organisations and People)

1. EdTech East Africa
2. Government of Kenya
3. Private Sector (Start-ups, Businesses)

Bibliography

Africa Check. (2020). What share of households in Kenya own a computer?. Retrieved 13 December 2021, from <https://africacheck.org/infofinder/explore-facts/what-share-households-kenya-own-computer>.

Aker, J. C., & Ksoll, C. (2019). Call me educated: Evidence from a mobile phone experiment in Niger. *Economics of Education Review*, 72, 239-257.

Alwy, A., and Schech, S., (2004). "Ethnic Inequalities in Education in Kenya." *International Education Journal* 5(2): 266-74

Amuko, S., Miheso, M., & Ndeuthi, S. (2015). Opportunities and Challenges: Integration of ICT in Teaching and Learning Mathematics in Secondary Schools, Nairobi, Kenya. *Journal of Education and Practice*, 6(24), 1-6. <https://eric.ed.gov/?id=EJ1078869>.

Araka, E., Maina, E., Gitonga, R., & Oboko, R. (2019, May). A conceptual model for measuring and supporting self-regulated learning using educational data mining on learning management systems. In 2019 IST-Africa Week Conference (IST-Africa) (pp. 1-11). IEEE.

Baker, B. (2016). Does Money Matter in Education? Second Edition. In Shanker Institute. Retrieved from <https://www.shankerinstitute.org/resource/does-money-matter-second-edition>.

Bariu, T. N. (2020). Status of ICT Infrastructure Used in Teaching and Learning in Secondary Schools in Meru County, Kenya. *European Journal of Interactive Multimedia and Education*, 1(1), e02002. <https://doi.org/10.30935/ejimed/8283>

Barrett, A., Bennett, D., & Helmich, E. (2018). How to...analyse qualitative data in different ways. *The Clinical Teacher*, 16(1), 7-12. <https://doi.org/10.1111/tct.12973>

Bishop, G. (1989). *Curriculum development: A textbook for students*. Macmillan publishers

Breiter, A., & Light, D. (2006). Data for School Improvement: Factors for designing effective information systems to support decision-making in schools. *Journal of Educational Technology & Society*, 9(3), 206-217. Retrieved from <https://www.jstor.org/stable/pdf/jeductechsoci.9.3.206.pdf>.

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3 (2). pp.77-101. ISSN 1478-0887.

Cohen, D. K., Raudenbush, S. W., & Ball, D. L. (2003). Resources, Instruction, and Research. *Educational Evaluation and Policy Analysis*, 25(2), 119-142. <https://doi.org/10.3102/01623737025002119>.

Crawford, L. (2020). Why the COVID Crisis Is Not Edtech's Moment in Africa. Retrieved from Center For Global Development website: <https://www.cgdev.org/blog/why-covid-crisis-not-edtechs-moment-africa>.

de Ree, J., Muralidharan, K., Pradhan, M., & Rogers, H. (2017). Double for Nothing? Experimental Evidence on an Unconditional Teacher Salary Increase in Indonesia. *The Quarterly Journal of Economics*, 133(2), 993–1039. <https://doi.org/10.1093/qje/qjx040>.

Donahoe, B., Rickard, D., Holden, H., Blackwell, K. & Caukin, N. (2019). Using Edtech to Enhance Learning. *International Journal of the Whole Child*, 4(2), 57-63.

Duflo, E., Hanna, R., & Ryan, S. P. (2012). Incentives Work: Getting Teachers to Come to School. *American Economic Review*, 102(4), 1241–1278. <https://doi.org/10.1257/aer.102.4.1241>.

Education Technology. (2021). What Is EdTech? A Guide. Retrieved from <https://builtin.com/edtech>

Escueta, M., Quan, V., Nickow, A. J., & Oreopoulos, P. (2017). Education Technology: An Evidence-Based Review. National Bureau of Economic Research. Published. <https://doi.org/10.3386/w23744>.

