

Towards Digital Multigrade One-room Schoolhouses for Underprivileged Communities in Rural Pakistan

Faisal Badar & Jon Mason

Charles Darwin University, Australia.

Corresponding author: faisal.badar@students.cdu.edu.au

Abstract. Context matters in the design and development of educational opportunities. Despite extensive global efforts to make education accessible for all, one out of every five children are out-of-school. The situation demands re-thinking of learning strategies, particularly in underprivileged contexts. Continued advancements in learning technologies may offer novel solutions. The one-room schoolhouse is a centuries-old proven educational system, which has yielded promising results for rural areas. Using a multigrade teaching method, the one-room schoolhouse provides a resilient model for educating children where school administration faces typical issues of remote and rural areas such as lack of quality teachers, fewer children in each level, low socio-economic status of parents, lack of rooms in a school building, etc. This paper reports a case study of an integrated approach to teaching out-of-school children in rural Pakistan using education technology in a one-room schoolhouse environment using a multigrade teaching method. The paper (1) synthesizes the knowledge of practice and research on one-room schoolhouses, multigrade teaching, and education technology developments; (2) reports the on-ground practices of multigrade one-room schoolhouses in a real-life scenario in rural Pakistan and integrating digital capabilities into these schoolhouses; and (3) proposes the ways to implement and scale this method to educate out-of-school children in other underprivileged communities.

Keywords: Pakistan, rural education, out-of-school children, globalization, ICT, one-room schoolhouses, multigrade teaching, underprivileged

1 Introduction

Worldwide innovations in digital technology infrastructure continue to evolve, delivering globalized benefits to many. Overwhelmingly, however, these benefits are mostly experienced in the developed world, leaving the developing world to ‘catch up’. This is not to say these innovations do not also bring new challenges to the developed world – such as a tribalized Internet, the spread of misinformation, cybersecurity threats, and an erosion of trust in public institutions. For the developing world, local contexts matter and harnessing the benefits of technology innovation very much depends on local driving factors and challenges such as education of parents, socio-economic circumstances, their interaction with technology, etc. – moreover, there is not just one ‘developing world’ and the challenges extend beyond simplistic ideas of access to technology. While development is often measured in economic terms, the development of any society can also be determined by assessing the measures taken to provide quality education to every child, and to eradicate educational inequality that may be prevalent. Global initiatives such as ‘Education for All’ (EFA) and ‘Millennium Development Goals’ (MDGs) were adopted through the involvement of most member nations to provide primary education to all children of the world (UNESCO, 2000; 2015). In 2015, member states of UN have since adopted 17 Sustainable Development Goals (SDGs) as part a comprehensive sustainable development agenda to 2030, in which SDG4 refers to inclusive and equitable education lifelong learning opportunities for all. Despite such initiatives, global statistics show that one out of five children are out-of-school. Furthermore, a decline in efforts from participating governments, progress in decreasing the number of out-of-school children, adolescents, and youth has significantly reduced in recent years (UNESCO Institute of Statistics [U.I.S], 2018). The World Economic Forum (WEF) Gender Gap Report also indicates that there is a significant difference in the average attainment of education by girls in South Asian Countries such as Pakistan, India, Afghanistan and Bangladesh (World Economic Forum, 2017). Alarming, the 2020 WEF Gender Gap Report predicts that ‘gender parity will not be attained for 99.5 years.

Nevertheless, advancement in technology during the last two decades has also paved the way to resolve many problems in all walks of life and education is no exception. Mobile and wireless-based Information and Communication Technologies (ICT) have enabled new ways to teach and learn where they are no more dependent on a specific time, place, or teachers (Badar, Mason, & Khan, 2018). Research in Information and Communication Technology for Development (ICT4D) has focused on diminishing the digital divide between high-income and low-

and middle-income economies by exploring how information systems and technology can be utilized for the benefit of underprivileged communities (Ayanso et al., 2014). While progress is being made (Heeks, 2020; Walsham, 2017), there is an argument that ICT4D research also ‘fails the poor’ (Harris, 2015). While innovative e-learning solutions are emerging in remote and rural areas in developing countries, the sustainability of sometimes-disruptive innovations creates challenges for governments and policy makers (Badar, Mason, & Khan, 2018). In this context, older institutions such as the one-room schoolhouse offer a practical and adaptable approach for 21st-century learning where student-centric learning is focused within a multigrade student class (Goodlad, 1996). The rationale behind the concept also includes a positive alternative to a traditional form of ability grouping, and grade labelling while encouraging personalized learning (Bennet, Hare, & Lee, 1983; Pratt, 1986; Veenman, 1995).

This paper reports on an ongoing study informed by a growing body of research on harnessing digital technology affordances in education and, more specifically, how the integration of contemporary digital technologies with time-tested learning methods might provide innovative formal education solutions to out-of-school children in underprivileged contexts in Pakistan. The study has been designed to examine the effectiveness of Raunaq-e-Islam Neighborhood Schools (RINHS), operating as digital multigrade one-room schoolhouses, under the umbrella of Pakistan Memon Women Educational Society (PMWES) in underprivileged communities in Sindh, Pakistan. Findings to date highlight the role of socio-cultural contexts where these schools were established, societal contributions of these schools in educating out-of-school children, and the challenges faced. Initial data were collected during the field visits and transcribed from notes gathered from on-site observations and unstructured interviews with PMWES stakeholders. Visits were conducted with a threefold aim: firstly, to explore the effectiveness of learning in multigrade one-room schoolhouses; secondly, to study the instructional model of RINHS based on responses of stakeholders; and thirdly, to examine different digital learning strategies for implementation and improving quality of education with a focus towards innovative learning environment. This paper also represents an extended version of a paper published in the proceedings of the 27th International Conference of Computers in Education (Badar & Mason, 2019).’

2 Out-of-school children and digital technology for education

“There are 58 million children out of school globally, and around 100 million children who do not complete their primary education. The world’s poorest children are four times more likely not to go to school than the world’s richest ones” (UNESCO, 2015). The number is now even more alarming as a consequence of COVID-19 and now exceeds one billion. Children from economically and educationally disadvantaged families tend to have weaker educational foundations compared to their advantaged counterparts within the society, and the gap only widens during the school years (Andrews, Hutchinson, et al., 2017). Several factors are leading to this gap including learning environment at home, opportunities to hear and read more words, and access learning activities outside the home (Latchem, 2018; Smees & Sammons, 2017). The gap often leads to a higher number of dropouts. Children from affluent families have a better probability of forming a strong bond with their parents, which leads to their social and emotional development, and subsequently towards a successful life (Moullin et al., 2014).

To tackle educational challenges, systemic integration of ICT has been outlined as an opportunity for improving the quality of teaching and learning as well as expanding access to learning opportunities (UNESCO, 2015; Mitra, 2005). While the main reasons behind out-of-school secondary level children are poverty, location, and gender, learning models based on mobile technology can potentially provide access to “people who live in a remote location where there are no schools, teachers and libraries” (Ally, 2009). SDG9c specifically targets “universal and affordable access to the internet in the least developed countries by 2020”

2.1 Role of education ICT in spreading education. Information and communication technologies for development (ICT4D) is a general term used to define the applications of ICT for the socioeconomically disadvantaged groups. Education in developing countries could be transformed and benefit from ICT4D strategies such as mobile technology (Badar, et al., 2018). With mobile-learning, learners have more flexibility of what, when, where, why and how to learn, making it an individualized, personalized and highly interactive learning (Bikanga Ada, 2018; Khaddage, Muller, & Flintoff, 2016; Cobcraft, Towers, Smith, & Bruns, 2006). Mobile phones are widely considered as the optimal solution for delivering education in developing countries, because of their usability, accessibility, and affordability (Grimus, et al., 2013; Ford & Leinonen, 2009). Mobile technology has the potential to shift the teaching focus to the learner (Grimus, et al., 2013). ICT4D is focused on minimizing the digital divide globally through effective and adaptable use of Information Systems (IS) and technology for the benefit of the deprived communities in developing countries (Ayanso, et al., 2014). Despite its potential for transformation, the role of ICT4D research has been questioned by critics due to numerous failures of projects during the last half-century such as telephone and

satellite communication in Africa in 1960s (Unwin, 2009), computer systems implementation in India and Latin America in 1990s (Montealegre, 1998), and various e-government projects in Southeast Asia (Mirchandani et al., 2008). The recent COVID-19 pandemic has added sudden and unprecedented challenges with formal education disrupted in 194 countries, affecting 1.57 billion learners (91.3% of total enrolled learners globally) in just a few months (UNESCO, 2019). Moreover, education systems in advanced countries were not prepared to shift to digital learning. According to PISA, around 70% of OECD countries provide adequate digital resources to a 15-year old student at school, and most advanced countries such as Japan provide only 40% of the 15-year old students with relevant software for learning (Petrie et al., 2020).

