

The Millennium Development Goals Agenda: Constraints of culture, economy and empowerment in influencing the social mobility of Pakistani girls on mathematics and science related higher education courses in Universities in Pakistan

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The third of the eight Millennium Development Goals is *to promote gender equality and empower women*. This paper discusses the factors which are associated with 31 female higher education students' choices and aspirations to pursue education and careers in mathematics and science related fields. The analysis is based on semi-structured interviews. Patriarchal values in society impacted females' own perceptions of their ability and aspirations. Although extrinsic social gain motivation underpinned females' choices, they had little awareness of the economic benefits of mathematics and science qualifications. Teaching styles were associated with females were leaving the mathematics and science pipeline.

Key words: Pakistan; gender; psychology; mathematics; science; aspirations; motivation

Introduction

Pakistan, a member of the Commonwealth, consists of eight provinces and federal territories; the most densely populated is Islamabad (the area in which this study is based). At present Pakistan has a range of challenges which include poverty, corruption, high rates of illiteracy, overpopulation, terrorism and gender inequalities both in education and the workforce(UNDP, 2013). At the age of 16, in order to obtain the Secondary School Certificate, students need to take exams in eight subjects, five of which are compulsory:

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mathematics, Urdu, English, Islamic studies and Pakistani Studies. Upon completion of the Secondary School Certificate students are able to move on to the Higher Secondary School Certificate (HSC). Pakistan divides up HSC programmes into science and non-science (arts), leading either to an award in Faculty in Science or Faculty in Arts. The Faculty in Science (FSc) programmes (which are of relevance to this study) are sub-divided into specialist areas such as pre-medical and pre-engineering. There are other (private) alternatives to these awards, the most common of which is based on the England system of education (O-levels and A-Levels).

Many industrialised and developing countries would like to improve their population's proficiency in scientific and mathematical skills to enable them to participate and compete more effectively within a competitive global economy. Within the Pakistan context, there is a clear need to make advancements in science, technology, engineering and mathematics (STEM), given the country lags behind in the number of proficient scientists, mathematicians and engineers it has compared to industrialised nations (UNDP 2013). There is a concern in education policy circles in industrialised nations about the low rates of progression of students into further and higher education in the sciences and, furthermore, that females are less likely to participate in the sciences in higher levels of education (e.g. Francis *et al.*, 2003; Hazari *et al.*, 2010; JCQ, 2013; Bøe *et al.*, 2011). However, the concern about the number of girls continuing with STEM subjects at higher education within Pakistan is an under-researched area with, to date, little policy interest, undoubtedly because this is concealed by wider more general concerns with females' participation in education. Pakistan has long been an international outlier in the gender gap in education; according to the World Bank Indicators (2013), the female literacy in 2009 between the ages of 15-24 was only 61 percent in 2009.

There is evidence to show that students within developing countries typically show more of an interest in science than do students from industrialised nations (e.g. Sjoberg & Schreiner, 2005); the interest of females in science and mathematics is an area we explore within this paper. At the start of our data collection, given the additional concerns with Pakistan being a patriarchal society, we had wondered whether there would be a problem in obtaining a sufficient sample of girls with a high interest in STEM subjects and careers. In industrialised nations, despite some movement away from gender stereotypical attitudes in career choices, these still remain alongside gendered patterns in subject choices and STEM aspirations (e.g. Francis *et al.*, 2003; Mujtaba & Reiss, 2013a). The gender gap in science participation in industrialised nations has been associated with family influences (e.g. Eccles, 1994), social class differences (e.g. Aschbacher *et al.*, 2010), girls being less likely to enjoy their lessons (e.g. Mujtaba & Reiss, 2013b), girls feeling they are less able to discuss and experiment with ideas (Mujtaba & Reiss, 2013b), boys having more positive attitudes towards the sciences (Reiss, 2004) and gender-specific attitudes that are impacted by socially embedded influences (e.g. Archer *et al.*, 2013).

Within the Pakistan context there has been little research in this area but in studies that have compared the attitudes of boys and girls to science, there is evidence that findings contradict those from industrialised nations. So, for example, one study found that primary girls had more positive attitudes towards science (Muhammad *et al.*, 2008). Another study found similar findings at the secondary level (Anwer *et al.*, 2012), though no gender differences were found for career interest in science. This study also found a geographic effect; despite the fact that students in rural areas were from lower socio-economic status (SES) backgrounds and had fewer educational facilities within their schools, they had more positive attitudes towards science than did the students of urban areas.