Funston, A., & Morrison, M. (2000). Investigating gaps and opportunities: young people's access to IT in Australia.

Freudenberger, E., & Davis, J. (2017). Tusome External Evaluation-Midline Report. Retrieved from https://pdf.usaid.gov/pdf_docs/PA00MS61.pdf.

Gaduh, A., Pradhan, M., Priebe, J., & Susanti, D. (2020). Scores, Camera, Action? Incentivizing Teachers in Remote Areas. *Research on Improving Systems of Education (RISE)*. https://doi.org/10.35489/bsg-rise-wp_2020/035.

Haßler, B., Nicolai, McBurnie, Chris, Jordan, Katy, Wilson, Sam, & Kreimeia, Adam. (2020). EdTech and COVID-19 response [EdTech Hub Report]. <https://doi.org/10.5281/zenodo.4118177>.

Hanushek, E. A. (2008). Impact of Differential Expenditure on School Performance. *Hanushek Source: Educational Researcher*, 18(4), 45–62. Retrieved from [http://hanushek.stanford.edu/sites/default/files/publications/hanushek%201989%20EducResearcher%2018\(4\).pdf](http://hanushek.stanford.edu/sites/default/files/publications/hanushek%201989%20EducResearcher%2018(4).pdf).

Heinrich, C. J., Darling-Aduana, J., & Martin, C. (2020). The potential and prerequisites of effective tablet integration in rural Kenya. *British Journal of Educational Technology*, 51(2), 498-514.

Hennessy, S., Jordan, K., Wagner, D. A., & EdTech Hub Team. (2021). Problem Analysis and Focus of EdTech Hub's Work: Technology in Education in Low- and Middle-Income Countries (Working Paper No. 7). The EdTech Hub. <https://doi.org/10.5281/zenodo.4332693>

ITU (International Telecommunication Union). (2018). *Measuring the Information Society Report 2018 – Volume 1*. Geneva, Switzerland: ITU.

Jere-Folotiya, J., Chansa-Kabali, T., Munachaka, J. C., Sampa, F., Yalukanda, C., Westerholm, J., ... & Lyytinen, H. (2014). The effect of using a mobile literacy game to improve literacy levels of grade one students in Zambian schools. *Educational Technology Research and Development*, 62(4), 417-436.

Jordan, K., & Mitchell, J. (2020). *Messaging Apps, SMS, and Social Media: A Rapid Evidence Review (Rapid Evidence Review No. 8)*. EdTech Hub. <https://doi.org/10.5281/zenodo.4556938>

Jordan, K., David, R., Phillips, T., & Pellini, A. (2021). Education during the COVID-19 crisis Opportunities and constraints of using EdTech in low-income countries. *Revista de Educación a Distancia (RED)*, 21(65).

Kaindio, M. P., & Wagithunu, M. N. (2014). Integrating information communication technology skills in Preschool Education in Kenya. *Mediterranean Journal of Social Sciences*, 5, 89–102. <https://doi.org/10.5901/mjss.2014.v5n5p>.

Kang, E. (2021). Whose money matters in public education: A “public” good that parents purchase. *Policy Futures in Education*, 147821032110343. <https://doi.org/10.1177/14782103211034348>.

Kaye, T. (2020). Educational Technology to Improve Capacity – Integrating Adaptive Education Programmes in Public School in Kenya. In *Trust, Accountability and Capacity in Education System Reform* (pp. 182–200). Retrieved from 9780429344855.

Kenya SchoolNet. (2003). *Preparing a Workforce for the Evolving Information Economy: A Survey on ICT Access and Use in Kenya Secondary Schools*. Nairobi: Summit Strategies Limited.

Kipsoi, Dr. E. J., Chang’ach, Dr. J. K., & Sang, H. C. (2012). Challenges Facing Adoption of Information Communication Technology (ICT) In Educational Management in Schools in Kenya. *Journal of Sociological Research*, 3(1). <https://doi.org/10.5296/jsr.v3i1.1882>.

