

RESEARCH REPORT

Science education for empowerment and social change: a case study of a teacher educator in urban Pakistan

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In this manuscript we focus on the question, 'What should be the purpose of science education for children of the very poor class in caste-oriented developing countries such as Pakistan?' In other words, in a country where the literacy rate hovers around 10 per cent for the poorest segment of society and where there is no expectation that children will complete primary school, of what importance is primary science education and to what end should it be offered in schools? We begin a conversation around this question by presenting, in this manuscript, a case study of one teacher educator whose beliefs and practices sharply deviate from the norm – she believes science education ought to be about empowering students to make physical and political changes in their community. In particular, using the rich, contextual interview and observational data generated through case study, we show how Haleema's (pseudonym) orientation to science teacher education are buttressed by three fundamental beliefs: that low levels of literacy and school achievement among poor children have as much to do with poor families' lack of power/influence on the purposes and processes of schooling as it has to do with opportunities and resources; that school science can begin to address inequalities in power by fostering a kind of scientific literacy among children that leads to individual and community empowerment around health and environmental issues, the very science-related issues that divide quality of life and opportunity for poor families; and that teacher education programmes can play a role in transforming a society's views about how science and scientific practices might play a role in bringing communities together to effect change for the better.

Introduction

We begin this manuscript with two quotes taken from an in-depth case study of Haleema,¹ a teacher educator, and her beliefs and practices regarding the science education of poor children in Lahore, Pakistan. Both quotes focus on her vision for the role and importance of science education in poor settings, and the kinds of collaborations and support structures that might make that vision possible.

[Rich communities neighbouring poor communities] should feel and develop a sense of responsibility towards children living in poverty. Local resources should be exploited to the fullest extent to help the community. Funding should also be allocated for the training of teachers about how to make use of easily available and even thrown away material for teaching about the environment. What ever is done should

involve sitting together and thinking about what is needed for the community and how we can meet each others' interests and needs. It should be a systems approach and parents should be a part of the decision-making process. The target should be to empower children and to enable them to develop a sense of equality with the rest of the community and how important their role is in their community.

Teachers should teach science to empower students to be more involved in social change because, for me, it should be the ultimate aim of education. I have seen parents and people around listen to children a lot. Even initiatives at home empower parents and enable them to feel proud of the fact that they are learning something from their children or she/he is becoming so concerned about the environment. The same thing goes out in the community. The whole street and community would appreciate it and this political change will empower the whole community. A very important thing is that it is not that people do not want to do it. In Pakistan, and I think in many other countries, people just wait for initiatives sometimes because of lack of knowledge about how to do it and sometimes just because of their involvement in their daily life schedules. I have experienced it many times. Even children start taking care of the gardens by asking other children and people not to pluck the flowers from the garden. It is most of the time appreciated by parents, and children do listen to each other too. We did it with how garbage is dumped in a community and what should we do? No one was willing to care about it but once it was done by the children every mother started doing it. They made compost with the help of gardeners of different homes and they shared it within the community.

These quotes suggest that Haleema believes science education in her country must take on a new emancipatory role, especially for poor children. Science education must help children in poverty to gain voice and space in the current social and political climate. Science education must also provide a path to enhancing the quality of life for both the children in school and the communities where they live. In short, Haleema believes that science education for poor, urban children must be about empowerment and social change.

Haleema's views are particularly interesting and powerful given that Pakistan's social structure and economy have been supported by socioeconomic and gender caste systems. Although in Pakistan one's educational attainment may influence one's occupation, education by and large does not move individuals across socioeconomic strata, especially for the extreme poor (Khan 1993; Hoodbhoy 1998). This lack of movement across social strata is due to the socioeconomically segregated educational systems to which poor children have access and the implications this has for the kinds of educative experiences they have in school, as well as to the expectations that both society and local communities have for their educational and professional trajectories. This lack of movement is also infused with beliefs about why people are poor and the potential contributions that poor people can make to society, and has a long history in inequitable access to resources and power positions across ethnic/tribal and religious groupings (Kizilbash 1995; Bregman and Mohammad 1998). With few exceptions, children in the lowest socioeconomic strata do not graduate from secondary schools (US equivalent, year 10). In fact, poor children in urban Pakistan, like poor children in many parts of the developing world, are expected to leave school after primary education for gainful employment in the factories, on farms, or in the home (Ismail *et al.* 1994; Wijetunge 1995). Many poor families believe that they need the added financial support that teenage labour provides for daily survival, while at the same time acknowledging that the cost of secondary education (even government sponsored public education) is too great for most poor families to bear.

Given this economic and political climate for education in poor Pakistani communities, we began to wonder about the following questions:

- What should be the role of science education in poor urban communities in Pakistan, especially for children for whom professional careers historically have not been part of their socioeconomic class?
- How might science education focused on political empowerment and social change break down the oppressive boundaries between those who have and those who don't and the impact this has on children's education and daily well being?
- How do teachers craft their role when engaged in science education for political empowerment and social change? And, what kinds of structures do these teachers use to enact such a vision (in terms of parent-teacher and community-teacher relationships, material resources, student participation and involvement, time, and space)?

These questions were used to structure a set of in-depth case studies of science teacher educators and science teachers and their practice in a large urban centre in Pakistan. One of these case studies is reported in this paper. First, an overview of the issues facing poor urban children and their education in Pakistan is presented. Second, an in-depth case study of one teacher educator, Haleema, is described; her views and practices, like the other teachers involved in our study, deviate from current educational practice in Pakistan. We show how Haleema believes that science education must foremost be about empowerment and social change, especially for poor urban children for whom schooling and society has little regard. In the concluding section, questions around the potential role and importance of teaching science for empowerment and social change in poor settings in developing countries are raised.