The Millennium Development Goals

The Millennium Development Goals (MDGs) consist of eight international development goals which principally arose out of 189 countries, including Pakistan, committing themselves to the United Nations Millennium Declaration, with the aim of reaching such goals by 2015 (MDG, 2013).. Of particular importance for this paper is the third goal: *to promote gender equality and empowering women*. This was deemed important because “whether in the public or private sphere, from the highest levels of government decision-making to households, women continue to be denied equal opportunity with men to participate in decisions that affect their lives” (MDG, 2013, page 5). Whilst research papers in science and mathematics education in developing countries would not usually link their research with the MDGs (though, of course, gender equality in STEM education is an issue in developed nations), the issues faced by girls in Pakistan wanting to progress in STEM education are infiltrated by several layers of barriers (in addition to the barriers faced by girls in developed nations) which are very much linked to the MDGs. Although Pakistan is a signatory of the UN Education for All (EFA) Framework for Action (UNESCO, 2000), which places considerable emphasis on women’s education, particularly the elimination of gender inequalities in primary, secondary and higher education, the objective of achieving Education for All in Pakistan is still far from being realised.

Demographic profile of Pakistan

Pakistan’s demographic profile has significant implications for education and for gender equality in education. The Human Development Index (HDI) is important when considering the influence of Pakistan’s demographic profile on women’s participation in education. The HDI is a summary measure of human development. It measures a country’s average achievements in three basic dimensions of human development: a long and healthy life; access to knowledge; and a decent standard of living. In 2009 Pakistan ranked 141st out of 182 countries on the HDI (UNDP, 2009); in 2012 it ranked 146th out of 186 countries

(UNDP, 2013) and ranked 123rd out of 186 countries on the gender equality index, placing Pakistan at the lower end for both HDI and gender equality. In comparison, the figures for the UK (where the two of us are based) in 2012 were 26 for human development and 34 for gender equality.

There are many reasons why girls are disadvantaged in Pakistan's education system, some of which relate to poverty, others to cultural expectations and some to the quality of schooling, but all are linked with the HDI profile. The pupil-teacher ratio in Pakistan is 39.7; the adult literacy rate is 55%; the gross enrolment rate at primary level is 85.1% which sinks to 33.1% at secondary level and further reduces to 5.2% at tertiary level (UNDP, 2011). The reasons for the low levels of girls' participation in education is due to a number of issues: cultural (it is not seen as important to educate girls, particularly as they get married and become part of another family), poverty (those from poor backgrounds do not educate girls for economic reasons) and government infrastructure (Khalid & Mukhtar, 2002). Though little has been written about the widespread sexual harassment of women in Pakistan, our paper will indicate that this is a fourth barrier towards women's participation in education and employment. These issues collectively impact who goes on to higher education and this has an implication on the social backgrounds of the females we interviewed; none of the sample consisted of those from poor backgrounds.

Methodology

Methods

We used semi-structured interviewing methods; the interview schedule was developed from our earlier work about the factors which help keep males and females (in the UK context) within the STEM pipeline (Reiss, 2004; Reiss *et al.*, 2011). Our interview style (relaxed and friendly; all interviews were conducted by the first author, who is female and of Pakistani extraction) enabled us to pick up on issues that we had not envisaged were important within

the Pakistan context (most notably extrinsic social gain motivation, as discussed below). We were able to take a holistic approach to exploring the societal, individual, family and school factors that are associated with girls' choices in STEM subjects both at the age of 16 at FSc level (the first level of post-compulsory education), at degree and higher degree level and in future careers. The interview schedule was based on the findings of our earlier work within the UK whilst incorporating additional questions specific to Pakistani cultural practices that we felt would be of relevance. Prior to piloting the interview schedule we sent the instrument along with a consent form and a summary of the procedures we would follow to our university's research ethics committee. The study was approved and conforms to the Institute of Education's ethical guidelines for research that involves people and international research.

The interview schedule was piloted with four students studying computer science and mathematics courses; small refinements were made before data were collected from 31 students from two Universities. The Universities were chosen because both were well known for their STEM courses, with one being a single-sex university and the other co-educational. In both Universities Heads of Department were approached two months ahead of our visit to Pakistan in order to ensure the right processes were followed for access; interviews were conducted over the course of several weeks. All of the interviews were undertaken 1:1, face-to-face, audio-recorded and selectively transcribed. We used thematic analyses to explore why girls were within the STEM pipeline and why, if they did, they said they might leave. We identified themes which fell within four overarching areas: family factors, societal factors, individual factors and teaching factors. Each of these four areas consistently appeared to be important for each of the interviewees. We indicate below how representative of all the interviewees our chosen extracts are. The pilot phase had indicated how important patriarchal culture was on females' academic and professional progression in the STEM area and how this was quite closely tied in with social class. Having introduced questions on these themes

for the main phase of interviewing, no additional themes emerged during the main phase of interviewing as being important.