Table 1. ICT4D Discourses.

Streams	Description	Properties
Technology and diffusion discourse	Measure adoption of technology by developing countries through solutions imported from developed countries	• Take established IS research knowledge and good practice models (e.g. methods, analytical approaches, or theories) as reference and measure level of adaptation in developing countries context. • Use quantitative research methods and related theories such as DOI, TAM, UTAUT, established IS concepts or best practices such as organizational change and IS management.
Social embeddedness discourse	Study local socio-cultural context and the constellation of actors to develop new socio-technical structures	• Study socio-cultural phenomenon to understand technology-driven social change, using qualitative research methods. • Social sciences theories such as Actor-Network Theory (ANT), institutional theory, complexity, social network, are applied.
Transformative ICT4D discourse	Explore possibilities for socio-economic transformation through ICT interventions to improve lives.	• Social embeddedness stream theories and methods may be applied to investigate possibilities of transformational outcomes. • Targets ICT-enabled transformation by resolving the developmental challenges in a particular social context either by solving the vulnerabilities or by improving capabilities.

Researchers have also criticised the linear and deterministic direction of ICT4D research (Brown & Thompson, 2011; Diniz et al., 2014) which is built on the foundations of Diffusion of Innovation (DOI) (Rogers, 1962) and similar theories, such as the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) while neglecting the greater role of socio-cultural elements in any community (Hayes & Westrup, 2014; Ramadani et al., 2018). Therefore, despite the development of policies, programs, projects and significant investment to diminish the digital divide gap, ICT4D efforts are widely criticised for lack of transformation in the lives of least privileged communities (Marais, 2011; Harris, 2015; Meyer & Marais, 2015; World Bank Group, 2016; Independent Education Group, 2011; Silva & Fernandez, 2016). ICT4D research has diverged over the years into three major discourses as shown in Table 1 (Avgerou, 2008).

According to Ramadani et al., (2018), out of 45 articles published in IS journals between 2007-2016, technology and diffusion discourse dominated with 28 publications, followed by social embeddedness discourse with 15 publications, and only 5 research publications were found related to transformative ICT4D discourse. Also, 79% of research adopted a quantitative method, 14% adopted a qualitative method, and only 7% adopted a mixed research method. Reflecting on the broad evolution of ICT4D discourse and the shifts in priorities articulated by UNESCO, some researchers (Heeks, 2020) also suggest the emergence of a new paradigm that repositions the term digital in development contexts.

Thus, the focus of this paper is transformative ICT4D where the researchers seek to investigate possibilities of ICT-enabled transformation by resolving local challenges in context by improving system capabilities and

strengthening the weak links. In this study, however, the context has stimulated an innovation that is not led by digital capabilities in isolation.

2.2 Pakistan; education and out-of-school children status. Pakistan is the sixth most populated country in the world, with 63% population under the age of 25 years and the fourth largest pool of out-of-school children (UNESCO, 2017). Most of these out-of-school children are residing in remote, rural or underprivileged city areas where prevailing challenges in providing quality education include a shortage of good teachers, the hidden child labor challenge, affordability and cultural barriers to pursuing educational goals (Titola-Meskanen, 2014; Ashraf & Ismat, 2016). Family socioeconomic status (SES), parents' education, income, and occupation all determine the level of respect in the society (Ghazi, et al., 2013). Education quality and standards are declining in rural areas and increasing urban/rural disparities and inequalities, which is creating a learning crisis in low-income rural areas (Agarwal, 2014). Due to continued lack of focus on quality aspects of education, the increasing divide between rural and urban as well as between rich and poor, Pakistan is likely to further lag its neighboring South Asian countries in the future (Mamoon, 2018). Funds granted by international funding agencies do not get utilized effectively and hence the education sector has been badly affected in the last few decades (Khan, Lurhathaipat, & Matsushita, 2016).

3 Multigrade One-room Schoolhouses

3.1 One-room Schoolhouses. One-room schoolhouses are simply understood to consist of one classroom where a single teacher teaches academic basics to several grade levels of elementary-age boys and girls. One-room schoolhouses can be seen historically as a natural first step for a community to introduce educational opportunities for their children. Such buildings have been common all around the world and operating for the last 300 years (Williams, 2005). They also persist today in many rural contexts; however, while popular in the nineteenth century, they were also used as community centers. In addition to being used for educational purposes, they were used for church services, local council meetings, Christmas parties, community suppers, lectures, etc. Thus, an element of 'community outlook' was integral to the experience of usage. School attendance was voluntary, and more dependent on local variables such as weather, home-chores, and affection for the teacher. Parents considered these schoolhouses a proper place for their children's education and often sent them to school before the age of six. After completing the school year, students were examined orally covering their spelling, arithmetic problem-solving competence, and other subjects, based on which teachers determine the students' future level of studies (Heritage Alliance, 2005).

3.1.1 Benefits and achievements of one-room schoolhouses. The one-room schoolhouse has traditionally provided the means for an integrated approach to the curriculum, often mixing age and aptitude. As a method for a 21st-century education, it is distinguished from conventional curriculum design because it revisits this older integrated 'multi-grade' approach, as discussed in detail in sub-section 3.2. Interestingly, recent research indicates the setting improves the non-cognitive abilities of the students, giving them broader social engagement and the opportunity to mentor relatively less advanced students (Cundra, Benzol, & Schwebach, 2017). It "allows for one to take advantage of a wide disparity of abilities in a classroom and nearly everyone can learn more, faster, and more enjoyably than in a traditional classroom of students with similar abilities" (Abacus Educational Journal, 2016). The one-room schoolhouse encourages and supports peer-mentoring between relatively more and less experienced students. This pedagogical approach helps students to access challenging course material and research methodologies when someone among them has more relevant knowledge and provides the opportunity to educate the less knowledgeable ones (Bhuiyan, Supe, & Rege, 2015). Thus, the one-room schoolhouse integrates peer-mentorship into the curriculum design directly and provides a more conducive learning environment as compared to the traditional grade-based learning approach (Cundra, Benzol, & Schwebach, 2017).

3.1.2 Global experimentation on one-room schoolhouses learning method. Beyond a strategy that effectively utilizes available resources, the one-room schoolhouse is also being adopted by higher education institutions (HEIs) globally due to inbuilt structural benefits. For example, at Drake University a three-week research course was designed around the same foundation and principles (Henderson, Buising, & Wall, 2008). As such, this strategy is also a pedagogical method. This method connects students from varying levels of experience and ability and engages them creating the synergy of efforts, in contrast to the traditional approaches (Baxter, 2000). George Mason University has also experimented with a course design comprising nine undergraduate students and five advanced level high school students working together, where the more experienced ones are found helping the less experienced ones (Cundra, Benzol, & Schwebach, 2017).

3.2 Multigrade classroom teaching. Formal academic learning can be organized in two ways: single-grade classroom (a class based on age) and multigrade classrooms (Little, 2001; Mycock, 1967). Multigrade classrooms are generally organized due to some forced conditions such as lower numbers of students in one grade, lack of teachers, lack of other resources, etc. (Ford, 1977; Erdem, Kamac, & Aydemir, 2005). While there is no one way to manage a multigrade classroom there are many benefits such as a rich student centric-learning environment, a learning pace adaptable to individual capacities, flexible school enrolment requirements and an innovation-supporting atmosphere (Kalaoja & Pietarinen, 2009). Smit and Engeli (2015) highlighted that in multigrade classrooms, younger children learn appropriate social behaviors from older children, and teachers in multigrade classrooms often plan peer learning in small collaborative groups. Multigrade education is also an acceptable and commonly adopted phenomenon in both developed and developing countries (Cornish, 2006). Several research studies from around the world likewise articulate the advantages and disadvantages of multigrade classrooms (Aghazadeh & Fazli, 2010; Kouchaki & Abbasi, 1995; Eliasvand & Jamshidi, 1995).

3.2.1 Factors leading to multigrade classrooms. According to Little, (2001), multigrade teaching is adopted due to various conditions, including low population density in the vicinity of a school, schools at multiple locations, population decline in recent years, recent population growth and school expansion with low enrolments in higher grades, lack of popularity of schools leading to dropouts, lack of practical availability of teachers despite adequate teachers enrolments, over admissions to students in any particular grade, teachers absenteeism, and an academic decision due to pedagogical reasons. All these conditions evolve from the situational necessity except the last one, which arises from pedagogical choice. Globally, multigrade classrooms are found primarily in rural areas and overwhelmingly due to the factor of necessity.

