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Evidence Over Intuition: Identifying Factors That Influence the Effectiveness of Large Scale Edtech Initiatives

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Abstract: We analyze four EdTech initiatives in India to identify relevant factors that determine their effectiveness. We use a two-fold data analysis technique to first comparatively analyze these EdTech interventions and then use a broader theoretical framework to further probe the identified factors. This study reveals that the primary factors involved in effective implementation of EdTech initiatives are: learners' interest in the device and content, the support provided by teachers and mentors, the interest shown by the learners' own community, the functionality and a provision for maintenance of the devices, the mode of implementation, availability of appropriate pedagogical and technical support, the socio-cultural-economic background of the learners, and cost, scalability and sustainability of the initiative.

Keywords: EdTech Initiatives, Large Scale Initiatives, Indian context

1. Introduction

In recent years, many developing countries have been expanding their education systems which has created an additional stress resulting in lags in learning, retention, graduation rates, and socioeconomic equity. Investments in educational technology (EdTech), are seen as a possible way to improve these outcomes. However, in some cases, these EdTech projects fall short of delivering their intended effects or in other cases their effects are not long-term. One reason for this is they do not have sound empirical support. There is a need to go beyond intuitive ideas and move in the direction of empirical research-based guidelines for EdTech interventions.

In the developing countries, EdTech boom has created the need for governments to regulate this sector so that fair practices and standards can be implemented. This regulation will be based on research-based guidelines about effective use of educational technology. Hence, a rigorous study of EdTech initiatives is needed to understand their adoption and integration which can inform what factors might influence effective or ineffective interventions. The goal of this paper is to identify a list of essential factors that must be accounted for while designing an EdTech intervention, particularly in the context of developing countries like India.

In developed countries, a fair amount of research has been conducted to identify factors responsible for effective implementation of EdTech initiatives. However, there exist limited studies in the context of developing countries, and they mostly analyze a particular initiative to understand the factors. Rodriguez-Segura (2021) has conducted a literature review of EdTech in developing countries and has categorized the initiatives under four broad themes: access to technology, technology-enabled behavioral interventions, improvements to instruction and self-led learning. He analyzes these programs in terms of their intended policy targets, effectiveness, cost-Effectiveness, best

uses, potential pitfalls and challenges. A similar literature review was conducted by Keengwe & Malapile (2014) who concluded that the responsible factors were the selling of refurbished computers for use on a large scale, the high prices and low effectiveness of services provided by technology-related multinational corporations in developing countries, the philosophical perspectives and priorities of organizations, foundations, and development agencies promoting the implementation of ICTs in developing countries, and the predominance of the English language in the software.

There exist some relevant studies which have focused on individual EdTech initiatives to arrive at the relevant factors for success and failure. Ezumah (2012) in their study regarding use of the One Laptop Per Child (OLPC) projects in Nigeria and Ghana, claimed that lack of meticulous preparationand implementation of the adoption process prevented the project from achieving its objective. Similarly, in India, Ale, Loh & Chib (2017) had conducted a study to measure the learning and mediation of computer self-efficacy of OLPC project in the rural areas. The findings of their study showed how contextualized technology might be used in rural classrooms together with knowledge of how user psychology affects learning outcomes. Another study by Karunaratne, Peiris & Hansson (2018) in a different setting argued that the main challenges in implementation of smallscale ICT projects in developing countries were the usual technical and infrastructural restrictions.

The current paper focuses on a single country, India, and covers different initiatives within it. This method can provide rich data on country specific factors which can inform the contextualization issue in EdTech in developing countries. This alternative approach has the potential of being used as an exemplar to conduct similar studies in various other developing countries. This current paper not only does a comparative analysis of initiatives like previous studies but also uses a theoretical lens to further analyze them. This paper has three primary contributions. The first contribution is moving beyond intuition or a utopian belief about the transformative potential of technology, and instead using empirically available data to plan guidelines for future EdTech initiatives. Second, this analysis is an attempt to shed some light on the unique conditions of the Indian EdTech scene. This can lend weight to the demand for customizing EdTech projects according to local needs. Third, this paper brings together information available in various reports and studies on diverse EdTech initiatives at one single place and attempts to provide an accessible document to get a broader understanding of this phenomenon.