Educating poor children in Pakistan

Pakistan ranks 120th out of 160 countries in terms of economic development and falls in the 'low human development' category (UNDP 1997a). As an indicator of poverty, in the early 1990s 40 per cent of households in Pakistan received only 8 per cent of the total income (World Bank 1995). Pakistan's per capita GDP was US\$460 in 1993, of which 25 per cent was contributed by agriculture (including forestry and fishing), 25 per cent by industry and 50 per cent by utilities, construction, trade and services. Although Pakistan's economic development has improved in the last decades, such improvement has facilitated significant social distortions and considerable damage to the environment (Parikh 1998; UNDP 1999). Levels of poverty, pollution, congestion, crime and violence have increased in most of the metropolitan cities. In fact, poverty in Pakistan increased between 1987 and 1998 with the trend being increased inequalities within rural and urban areas (Kahn 1999). Simultaneously, there has been little improvement in social indicators like the literacy rate, infant mortality rate, and life expectancy (Hoodbhoy 1998).

Lahore, a city of nearly 5 million people and located in the North-east region of Pakistan, is the second largest city in the country (see figure 1). In Lahore, rapid urbanization has led to the breakdown of the urban management system, impacting both poverty and the general quality of life in the city (UNDP 1997b). Lahore

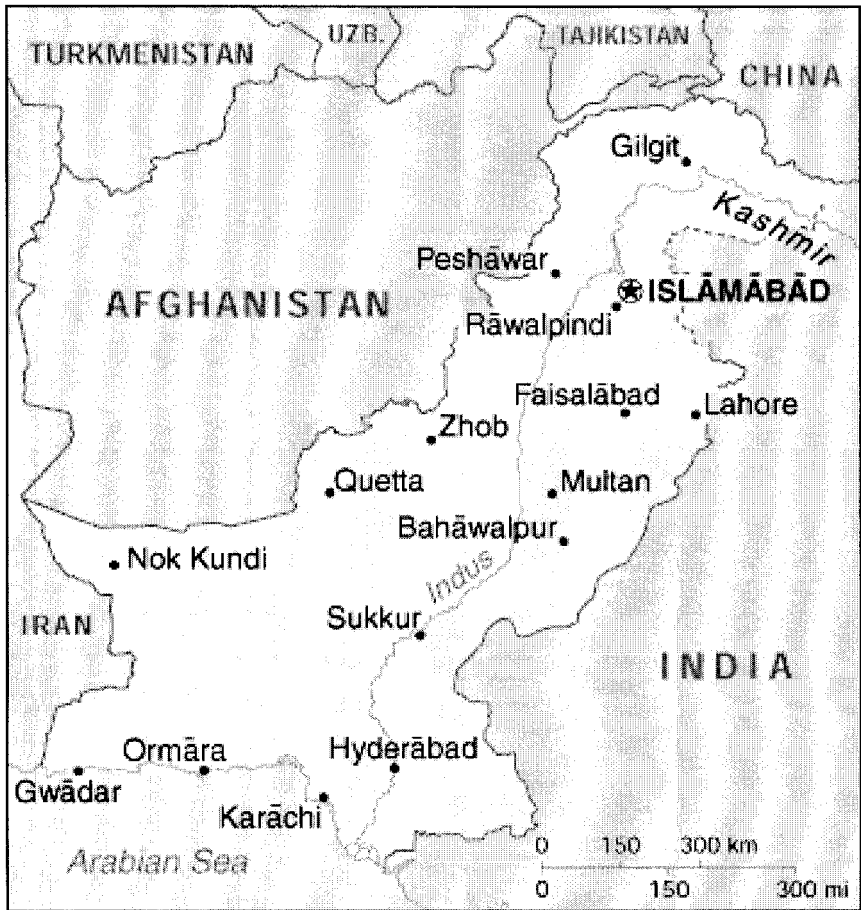


Figure 1. Map of Pakistan (University of Texas at Austin Libraries 2001).

presents an acute contrast of wealth and poverty. Its poor residents are among the worst-affected segments of the poor urban population in Pakistan, despite Lahore's tradition as a cultural and education centre. Like the urban poor in much of the developing world, they have poor access to clean drinking water, sanitation and waste disposal services, schools, health facilities and jobs (UNDP 1997a; Parikh 1998).

Roughly one-third of the population in Pakistan is literate, however the statistics are much more dramatic for those living in poverty, with estimates of literacy rates around 10 per cent for people in poverty (UNDP 1997a). Although universal education was a major national education goal in the late 1980s and early 1990s, the most recent survey shows that 27.9 million children are not in school, 43.5 million adults (>15 years) are illiterate, and only 57 per cent of primary-aged children attend school regularly, with only 22 per cent attending secondary school regularly (Lawrence and Tate 1997; Hoodbhoy 1998). Furthermore, only 3 per cent of 17–24 year olds enter the university, and this statistic cuts across all social classes. At all levels of education, enrolment is particularly low for females. From a cultural standpoint, many Pakistanis believe that

a women's greatest contribution is in the home, and for families living in poverty, the financial burden of sending a daughter to school is often too great when she could be developing her home-based talents. Furthermore, teachers are inadequately prepared for their positions, and in many cases teachers have only a few more years of education than their students (Kizilbash 1995). Resources including consumable items and materials, basic equipment, libraries, laboratories, and textbooks are inadequate in quality and quantity, and buildings are poorly maintained (if existent at all). This is not surprising given that the share of government expenditures on education as a proportion of the GNP hovers around 1.5 per cent (Birdsall *et al.* 1993).