Little (1995) earlier reviewed many studies highlighting problems and challenges in multigrade teaching, particularly focusing on their implications on developing countries, and concluded that in the contexts where the choice for these underprivileged children is either to attend these multigrade schools or none at all, the real comparison of outcomes must include the out-of-school children as well. In addition, following the broad global commitment during Education for All in Dakar in 2000, multigrade teaching was recognized to be one of the most effective and practical solutions

3.2.2 Benefits and challenges of multigrade classrooms. Mycock (1967) observed that multigrade classrooms create a leader-follower approach among students, while Myende and Nhlumayo (2020) highlight that leadership is also often performed by parents in collaboration with teachers in rural school settings. Researches showing the benefits of grouping students from multiple ages emphasizes that these groups “more aligned with children’s natural groupings and learning tendencies” (Ong, Allison, & Haladyna, 2000) and gain more non-cognitive and cognitive benefits (Katz, Evangelou, & Hartman, 1990; Pavan, 1992; Veenman, 1995; Allison & Ong, 1996; Kelley & Fitterer, 1998; Ong, Allison, & Haladyna, 2000). The older students are encouraged to serve as leaders in the class helping the younger ones, which boost their self-esteem and leadership qualities (Stehney, 1970). Several researchers highlighted that multigrade classrooms develop many non-cognitive and life skills among the students such as self-concept, self-esteem, emotional intelligence, and social characteristics (Millar, 1991; Pratt, 1986; Thomas & Shaw, 1992; Veenman, 1995). Veenman (1995) found that students in multigrade and multi-age classrooms do not appear to learn more or less than their counterparts in single-grade and single-age classes. However, their non-cognitive (social and affective) skills such as attitude towards school, personal adjustment, and self-concept tend to score similar or better than students from single-grade and single-age classrooms.

Conversely, several researchers have also highlighted limitations and challenges of this approach for both teachers and students (Erdem, et al., 2005; Kilic & Abay, 2009; Ozci, Duran, & Tauar, 2010; Kouchaki & Abbasi, 1995; Eliasvand & Jamshidi, 1995), whereas, some studies have highlighted quality outcomes of multigrade teaching method (Bashiri, 2013; Hashtjin, Saedi, & Zarj Abad, 2001; Ghaisar, 2001). For example, Erdem et al., (2005) conducted research with 72 teachers in Turkey and found that most teachers teaching in multigrade classrooms have five years or less teaching experience and were identified having problem in using of curriculum supportive tools and methods. Sag, Savas and Sezer (2009) highlighted that majority of multigrade teachers were not trained to handle multigrade classes at any stage of their teaching education. Moreover, they lack instructional material support, are less motivated to teach multigrade classes, and were paid insufficiently. Taole and Mncube (2013) studied multigrade schools in South African rural context and concluded that similar national-curriculum based textbooks to mono-grade and multigrade classes, with no flexibility for multigrade classes, teachers are not trained for multigrade teaching, and these schools lack human and physical resources. On the other hand, an Australian study conducted by the New South Wales Curriculum Directorate (1997) concluded that outcome-based curriculum “significantly contributed to successful multi-age operations” (p. 23). McEwan (2008) highlighted that pedagogical practices specific to multigrade

teachings are the key to successful students' outcome multigrade settings. Broome (2009) highlighted the social and emotional benefits of multi-age settings in a classroom, Heins et al. (2000) discussed that multigrade setting provide high-quality classroom environment, and Davenport (1998) mentioned that multigrade environment helps develop a supportive community.

4 RINHS Schools- Multigrade One-room Schoolhouses in Rural Pakistan

In September 2018, we explored the schools serving out-of-school children in the underprivileged context in rural Pakistan. We started our investigation through discussions with international, national and local organizations and advisors directly involved with education in Pakistan such as UNESCO, Karakoram International University, Dadabhoy Institute of Higher Education (DIHE), Behbud Foundation, and the World Memon Organisation (WMO). After three months and a series of discussions and virtual meetings, the visit schedule for Pakistan was finalized including meetings with various influencers in school education in Pakistan including UNESCO Pakistan team in Islamabad, Director Ghizar Campus Karakoram University Gilgit, Director QEC DIHE, President Behbud Foundation, Chairman Education for All Committee WMO. Most of the scheduled meetings were productive during our visit to Pakistan, and we gathered details of many other organizations actively supporting out-of-school children in various aspects. However, due to time limitations, we could not explore deeply the working philosophy of every organization in our contact list.

Our focus soon developed as an in-depth study of the Raunaq-e-Islam Neighborhood School System (RINHS). Raunaq-e-Islam Neighborhood Schools are a chain of multigrade one-room schoolhouses in rural Pakistan operated by the Pakistan Memon Women Educational Society (PMWES) and serving out-of-school children in underprivileged communities since 2010. We gathered data through series of meetings with the RINHS management team, visiting several RINHS campuses, semi-structured interviews with campus leaders, teachers, and other staff, focus groups with students' parents, observation of classrooms and community activities. We undertook a thematic analysis of our transcriptions and observational notes, along with photographic evidence.

4.1 The environmental Context at RINHS. There is a serious inequality in educational attainment levels in Pakistan where more than twice the individuals aged 10 years or above are illiterate in rural areas compared to that in urban areas (49% in rural areas and 24% in urban areas) (Pakistan Bureau of Statistics, 2020). In Karachi alone, there is a huge disparity in education between the urban and rural areas. The Gini index of Education in Karachi shows the value of 0.611 in rural areas and 0.346 in urban areas (Saeed & Fatima, 2017). RINH Schools are operating in rural and low-socioeconomic areas of Karachi with limited access to educational institutions. Government schools are in a worse condition where basic school infrastructure (classrooms, drinking water, and toilets) is poor. Most parents are living below the poverty line and cannot afford to send their children to private schools in the vicinity. Moreover, cultural and traditional norms also restrict the transportation of female students to far-away areas for educational purposes. The established classification of educational institutions in Pakistan comprises pre-primary, primary, middle, secondary, higher secondary and higher education. RINHS management has adopted the multigrade one-room schoolhouse approach in their 20 schools spread around Karachi's extremely low socio-economic areas. Students from grade pre-primary to grade-7 are taught by the local teacher/s in multigrade classrooms settings where students from 2-4 grades are accommodated in a single class. Many teachers are also owners of the houses where these schools are established. These schools are equipped with necessities such as ventilation, electricity, course books and writing material, makeshift arrangement for the digital learning environment, drinking water and access to clean toilets.

RINH Schools represent an alternative learning environment with suitable hygienic conditions for students not going to schools elsewhere. Students are taught in a multigrade environment with considerable range of age cohorts within one classroom. Instructions in these classrooms follow weekly plans developed by RINHS academics using government curriculum and books. However, extra-curricular activities are regularly conducted to develop these students' cognitive, non-cognitive and social skills and abilities. Teachers dedicate their time and efforts and aim to bring their students beyond the curricular goals and to develop them as responsible and independent learners. The learning atmosphere in these schools is also influenced by the local socio-cultural context. The parents are happy with the dedication and efforts of the teachers and the efficacy of the multigrade classrooms. The multigrade classroom is also successful in integrating children with varied capacities and needs.

Educating out-of-school children in underprivileged contexts needs an in-depth understanding of the problems beyond teaching and schooling operations. It also requires developing an empathetic mindset for the educationally deprived child who is typically distracted due to various socio-economic and cultural factors and also providing due support to parents or guardians so they may permit and encourage their children to attain education. It is worth

understanding and realizing that for these parents, there is an opportunity cost in providing education to their children in normal schools, which can be the income that their children earn, or taking care of younger siblings and the household when both parents are working outdoors during the daytime.

