GETTING REAL ABOUT MATHEMATICS EDUCATION REFORM IN HIGH-POVERTY COMMUNITIES

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I am afraid that our system is not as progressive as I and some of the teachers are, or are willing to be. I feel discouraged from the administration level and sense that change will be hard A reality check says that my district, New Mexico, and many areas are having the same problem [..] I am a progressive thinker, ready for change and anything that will improve student involvement in their education, but often see my ideas seen as radical.

> Technology, even though we have a computer lab, is virtually non-existent in the classroom, and I see little hope for short-term improvement Some of the math teachers, through here [professional development academy] and lesson plan study, have worked nicely and progressively together and share an enthusiasm for improving the math program at our school. (Ms W, 27th January, 2003)

Ms W was describing some of the challenges associated with teaching mathematics at a rural middle-school, serving students from a high-poverty community in the state of New Mexico in the United States She moved to the state after raising a family and working as a political activist for many years. This new teacher expressed her frustrations with the apparent lack of commitment shown by her district to meet her students' distinct needs As a participant in a long-term professional development academy, this teacher also noted how the project had provided her with ideas that could positively impact her students' mathematical learning.

Like other novice teachers, Ms W faced a plethora of challenges. She wanted to impact her students' learning positively. As a participant in the mathematics academy, Ms W had experienced first-hand reforms recommended and supported by national organizations in the United States (see National Council of Teachers of Mathematics (NCTM), 1989, 2000; National Science Foundation (NSF), 1996). These reforms stress the need for a problem-solving rich curriculum and instructional strategies that foster students' understanding of mathematical ideas:

> learning is primarily a process of concept construction and active interpretation – as opposed to the absorption and accumulation of received items of information (Schifter and Fosnot, 1993, p. 8)

Pedagogy inspired by this view engages students in posing and solving problems, making and proving conjectures, exploring puzzles, sharing and debating ideas, and contemplating the beauty of ideas in an academic discipline.

Missing from documents that delineate needed reforms in mathematics education are references to the sociopolitical contexts in which teachers such as Ms W labor. Specific approaches are seldom offered to teachers to help *all* students, particularly diverse students from high-poverty communities, learn challenging mathematical content Moreover, the incongruity between the reform vision and how the majority of practicing teachers were taught mathematics (teaching that focuses on memorization and following procedures) is well established

To implement reforms, teachers will need access to professional development that models the ways in which teachers are being asked to teach (Ball and Cohen, 1999; Smith, 2001) Indeed, the professional culture of mathematics education must be transformed and requires extensive changes in teachers' deeply held beliefs, knowledge and habits of practice (Thompson and Zeuli, 1999).

While the 'how to design transformative professional development experiences for mathematics teachers?' is gaining long-overdue attention (Loucks-Horsley *et al.*, 1998; Smith, 2001), little is known about potential barriers to reform and how teachers need to be supported to overcome them This is particularly problematic in schools that primarily serve high-poverty, diverse communities, precisely because of the unique sociopolitical contexts of schooling in these communities

In this article, I present the words of participants in a professional development academy who discussed challenges associated with implementing mathematics education reforms in their classrooms and schools My goal is to provide insight into the complexity of issues that hampers the transformation of the mathematics education culture, particularly in schools that serve high-poverty, diverse student populations

Setting the context: schooling in high-poverty communities in the US

Poverty in cities in the United States has increased dramatically over the past three decades. Urban poverty levels in the late 1960s were estimated at about 15% (Hummel and Nagle, 1973) By the early 1990s, the poverty rate in cities across the United States was approximately 20% for all groups and 33% for African Americans (Goldman and Blakely, 1992). According to Rury (1993), given the high concentration of students living in poverty in urban areas, it is little wonder that big-city schools exhibit low levels of achievement, high dropout rates, and a diversity of other problems. In large, urban districts in the US:

> even if the schools were remarkably well organized and staffed by exceptional educators, they would be hard pressed to contend with changes such as these. (Rury and Mirel, 1997, p 52)

Schools that serve high-poverty communities (defined here as schools in which 70% or more of the student population qualifies for free or reduced price lunch) have unique sets of problems that distinguish them from their more affluent, suburban counterparts For example, at high-poverty schools, students often attend classes in dilapidated facilities, have higher percentages of novice teachers, teachers without a teaching credential and teachers who are teaching subjects in which they have neither a major nor a minor (Ingersoll, 1999; National Research Council (NRC), 2001) Fetler (1999) investigated the relationship between a teacher's experience in mathematics and educational level, and student achievement in mathematics Fetler found that student achievement in mathematics significantly correlated with teacher experience and preparation This finding is particularly significant for high-poverty, diverse schools that have greater teacher turnover rates and higher concentrations of novice teachers than in more affluent schools.

High-poverty schools are also characterized by their highly bureaucratic organizational structures (Kaestle, 1973); lack of support for change, particularly to personalize and individualize education (Louis and Miles, 1990); and standardized and uncoordinated instructional programs that encourage a custodial attitude towards children (Winfield and Manning, 1992) Many scholars (see for example, Kozol, 1967) have highlighted similar characteristics of schools that serve diverse populations (defined as schools that serve a majority of the minority population) For example, these schools have fewer resources and poorly trained teachers in contrast to predominately white schools, particularly white, suburban schools

Mathematics for the poor – since when?