When poor, urban children are able to attend school, their schooling experience is often quite rigid. In most public schools, there is a great emphasis on memory work or *madrasah* (Nayyar 1998). Madrasah education emphasizes knowledge as a set of unchallengeable, immutable truths, students as empty vessels to be filled with these immutable truths, and teachers as sole authoritarians and disciplinarians. Science education is a compulsory part of the curriculum in both the primary and secondary school. However, the focus of science courses, in most cases, is on following detailed syllabi composed of long lists of facts (The British Council 1988). More importantly, the state syllabus has been derived from the British school science syllabus. Indeed, students take the British-style end-of-course exams. This is important because not only does this type of emphasis value fact learning over theory building, it precludes local concerns as the basis of science instruction. Thus the very health and environmental issues driving social and economic reform in Pakistan are absent from the state-endorsed curriculum. Although in recent years there have been national efforts to improve science education so that it is more student centred, these efforts have been concentrated at the secondary level and in more affluent schools. Yet, even in these schools that have undergone science education reform, there remains a great emphasis on teaching a decontextualized curriculum.

Thus, given that large numbers of Pakistani children in poverty leave school by the age 14 and that girls leave at an even earlier age, that most science courses are teacher centred and fact driven, that the economic and political climate in Pakistan prevents social and economic mobility and maintains itself through a caste system, and that environmental issues are of utmost concern to the health and well-being of the inhabitants of the country, we have been most interested in understanding what role science teacher education might play in transforming schooling as well as urban life. In this paper we present a richly detailed case study of one teacher educator whose beliefs and practices deviate from the standard science curriculum and whose commitment to poor urban children questions the economic and political overtures of a caste-oriented society. In what follows we present the methodological grounding of our case study. We then present our findings followed by a discussion of implications this case study has for science education in poor urban settings in developing countries.

Using case study

We have applied a case study approach to our efforts to understand what it might mean to prepare science teachers to teach for empowerment and social change. By 'case study' we refer to the systematic, in-depth and contextual exploration of a

particular person or event which allows the researcher to document and report in rigorous detail (Yin 1984). For the case study presented in this paper, we explored through conversation and written communication one teacher educator's (Haleema) beliefs and practices in science teacher education. Our case study began to take shape in the summer of 1998 when in a conversation with Haleema the questions arose, 'So what should be the point of science education in poor urban settings? Why educate children in science if there is very little expectation that they will move beyond primary school?' These questions framed, in ways we had not intended, a long-term study of what it means to build a science education programme around the goals of empowerment and social change. Between Summer 1998 and Spring 2000, we had numerous conversations, written communications and observations. Specifically, during July 1998 over the course of two weeks, we conducted, in Lahore, 12 hours of conversation with Haleema focusing on her beliefs and practices as a science teacher educator. We also conducted the following observations: 6 hours of teaching science methods to pre-service teachers, 8 hours of conducting workshops for practising teachers in schools that serve children in extreme poverty, and 20 hours interacting with teachers and teacher education faculty informally and formally throughout the school day. From the data collected during Summer 1998, we filtered out the key themes that appeared to be central in both our conversations and observations with Haleema, including the themes of empowerment, transformation, curriculum topics of health and environment, student-centred pedagogy and community involvement. We used these themes to focus a series of e-mail communications over the 1998–2000 school years.

All data sources were transcribed and entered into a qualitative computer program for coding purposes (QSR NUD*IST). Although we began the coding process with the general construct of teaching science to children in urban poverty, we used a process of grounded theory development to make sense of the subtleties, complexities and dilemmas inherent in that ideal as it played out in Haleema's life (Glaser and Strauss 1967) with the development of specific categories and types being an evolving and iterative process. We used both open coding and axial coding to accomplish this task. Finally, we were quite provoked by Haleema's story and have since expanded this research to include five additional teachers.

There are three primary reasons we selected case study for our own work. First, case study allows us to provide the reader with an opportunity 'to experience vicariously unique situations and unique individuals within our own culture' (Donmoyer 1990, p. 193). In other words, a major advantage to using case studies is that they can take the reader to places where most of us would not have the opportunity to go (Yin 1984). Second, we believe that a case study approach will allow the reader to look at the world through our eyes and in the process to see things that they might otherwise might not have seen (Holland *et al.* 1995). As co-authors we come to this research from different perspectives: The first author is Pakistani, a member of the professional class, bilingual, educated in Pakistan and the USA. The second author is a white woman raised on the east coast of the USA with experience of living in urban poverty. The third author is Nepalese, a former teacher educator in Nepal, fluent in six languages, educated in Nepal and the USA, and interested in teachers who teach children in poverty and multilingual contexts. We believe the similarities and differences we bring to doing case study research together – as well as bringing to the participants of the study – allows for multiple

insights into our story. Donmoyer (1990) indicates that the value of case study allowing for the reader to 'see through the researcher's eyes' does not mean that the reader looks at the world through the researchers' personal idiosyncratic perspective, but rather the intersubjectively shared theoretical perspectives and life experiences. Third, we believe it is important to raise one last issue regarding case study and that is the issue of generalizability. As Donmoyer (1990), Becker (1990), and Eisner and Peshkin (1990) all remind us, the practice of education is inevitably focused upon individuals. Here, generalization emerges as 'a form of personal knowledge often revealed in the narrative of the parable or story; we generalise each time we try to learn lessons from the past' (Eisner and Peshkin 1990, p. 172). Donmoyer (1990) refers to this as naturalistic generalisation (as opposed to formal generalization which is that used through statistically driven research).