Good education must develop a child's social aspects and make the student a responsible citizen. In privileged developed world contexts, this has developed as an agenda focused on social and emotional learning (SEL). Oberle and Schonert-Reichl (2017) explained SEL as the process of providing opportunities to children and adolescents to learn, acquire, and practice the knowledge, attitudes, and skills necessary to identify and achieve positive goals, regulating emotions and making responsible decisions. Educational institutions find it difficult to bring a sustainable positive change in the child's personality when the values taught in school contradict with the norms practiced at home. Therefore, the measure of educational success may go beyond the students' exam results to bring a meaningful, fulfilling and positive change in the lives of the ones collecting the exam results of the student. Research shows that those schools that build relationships with other schools and community partners bring equality in education, schooling, and society as a whole (Ainscow, et al., 2012)

Even though government schools in these rural locations often serve the immediate population, they also face a serious challenge in developing strong relationships with the students' families and local communities. RINHS has a philosophy of developing communities along with the children of the underprivileged areas. They believe that if they do not develop a strong connection with students' families and community, they risk missing out the whole process of developing a conducive environment for their students' sense of becoming a responsible citizen. The RINHS administration continuously strives for community engagement and external partnerships for the benefit of students and community in the following directions:

- Overcoming poverty through partnerships with families and communities: RINHS management team tirelessly engage with affluent community members to support students' families to eliminate barriers in students' learning process. They have observed significant improvement in children's learning after the families are provided basic living necessities. Outstanding and needy students are provided scholarships to encourage their learning efforts.
- Building students' real-life learning foundations through knowledge and skills development: RINHS organize activities, workshops, and invite qualified community members as guest speakers to broaden students' and families' awareness, knowledge and skills.
- Providing quality education and citizenship awareness through educational technology tools: RINHS students are also regularly delivered educational and social content through various open educational resources to prepare them to compete at the international level and become a committed and responsible citizen in future.

During the field visit and informal interactions with the parents of these children, it was also found that parents' willingness to educate plays a vital role in children attending schools. Parents' interest in educating their children is found to have a direct correlation with students' attendance and academic performance. Parents' financial position is also found to influence students' academic interest and performance. Parents highlighted that they want their children to continue education but due to scenarios such as the illness of the father and shortage of work, children get involved in skill-based unstructured training at a meagre wage rate under supervision of some skilled worker to earn for their families. These children need to travel long distances to reach their workplaces and therefore, cannot go to schools anymore. Female students also help their mothers in some handicraft work during their spare time, and some of them quit schools after a few years to take these handicrafts making as full-time work for better family income...

4.2 The Learning Context and Instructional Model at RINHS. RINHS management has a strong vision to educate the underprivileged children of Pakistan through digital one-room schoolhouses in rural communities and believes that their pursuit of this mission can only be accomplished through consistent engagement with the world beyond the school gates. RINHS is a unique combination of heterogeneity in terms of its campus locations, teachers who are teaching in various campuses, student cohorts and their family backgrounds. RINH Schools are established within the houses of local inhabitants in any underprivileged area through the support of PMWES. These schools are generally established using one room in the volunteer person's house, and the female member of that family is provided adequate teacher training after confirming the suitability of her academic qualification to teach the students. All other resources are provided by RINHS administration. The academic supervision team visits weekly to monitor the quality of education. The selection of local teacher resolves many issues such as cultural and traditional barriers, communication with students and their parents, getting support from community influencers, and neutralizing anxiety that local traditions are being spoilt by external elements.

Each RINH school campus has its localized dynamics, drivers, and set of challenges. Even located within one town, the multiple campuses have varied resources, available classroom space, and bonding with the students and parents. These differences are primarily due to many variables including the parents' socio-cultural and financial status, and educational background within the nearby surroundings; teachers' motivation level; community participation; and structural/cultural factors to facilitate outside teams to visit the campus. Due to a centralized teacher training system and curriculum implementation model, RINHS was able to overcome the potential variation in the quality of education that could emerge due to the above socio-economic differences in various locations.

Even though the students of each campus of RINHS is assigned a grade, they are generally instructed as one group. Those students who show the capacity to advance in learning are given advanced learning resources. Each campus has a different cohort of students. Campuses with more rooms/area and teachers accommodate more students. RINH Schools have students from ages 3 years to 15 years, studying in grades pre-primary to grade 7. Campuses with two or more rooms have the capacity to divide students into more than one multigrade classrooms, whereas those having only one room generally accommodate all students in a single classroom. This arrangement may not yield the best educational results but compare to the situation where these children were not going to the school otherwise, multigrade one-room schools are serving the purpose of educating out-of-school children.

The family plays a very important role in motivating children for education. It was observed during the focus group sessions with the parents that the parents with educational background tend to understand the importance of education better than uneducated parents. However, in some cases, the opposite trend was also observed, as uneducated parents wanted their children to get an education because they faced social problems due to illiteracy and didn't want them to face the same problem in their lives. Similarly, when elder siblings are already going to school, the younger siblings are more inspired to go to school as well. However, few parents also shared their difficulty in re-connecting the elder children to education who have left the school after completing few years of schooling due to various reasons such as to support the family financially, or not getting motivated enough to continue studies, etc.

The learning objectives defined by the government education department are generally followed at RINHS. However, additional educational objectives include:

- Inclusive education and learning environment to cater for the local context
- Social skills and ethics
- Problem-solving and self-dependent working skills

Each campus arranges special events on a regular basis according to RINHS academic guidelines to meet these objectives. Recently, teachers at many campuses have started using educational technology resources to provide their students with quality educational content. In RINH Schools, teachers engage students according to the weekly plans provided by RINHS academic planning team. Important subjects such as Mathematics, English, and Science are taught daily, whereas other subjects are taught twice or thrice a week. Every week, a two-hour extra-curricular session is arranged where teachers plan activities focusing on the non-cognitive skills of the students. Regular faith-based ethical teachings are conducted at the beginning of each day. Teachers give extra emphasis on students' personality grooming and mannerism such as how to respect and greet elders, how to take care of personal hygiene etc. Teachers are trained to handle multi-age students' in their classrooms. Teachers use blended instructional format, which combined learning for the whole class, individualized/small group learning by the teacher according to the students' grades, and revision of teachers' instruction in small groups through peer mentoring by advanced students. Weak students are provided additional instructions and daily homework is also given to the students for practising the learned lessons at home.

The education planning team of RINHS provide a quarterly program to the teachers, which is developed in a weekly lesson plan format. The teacher in her weekly progress diary records each student's progress and follow students' progression according to the pace of the students. Teachers have the leverage to provide reasonable adjustments in the plan by providing advanced learning material to fast learning paced students, and to give additional instructions to slow learners. Teachers prepare homework for the students of each grade comprising practice activities and provide to the students at the end of each day. Every student has own diary where they note down their homework. The teachers regularly update student's parents about their child's progress also use this diary.

5 Digital Learning Transformation at RINHS

5.1 Technology adoption for improving quality of learning at RINHS. It was repeatedly highlighted by the RINHS management and campus leaders during discussions and informal interviews that quality of teachers is the weakest link in RINHS multigrade one-room learning system. As these schools are in far-away remote areas, good quality

teachers from urban areas do not prefer to join these schools. The locally trained teachers have limitation in term of their educational backgrounds, exposure to the latest teaching techniques and technology related educational developments. RINHS Management Board recently took a step forward towards adoption of 21st Century learning techniques for RINHS students, where the on-site teacher's role is re-defined as a facilitator, and educational content carefully selected from open educational resources is used. The regular assessment through digital communication by a team of qualified and experienced teachers working remotely, to fill the gap of weak link of quality teaching and to provide personalized learning and assessment of each student through a customized Learning Management System (LMS) was also proposed.

After lengthy content selection and assessment development process, an in-house test was conducted in selected schools from another chain of normal private schools, under supervision of the same Board of Advisors. The aim was to educate children using open educational resources in the form of videos, games, and quizzes through the laptops in a controlled and limited setting and record their academic progress through customized Learning Management System (LMS), to resolve the teething issues related to digital learning structure before implementing in RINHS. Response from the teachers and students show that the learning progress of the students has increased significantly through the globally recognized quality educational resources. RINHS administration plans to continue this experiment, and if the long-term overall impact is positive, they may expand digital learning partially to all branches of these normal private schools next year. Once established, digital educational resources will be primarily used for the learning and assessing part, and the teachers will perform the role of facilitators in the classroom. This transformation will bring RINHS teaching methodology closer to 21st-century learning methods. RINHS has successfully penetrated the isolated communities in rural and remote areas around the Karachi region through their one-room schoolhouse educational model. The model offers a sense of security to these communities as their own community member/s teach the children. Moreover, RINHS provides financial support to interested students through philanthropic activities where appropriate. However, RINHS is much concerned about the improvement of the teaching process in their One-room Schoolhouses. To overcome these issues, RINHS is exploring the possibility of technology-based learning solutions for these neighborhood schools. Digital transformation of RINHS according to the 21st-century learning techniques which limit the role of local teacher to a trained facilitator supervised and supported by remote qualified academic teams looks promising.