Kiptalam, G. K., & Rodrigues, A. J. (2010). Accessibility and utilization of ICTs among secondary school teachers in Kenya. In *The International Conference on Computing and ICT Research* (pp. 246-263). Uganda: Kampala.

Kiptalam, G. K., & Rodrigues, A. J. (2010). Internet utilization: A case of connected rural and urban secondary schools in Kenya. *International journal of computing and ICT research*, 4(1), 49-63.

Kirimi, K. J. (2014). Impact of information communication technology on education-Kenya. *Journal of Educational and Social Research*, 4(1), 435-435.

Kisirkoi, F. K. (2015). Integration of ICT in Education in a Secondary School in Kenya: A Case Study. *Literacy Information and Computer Education Journal*, 6(2), 1904–1909. <https://doi.org/10.20533/licej.2040.2589.2015.0253>.

KIPRA (2019). Education and Training Budget Brief [PDF] (pp. 1-16). The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS. Retrieved 13 December 2021, from <https://www.unicef.org/esa/sites/unicef.org/esa/files/2019-03/UNICEF-Kenya-2018-Education-Budget-Brief.pdf>.

KNA1 (2021). Digital literacy programme on course – Kenya News Agency. [online] Kenyanews.go.ke. Available at: <https://www.kenyanews.go.ke/digital-literacy-programme-on-course/>.

Kramon, E., & Posner, D. N. (2016). Ethnic favoritism in education in Kenya. *Quarterly Journal of Political Science*, 11(1), 1-58.

Kremer, M., Brennen, C., & Glennerster, R. (2013). The Challenge of Education and Learning in the Developing World. *Science*, 340(6130), 297–300. JSTOR. <https://doi.org/10.1126/science.1235350>

Lawson, T., & Comber, C. (2000). Introducing information and communication technologies into schools: The blurring of boundaries. *British Journal of Sociology of Education*, 21(3), 419-433.

Li, J. (2017). Ethnic favoritism in primary education in Kenya: effects of coethnicity with the president. *Education Economics*, 26(2), 194–212. <https://doi.org/10.1080/09645292.2017.1398310>

Lynch, M., Edvocate, C. of T., & Edvocate, T. T. (2011). Allocating Resources to Improve Student Learning. Retrieved from HuffPost website: <https://www.huffpost.com/entry/allocating-resources-to-i b 1018778>.

Maina, F. (2003). Integrating Cultural Values into the Curriculum for Kenyan Schools.

Mariga, G., Ogenga, S., Shikali, C., & Muliaro, J. (2017). Computer laptop project strategy for basic education schools in Kenya. *International Journal of Information and Communication Technology Research*, 7(5). Retrieved from <https://pdfs.semanticscholar.org/9ac1/3c23157d3fd44e73bb0aa7bbcefc21d98180pdf?ga=2.154147832.1750334033.1572288542-1256155719.1572288542>.

Major, L. & Francis, G. A. (2020). Technology-supported personalised learning: Rapid Evidence Review. EdTechHub. <https://zenodo.org/record/3948175#.YbePML3P23A>.

Martin (2020). How to Optimize Online Learning in the Age of Coronavirus (COVID-19): A 5-Point Guide for Educators. UNSW Newsroom. Retrieved from <https://newsroom.unsw.edu.au/news/social-affairs/how-optimise-online-learning-age-coronavirus>.

Miima, F., Ondigi, S., & Mavisi, R. (2013). Teachers' perception about integration of ICT in teaching and learning of Kiswahili language in secondary schools in Kenya. *International Journal of Arts and Commerce*, 2(3), 27-32.

Ministry of Education. (2018). 2018 Education Quality Dialogues. Retrieved from https://education.go.ke/images/GPE_PRIEDE/2018-FINAL-DIALOGUES-.pdf.