We were transparent as to the purpose of our interviews with both the students and the senior management at the Universities. They were informed of the ethical guidelines for research we were following and it was explained that only those within the research team (i.e. the two of us) would have access to their interviews and that any reference to their interviews in publications would be anonymised. The students were guaranteed confidentiality and were informed of their right to withhold any information and withdraw their interview data from the study at any point up to publication. We were also conscious that students might not feel at ease given that we were from a well-known University from England. Given that the interviewer is fluent in several of the languages in Pakistan, students were reassured they were able to respond in either Urdu or Punjabi (or that we would ask questions in Urdu or Punjabi if they required it); this in part helped relax students before the interviews began. All of the students conducted the interviews in English with the exception of four students who had very small parts of the interview (when they were unable to understand a question in English) conducted in their mother tongue. There was no requirement for translation and back translation. Prior to the data gathering process, the two of us had already been involved in detailed discussions about coding and interpretation of the data from the UK context and the first author used the UK coding approach for the Pakistan data. Interpretations, with reference to the coding, were discussed between the two of us which helped ensure validity for our conclusions.

Theme 1: Family factors

Parents' social class and its relationship to supporting daughters' education

In Pakistan there are strong cultural factors which underpin why girls are less likely to continue with education despite the fact the economic returns to women's schooling and

skills in Pakistan are higher than men's in all occupations and among all age groups (Aslam *et al.*, 2008a, 2008b; Aslam, 2009). Pakistan's female literacy and school enrolment rates demonstrate that investment in human development favours males (Lloyd *et al.*, 2007). Financial constraint is a major barrier to female education, particularly for poor and low income families where there is a strong bias to not educate daughters given the financial returns to individual families for educating girls is quite low (despite the fact that the returns to society and females themselves is high). Pakistan has no state benefit system; family investment is directed towards sons which becomes a returned investment; the cultural expectation is that women become a part of their husband's family and therefore there is no financial benefit to parents for educating girls. In Pakistan there is a strong association between family income and girls' participation in education (World Bank, 2002; Sathar & Lloyd, 1994; Hazarika, 2001). Girls lag behind boys in education access, in the quality of schooling available and in the outcomes of education (Tembon & Fort, 2008). Contrary to this situation, our sample did not face such problems and we believe this may be largely related to the socio-economic profile of our sample. There are other issues which impact girls' participation in education which are associated with low socio-economic status (e.g. Lloyd *et al.*, 2007) which are not of relevance to this paper, given our sample type.

Of relevance to our sample are the patriarchal values which infiltrate wider Pakistani society. Such values predetermine the social value of gender; females are associated with inferior reproductive roles whilst males are associated with superior productive roles as financial earners; such stereotypical value judgments transcend into barriers towards women's professional progression. So, for example, qualified women are presented with limited opportunities to enter higher education and attain professional and technical degrees (Khan, 2007).

In developed countries the impact of social class on educational attainment, social mobility and higher education participation is important alongside other factors which have an influence, such as gender and ethnicity. Within the context of Pakistan, social class and gender are the main factors associated with participation in higher education. There are a limited number of research papers which explore participation in STEM subjects in higher education in Pakistan but we assumed prior to our data collection that gender and social class were equally relevant for such subjects. Those from low socio-economic backgrounds are further disadvantaged as the allocation of government funds is skewed towards higher education (rather than primary or secondary education), and therefore the benefits of the public subsidy of education are largely reaped by the more advantaged members of society.

In many societies socialisation encourages and perpetuates gender differences and assumptions about male and female roles. Our work within the UK context indicated that girls, regardless of aspirations and after controlling for family socio-economic status, were less likely to be encouraged by their families (and their teachers) to continue with mathematics and physics in post compulsory education and were less likely to receive support at home in learning these subjects (Mujtaba & Reiss, 2013a, 2013b). In patriarchal societies like Pakistan the socialisation process is markedly more discriminatory than is found in western cultures as females are conditioned from early childhood to accept different entitlements than males, such as accepting fewer resources being spent on their education, spending most of their time at home (in poor families this means missing or leaving school), supporting the economic growth of the family by accepting they need to support activities at home whilst their brothers are educated (Social Policy Development Centre, Survey, 2003). Such discrimination is more apparent and marked amongst those from low socio-economic backgrounds. Our sample is constituted by females who have managed to attend university on post-graduate or under-graduate courses; it does not include those from extremely poor

backgrounds who have dropped out of the education system – an issue that we envisaged at the start of the research process. Unlike in developed nations, it would be a rare exception in Pakistan for a female from a low socio-economic background to get to higher education. This paper therefore discusses the experiences of females who are predominately from middle class backgrounds on under-graduate or post-graduate STEM degree programmes, and who largely came from supportive families. As we shall show, despite family support these females still experienced several problems with academic and professional progression.

In our work we found that family support and family social class were intrinsically linked. The only female from a working class background (Farzana Zafar) accessed University primarily because of a scholarship programme. She was from an unsupportive family who discouraged their daughters from attending university. The remaining girls in our sample were from middle class backgrounds with supportive families who encouraged their daughters to be educated. Mothers' aspirations and the role of support and encouragement given to daughters in continuing with education was closely tied; without actual prompts about family support, 15 (middle class) girls talked about the supportive role of their mothers. In a society where patriarchal systems are in place, in the home, in extended families and in wider society, our interviewees appreciated the more liberal views of their families and the enhanced status of their mothers and thus mentioned them within the interviews.