A Learning Management System is now typically a cloud service that provides a teaching and learning environment independent of time and location. An LMS now plays a pivotal role in online and distance learning as it enables a mix of teacher-led courses, and interaction between the teachers and students (Sharma, 2013). Because it is freely available with a proven capability to enhance learning, Moodle was selected as the LMS for the digital transformation process at RINHS (Stanley, 2014). Due to its open-source architecture, Moodle can be utilized in many environments, which can help developers to create and edit the features according to RINHS needs and desires. A basic framework of e-learning policies for RINHS was developed involving all stakeholders.

5.2 Roadmap to Digital Learning transformation at RINHS. Digital learning transformation of RINHS needs a complete revival of learning strategies, where the traditional learning pedagogies need to be augmented with digitally suitable pedagogies. Similarly, the traditional learning content also needs to become digitally compatible for seamless delivery at the school's level. Moreover, teacher and facilitator trainings were also a major challenge, as without a motivated and capable teaching team the digital transformation may not bring the desired outcomes. Another challenge for the digital transformation team at RINHS was to gain the confidence of the stakeholders about the myths related to e-learning environments such as digital learning is not effective learning method particularly for underprivileged population due to their lack of technology adoption; implementing ICT systems in the underprivileged areas will not bring positive outcomes as these tools suit to the tech-savvy children; teachers' training in a digital environment is similar as of traditional classroom teaching; digital pedagogies may distract children from real learning towards technology fascination. Series of awareness forums were conducted with RINHS stakeholders to discuss these myths and address their concerns.

The project team comprising members from RINHS Academic team, RINHS Technology team and consultant's team members having expertise on digital learning content, pedagogies and training, and was responsible to study the existing learning content in use at RINHS and analyses the possibility of using it in a digital environment. The team also studied the OERs and MOOCs available and the possibility to utilize them in place of, or in conjunction with the existing content, in the new environment. The team emphasized on minimizing the teachers, facilitators and learners' discomfort during the digital transition period and proposed blended digital content for the learners comprising digitized version of existing content augmented with OERs. The aim was to provide smooth adoption of existing content in the digital environment among the learners in the beginning, and subsequently exposing to improved quality OERs based learning content developed after extensive global efforts. A sample blended learning material on selected

topics was developed to be implemented during the pilot testing phase. In the next step, the project team studied the existing pedagogies implemented at RINHS campuses, their effectiveness and the possibility of using the same pedagogies in the digital environment. The team also researched the contemporary learning strategies in use in various digital environments. Furthermore, the team also deliberated the capacity of present in-school staff to adopt new learning pedagogies, to provide a challenging but realistically implementable pedagogical solution for these underprivileged areas. The team developed a pedagogical approach where the in-school staff will facilitate the learning process, and qualified and well-trained teachers will control remotely the learning environment of the classrooms with the help of pre-selected learning material and activities. The facilitators and remotely operating teachers will be provided with the learning material and pedagogical details reasonably before the class activity, so they are well-aware of the learning content and strategies before engaging the learners. Moreover, certain activities will also be designed to be conducted for the learners by the in-class facilitators to keep their effective control and authority on the learners. A fine balance between remotely operating teachers and in-class facilitators was foreseen to bring optimum and most effective learning outcomes.

The digital transformation roadmap proposed redefining the role of local teachers into in-class facilitators as defined in 21st-century teaching and learning methods and digital learning environments. This transformation will overcome the continued challenge faced by RINH management to provide a well-qualified and experienced teaching resource for their school, as most of these schools are situated in remote locations, far away from the urban areas of the city. To implement this transformation effectively, strong and comprehensive in-class and remotely operating teachers' technological, motivational and academic training is considered prudent. The team designed sample training to cover all the three aspects of the pilot project. In addition to the face-to-face lectures, online training component is also added including video lecture, digitally executed assessments, and online academic and communication activities, to make the training participants realize the real online learning atmosphere as students, and to prepare them to understand empathetically in a real-class digital environment. ICT equipment for digitizing the existing one-room schoolhouses includes a smart TV for class-level learning, four laptops in each class for small group learning activities, a reliable internet connection, learning content downloaded and installed in laptops and TV for offline contingencies, and a Wi-Fi-enabled camera for remote teams to monitor classroom activities. A complete package of sample digital learning content, digital pedagogies and training components are being provided to RINHS management to be implemented during the pilot project. The project's pilot testing is planned on a selected sample of teachers and student for the duration of six months. During the pilot testing phase, the implementation of developed digital content will be taught to the selected group of students in a controlled environment through the developed pedagogical approach. The basic one-week teachers' professional development training initiated the pilot project which will be followed by subsequent one-day sessions every fortnight during the whole testing phase. The feedback from the teachers in the initial and subsequent training will help the designers understand the real-life learning dynamics and challenges in the digital environment and amend the digital learning structure before implementing on the complete RINHS educational system.

RINHS One-room Schoolhouse is an initiative that can be transformed into an ICT4D project through adaptable and sustainable adoption of technology, suited to the local context. The salient features of RINHS discussed in sections 4 and 5 are summarized below:

- RINHS is a chain of multigrade one-room schoolhouses, serving OOSC living in underprivileged communities in rural Pakistan.
- In parallel to educating OOSC, RINHS also support their families which develops a better bonding and trust between both the stakeholders.
- RINHS operates in multiple locations, with OOSC from families with diverse socio-economic and cultural challenges.
- In addition to government provided learning objectives, RINHS provides locally acceptable inclusive education to their students, with special emphasis on social and ethical development of students.
- RINHS follows centralized instructional format applied at every campus for uniformity of learning outcomes among heterogeneous learning cohorts.
- Quality teachers are the weakest link in RINHS value chain.
- RINHS administration understands the need to adopt technology for sustainability and improving quality of education for their students
- RINHS is planning to actively use digital tools for the education of their students, including LMS, OERs and MOOCs.

6 ICT4D Implementation Case Studies: Benefits and Challenges

ICT is not an intrinsic enabler and it can also present new challenges to overcome; however, it can facilitate the development of meta-cognitive skills, and help us know how to learn, rather than just learning a particular skill (Gurubatham, 2018; Monteith, 2002). Thus, to reap the real benefits of ICT4D in education, schools must be mindful of not just attending to ‘cosmetic use’, ‘technological imperative’, ‘romantic vision’, and ‘technological competition’ (Cappola, 2005). Challenges in implementing ICT in education may vary from school to school, region to region and country to country, and effective implementation of ICT implementation may need deep consideration of organizational aspects such as schools’ culture, the role of the leaders, selection of technology, integrity and ethics issues and school management structures. Moreover, assumptions that implementation of ICT4D in high-income economies is seamless is not necessarily so (Suryani, 2010). Research also shows that adaptive culture leads to acceptance of the constructive change (Tearle, 2004), and effective implementation depends more on the users’ (teachers and students) acceptance and use of technology rather than on the technology itself (Yuen et al., 2003). Benefits and challenges of implementing ICT in schools are being discussed in research literature for last many decades. Thus, to provide important practical perspective, we summarize selected case studies related to different ICT4D contexts in education, highlighting the benefits and challenges faced during the implementation phase. The case studies are selected from different geographical regions, from high- and middle-income economies, from latest to comparatively older initiatives, and from western and eastern educational context and are sequenced in reverse chronological order of reporting/ publishing in subsequent paragraph. Furthermore, Table 2 shows common benefits and challenges related to implementation of ICT4D discussed within these studies.

- i. UNESCO-Korean Funds-in-Trust (KFIT) implemented a first phase of a ‘Transforming Education in Africa’ project from 2015 to 2019 in Mozambique, Rwanda and Zimbabwe, focusing on addressing fundamental challenges faced by these nations.
 - In Mozambique, an e-school model was developed and piloted in 22 schools in 13 provinces, where over 500 teachers and technicians were trained, over 263 digital lesson plans were produced and were linked to 286 online educational resources covering eight subjects.
 - In Rwanda, the project benefitted about 150 teachers, created about 950 assessments, and over 2500 students from 59 schools used formative assessment material. In Zimbabwe, e-school model was piloted in 20 schools with over 400 teachers were trained, and over 1300 OERs were developed. Project teams from all three countries discussed their achievements, implementation challenges, and lessons learnt during their series of meetings.

The second phase of the project is planned in Côte d’Ivoire, Ghana and Senegal from 2020 to 2023 (UNESCO, 2020).