Discussion: looking at the belief and experiences of Haleema

Getting to know Haleema

Haleema entered science education through the sciences. She possesses both a B.Sc. and an M.Sc. in Botany and has engaged in laboratory research for several years. Since 1995, Haleema served as a lecturer and later department chair in the Science Education programme at an educational institution in Lahore, Pakistan. It is at this education institution where Haleema has been teaching in the pre-service and in-service programmes, conducting study tours and collaborating with the schools to conduct different kinds of programmes related to teaching of environmental science.

As a teacher educator in Lahore, Haleema divides her time between teaching pre-service primary science methods courses, conducting in-service workshops with practising teachers, and carrying out action-based research with children and teachers in urban areas of Pakistan. Nearly all of the primary school teachers with whom Haleema works are female, as is the case across Pakistan. The only rare exceptions are the occasional men who enrol in the programmes to serve as 'technology experts' for primary schools. These women come to her programmes from middle-class and lower middle-class backgrounds with little science education experience, and many of them openly acknowledge a fear of science. Haleema thus views her job as a teacher educator as a challenge to help these women learn science and learn how to use science in empowering ways in their own lives, to understand children better, and to realise that they, as teachers, can have a profound impact on the lives of children:

The situation I am working in is with the pre-service teachers who come to our programme after 14 years of their education. Sometimes they come with science and sometimes without science. . . . For me, they are like primary school teachers who have never thought about the fact that they are important beings of the world. Especially the girls! We have 98 per cent girls, from middle class and lower middle class. They can create a difference!

Haleema takes her job as a science teacher educator seriously. If schools are to improve, if poor, urban children are to gain a meaningful and relevant education, and if teachers are to feel empowered enough to make a difference in the lives of children, she believes she must work with teachers to help them feel confident and

comfortable with science and the ways science may intersect in empowering ways with the lives of poor children and their communities.

Haleema's beliefs about science education in poor urban settings

Our case reveals that Haleema's beliefs about the science education in poor urban centres divide into three core areas: (1) the lack of school-based achievement in poor urban children and the social, cultural, economic and political reasons for their lack of success (including issues of resources, curriculum and teaching decisions, and a prevalent belief system around the goals and purposes of education); (2) why the primary goal of urban science education ought to shift from the acquisition of the state curriculum to empowerment (individual and community) and social change; and (3) the role that pre-service science education programmes might play in helping to realise the goal of science education for empowerment and social change. In what follows we develop these core areas and illustrate how they serve as core beliefs in her science teacher education practice.

The academic achievement of poor urban children in Pakistan. Haleema believes that schooling has failed to meet the education needs of poor children. On numerous occasions, she has cited statistics that show that among the urban poor in her country less than 10 per cent of the population is literate, that an even smaller percentage graduate from primary schooling (grade 6) and that there is little to no expectation that formal schooling is important in their lives. She backs up her reports with stories of how it is extremely rare for children from the poorest classes to attend secondary school or college, and of how the social norm is for poor children to leave primary schooling to enter the menial labour force by age 10 or 12.

The idea that schools are failing poor children drives Haleema's practice as a science teacher educator. She believes that it is imperative that as a teacher educator she must help to uncover the reasons for why schools are failing children, and that she must help her pre-service and in-service teachers do the same. In particular, Haleema cites two main challenges facing poor schools and the children and teachers in poor urban schools: (1) the challenge of resources; and (2) the challenge of teacher preparation.

The challenges of resources relates directly to the physical needs of poor children. For example, Haleema described how children come to school hungry, without adequate clothing, and sometimes without adequate access to sanitary facilities. For Haleema these are basic necessities fundamental to children's academic success. More related to schooling, however, Haleema also described the kinds of academic resources families and schools provide children. For example, Haleema described how poor children lack the kinds of home-based academic resources to which children from professional families have access such as literacy instruction, books, and educational toys. She also described how schools that serve very poor children have extremely limited resources (i.e. no books or outdated books, no science equipment, no computers or other educational technology, limited blackboard space), and in some cases, the very poorest of schools even lack school buildings. Resources are a crucial issue in reversing the trend of low literacy levels among poor children.

Working with teachers to understand the challenge of resources is important for Haleema. Haleema described how the differences amongst the poor populations in Lahore impacts the degree to which children lack resources. Haleema suggests that because poverty takes different forms and places children in different poverty classes, it is important for teachers to really understand the child's background. It is not enough just to know the child is poor: 'In a poverty area first of all I will have to worry about their hunger, then their background, and what made them to be in that situation because there are again different classes of people living in poverty.'

Haleema also outlines teacher preparation as a second important challenge faced in the schooling of urban poor children. Haleema described a lack of qualified teachers to teach science in the poor, urban schools. She views this lack of teachers as a result of a complicated myriad of reasons. The pay scale offered teachers is inadequate: Most qualified teachers accept higher paid positions in the private schools or in the schools which serve the professional class. She also states that the 'reputation' of teaching in poor schools is held in low regard: teaching in schools which serve the professional community is looked upon as a higher position – one with more prestige and power. Haleema summarizes these issues and challenges:

[We do not have] trained teachers, availability of resources, or even the knowledge of how to make use of available resources, or the knowledge to make connections between science and the children's everyday life. ... If a teacher does not know how to make use of local resources, that can create a serious problem. It is an issue for teachers to learn when, how, and where to make use of local resources or the immediate environment. School as a separate entity (separating children from their community) strengthens students' loneliness. Science (if taught appropriately) can help the children develop and have relationship with their everyday life needs and experiences.