Farazana Zafar (working class background) did not express the same sentiments about family support. She was from a small town in Northern Pakistan where the large majority of people had not completed secondary education; however, a charitable foundation has helped some females realise their academic potential – though, of course, such progression goes hand in hand, as in Farzana's case, with issues to do with social isolation. At the time of her interview she had not seen her family in nine months and her father was not on speaking terms with her, she was staying on campus at the university and had indicated she would not

be returning back to her village until the end of her four year degree programme. None of her family were on speaking terms with her and she was unable to connect with anyone at university during her first few terms:

I still have difficulties, they [her parents] are still angry; ‘why you are there [at university]?’ , ‘why you took a step like this [pursuing higher education]?’ . They are in a remote area, they are not educated, that’s why they have congested mind, that’s why I feel problems from family’s side ... sometimes I used to cry after coming [to university].

Having gone against her family’s wishes to pursue education Farazana continued to face societal obstacles in getting onto an engineering degree course; she was refused entry to sit an entrance exam to get on to a pre-engineering course because of administration issues she was not informed of. She felt it was a possibility that being misinformed by officials had something to do with her being a female. Her ambitions to enter higher education led her to accepting an offer to undertake a programming degree. Whilst societal discrimination is distressing for any female, it is markedly worse for those who go against all odds and come from backgrounds with very little practical or social support.

Pakistan’s patriarchal values further present themselves in the importance and precedence given to the role of male members of the paternal side of the family in influencing decisions about young people; this is a strong part of Pakistani culture. Such practices are reinforced further for those who live in a joint family system, where two brothers and their wives and children all live in the same house – a practice which is common within Pakistan. Two thirds of the sample spoke (without being prompted) about the role of the paternal family in having an influence or trying to influence decisions about their educational prospects. For 26 of the interviewees, much of the guidance being given by paternal relatives was for females not to continue with degrees or higher degrees. However, all of these

interviewees spoke about how their parents had ultimately decided to encourage and support their daughters in continuing with higher education.

Contrary to widespread beliefs that females in Pakistan receive little support from their families in continuing with education, all 30 of our interviewees from middle class backgrounds said they received much support from their parents, in particular their mothers, in ensuring that they would be able to pursue an education and a career. Hadia indicated that her mother was so intent on helping her realise her potential that she negotiated with Hadia's future in-laws for her to be able to continue with a job after she was married. It is probable that amongst our sample of middle class females that discrimination (in pursuing education) within the family to a greater degree because of a combination of factors related to family social class, mothers' education and the social gains of having a STEM qualification (see individual factors below).

Careers and married life

With the exception of Farzana, the remaining 30 interviewees spoke (unprompted) about the support and encouragement they received from their families in continuing with higher education, for example: "my mother is my best friend, I can tell her anything". Though such support helped to push these young women through to higher education in a society where educating girls is at best not a priority and at worse frowned upon, it was disheartening to hear how these young women lacked confidence and assertiveness in shaping their own lives after they were married.

We asked our interviewees whether they would continue with the STEM pipeline, what careers they would choose and whether they would remain in their chosen profession after they were married. Hadia, along with 27 other females, indicated that the ultimate decision about whether or not she could continue with a career would be up to her in-laws (one interviewee did not express an opinion on this and two indicated they would not marry

until they were financially stable). Some of the interviewees explicitly raised, without being prompted, the fact that many families restrict females from entering the workplace because of the widespread sexual harassment of women even whilst conducting everyday tasks such as shopping; interviewees suspected that future in-laws would not allow them to work. Although the impact of married life on females' future careers is not of relevance in some cultures, it certainly is within Pakistan. It is a society with strong beliefs that a woman is expected to get married and then expected to follow the views and decisions of her husband and his family. So, for example, the biggest obstacle in continuing with a mathematics career for Wajeeja was possible foreseen restrictions after marriage from prospective in-laws who at the time of the interview were not anyone in particular: "I want to do something in the maths field after the MSc but it depends on who I marry and if they [meaning in-laws] think it will be possible".

The majority of interviewees envisaged an arranged marriage and most of them at the time of the interview were not engaged but said that they would be submissive to the requirements of future in-laws about entering the world of work. So, for example, Ammara Saed stated "it totally depends on what my husband wants". However, six of the interviewees felt they would try to negotiate expectations: "I think there will be hurdles but I will manage" (Hadia), but if such negotiations were not fruitful they would not go against the expectations of future husbands and in-laws.