- ii. During the COVID-19 pandemic, UNESCO in partnership with Technovation, organized a free, online five-weeks tech education program for girls in Brazil, India, Kenya, Mexico, Nigeria, and Pakistan. The program is designed on project-based curriculum and empowers girls to contribute and lead change in their communities through the active use of technologies such as artificial intelligence (AI) (UNESCO, 2020a).
- iii. The former British Educational Communication and Technology Agency (BECTA) analyzed difficulties in implementing ICT in education in high-income countries such as UK, USA, Australia, Canada, Netherland and Hong Kong, and concluded that:
 - Teachers were reluctant to use technology due to embarrassment in front of students for not being technologically competent enough and being technophobic;
 - Schools were insufficiently equipped with technological resources; and
 - Attitude and belief barriers related to benefits of ICT in classrooms were high from school leadership (BECTA, 2004). Such issues are not new to the use of technology in education, and they persist today (Onji & Amadi, 2016),
- iv. Ghavifekr et al., (2015) highlighted that lack of teachers’ training is one of the foremost factors that hinders effective implementation of ICT in educational process. Cha et al. (2020) developed a conceptual framework

for implementation of ICT in classrooms in developing countries at national level, with:

- ICT Education Policy Status;
 - education goal;
 - using ICT in education goal;
 - ICT-Integrated classroom project goal;
 - learners' competency;
 - pedagogical methods; and
 - suggested classroom model, as its sequential components.
- v. Suryani (2010) analyzed the benefits and challenges of implementing ICT in schools in Indonesia. The highlighted benefits were an encouragement to teachers and students for collaborative work, stimulating students' visual and auditory learning skills, stimulating students' creativity, and providing challenging tasks to stretch students' learning capacities. The challenges identified were difficulties in adapting technologies, refusal by teachers to adopt new teaching methods, financial limitations, the reluctance of students to optimally use technology, and other organizational issues within the school.
- vi. Implementation of wikis in Open University of Hong Kong was analyzed by Choy and Chong (2007), and they found benefits such as improved connectivity and collaboration of teachers and students through technology, access to the latest information, increased motivation among teachers by having their own webpages, and convenience and efficiency in sharing knowledge and in accessing learning material. They also highlighted some challenges such as lack of technical competence among teachers, the reluctance of students' collaboration through wikis, lack of wiki's compatibility with few subjects.
- vii. Samuel and Bakar (2006) found benefits of integrating ICT in Malaysian schools such as improved English grades due to collaborative learning, learning beyond time and space limitations, independent learning; as well as challenges such as technological barriers among teachers and students, lack of resources, lack of school support, and lack of teachers' training.
- viii. Huffakar (2003) analyzed the implementation of ICT in UK schools and identified some benefits such as active learning engagement among students, social learning support, an opportunity for continuous feedback, and scalability and modularization; and some challenges such as high cost of implementation, lack of cooperation from teachers, difficulties in standardization, academic dishonesty, and restriction of access to unwanted websites.
- ix. Fleer (1989) conducted research in Australian schools and found that teachers were insufficiently trained for the technology to be implemented in classrooms; there was lack of technological support for the teachers; school principals were not actively involved; and class structure and software introduced were not appropriate.

In Table 2 some of the common benefits and challenges of implementing ICT in education, as highlighted in the above studies, are summarized:

Table 2. Common benefits and Challenges of ICT4D implementation in Education

Benefits	Geographical Location	Highlighted by
ICT helps improving quality of education, problem-solving and learning capacities	Brazil, India, Indonesia, Kenya, Malaysia, Mexico, Nigeria and Pakistan	Samuel and Bakar, 2006; UNESCO, 2020a; Suryani, 2010;
ICT improves interaction, connectivity and collaboration among teachers, students and other stake holders	Hong Kong, Indonesia Mozambique, Rwanda, UK and Zimbabwe,	UNESCO, 2020; Yuen, et al., 2003; Huffakar, 2003; Choy and Chong, 2007; Suryani, 2010;
ICT provides convenience in access and sharing of learning material and latest information	Brazil, Hong Kong, India, Kenya, Mexico, Mozambique, Nigeria, Pakistan, Rwanda and Zimbabwe	Choy and Chong, 2007; UNESCO, 2020a; UNESCO, 2020;
ICT provides learning opportunities beyond school limits and independent of time and space	Malaysia, UK	Huffakar, 2003; Samuel and Bakar, 2006;
Challenges	Geographical Location	Highlighted by
Fear of use of technology among teachers and students	Australia, Canada, Hong Kong, Indonesia, Malaysia and Netherland	BECTA, 2004; Onji & Amadi, 2016; Choy and Chong, 2007; Samuel and Bakar, 2006; Suryani, 2010;
Lack of ICT resources within institutions	Australia, Canada, Hong Kong, Indonesia, Malaysia, Mozambique, Netherland, Rwanda, UK, USA and Zimbabwe	BECTA, 2004; Onji & Amadi, 2016; Fler, 1989; Choy and Chong, 2007; Samuel and Bakar, 2006; UNESCO, 2020; Suryani, 2010;
Lack of interest from leadership to implement ICT	Australia, Canada, Hong Kong, Indonesia, Malaysia, Netherland, UK and USA	BECTA, 2004; Onji & Amadi, 2016; Fler, 1989; Samuel and Bakar, 2006; Suryani, 2010;
Lack of Teachers' Training	Malaysia, Mozambique, Rwanda and Zimbabwe	Ghavifekr, 2015; Fler, 1989; Samuel and Bakar, 2006; UNESCO, 2020;

In summary, implementing ICT in education brings both benefits and challenges. To be effective and sustainable, implementation of ICT in education needs to be supported by local socio-cultural research. It also requires creation of a conducive atmosphere for stakeholder adoption and for smooth transition of technology within existing educational structures.

7 Research Limitations and Suggestions for Future Research

Our study has the following limitations:

- *Sample Size.* With almost half of Pakistan's school-age children, adolescents and youth out-of-school, our sample coverage is much limited. Moreover, we focused on the operational model of only one non-profit educational organization i.e. the Raunaq-e-Islam Neighborhood School System and only one method to educate OOSC, i.e. One-room Schoolhouses.
- *Data Collection Process.* We did not use formal qualitative or quantitative methods to collect field data, and rather relied on field visits, informal interviews and discussion with various stakeholders to collect data, presented in this paper.

- *Lack of Prior Research.* We were unable to find any prior research similar to our Digital One-room Schoolhouse model, therefore, unable to conduct a comparative analysis with similar projects.
- *Digitization Process.* The paper does not reflect the outcomes of the digitization process of one-room schoolhouses, as the digitization pilot project has not been fully implemented yet, and therefore limits the assessment of viability and practicability of learning eco-system of the proposed Digital One-room Schoolhouse concept.

Future research that builds on findings in this paper could involve:

- Conducting field research in similar one-room schoolhouses to understand limitations of the learning process and strengths of their organizational structures.
- Investigation of the digitization process of any traditional educational set-up serving the education deprived children and assess the outcomes of emerging learning eco-systems.
- Study of other approaches to educate out-of-school children through the effective use of education technology tools and propose an adaptable and sustainable technology-based educational solution for OOSC, suited to their local circumstances.

8 Conclusion

Despite several high-profile global initiatives to educate every child over the last few decades, the fact remains that one out of every five children are still out-of-school. The educational technology-based solutions designed and developed in advanced economies and ‘exported’ to developing countries have not (yet) yielded desired outcomes. The initial stages of the investigation into whether local context plays a key role in determining the outcomes of technology-enabled learning and pedagogical systems are encouraging.

This paper describes and proposes an innovative approach to resolve the issue by integrating the multigrade one-room schoolhouse with educational technology resources to educate out-of-school children. A real-life successful case study in Pakistan is described in which results are encouraging, indicating a key role of training local teachers and community support. Based on our findings several recommendations are made for other stakeholders interested in working in similar domains. Prominent among these is the importance of involving the local community in the learning process of underprivileged out-of-school children, and how leveraging an existing strong relationship can lead to a chain reaction towards capacity building.

The contemporary era of digital technology capabilities continues to evolve rapidly. It is expected that further innovation will provide new opportunities specific to out-of-school children in underprivileged contexts that might also further inform this research.

Acknowledgments

We would like to thank RINHS management and staff, particularly Mr Shoaib Ghaziani, Mr Qasim Lawai, Ms Salma Wahidi, Ms Sadia Wahidi, and Mr Asif for their continued cooperation and providing access to their facilities and information. We are also very thankful to Ms Ambreen Qureshi from Daabhoy Institute of Higher Education (DIHE) and FB Badar Training & Consultancy team for the out of the way efforts provided by them to facilitate the research process.