2. EdTech initiatives considered

Four EdTech initiatives out of India were explored and analyzed in this paper: Hole in the Wall Education Limited (HiWEL), Connected Learning Initiative (CLIx), Mindspark and Pratham Digital Initiative (PraDiGi). A purposive sampling technique was used to select these initiatives on the basis that these interventions go beyond information dissemination and provide a blended experience to the learners where the role of technology is to enhance creativity and collaboration. The data for these initiatives was taken from published reports and research papers available in the public domain.

HiWEL aims to provide a fun learning environment for underprivileged children by establishing Playground Computer Learning Stations (50+ kiosks) that operate outside of school boundaries. Arora (2010) in her study of two HiWEL kiosks in the Uttarakhand state of India explored factors that can derail such an initiative.

CLIx is a large-scale, technology-based project for high school students implemented in 478 schools. CLIX team has published reports exploring themes from implementation of the program to its success and community engagement (Connected Learning Initiative, 2020; Mulla, Shende, & Nagarjuna, 2019).

The Abdul Latif Jameel Poverty Action Lab (J-PAL) conducted an evaluation study of the impact of a personalized technology-aided after-school instruction program,

Mindpsark, in middleschool grades in urban India (Muralidharan, Singh & Ganimian, 2019).

PraDigi is a digital programme that delivers tablets to rural communities, as well as a learning app that provides children with high-quality, interactive information to help them improve their fundamental reading and numeracy abilities, as well as their capacity to think critically and collaborate (Pratham Education Foundation, n.d.).

3. Findings

A two-fold analysis technique was implemented. Each initiative was analyzed in detail and a concept map was created to identify common features across initiatives. Next, a characterization table was generated to analyze the similarity and differences between these initiatives. These similarities and differences were coupled with broader theoretical frameworks to get a holistic picture.

Table 1 shows the factors identified, the empirical support (the presence/absence of the feature), the resulting outcome and the aligned theoretical frameworks. Each factor is discussed in detail below, from the lens of its contribution to the effective implementation of EdTech initiatives. While the degree of importance of these factors might vary across programs and contexts, they still are prominent enough to be covered while planning any potential initiatives.

Table 1. *Empirical data and theoretical frameworks in data analysis*

Factors	**Empirical Data from Initiatives**				**Theoretical framework**
	Factor is incorporated		**Factor is not incorporated**		
	Feature of program design	*Outcome*	*Feature of program design*	*Outcome*	
Learner interest in the device and content			HiWEL provides access to computer and internet without a set curriculum	Students used the systems for entertainment activities like playing games	Underprivileged children primarily tend to use computers for entertainment (Anthony, & Padmanabha, 2010)
Support provided by teachers or mentors	CLIx incorporated a TPD program	Teachers' advanced digital skills improved significantly	HiWEL did not employ teachers	Children struggled to make optimum learning use of devices	Diverse theories from Behaviorism to Constructivism recommend teacher support (Brau et al., 2022; Mcleod, 2019)
Learners' community interest in the initiative	PraDiGi leaders raise community awareness about their initiative	Expect the community to get involved with the initiative	HiWEL tried to substitute mainstream govt school education	School teachers felt threatened by this initiative	Community Outreach Programs are essential for out-of-school learning (Peppler, 2017)
Functionality and maintenance of the devices			HiWEL expected the community to automatically take over kiosk maintenance	Community showed no interest in maintenance of the kiosks	Theory of preventive maintenance suggests use of periodic maintenance drives (Hyman, 2003)
Mode of implement-ation of the initiative	PraDigi gave personal learning devices to students	Students utilized them in school and out of school			Social constructivism theory views school as a place to facilitate peer learning (Parr & Townsend, 2002)
Availability of pedagogical and technical support	Mindspark had trained staff available at centers to assist the learners	Expects that staff to help and guide the learners			While students maybe digital natives, teachers need support to use edtech in classrooms (Inoa & LoCascio, 2020)