Only one interviewee (Fozia) mentioned being engaged to someone she had fallen in love with and said that she was not going to have an arranged marriage. Her family were very supportive of both her educational progression and her choices in life. Despite coming from a supportive and liberal background, Fozia seemed to lack confidence and felt that the society she was living in was eroding her beliefs that women were able to progress the same as men. This lack of confidence was notable, particularly when she spoke of her fiancé's choices for

her own future. Despite coming from a more liberal family and having chosen her own partner to marry, Fozia still held the same views as the other interviewees about respecting the wishes of husbands/in-laws:

After I get my degree I have two plans, being a girl is not good I guess I've been very strong and fought with my family on stuff because in my family [her extended family] girls get married early after high school ... like between 18 to 20 ... I stood against it [getting married as a teenager and not continuing with higher education] ... my boyfriend does not want me to study more, I don't know why but I will make him agree ... in my family girls have not been given chances and I have, I want to go higher and higher and help them [with respect to being a mentor]... one side of my mind says 'do what your boyfriend says' and the other says 'study more' [she planned to get a post-graduate scholarship in the UK or USA as she found her previous one year study in the USA to be inspiring] ... I want to make a difference in my community. I was talking to a girl who was study psychology ... she said many men think if their wives are more educated than themselves then they feel inferior so it's a complex in men, then I understood why my boyfriend doesn't want me to study ... but I won't go against him.

Theme 2: Societal factors

Sexual harassment in Pakistan

Discrimination within our group of middle class females largely took place in the wider society outside of the home; such discrimination had an impact both on their perceptions of what their future selves would be and on access to educational resources. Harassment of women in Pakistan is an accepted part of everyday life; very little has been written about this and of the implications this has on women's progression and access to equal rights. Every single one of the interviewees indicated that moving openly in public meant that they were

valid targets for males, given they were inhabiting men's spaces; all of the females reported being physically or verbally assaulted by men or being leered at if they travelled without a chaperone. It was quite evident from all of the interviewees that women were seen as sexual beings who by entering the male sphere (the world outside of the home) could expect to be harassed, and that harassment of females was the norm. In order to minimise sexual harassment many women wear Islamic dress, covering their bodies in a loose outer garment and head scarves, particularly when moving around in crowded places in less liberal areas outside of Islamabad. As Fozia Zarr reported:

The kind of environment we live here, engineering girls find a tough time because, for example, doing a project we have to go to shops to buy electrical stuff and for a girls it's very difficult if you have to keep going to the shops here ... for girls it's difficult to keep going to the markets or move around by their own ... the men here, it's a male-dominated society and the men tend to tease girls or women. A woman can move alone during daytime if she is very confident or very brave but after evening time it's not safe for them; it's not even safe for them in the daytime if they are alone ... girls have a very limited time to go out and they have to find someone to go with them and that is why engineering is better for boys, no matter if they can do good in them but for boys it's more suitable.

Many of these females' parents had arranged for a 'drop and collect' service to university, a term used in Pakistan for hiring private drivers; given that sexual harassment is widespread, hiring private drivers has become the norm. Of course, being able to secure females' safety whilst regularly travelling to university requires money and this is another barrier for those females who are unable to afford this. Our interviewees also indicated they envisaged harassment within working spaces amongst future colleagues:

Pakistan is a male-dominated society, women face problems inside the house and outside the house in offices ... women are secure [away from sexual harassment] in professions like teaching or medicine [less male-dominated] ... women are standing on the road and boys start fun and from very start [as a student] women are not safe and offices [as a professional] are occupied by men, so women not safe. (Rabbiya)

When Rabbiya and others were asked about their views about being in a male-dominated society, every female gave a response similar to Rabbiya's:

To some extent we are upset but family has trained us in the same way in the society it is so we have grown up listening; it is a male-dominating society that girls sit at home ... we have no authority, single woman can't do anything.

Manmooyat was studying a physics degree and was the only interviewee who indicated that her parents had already decided that she would be unable to pursue a career after university because of issues to do with female safety: "They prefer marriage after education ...because of this society [in reference to the harassment of women being common]".

Anticipated discrimination in the workplace

Interviewees reported that perceived harassment in the workplace was going to have an influence on their choice of careers and whether they would have a career. Although we did not explicitly ask about societal barriers in working within the STEM field, six females raised this as a particular issue. Falak Shahzadi indicated that "society doesn't support males and females working together" and said that primarily because of this she won't be able to continue working within the STEM field and will switch to a teaching career. Wajeehaa highlighted that it was norm for men to be in mathematics careers and she would find it difficult entering a male-dominated sphere. She also raised the issue of changing her outward appearance if she entered the world of work; although she was not at the time of her interview wearing traditional Islamic clothing, Wajeehaa indicated that in order to pursue a

career in mathematics she will wear the Islamic veil to overcome negative attitudes of women in the workplace. Sajida Naz also wanted to pursue a career in the mathematics field and although she felt men were not preferred over women in entering a career related to mathematics, she indicated that there would be problems with sexual harassment and, like Wajeeja, said that she would have to wear the Islamic veil in order to pursue a mathematics career. Twenty two of the interviewees indicated that access to opportunities was a real barrier in progressing within the STEM field, both in the quality of their education and employment. Rabbiya indicated that for her and any woman who aspired to pursue a career in the STEM field being successful is dependent on both quality of education and opportunities:

The practical work, especially in physics, [requires access to materials and experimentation]; when you have more opportunities in practical life and labs you get good marks ... and opportunities [for jobs] but in society males are supported more than women.