References

- Abacus Educational Journal, (2016). Advantages of the one-room schoolhouse approach to teaching. *Abacus Educational Journal*. Retrieved from <http://www.abacus-es.com/journal/education-theory/advantages-of-the-one-room-schoolhouse-approach-to-teaching/>
- Agarwal, T. (2014). Educational Inequality In Rural And Urban India. *International Journal Of Educational Development*, 34, 11-19.
- Aghazadeh, M., & Fazli, R. (2010). Guidance of teaching in multigrade classes. *Tehran: Aaeizh Press*.
- Allison, J., & Ong, W. (1996). Advocating and implementing multiage grouping in the primary years. *Dimensions of Early Childhood*, 24(2), 18-24.
- Ally, M. (2009). Mobile learning: Transforming the delivery of education and training. Athabasca: *Athabasca University Press*.

- Asadi, P. (2001). A study of problems of multigrade classrooms in Golpayegan city and providing more appropriate teaching methods in these classes. *Golpayegan: Research Council of Kurdistan Education Organization*.
- Ashraf, M.A., & Ismat, H.I. (2016). Education and Development of Pakistan: A Study of Current Situation of Education and Literacy in Pakistan. *US-China Education Review B*, November 2016, 6(11), 647-654 DOI: 10.17265/2161-6248/2016.11.003
- Avgerou, C., (2008). Information systems in developing countries: A critical research review. *Journal of Information Technology*, 23(3), 133–146.
- Ayanso, A., Cho, D. I., & Lertwachara, K. (2014). Information and communications technology development and the digital divide: A global and regional assessment. *Information Technology for Development*, 20(1), 60–77.
- Bashiri, H. K. (2013). Teachers and experts' perceptions and experiences of multigrade classes in primary schools in Caliber rural areas. *Tabriz: Faculty of Education and Psychology-Tabriz University*.
- Baxter, B. (2000). Returning to the one-room schoolhouse. *The Technology Source*.
- Bennet, N., Hare, E., & Lee, J. (1983). Mixed-age classes in primary schools: A survey of practice. *British Educational Research Journal*, 9(1), 41-56.
- Bhuiyan, P., Supe, A., & Rege, N. (2015). The art of teaching medical students. *Delhi: Elsevier India*.
- Bikanga Ada, M. (2018) Using design-based research to develop a Mobile Learning Framework for Assessment Feedback. *Research and Practice in Technology Enhanced Learning*, 13(3) DOI:10.1186/s41039-018-0070-3
- Brown, D. H., & Thompson, S. (2011). Priorities, policies and practice of e-government in a developing country context: ICT infrastructure and diffusion in Jamaica. *European Journal of Information Systems*, 20, 329–342.
- Cobcraft, R., Towers, S., Smith, J., & Bruns, A. (2006). Mobile learning in review: Opportunities and challenges for. Proceedings. *Online Learning and Teaching (OLT) Conference*, 21-30. Brisbane: Queensland University of Technology.
- Cornish, L. (2006). Reaching EFA through multigrade teaching: issues, contexts, and practices. *Armidale NSW: Kardoorair Press*.
- Cundra, L. B., Benzel, C. A., & Schwebach, J. R. (2017). Using the one-room schoolhouse method: The design and teaching of a summer undergraduate research course in Phage Biology. *Perspectives on Undergraduate Research & Mentoring (PURM)*.
- Da Silva, A. P., & Fernández, W. D., (2016). Significance of 'Contexts' in ICT4D projects: Alignment and Misalignment of Stakeholders' interests. In *Proceedings of the 49th Hawaii International Conference on System Sciences 2016 (HICSS)*, IEEE-2016, 2708–2717.
- Da Silva, A. P., & Fernández, W. D., (2016). Sustainability of ICTD Projects and its Influencing Factors: A Comprehensive Literature Review. In *Proceedings of the 49th Hawaii International Conference on System Sciences 2016 (HICSS)*, IEEE-2016, 2718–2727.
- Diniz, E. H., Bailey, D. E., & Sholler, D. (2014). Achieving ICT4D Project Success by Altering Context, Not Technology. *Information Technologies & International Development*, 10(4), 15–29.
- Eliasvand, A., & Jamshidi, A. (1995). A study of the problems of rural multigrade classes in Divandareh city in the academic year 1994-1995. *Divandareh: Research Project-Research Council of Kurdistan Education Organization*.
- Erdem, A. E., Kamac, O. S., & Aydemir, T. (2005). The problems of primary school teachers in charge of teaching and training united classrooms. *Theory and Practice in Education*, 1, 3-13.
- Esqueta, M., Quan, V., Nickow, A. J., & Oreopoulos, P. (2017). Education Technology: an evidence-based review. *National Bureau of Economic Research Working Paper Series*. Working Paper 23744. Retrieved from <http://www.nber.org/papers/w23744>
- Ford, B. E. (1977). Multi-age grouping in the elementary schools and children's affective development: a review of recent research. *The Elementary School Journal*, 78, 149-159.
- Ford, M., & Leinonen, T. (2009). MobileD: a mobile tools and services platform for formal and informal learning. *5th World Conference on Mobile Learning*. Banff.
- World Economic Forum (2017). *The Global Gender Gap Report*.
- Ghaisar, S. (2001). Recognition of teachers' problems in rural multigrade classes in Korani area from the perspective of managers and teachers in the academic year 2001. *Korani: Research Council of Kurdistan Education Organization*.
- Ghavifekr, S., & Wan Athirah, W. R. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science*, 1(2), 175-191.

- Ghazi, S. R., Nawaz, K., Shahzad, S., Shahzada, G., & Rukhsar, M. (2013). Relationship Between Parents' Socioeconomic Status And Their Children Academic Performance. *International Review Of Social Sciences And Humanities*, 5(2), 58-65.
- Goodlad, J. I. (1996). Schools, curriculum and the individual. *Waltham MA: Blaisdell Publishing Company*.
- Grimus, M., Ebner, M., & Holzinger, A. (2013). Mobile Learning as a Chance to Enhance Education in Developing Countries-on the Example of Ghana. *CEUR Workshop Proceedings*, 955,] 340-345. Helsinki.
- Gurubatham, M. R. (2018). Facilitating the Far Transfer of Knowledge by Metacognition in ICT Enabled Globalized Learning. *Journal of Education and Social Sciences*, 9(2), 159-174.
- Gutierrez, R., & Slavin, R. E. (1992). Achievement effects of nongraded elementary school; A retrospective review. *Baltimore*.
- Harris, R. W. (2016). How ICT4D Research Fails the Poor. *Information Technology for Development*, 22(1), 177–192. <https://doi.org/10.1080/02681102.2015.1018115>
- Hashtjin, B., Saedi, A., & Zarj Abad, A. (2001). A study of the problems of multigrade classes. Khalkhal: PNU Khalkhal branch.
- Hayes, N., & Westrup, C., (2012). Context and the processes of ICT for development. *Information and Organization*, 22(1), 23–36.
- Heeks, R. (2020). ICT4D 3.0? Part 1—The components of an emerging “digital-for-development” paradigm. *The Electronic Journal of Information Systems in Developing Countries*, 86(3), e12124. <https://doi.org/10.1002/isd2.12124>
- Henderson, L., Buising, C., & Wall, P. (2008). Teaching undergraduate research: The one-room schoolhouse model. *Biochemistry and Molecular Biology Education*, 36, 28-36.
- Heritage Alliance (2005). America's one-room schools of the 1890s. *Retrieved from: www.heritageall.org*
- Hussain, S., Wang, Z., & Rahim, S. (2013). E-learning services for rural communities. *International Journal of Computer Applications*, 68(5), 15-20.
- Independent Evaluation Group, (2011). Capturing Technology for Development. An evaluation of World Bank Group activities in Information and Communication Technologies, 1. The World Bank Group, 2011. *Retrieved from: https://openknowledge.worldbank.org/handle/10986/2370*
- Kalaoja, E., & Pietarinen, J. (2009). Small rural schools in Finland: a pedagogically valuable part of the school network. *International Journal of Educational Research*, 48(2), 109-116.
- Katz, L. W., Evangelou, D., & Hartman, J. A. (1990). The case of a mixed-age grouping in early education. Washington DC: *National Association for the Education of Young Children*.
- Kelley, M. F., & Fitterer, H. (1998). Multiage and traditional classroom programs: A comparison of standardized test score data, group cooperation, and problem-solving performance. *Annual Conference of the Association for Childhood Education International*. Tampa, FL.
- Khaddage, F., Müller, W., Flintoff, K. (2016). Advancing mobile learning in formal and informal settings via mobile app technology: where to from here, and how? *Educational Technology & Society*, 19(3), 16–26. *Retrieved from https://espace.curtin.edu.au/handle/20.500.11937/23273*
- Khan, S., Lurhathaiopat, P., & Matsushita, S. (2016). The Contribution of the international community and the dynamics of history in educational policies in Pakistan: The case of success or failure. *International Journal Of Current Research*, 8(2), 42150-42156.
- Kilic, D., & Abay, S. (2009). Primary School Teachers' opinion on the problem facing in the process of teaching and learning in the multigrade classrooms. *Journal of Turkish Education Sciences*, 7(3), 623-654.
- Kouchaki, N., & Abbasi, M. (1995). A study of the problems of rural multigrade classes in the academic year 1994-1995 in Bijar city. Bijar City: *Research Project-Research Council of Kurdistan Education Organization*.
- Kukulska-Hulme, A., & Shield, L. (2008). An Overview of Mobile Assisted Language Learning: From Content Delivery to Supported Collaboration and Interaction. *ReCALL*, 20(3), 271-289.
- Latchem C. (2018) Education for Sustainable Development. In: Open and Distance Non-formal Education in Developing Countries. SpringerBriefs in Education, pp155-165. *Springer, Singapore*. https://doi.org/10.1007/978-981-10-6741-9_15
- Little, A. (1995). Multigrade teaching: A review of research and practice. London: Overseas Development Administration.
- Little, A. W. (2001). Multigrade teaching towards international research and policy agenda. *International Journal of Educational Development*, 21, 481-497.
- Mamoon, Dawood (2018). Progressing Pakistan should ensure quality education for all. *Journal of Social and Administrative Sciences* 5(1).