As this quote suggests, Haleema perceives the lack of resources and the under-qualification of teachers, when coupled together, as a major cause of inadequate science instruction in poor urban schools. If teachers are not qualified to teach science, as many are not in poor, urban schools, then chances are great that not only will they not know the science well enough to teach it, they also will not know the students well enough to make connections between the science and the students. Furthermore, she believes that the lack of qualified teachers coupled with the limited resources facilitates a kind of science education which will not meet the needs of children. Teachers will lecture from textbooks because they have no other equipment, they may not know how to use their local environment and every day resources as science tools, and they may not know the science well enough to improvise from the given text. This kind of teacher preparation and access to resources makes it difficult to build a science education that is squarely situated in the needs of children. As Haleema states:

I do not think right now that schools meet the needs of the children in poverty. In public schools teachers teach only the text books, sometimes there is only one teacher who has to teach three grades at the same time! She will make them memorise many things but will not be able to enable them to do what I think children should learn: to be curious, critical, inquisitive, and try to explore the world around them and try to link the school with their lives. If teacher is not able to bridge the gap between the school and everyday life, it is of no use if they teach.

Thus, Haleema believes that central to the issues faced in urban science education is that science education focuses on the memorizing of scientific facts and theory rather than scientific understandings and applications and schools use 'texts' rather than 'real life' as the basis for science education. Thus, children in urban poverty are treated as passive, empty vessels to be filled with outdated facts and theories taken directly from textbooks. They will not be provided with opportunities to learn about and act upon their own environment.

Why the goal of urban science education ought to be empowerment and social change. The first theme laid out the ways in which Haleema perceives challenges posed in poor urban settings. This next section will address what Haleema understands as the goals and purposes of science education in poor, urban settings. In the second quote we used to open this manuscript, Haleema articulates her belief that if schooling is to make a difference in the lives of poor urban children it must be transformed so that the ultimate goals of education are student empowerment. She raises questions about survival, equity, and the purposes and goals of schooling. Thus, Haleema believes that science education for children in urban poverty in urban centres must fundamentally be about self- and community-empowerment and it is must also be about teaching for and promoting grassroots social change.

The ideals of education for empowerment and social change play out in terms of the content and process skills that get covered in school, how that content gets taught, and the ways in which teachers position students within the community, the school, and the practice of science. We take up all three of these points in our discussion below.

Haleema first and foremost addresses the idea of science for empowerment and change in terms of the science content and process skills that ought to be taught in school. Haleema believes that science must be taught and learned within relevant contexts that have direct meaning and application in the lives of the children. Specifically, Haleema believes that teaching students to be agents of change with and through science is important in two main areas in particular – the environment and health – and therefore science education in poor urban settings ought to focus on these two themes. Haleema describes how her work with urban children brought her to this point in her thinking:

[My experiences with urban children] convinced me more to deal with the issues of environment because like my other third world countries we are in real trouble because of environmental issues. Keeping in view what is happening in my city and surroundings, we lack basic education. We do not have any sense of responsibility and sense of ownership. I will clean my home and throw the garbage outside. I know I cannot change the whole Pakistan. It might not make any difference to the environment if one shopper bag is lying on the road, but it makes a lot difference to the shopper bag if it will reach its destination.

As Haleema alludes to in the quote above, urban centres in Pakistan struggle with environmental issues. Although in the quote above Haleema addresses the issue of recycling and pollution, she has shared numerous stories about how the environment and its intersections with health are key survival issues for families in urban poverty. Most children in poor neighbourhoods in urban Pakistan live without adequate running water and proper sewage disposal facilities – indeed much of the sewerage drains into open irrigation systems mixing sometimes with potable water sources. From traffic and tropospheric ozone, carbon monoxide, and carbon par-

ticulate levels, to industrial as well as personal waste, urban communities struggle with air quality issues as well.

For example, Haleema told us numerous stories about how access to bathing water for families in extreme poverty may only be through the open irrigation canals that run for many kilometres alongside the roads in the poorer neighbourhoods. These open systems often contain high levels of industrial, agricultural, farm run-off, and human waste and are unsuitable, indeed dangerous, for human bathing. Yet because this is the only access to water that many extremely poor families have, they continue to use these sources for bathing. Access to cleaner water, however, is not the only issue here. As Haleema describes, part of the reason why many poor families use these open irrigation systems for bathing is that they do not realize the health or environmental consequences of bathing in such polluted water. Haleema believes that an exploration of these open irrigation systems could help to educate children about a series of science, technology, society, and health issues. For example, a complete study of these systems would educate children about why these streams exist in poor neighbourhoods and not in more affluent neighbourhoods; where the water in these systems comes from and where it goes and how this changes with the weather patterns, seasons, and geography; what other things might be present in the water and how they got there; why bathing in or drinking the water might be dangerous; and the kinds of things they might do to improve the quality of water to which they might have access. Haleema described how a study of open irrigation systems could incorporate environmental science through studying how the canals were created, where the water comes from and where it goes, how the water (in both quantity and quality) is influenced by weather patterns, and the kinds of pollutants (both visible and invisible) which may lurk in the water and their sources (open sewerage systems, agricultural and industrial run-off). Additionally, Haleema also describes the ways in which health science emerges from such a study as well. Many of the diseases to which poor children are exposed (and some of which are the leading causes of death among poor children) are water borne, such as typhoid, hepatitis, dysentery and various forms of food poisoning. She also explained how a study of these systems could also lead into various epidemiological issues, like cancer and its causes.

Another example provided by Haleema relates to air quality. She told us the story of how many children in the poor neighbourhoods suffer from respiratory problems as a result of poor ventilation systems in the home. Many poor Pakistani families heat and cook with wood and impure coal, both of which generate large amounts of smoke. Poor ventilation systems can cause the smoke to stay in the house leading to respiratory problems. Haleema believes that this issue should be explored with children, allowing them to understand why their homes are often filled with smoke and the impact this has on them. She also believes that such an exploration might provide children and their families with ideas for relatively inexpensive changes that families could make to reduce the levels of smoke in their breathable air. Haleema states that not only would this kind of exploration be helpful in teaching children useful science concepts such as air quality, convection, and respiratory systems, to name just a few, but also would draw heavily from students' prior knowledge about the key issues that frame daily life in poor, urban Pakistan. Haleema views this approach to science education as crucial for a number of reasons. Children would gain the needed knowledge and experiences to help

bring about quality of life changes in their communities. This approach would also help to improve the health of children living in poverty. In Pakistan, prevention is the key idea behind health education because poor people cannot afford treatment or do not have access to doctors and hospitals.