Rabbiya then went on to indicate the problems women face with Pakistan's patriarchal system.

Self-concept and girls' views about girls' abilities

In Pakistan, there is a widespread belief that males are better at STEM subjects and careers than females. Globally, examination performance in STEM subjects does not necessarily indicate that males are better in these subjects. Attainment data certainly suggest that there is no gender difference in some societies or that the gender difference is small such as those found in England (JCQ, 2013). However, aptitude for STEM subjects doesn't explain the gender disparities that exist in uptake of science and mathematics careers. The prevalent stereotypes about males being better in STEM subjects are in contrast to the actual reality. Our work within the UK context indicated that even if girls had high aspirations to continue with mathematics or the sciences, such girls were statistically significantly less likely to be

encouraged by teachers and parents to continue with these subjects and were less likely to receive support at home in learning these subjects, as compared to boys with high aspirations (Mujtaba & Reiss, 2013a 2013b). We also found, in line with many other studies, that girls had lower mathematics and physics self-concept than did boys. We expected that in Pakistan females would have internalised cultural norms that males have a better aptitude for STEM subjects.

The interviewees were asked whether they thought girls had the same ability as boys in undertaking STEM subjects and being successful in STEM careers. In total nine interviewees reported that boys were better at STEM subjects and careers than girls because of inherent intellectual differences, for example: “Boys are more genius than girls, they pick [meaning learn] rapidly than girls; girls are hardworking but can’t pick rapidly as boys ... maybe it’s natural”.

However, twenty of our interviewees indicated that such gender differences were due to socialisation processes, with boys being given the right educational tools and that intellectual biases were created by Pakistan’s gendered culture:

From my childhood I thought girls are equal to boys but gradually I realised it’s not true ... society thinks it’s not true and it makes me gradually think that women are not capable of doing stuff in this society, not everywhere [with reference to other societies as she had been on a study visit to the USA] because it takes a lot of courage for a woman to go out and stand up for her rights. (Fozia)

Girls can do good as boys in physics – but not equally supported ... if a family is totally supportive there are other problems which arise due to environment [meaning the patriarchal systems in place in wider society] ... there are problems in doing jobs girls compared to boys. (Effal Khadim)

Boys are better than girls because they have more facilities [meaning access to resources]. (Zubia Abid)

Only two of our interviewees felt that there were no differences between girls and boys, reporting positively about gender equality. As one of them, Kudija, put it: “Boys and girls are equal, it is a matter of mind – girls and boys are equally supported depending on family ... society has changed”. This in itself is an interesting finding and highlights how females from the middle classes are better able to secure equality of opportunity.

Theme 3: Individual factors

Motivation

Our work with UK students demonstrated that extrinsic material gain motivation (which measures students’ intentions to continue with STEM subjects for the purposes of higher education entry, career prospects and well paid salaries) was the most important factor in explaining why students continue with STEM at higher levels (Mujtaba & Reiss, 2013a 2013b). However, within our sample of Pakistani females only five of the 31 indicated that they had chosen to continue in the STEM field post-16 for career reasons. The type of extrinsic motivation which is important within the Pakistan context is very different to what we have found to be important within the UK context.

The females within our Pakistan sample continued with STEM subjects for extrinsic *social gain* motivation, in other words continuing with STEM subjects post-16 for social rewards, e.g. to be more popular or, within the Pakistan context, to be seen as socially desirable. We developed the term ‘extrinsic social gain motivation’ within our UK study (Mujtaba & Reiss, 2013a) but found that it had relatively little importance in the UK context. Within the Pakistan context, or at least within our sample of predominately middle class girls, there was much extrinsic social gain of attaining a degree or postgraduate qualification in STEM subjects. Within our sample, 25 of the 31 interviewees reported studying for a post-16

STEM qualification at both FSc and degree level because of the social gains of having a STEM qualification. These findings are even more important when comparisons are made with females' ideas about continuing to work post-marriage; many of them accept the possibility they may not be allowed to have a career, yet here they are studying STEM subjects at university.