Mugedi, E. (2016). Kenya's Digital Literacy Programme enters the next phase as two firms are selected for proof of concept. [online] TechCabal. Available at: <https://techcabal.com/2016/02/09/kenyas-digital-literacy-programme-enters-the-next-phase-as-two-firms-are-selected-for-proof-of-concept/>.

Mulwa, A. S., & Kyalo, D. N. (2013). The influence of principals', teachers' and student's attitude on readiness to adopt e-Learning in secondary schools in Kitui District, Kenya. *European Scientific Journal*, 9(5).

Muyaka, J. (2018). Community Environment and Education of Girls: The Case of Communities in Marsabit County, Kenya. *Universal Journal of Educational Research*, 6(3), 430–439.

Mwendwa, N. K. (2017). Availability of Resource Materials and Facilities for ICT Integration in the Public Primary School Curriculum in Kitui County, Kenya.

Myers, C., Kaye, T., Bapna, A., Williams, A., & Mitchell, J. (2021). [Review of Country-Level Research Review: EdTech in Kenya]. Creative Commons Attribution 4.0 International. <https://doi.org/10.5281/zenodo.5256847>.

Nchunge, D. M., Sakwa, M., & Mwangi, W. (2012). User's perception on ICT adoption for education support in schools: a survey of secondary school teacher's in Thika district Kenya. *International Journal of Humanities and Social Science*, 2(10), 17-29.

Ngari, S. M., & Ndung'u, S. W. (2020). Disaster Management Preparedness in the Education Sector in Kenya – A Case of the COVID-19 Pandemic. *Edition Consortium Journal of Educational Management and Leadership*, 1(1), 86–96. <https://doi.org/10.51317/ecjempl.v1i1.192>.

Ng'ang'a, M. M. M., Kimani, P. S., & Kimwele, D. M. W. (2020). An Improved Model for the Implementation of Web-Based Learning in Adult Secondary School Education in Kenya. *International Journal of Computer (IJC)*, 38(1), 22–36. <https://ijcjournal.org/index.php/InternationalJournalOfComputer/article%20/view/1571>.

Piper, B., Zuilkowski, S. S., Kwayumba, D., & Strigel, C. (2016). Does technology improve reading outcomes? Comparing the effectiveness and cost-effectiveness of ICT interventions for early grade reading in Kenya. *International Journal of Educational Development*, 49, 204–214. <https://doi.org/10.1016/j.ijedudev.2016.03.006>.

Rodriguez-Segura, D. (2021). EdTech in Developing Countries: A Review of the Evidence. *The World Bank Research Observer*, 0(0). <https://doi.org/10.1093/wbro/lkab011>.

Odera, F. (2011). Learning English Language by Radio in Primary Schools in Kenya. <https://docplayer.net/22250369-Learning-english-language-by-radio-in-%20primary-schools-in-kenya.html>.

Ogembo, J. G., Ngugi, B., & Pelowski, M. (2012). Computerizing Primary Schools in Rural Kenya: Outstanding Challenges and Possible Solutions. *The Electronic Journal of Information Systems in Developing Countries*, 52(1), 1–17. <https://doi.org/10.1002/j.1681-4835.2012.tb00371.x>.

Omariba, A., Ondigi, S. R., & Ayot, H. O. (2016). Challenges Facing Teachers in Integrating Educational Technology into Kiswahili Teaching. A Case of Selected Secondary Schools in Kisii County, Kenya. *International Journal for Innovation Education and Research*, 4(12), 23–39. <https://doi.org/10.31686/ijer.vol4.iss12.42>

Oulo, I.O., 2013. Preparedness of the head teachers in the use of Information Communication Technology in public primary schools in Bondo District, Kenya (Doctoral dissertation, University of Nairobi).