A third example involves gardening. During the time we were in Lahore, Haleema worked with her pre-service teachers to plant and tend a garden in an overgrown littered public area. She wanted to teach her students about plants; after all, it was her own study of botany that drove her own interest in science. However, she wanted to weave learning about plants in a much larger sociopolitical and economic fabric. She selected a place for a garden that needed cleaning up. A garden would serve this purpose of beautifying the community while at the same time teaching the students some things about recycling, reusing, and decomposition. Because she chose to grow common foods and flowers, she also believed a garden would connect to areas of science in which her students had some experience, or at least felt comfortable. This was important to her because her own students, pre-service teachers, overwhelmingly felt distanced and afraid of science. She believed the produce from the garden could be used by those families who needed access to fresh fruits and vegetables. Finally, because the garden was in a community centre, she felt it would provide sustained contact between doing science for change and the people in the neighbourhood.

In short, Haleema believes that science curriculum and textbooks need to address the needs of the children from poor neighbourhoods and one way to do this would be to focus on environmental and health science. Not only can children be taught about how to grow food for their family or the dangers of bathing in polluted water, they can also learn about ways to help clean up the community or the water. They can even learn about the sources of pollution and engage in the kinds of activities that might promote community awareness and action around the issue. Although Haleema does not want to spend educational time on only 'negative issues' like the water quality and air quality, she believes that children living in extreme poverty positions need concrete ways to improve their quality of life. Thus, the focus on health and the environmental science not only has direct applications, it also focuses on self-empowerment.

Connected to the content areas Haleema deemed important for exploration, Haleema also explained that how the content gets explored is just as important in working to empower children. As her examples above demonstrate, Haleema believes that not only should students learn about environmental and health science, they should have opportunities to explore these topics in their communities. As Haleema describes in the quote below, she believes that science education must be transformed from being rigid and fact oriented to situational understandings, knowledge, and action.

We have a very rigid curriculum where things are written very strictly and the focus is upon facts and ideas. Given the situation, I bring attainment targets as broad outlines where immense importance is given to skills and ideas rather than facts and theories. Curriculum needs to be focused on processes and skills that will enable students to make connection between what they do in the class and how is it related to their everyday life experiences. Curriculum will have a cohesion between child's world view and school's world view. Right now our school is a different entity, home is a different entity, and society is different. I would like to have the three as one big entity

where child learn to live in a democratic way, get stronger socially, feel and learn his responsibilities, and contribute to the immediate society of school and classroom effectively.

Also important to Haleema in terms of the ways in which the ideals of education for empowerment and social change play out is through how teachers position children in relation to science, to their communities and to themselves. Haleema believes that just as scientific ideas and knowledge are not static, neither are children. Children, regardless of their life circumstances, are agents of change, and can and should have a positive impact on their community. As Haleema describes:

[It is important to create a] sense of accepting children as agents of change for future and accept their right to get education and try out their competencies and contribute to the society as well as to empower students to have a sense of belonging and readiness to contribute to their surroundings, parents and brothers and sisters.

Haleema believes that children can apply their knowledge and use these ideas to improve their own lives and that they have a responsibility to do so. Throughout the time we conducted this case study, Haleema demonstrated both in words and in action the role and importance of self-empowerment for poor children. For example, in the following quote, Haleema describes in particular how self-empowerment in science education is tied to: (1) learning to use the resources to which one has access to better one's life; and (2) having a positive outlook by focusing on what one can do rather than on what one cannot.

The following quote also shows how Haleema is particularly keen on wanting poor children to realize that what nature offers is accessible to everyone, poor or rich, and that children should also learn to take advantage of that as well. They also need to learn to be responsible for what they have because it is precious and should not be destroyed:

Children in poverty lack resources, good food, clothes and home. Once they look at themselves they start becoming sympathetic and remain caught in what they do not have. They do not pay any attention to what they have and I think sometimes they are never facilitated to see what they have. They are complete human beings, two eyes, two ears, two hands. They can walk the way they want to. They can run, and they can make a difference to what they have in their surroundings. I want them to start appreciating nature because at least this is what all of us on this globe share. Parks, grounds, deserts, animals and water bodies. Why do not we start seeing who has created it and what for? For all of us human beings. Is there anyway we can contribute to these things? They should feel empowered and should have sense of belonging.

In addition, Haleema believes that perhaps being an agent of change may be even more important for children living in poverty than for those that do not because children in poverty often have fewer resources and fewer people and organizations working for them. Thus they must learn not to feel sorry about their lot in life but rather concentrate on working to improve it. Haleema ties the importance and role of self-empowerment not just to science education but also to the overall importance of schooling:

I would say here we will have to worry about the purpose of education. What do we need: education or schooling? Do we want our children to be able to live a comfortable and happy life where they are able to critically analyse the situations? . . . So we need school as an entity that empowers people with skills and knowledge.

Haleema's ideal vision of education for poor children as about empowerment and social change also plays out in how she links science education for self-empowerment to community empowerment. Community empowerment is important to Haleema because it will hopefully lead to 'grass roots movements to improve society for all'. She describes this point in terms of environmental education:

In order to be on the right track we have to start working in science education at grass root level. I think if I will be able to create a positive sense towards environment they will be able to play towards its betterment and improvement.