Three of the interviewees indicated that they simply had no possibility of choosing an FSc in art subjects as all capable students are expected, by families and teachers, to continue with the sciences post-16. Studying art subjects post-16 is perceived to be a second-best choice compared to the sciences, with the view that and the less intelligent students should embark on an arts course; therefore, there is a positive social stereotyping associated with studying STEM subjects. Sehrish Aslam was studying an MSc in electrical engineering as she aspired to become an engineer and wanted to do a higher degree in engineering management or another course related to engineering. In her interview it transpired she was no longer fond of engineering (due to transmission teaching) and indicated that at higher degree level she intended to mix electrical engineering with management, primarily because she felt she was unable to change course or career direction at this stage in life:

I wanted people to think I was intelligent [why she chose an MSc in electrical engineering] ... it's a status kind of thing ... there's no career guidance at all [at school] ... I was interested in physics and mathematics too but now I realise ... if it was another field I would have done better ... not working on circuits and that boring stuff ... there was a kind of mind set that the students who are more hardworking choose like science or engineering or medical [at FSc or degree level] ... it is a mind set no matter if somebody is interested in the arts or something if he's a hardworking student he has to choose these fields because it happens this way... so parents and people appreciate these fields because they think they are prestigious or something but

they fail to realise that if some student can excel in some other field ... it's as good, in fact it's better.

Intrinsic value

Intrinsic motivation was an important factor in student choice to continue with STEM subjects. In total 12 of our interviewees indicated that intrinsic motivation was an underlying reason why they chose STEM subjects at FSc level, continued with it at degree/postgraduate level and were possibly intending to continue with it as a career. Farzana (from a poor background in a Northern part of Pakistan) said: "There was a picture of a pilot of a boy [in a story book]; from there it was my wish to be a pilot from childhood, it was my wish to be a pilot".

Two interviewees said that they were intrinsically motivated to complete the degree so that they could raise younger females' aspirations as mentors: "I want to benefit others with my knowledge and not so interested in payment [meaning that moving into a high paying job at the end of her degree was not a motivator]" (Sajida).

The fact that extrinsic social gain motivation and, to a lesser extent, the intrinsic value of STEM subjects were more important than extrinsic material gain motivation in having a STEM qualification may at least in part be related to the type of privileged female sample we interviewed. However, the socio-economic profile of our sample is not that dissimilar to the profile of young females at higher education in Pakistan as it would be a rare exception for females from low socio-economic backgrounds to enter higher education.

Theme 4: Education establishment factors

Poor laboratories, access to equipment and transmission teaching

The cultural influence of STEM degrees being held in high regard was enough to keep our interviewees within the STEM pipeline up to higher education level despite the fact that many cited they were switched off STEM subjects at secondary school as a result of

transmission teaching. However, the use of transmission teaching at University did influence their decisions about continuing with STEM subjects at an even more specialised level or in careers. Six of the interviewees explicitly indicated that they would not continue with the STEM stream after attaining their current qualification either because they felt uninspired by the teaching methods at higher education which dampened their enthusiasm with the subject or because they had not learnt well enough, because of the emphasis on rote learning as opposed to more engaging methods, to be sufficiently able to pursue a career or further studies in the same subject area.

Hadia, at the time of the interview, was studying for an MSc in physics at a single-sex university. One of the reasons Hadia continued with physics at MSc level was because of her science teacher at secondary school: “Inspiration at physics was my teacher at matric level, he taught me and was my inspiration ... I want to do something in physics ... I was inspired by him”.

Hadia came from a supportive and progressive middle class background: her mother had qualified as a solicitor and her father worked as a government official. She said of her mother: “my mum is an educated woman and never forced us to study a particular subject”. Hadia also reported that she was inspired by the sciences because of influence from her mother’s side of the family. Hadia was to have an arranged marriage; her mother had sought confirmation with Hadia’s prospective in-laws that Hadia should continue after she got married with whatever her chosen career path was. Hadia came from a family which had an interest in the sciences: her sister was studying medicine, her cousin had completed a PhD in statistics. Despite all these positive influences, Hadia had decided she would not continue with physics due to a combination of issues to do with transmission teaching at her (single-sex) university and the lack of commitment the university had towards supplying female students with adequate physics technical equipment and space:

Lab opportunities were not good ...we were not provided with good quality of labs ... my physics level is not that good by studying at this university and I have to stop physics because of that.

The same point about the problems of poor facilities experienced by female students was also made by several of Hadia's peers whom we interviewed. The interviews indicated that higher education lecturers in physics were not creating a stimulating environment, that practical work was unsatisfactory and that the teaching did not create opportunities to explore ideas and extend students' thinking.

Inspirational secondary school teaching

Mariyam Nawaz attended the same University as Hadia and she was studying for an MSc in mathematics with the intention of progressing onto PhD or MPhil level and then becoming a mathematics teacher or lecturer in post-compulsory education. She came from a similar family set up as Hadia, namely an educated middle class background (her father was a retired accountant) and had much support at home in continuing with education. She indicated that her interest in mathematics came from her out-of-school activities – “teachers at school were not good” – and indicated that much of the curriculum was about rote learning and cramming work in to pass exams rather than learning geared towards understanding concepts. At the same time she indicated that her experiences would not have been dissimilar to those of most students in Pakistan.