Otieno, J., & Abeba Taddese. (2020). EdTech in Kenya: A Rapid Scan. Zenodo. <https://doi.org/10.5281/ZENODO.3909977>.

Otieno, T. (2021). KNUT Boss Reveals Kenya's School Laptop Project Was a Scam. [online] Talk Africa. Retrieved from: <https://www.talkafrica.co.ke/knut-boss-reveals-kenyas-school-laptop-project-was-a-scam/>.

Peña-López, I. (2016). Innovating Education and Educating for Innovation. The Power of Digital Technologies and Skills.

Piper, B., Zuilkowski, S. S., Kwayumba, D., & Strigel, C. (2016). Does technology improve reading outcomes? Comparing the effectiveness and cost-effectiveness of ICT interventions for early grade reading in Kenya. *International Journal of Educational Development*, 49, 204-214.

Poggiali, L. (2017). Digital futures and analogue pasts? Citizenship and ethnicity in technoutopian Kenya. *Africa*, 87(2), 253-277.

Rakusin, M., & Bostock. (2018). School leadership and early grade reading: Examining the evidence in Zambia. In *Cultivating Dynamic Educators: Case Studies in Teacher Behavior Change in Africa and Asia*. RTI Press Publication BK-0022-1809.

Redempta, K., & Elizabeth, M. (2012). An e-learning approach to secondary school education: E-readiness implications in Kenya. *Journal of Education and Practice* [Online], 3(16).

Sampson, R., Johnson, D., Barton, H., Ruchika, J., Seth, M., & Shotland, M. (2019). Insights from Rapid Evaluations of EdTech Products. Retrieved from: https://centralsquarefoundation.org/wp-content/uploads/EdTech%20Lab%20Report_November%202019.pdf.

Simson, R., & Green, E. (2020). Ethnic favouritism in Kenyan education reconsidered: when a picture is worth more than a thousand regressions. *The Journal of Modern African Studies*, 58(3), 425-460.

Teach for All Spain (2022). Menttores. Retrieved 18 February 2022, from <https://menttores.org/>

UN (2016). Sustainable Development Goals. Retrieved 11 December 2021, from <https://sdgs.un.org/goals>.

UN (2016). Sustainable Development Goal 4. Retrieved 11 December 2021, from <https://sdgs.un.org/goals/goal4>.

UNESCO (2015). Incheon Declaration and Framework for Action. Retrieved 12 December 2021, from http://uis.unesco.org/sites/default/files/documents/education-2030-incheon-framework-for-action-implementation-of-sdg4-2016-en_2.pdf.

Uwezo (2021). Are All Our Children Learning? Uwezo 7th Learning Assessment Report. Nairobi: Usawa Agenda.

W Norton Grubb. (2009). The Money Myth School Resources, Outcomes, and Equity. New York: Russell Sage Foundation, Baltimore, Md.

Wambugu, P. (2018). Massive Open Online Courses (MOOCs) for Professional Teacher and Teacher Educator Development: A Case of TESSA MOOC in Kenya. *Universal Journal of Educational Research*, 6(6), 1153–1157. <https://doi.org/10.13189/ujer.2018.060604>.

Wanzala, O. (2018, July 25). Laptops lie idle in schools on lack of skilled tutors. *Business Daily*. Retrieved from <https://www.kionjo.com/news/client/desktop/newsarticle/Laptops- lie-idle-in-schools-on-lack-of-skilled-tutors/21bb33aa-d44b-4bba-93bf-c32e2c5b010a>.

Wims, P., & Lawler, M. (2007). Investing in ICTs in educational institutions in developing countries: An evaluation of their impact in Kenya. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 2007, Vol. 3, Issue 1, pp. 5-22.

World Bank. (2017). To take learning seriously, start by measuring it. In *World Development Report 2018: Learning to Realize Education's Promise* (Vol. 1-0, pp. 91–104). The World Bank. https://doi.org/10.1596/978-1-4648-1096-1_ch4