	CLIx technical team visits project locations to provide assistance	Expects this team to solve technical and pedagogical issues			
Socio-economic background of the learner	PraDiGi offered content for home, school & life needs	Expects learners to pick up a socially relevant course			Theory of connected learning embraces the diverse backgrounds and interests of all learners (Connected Learning Alliance, 2018)
	CLIx brought in teachers' inputs for course design	Expects teachers' inputs to represent students' expectations			
Cost, Scalability and Sustainability	CLIx works with government institutes	Expects the government machinery to sustain work in the long-term	HiWEL expected the community to financially support the kiosk	Kiosk was closed due to lack of financial support	The equal educational opportunities theory advocates schemes that do not discriminate
of the initiative	Mindspark initially offered their service free of cost	Students only attended the program while it was free			between groups of people (Amos & Abdul Kareem, 2013)

Factor 1: Learner interest in the device and content

The HiWEL initiative did not consider learner preference when designing the program. It provided free access to internet and computers without a set curriculum which resulted in the students using the systems for entertainment activities like playing games. Reports from other initiatives also suggest that learners from a disadvantaged socio-economic background may primarily use digital devices for entertainment and media consumption (Anthony & Padmanabhan, 2010). The CLIx program used a co-design approach, bringing in teachers' inputs for designing of the teaching-learning material, with the assumption that students' interest will be appropriately conveyed by teachers.

Factor 2: Need for teacher/mentor support

HiWEL did not employ teachers as they believed in minimal invasive education, this resulted in children struggling to make optimum learning use of devices (Arora, 2010). This means that just providing hardware is not enough, at least if the goal is to go beyond basic digital skills. Learning has to be supported and facilitated by competent mentors. In order to ensure effective teacher support, CLIx incorporates Teacher Professional Development (TPD) as part of their intervention. This TPD program has resulted in teachers' advanced digital skills improving significantly and behaviors aligned with CLIx pedagogic pillars being more evident. The need for teacher support is supported by contemporary learning theories, ranging from behaviorism to constructivism (Brau et al., 2022; Mcleod, 2019).

Factor 3: Developing community interest in the initiative

The HiWEL program in Uttarakhand initially projected their initiative as an alternative to the poor quality of learning that took place in government schools. The local teachers felt threatened in terms of their own role in education and developed antipathy for the initiative. On the other hand, PraDiGi engaged with the community to raise awareness and bring a sense of ownership. This sense of ownership can possibly engage a community in such a way that they accept an initiative as their own and support it in the long term. This need for community connection is also substantiated by the practice of Community Outreach Programs as part of out-of-school learning projects (Peppler, 2017).

Factor 4: Functionality and maintenance of the devices

HiWEL computer kiosks in the Hawalbagh region of Uttarakhand (India) had to be shut down after a short period because of lack of support. The HiWEL organization had expected the community to bear the expenses of the computer kiosk after an initial period of hand-holding. However, the community on the other hand still expected HiWEL to continue supporting their initiative. Even CLIx struggled with their ICT Lab infrastructure in Telangana as some of the ICT infrastructure was not optimally functional. This means that devices which are part of an EdTech initiative have to be maintained and repaired regularly. The theory of preventive maintenance suggests use of periodic maintenance drives to ensure the proper functioning of project equipment (Hyman, 2003).

Factor 5: Mode of implementation

The J-Pal study commented that Mindspark might have yielded different results if it was an in-school program as compared to an after-school program. HiWEL initially opened out of class computer kiosks but finally, they turned to schools for foundational technical training of the children and also to provide a safe space for the kiosks. CLIx decided to work with government schools to ensure sustainability, so the intervention can stay functional on its own. While Pratham did not work with schools, it did offer the learning content to prepare students for school life. Therefore, the success of an initiative is dependent on how they engage with the local school system, whether it tries to work with the schools or substitute them. Social constructivism theory places a significant emphasis on in-school education as it provides an opportunity for peer learning and collaboration (Parr & Townsend, 2002).

Factor 6: Availability of pedagogical and technical support

With the HiWEL initiative, the school teachers mostly perceived the kiosks as a distraction as the students spent their time playing games or consuming entertainment media at the kiosks. This could have been changed if instructors were available at the kiosks to guide the students in terms of their pedagogical and technical knowledge. The J-PAL evaluation proposed that Mindspark staff should be present at the centers for assistance of the learners. Similarly, CLIx has a provision for technical staff present on the ground to assist the initiative. The use of technology for learning can also create a technical barrier in terms of the ability to use the technology, hence it is important to provide appropriate pedagogical and technical support. Inoa & LoCascio (2020) advise that while students may be digital natives, teachers need support to use edtech in classrooms.