Sajida Zie, a peer of Mariyam's, with a similar educated and supportive family background (her father and brothers were accounts manager) indicated that she wanted to continue with mathematics at MPhil and PhD level. However, unlike Mariyam, Sajida felt that her experiences in compulsory education helped forge her interest in mathematics as opposed to the sciences which had much rote learning whilst with mathematics she was able to apply her knowledge when undertaking calculations. Calculations built on previous

knowledge whilst she felt the science teaching seemed like lots of unrelated topics. Sajida expressed a desire to choose a career which involved mathematics and/or calculations. Similarly, Wajeehaa, again from a middle class background with roots in STEM education and careers, indicated that her interest in mathematics began in the final few years of compulsory education and with the way her teacher engaged the class and instilled “a love for maths”; she indicated she would like a career in the field of mathematics.

The interviews indicate that for those higher education students who had come across a secondary school teacher who promoted learning through creating opportunities for questioning, student engagement and critical thinking had been helped to develop a positive association with and intrinsic value of the subject; this appeared to be linked to students wanting to continue with the STEM field in higher education.

Conclusion

From the perspective of the united nations development programme and government policy, there is a clear need for making reforms in several key areas in order to retain females proficient in STEM skills within the STEM stream and for their subsequent participation in the labour market. A whole section of society (those from low socio-economic backgrounds) is absent from higher education; therefore it was not possible to include such students within our sample. The government urgently needs to re-examine localised social and educational policies which subsidise girls’ schooling given that families from low socio-economic backgrounds are under-investing in girls’ schooling. For those females with the financial means and parental support to get into higher education, it might be thought that obtaining qualifications in the STEM field would promote entry into lucrative and important STEM jobs. However, despite the fact that there was strong support for education and possible careers from parents for the female students within our sample, many of the females indicated reservations about being allowed to pursue a career after they were married. In western

societies this may seem very surprising but within Pakistani culture, once a woman is married decisions about her life are as much to do with her husband's and her in-laws' views as her own.

Despite these young women being very able and highly intelligent females, most of them lacked confidence and assertiveness skills to indicate that they would be able to pursue a career (whether in or out of the STEM field) against the expectations of husbands or in-laws. In many ways, this goes beyond simply confidence; when a society is entrenched in particular gender-related values, going against expectations can leave women isolated and without support, as in the case of one of our interviewees. Pakistan is not a society in which women can thrive without any family support. Cultural expectations of women's roles within the family therefore limit the extent to which women can play a more equal role within the labour market. Government policy would need to focus on addressing conservative attitudes of women in the labour market through education campaigns both at the school level and wider society. This will take time but more of a start needs to be made now.

The science and mathematics school curriculum in Pakistan urgently requires a change alongside suitable training for teachers who are skilled enough to engage students with subjects. It was quite apparent in our sample that students were raising problems with rote learning and the interviews indicated that our interviewees had not received appropriate careers advice about the value of having a STEM qualification. Our work within the UK indicated that students' awareness of the extrinsic material gain of having a mathematics or physics qualification was the strongest predictor for students wanting to continue with these subjects post-16. Our work within the Pakistan context indicates that it is not enough for educators simply to impart knowledge; they need to help provide a connection between the learning in the classroom/lecture room and how subject knowledge and qualifications relate to future lives. Given there is already a high social gain value of a STEM qualification in

Pakistani society, making young people, parents and society aware of the financial benefits of a career that a STEM qualification can lead to may well be an incentive to start breaking down conservative attitudes towards women in the labour market. Given that many parts of Pakistani society function using gender-segregated methods (and often to the exclusion of women), perhaps the government can find ways of providing segregated roles within the workplace which may help the current young generation of qualified females to enter the labour market. Government police also needs to ensure that employers treat females equally within the workplace. Too often females who enter the labour market in Pakistan find that basic provisions, such as access to a ladies-only washroom, have not been provided. Society is always changing and it is quite possible that in decades to come segregation will no longer be an important element; however, to achieve that change a society has to adapt and start from somewhere.

Pakistan has signed up to the MDGs. With reference to the goal of promoting gender equality, Pakistan is failing and females have continued to be denied equality within all levels of society. Serious immediate policies are required to tackle the widespread sexual harassment of women if Pakistan wants to even begin trying to meet this MDG. It is unacceptable for females to have to accept that harassment is a normal part of everyday living and that in order to avoid sexual harassment they have to refrain from entering the workplace, are required by their families to restrict their movements and need to lower their expectations. Given that the STEM field throughout the world is male-dominated, the societal barriers we have identified in Pakistani society mean that women in Pakistan are even less likely to enter STEM careers.

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