This is an important statement because it takes individual and social agency and extends its boundaries beyond the school and beyond learning for the sake of the self to the sake of the larger community. It suggests that fundamental to what ought to be going on in urban science education are the sparks for social and environmental renewal.

Building a pre-service programme focused on pragmatism and socio-culturalism. For Haleema, science education for empowerment and social change embraces what she calls a 'pragmatic and socio-culturalism' framework. She believes that knowledge and action are critically linked, and that pre-service teachers must begin to make connections especially around the needs of poor children. She believes that if teachers are going to learn to teach for empowerment and social change, then they must have a handle on the lives that students bring to the classroom and the ways in which the children and teachers can work together to improve those lives. This pragmatic stance takes several forms for Haleema. First, Haleema believes that pre-service teachers must begin to think about science emerging from everyday experiences such as cooking in the kitchen or tending a garden:

We start from the kitchen and what do you do there, in cooking and in disposing of things. What science is there? How do you bake a cake? What do you use there and why? Where do the wrappers and packings go? What can you do with them? Have you ever read the safety aspects of things you use in the kitchen? What is written on shampoo, vinegar or oil, etc?

Beginning science instruction with the experiences of the pre-service teacher is a challenge because, as we described earlier, Haleema sees that most of her pre-service teachers come to her classroom afraid of science and expecting science to be about lectures on facts and theories. Yet, once teachers have a grasp on how science emerges from personal experiences, Haleema believes it is also vitally important to help them think about the experiences of poor urban children and the kinds of science that might grow out of their experiences. This too is difficult because her pre-service teachers do not come to her classroom with the same kinds of disadvantages that many of the poor children they will teach will have:

Our physical environment changes. There are certain places where we, as teachers, can contribute our part. What happens in our school? Is there garbage in the class, plant cuttings in the garden? What do gardeners do with them? How can we better use anything that is lying there? How can we make sure we are not wasting anything? You have made dustbins by using all thrown away material. Let us use them, sell them, make cards out of calendars and sell them, and give the money to any needy person. Let us buy books for the children. Since I teach science with all hands-on and minds-on my students do everything using all kinds of junk. We do not buy things from the

market because tomorrow they might teach in a school where there will be no resources! I must enable them to feel empowered. Once they have this experience they can do the same thing with their children in the classroom.

In this quote, Haleema also begins to allude to her belief that scientific ideas and understandings ought to be situated within the local community's needs and resources. According to Haleema, science educators in poor urban settings must realize that students have agency and that part of realizing that agency is learning to use local resources in positive enhancing ways. As Haleema stated, science education in poor urban settings must 'make use of the environment, local resources, ready to take initiatives and enable them to make links between children and their daily life issues.' This is an important issue. As stated earlier, poor urban schools have few resources. According to Haleema, one remedy to this situation would be to use the resources that a community already has such as thinking about the city and all of its offerings as an active scientific laboratory. This would be an essential step in not just locating resources, but also making science more situated and relevant.

Haleema has many ideas for how the city can be used as an active laboratory in this situated approach to science teaching. Areas of study include industry, ecology, the environment, and health and how these areas interact. Further, when the city becomes an active laboratory it not only provides resources, it begins to build rich connections between the school and those who work in the community:

The targets to be attained will be given in a way that one way or the other community will have to contribute to it. It will be a study of an industry in the given area, ecology and environment of the area, birds and animals of an area and what are some of the issues in the community, how factory or industry is contributing to environmental issues.

These kinds of connections are important because they engage everyone in their responsibility to help educate poor children. As the quote that opened this paper and the following quote both suggest, all community members, especially those who are secure materially and financially have an obligation to help educate and empower those in poverty.

A large community can be involved in couple of different ways for the environment in science teaching in poverty areas. In Pakistan usually a poverty area *kachchi aadabi* is surrounded by an area of very rich people. They should be involved both financially and physically. Different members of community like a counsellor who is usually elected by the people should know that it is his responsibility to look after people around him. He should know the composition of community and he can create situations where abandoned areas and parks can be easily used for this purpose. There should be one committee of different strata of community industrialists, factory owner, if there are teachers, factory workers, shop keepers, farmers, and hawkers. This committee should have a participatory approach where issue in this case education of children should discuss and decide what is to be done. Everyone should know the importance of children living in poverty. They should focus on the questions, What should be done for the children of that community and how can the community contribute? It can be funding for the children to pay their dues, to buy books to rent a school or a room, to have something to sit on, availability of local resources – industry, factory or workshop. Contribution of human resources is also important. Doctors can talk about health issues, voluntary professors should work with the children in or after hours to talk about recycling, reusing, compost making, how to utilise abandoned areas, grow plants and vegetables and so on. If we start doing this, I think we will have no problem in educating children in poverty.

Implications

What reasons should children in extreme poverty learn science beyond basic literacy skills? What reasons are there to teach subject matter knowledge in schools, especially when most children will only leave these schools for menial labour positions – even if they were to acquire a strong academic background? The general opinion in Pakistan is that schooling is not of any use for those children who are destined to remain in the very poorest class for their lives.

Yet, Haleema sees this picture differently. Indeed, it seems that there are several important ideas that emerge from our analysis of this case study. Since ‘graduation’ and ‘college’ and ‘professional careers’ are not realistic options for the poorest of children in a caste-society, Haleema believes it is necessary to make schooling mean something that will have dramatic impact on the students’ lives so that even if their education does not move them out of the poorest class (which she hopes that it will), then at least they will be empowered enough to use science as a tool to make their lives and their communities the kinds of places they want to live. According to Haleema, ultimately the goal of this kind of education is to transform schooling enough to break down those who have access to college and professional careers, but in the mean time (if society is not willing or ready to break the caste system) science teachers must focus on working with the children to enact social change that will lead to the eventual empowerment of all those in urban poverty. What we also see as interesting is that Haleema knowingly disregards the state mandated madrasah approach to curriculum to do this.