Factor 7: Socio-cultural-economic background of the learner

The designers of HiWEL initiative made an assumption that peer-learning is inherently beneficial. They believed that learners at a kiosk would help each other figure out how to use a computer. However, they failed to incorporate the fact that learners brought their own biases to the program, and this resulted in discrimination at the kiosks. There were cases of bullying at the kiosks, and it was mostly boys who would visit these kiosks (Arora, 2010). Therefore, it becomes essential that the socio-cultural background of the learners needs to be accounted for while designing an intervention. In the case of PraDiGi, they worked in a rural setting and so they had to accept the fact that many learners might prefer to also work in order to sustain their families, so they offered the learner a choice to pick courses which are relevant to their socio-economic needs. The need to cater to the socioeconomic differences of learners is supported by the theory of connected learning that embraces the diverse backgrounds and interests of all learners (Connected Learning Alliance, 2018).

Factor 8: Cost, Scalability and Sustainability of the initiative

Students attended the Mindspark centres only till it was free. Similarly, HiWEL expected the community to take over the maintenance cost of the kiosks after a period

of hand-holding but the community showed no interest and the kiosk had to be shut down. Even if the cost of initiatives might seem meager, it becomes financially unsustainable in a country like India with considerable income inequality. Therefore, as per egalitarian principles, cost-effective or state subsidized initiatives are better suited in such communities. This argument is supported by the equal educational opportunity theory, which advocates schemes that do not discriminate between groups of people (Amos & AbdulKareem, 2013). In terms of sustainability, initiatives like CLIx, Mindspark and HiWEL ensure that the same devices can be used by successive batches of learners. PraDiGi, while employing personally owned devices, has the option to collect and redistribute the tablets once a group of learners have met their learning goals.

4. Discussion

In order to use a broader lens to understand the four chosen initiatives, the authors also studied some EdTech initiatives from similar developing countries, particularly: One Laptop Per Child (OLPC), EdTech Hub and Digital Youth Network (DYN). OLPC was a non-profit organization which designed and distributed educational devices, along with software and content, for the developing world. OLPC did not make it a priority to account for learner preference when designing the program and its contents. As a result, a majority of the children either found the laptops of no use or they showed no interest in the learning content offered by the laptop (Ames, 2019). This strengthens Factor 1, learners' interest in the initiative. Another global initiative, EdTech Hub uses Sandboxes to make sense of the enabling environment for an initiative. In its Pakistan Sandbox, it was working to improve distance education for deaf learners (EdTech Hub, 2021). Researchers initially offered recorded lectures but then also incorporated live lectures over video call to make the learning experience more interactive. This supports Factor 2, provision of support by teachers/mentors. The final global initiative considered was DYN, a program that aims to assist economically disadvantaged adolescents in developing technical, creative, and analytical abilities (Barron, et al., 2010). The DYN initiative had the goal to create an equal platform for all members of an urban minority community to be digitally literate. DYN used the socio-economic background of the learners as an anchor for the learning activities to which students felt a connection and hence participated actively. Thus Factor 7, the socio-cultural-economic background of the learner needs to be taken into consideration while designing an EdTech intervention.

This paper has analyzed data from studies in India and has substantiated it by adding perspectives from studies of global initiatives, thus providing an empirical basis to the identified factors. The paper also explores challenges of edtech initiatives in a country like India with limited infrastructure and considerable economic disparities. India being a diverse country also needs initiatives that can be customized to local needs. Finally, this paper has synthesized data from multiple individual studies and has coupled it with broader theoretical frameworks to provide a broader understanding of the edtech initiative phenomenon.

Limitations of this paper include the consideration of only those initiatives which have both a virtual and physical element, so it has left out MOOC based initiatives. The paper has also used a purposive sampling technique which reduces its repeatability and generalizability. The small sample size of the initiatives selected limits the amount of empirical data available to corroborate the factors identified. The study is also limited by its reliance on secondary data for analysis, which even though common across such broad studies, limits understanding at ground level. Therefore, future research can be conducted at the site of an ongoing edtech initiative to substantiate the identified factors.

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