- Meyer, I., & Marais, M. A., (2015). Design for Sustainability: Countering the Drivers of Unsustainability in Development Projects. *The Journal of Community Informatics*, 11(3), 2015.
- Millar, B. A. (1991). A review of qualitative research on multigrade education. *Journal of Researching Rural Education*, 7(2), 3-12.
- Mirchandani, D. A., Johnson, J. H., & Joshi, K. (2008). Perspectives of citizens towards e-government in Thailand and Indonesia: A multigroup analysis. *Information Systems Frontiers*, 10(4), 483-497.
- Mitra, S. (2005). Self-organising systems for mass computer literacy: Findings from the 'hole in the wall' experiments. *International Journal of Development Issues*, 4(1), 71-81.
- Montealegre, R. (1998). Waves of change in adopting the Internet: Lessons from four Latin American Countries. *Information Technology & People*, 11(3), 235-260.
- Mycock, M. A. (1967). A comparison of vertical grouping and horizontal grouping in the infant school. *British Journal of Educational Psychology*, 37, 133-145.
- Myende, P. E., & Nhlumayo, B. S. (2020). Enhancing parent-teacher collaboration in rural schools: parents' voices and implications for schools. *International Journal of Leadership in Education*, 1-25.
- Oberle, E., & Schonert-Reichl K.A. (2017). Social and Emotional Learning: Recent Research and Practical Strategies for Promoting Children's Social and Emotional Competence in Schools. J.L. Matson (ed.), *Handbook of Social Behavior and Skills in Children, Autism and Child Psychopathology Series*. DOI:10.1007/978-3-319-64592-6_11.
- Ong, W., Allison, J., & Haladyna, T. M. (2000). Student achievement of 3rd graders in comparable single-age and multi-age classrooms. *Journal of Research in Childhood Education*, 14(2), 205-215.
- Orij, A., & Amadi, R. (2016). E-education: Changing the mindsets of resistant and saboteur teachers. *Journal of Education and Practice*, 7(16), 122-126.
- Ozci, E., Duran, H., & Tauar, H. (2010). An investigation in multigrade class teaching with respect to primary school teacher candidates' perception and in views of primary school teachers working in multigrade class. *Journal of Kirsehir Education Faculty*, 11(1), 19-35.
- Pakistan Bureau of Statistics (Jan 2020). Pakistan social and living standards measurement survey. Retrieved from <http://www.pbs.gov.pk/content/pakistan-social-and-living-standards-measurement>.
- Pavan, B. N. (1992). The benefits of nongraded schools. *Educational Leadership*, 50, 22-25.
- Petrie, C., Aladin, K., Ranjan, P., et.al. (2020, April). Spotlight: Quality education for all during Covid-19 crisis. (Report No. #011). Retrieved from https://hundredcdn.s3.amazonaws.com/uploads/report/file/15/hundred_spotlight_covid-19_digital.pdf.
- Pratt, D. (1986). On the merits of multiage classrooms. *Research in Rural Education*, 3(3), 111-115.
- Ramadani, L., Kurnia, S., & Breidbacj, C. F., (2018). In Search of Holistic ICT4D Research: A Systematic Literature Review. *Proceedings of the 51st Hawaii International Conference on System Sciences*, 2424-2433.
- Rogers, E. M., (1962). Diffusion of innovations. *Free Press of Glencoe*.
- Saeed, N., & Fatima, A. (2017). Educational Inequality in rural-urban Sindh. 30th AGM of Pakistan Society of Development Economists (PSDE). Islamabad: *Pakistan Society of Development Economists* (PSDE).
- Shankar, A. (1990). The end of the traditional model of schooling and a proposal for using incentives to restructure for public schools. *Phi Delta Kappan*, 71(5), 345-357.
- Smit, R., & Eneqli, E. (2015). An empirical model of mixed-age teaching. *International Journal of Educational Research* (2015). DOI: <http://dx.doi.org/10.1016/j.ijer.2015.05.004>
- Stehney, V. (1970). Why multi-aging grouping in the elementary school. *National Elementary Principal*, 49, 21-23.
- The World Bank Group, (2016). Digital Dividends. World Bank Development Report. The World Bank, Washington, US, 2016. DOI: 10.1596/978-1-4648-0728-2; <https://tinyurl.com/WB-digital-dividends>.
- Thomas, C., & Shaw, C. (1992). Issues in the development of multigrade schools. Washington DC: The World Bank.
- Titola-Meskanen, T. (2014). A mobile school in the digital era: Learning environment ecosystem strategies for challenging locations and extreme poverty contexts. *Proceedings of 6th Annual Architectural Research Symposium*, 292-304. Finland.
- Trucano, M. (2014, 7 22). Promising uses of technology in education in poor, rural and isolated communities around the world. Retrieved from The World bank Blog: <http://blogs.worldbank.org/edutech/education-technology-poor-rural>
- Trucano, M. (2017, 6 11). 20 innovative edtech projects from around the world. Retrieved from The World Bank Blog: <http://blogs.worldbank.org/edutech/20-innovative-edtech-projects-around-world>
- Trucano, M. (2019, 28 1). A new research hub on the use of technology in education in developing countries. Retrieved from The World bank Blog: <https://blogs.worldbank.org/edutech/>

- UNESCO. (2015). Global Monitoring Report 2015: Education for All 2000-2015: *Achievements and Challenges*. UNESCO.
- UNESCO Institute of Statistics, (2018). UIS Fact Sheet No 48. UNESCO.
- UNESCO. (2019). COVID- 19 Educational Disruption and Response. Retrieved from <https://en.unesco.org/covid19/educationresponse>.
- UNESCO, (2020). ICT Transforming Education in Africa. Retrieved from <https://en.unesco.org/themes/ict-education/kfit>
- UNESCO (2020a). UNESCO joins Technovision to launch free, online, 5-week Tech Education programme for girls in 6 Countries. Retrieved from: <https://en.unesco.org/news/unesco-joins-technovation-launch-free-online-5-week-tech-education-programme-girls-6-0>
- Unwin, T. (2009). ICT4D: Information and Communication Technology for Development. Cambridge: Cambridge University Press.
- Unwin, T., (2017). Reclaiming Information and Communication Technologies for Development. Oxford University Press, 2017.
- Veenman, S. (1995). Cognitive and noncognitive effects of multigrade and multi-age classes: the best evidence synthesis. *Review of Education Research*, 65(4), 319-381.
- Walsham, G. (2017). ICT4D research: reflections on history and future agenda. *Information Technology for Development*, 23(1), 18-41.
- Williams, F. K. (2005). Inside the one-room schoolhouse: A look at non-graded classrooms from the inside out. *National Forum of Applied Educational Research Journal*, 18(3), 2.