Haleema also regards her job, as well as the science education of children in poverty, as political; as being about changing how science is understood and practised in a local context. School learning is about critical explorations of community or ‘critical emancipatory knowledge’ (Freire 1972), and knowledge construction occurs within the context of *doing for change* (Arnot and Weiler 1993). Science is not a subject to be learned for learning’s sake. Rather, science ought to be a tool that the children and families need to have to make powerful changes in their lives. In other words, subject matter knowledge, in particular knowledge in the sciences (mathematics, science and technology) is critical for bringing about social justice within impoverished communities, such as working with children and parents to understand water and land pollution, their causes, effects, and possible ways to change it.

Haleema presents us with a provocative case for why science education in Pakistan ought to focus on empowerment and social change and the tensions in her stance are obvious. On the one hand, schools and teachers in schools are expected to allocate their teaching time towards covering the content of the state curriculum. According to Haleema, this method of teaching is advocated in Pakistan because promotions are based on high stakes exams geared towards testing students’ knowledge of the traditional canon of science rather than their understanding and skills, like problem solving, analysis of data, synthesis, etc. This kind of education is what is required by the state for formal advancement in school and science. However, on the other hand, there are widely held low expectations for school achievement and advancement of poor children, and in particular for girls. Women, both as teachers and as learners have very few formal opportunities to contribute to the dialogue around what is taught in schools, how girls might be better served in schools, or what all students should learn and be able to do. This

very approach denies students from poor communities an education that promotes social justice. Haleema, as a female teacher educator – a teacher of future primary teachers, most of whom are female too – advocates that teachers must live in the middle of this tension. Teachers must, in their daily practice and with or without the support from the state, find ways to incorporate local and indigenous knowledge and lived experiences of students in the curriculum. Indeed, Haleema is left in the precarious situation of having to respond to the demands of the state, while at the same time working with teachers to alter radically the science programmes in both content and pedagogy in order to use science education as a stepping stone to greater equality in her country. Like Delpit (1995), Haleema believes that poor urban youth need access to the science of school advancement, the culture of power as it were. However, she believes strongly that any introduction to the practice and culture of science must first and foremost be situated within the immediate needs and concerns of the local community. According to Haleema becoming scientifically literate is partly about school advancement and partly about being able to work towards immediate change in local communities. In this sense both kinds of knowledge and experiences are needed.

This research is not without its limitations. While this study adds to the knowledge base of teaching science to children of poverty in urban cities of developing countries, its limitations must be acknowledged in two ways. First, this study focuses on only one teacher educators' view of teaching science to children of poverty. To generate more accurate, diverse, rich and complex findings, teachers', parents', and students' (who are in poverty) views and perspectives on existing science education need to be researched. Second, this study has captured a limited perspective on science education because of the many diversities in Pakistani language and culture. For example, as a religious nation state, religion plays an integral part in Pakistani people's social, cultural, and personal lives. The influence of religion on science education for the children of poverty has not been looked into as part of this study.

Future research

This case study of Haleema leaves us with questions. On the one hand, we see Haleema's approach as a powerful way to begin to facilitate differences in the lives of poor urban children. For so long, poor children have remained in poverty regardless of their success in school. Haleema's approach, although sensitive to the reality that most poor children in Pakistan will not attend school beyond the sixth grade, pushes the goals and purposes of schooling so that schooling becomes about creating change. Children in urban poverty ought to be taught science so that they can gain 'political voice' and 'self-empowerment' in their community rather than to meet an abstract standard for 'academic success'. As Haleema believes, this approach might, over time, lead to grass-roots movements and larger social change. On the other hand, Haleema is part of a small minority of teachers in Pakistan who are willing to work against the political and social grain for what schooling ought to be like. Is it even reasonable to believe that this approach to schooling could ever go to scale? After all, Haleema passionately requested we leave out of this paper much of her personal history to guarantee she would not be identified. If the state regulations are so tight and if job security is compromised

by deviating in the kinds of ways advocated by Haleema, then why would one educate pre-service teachers to engage in such a practice as Haleema suggests?

Furthermore, in Pakistan, though women do not enjoy the same status as that of men in social and political life, most elementary teachers are female but most secondary science teachers are male. This generates a very complex tension between men and women. Further studies are needed to find out how classroom teaching differs between men and women teachers, especially around questions of equity and empowerment. How do power and social relationships play for male and female teachers in the school, community, family, with students, and other larger social, cultural, and political areas?

Finally, we believe that this study provides a framework for thinking about science education in poor, urban settings of developing countries. There are many South Asian countries (Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka) that have similar kinds of social, political and cultural settings. The struggles to bring change through education are similar if not the same in many respects. Children are generally marginalized both in the classroom and in the curriculum. It is imperative that for meaningful education, especially science education because it is believed to be an elitist subject, children have to be incorporated in research to find out why, what and how they want to learn in science. Children's lives can provide a rich and complex insight to what they want in their learning.

Haleema believes that science education for empowerment and social change are vital to the welfare of all poor children in her country, and, unless teachers are willing to deviate from the standard curriculum, change will never happen. We believe that Haleema's view of science education must be viewed as a call to action for all science educators to begin to reflect – and indeed act – upon the primary purposes and goals of our efforts as science educators.

Notes

- 1 All names used in this paper are pseudonyms used to protect the identity of the participants.

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