Ms W worked at a school that primarily served Hispanic students from a high-poverty community Students at her school routinely performed poorly on standardized tests. Nationwide in the US there are huge discrepancies in terms of test performance between schools that serve middle class and upper-middle class neighborhoods Research has consistently demonstrated over the past several decades that students from more affluent neighborhoods have greater access to high-quality educational opportunities than students from high-poverty communities (Oakes, 1990a; Tate, 1997) Instead of stressing high-level thinking and the development of students' critical thinking skills, schools that serve the poor tend to focus more on rote instruction of low-level skills (Haberman, 1991; Knapp and Woolverton, 1995).

Ability grouping has played a significant role in decreasing access to higher-level mathematics courses for students of color and students who live in poverty (Secada, 1992) Ability grouping (or 'tracking') has resulted in students having varying access to educational opportunities and is associated with increased dropout rates (Barro, 1984; Oakes, 1985; US Department of Education, 1998). The expectations that a teacher has for students is correlated to the mathematical content covered in class and the types of interactions that take place between teacher and students (Oakes, 1990b) In low-track mathematics classes, less is expected of students than in high-track classes (Oakes, 1990b; Johnson, 1999). Since students from poor, minority, or non-English speaking communities tend to populate low-track classes, mathematics teachers hold generally lower expectations for these students (Oakes, 1990b) Given the role of mathematics to sort people by denying them access to challenging coursework (D'Ambrosio, 1983; Gerdes, 1988), particularly students of color and students from high-poverty communities, ability grouping is a monumental deterrent to reforming mathematics education.

Though rote instruction and ability grouping continue in schools populated by students of color and students from high-poverty communities, policy makers, national organizations, politicians and others have recognized the special needs of students who have been under-represented in mathematics In the *Principles and Standards for School Mathematics* (NCTM, 2000), students who "live in poverty", non-native English speakers, students with disabilities, females, and "many non-white students" are identified "to be the victims of low expectations" (p 13) in mathematics While strategies are identified in the document to support the mathematical learning of non-native English speakers, students with disabilities, and students with special interests or exceptional talent, no recommendations are made about how to accommodate the unique needs of students who live in poverty Thus, teachers are left to sort out for themselves how to empower poor students mathematically

In addition to working to provide greater access to *all* students, particularly poor and diverse students, to opportunities to learn mathematics, what mathematics students actually study needs to be problematized For example, critical mathematics educators (see for example, Ernest, 1991; Skovsmose, 1994) posit that mathematics can promote mathematical literacy as a means to achieve social, political and economic justice for all From this perspective, the study of mathematics should promote a critical perspective among students of the discipline.

Such an approach challenges students to question the use of mathematics as a mainstream tool of destruction and violence. For instance, the US military recently engaged in a 'shock and awe' campaign to frighten the Iraqi people into subservience Mathematics was an essential component of this campaign, since the weapons used were designed with the use of sophisticated mathematical ideas In the US for the most part, little consideration was given to the moral and ethical implications of this campaign Viewed from a critical perspective, the role of mathematics in this immoral campaign must be acknowledged and made problematic The uses of mathematics are not always benign and students should learn to question mathematics from a moral and ethical perspective as they learn about its many powerful applications

Related to this is how science and engineering applications are so prevalent in school mathematics (Roy, 2000), yet few resources are available that include socially-oriented contexts in mathematics (for highly engaging examples, see Bohl, 1999). I suggest that the development of students' mathematical power (NCTM, 1989) implies the capacity to analyze the world critically. This requires that students interrogate statistics that include data about social and political inequities (Kitchen, 1999), engage in measuring activities to explore issues related to body image (Kitchen and Lear,

2000), examine how mathematics has been utilized to design and build weapons of mass destruction, and learn how mathematics has been used to maintain a racist status quo

Social, cultural and political context of mathematics education

Though reform documents have little to say about the mathematical preparation of students from high-poverty communities, there is a developing body of inquiry into the social, cultural, and political context of the teaching and learning of mathematics (see Atweh *et al.*, 2001; Gutstein, 2003; Kitchen, in press, a; Secada, 1995; Tate, 1995) This research and teaching in mathematics education that takes seriously the social, cultural, and political context of learning examines how tracking affects learning, whether diverse students have equitable opportunities to learn challenging mathematics, and how race and class play out in the classroom Some scholars have employed a multidisciplinary framework to investigate the intersection of students' language, culture, and family as a means to support high achievement in mathematics (Civil and Andrade, 2002; Gutiérrez, 2002; Khisty, 1997; Lipka, 1994; Moschkovich, 1999) Others apply a social reconstructionist orientation in their teaching to prepare prospective teachers to incorporate equitable and socially-just, instructional strategies in their classrooms (Dunn, in press; Leonard and Dantley, in press)

In this article, academy participants describe how their work conditions affected their attempts to implement mathematics education reforms. Over the course of the summers of 2001 and 2002, there were 50 participants in the mathematics academy Thirty-two percent of the participants were people of color: five were native American, nine were Hispanic, one was African American, and one participant identified himself as "Middle Eastern." By the summer of 2002, 22 of the teachers were licensed to teach secondary mathematics, 19 of the participants held a credential to teach in the elementary school (grades K-8, ages 5 to 14), four teachers were licensed in secondary science and one in secondary art. The remaining four participants did not hold a teaching license.

Novice teachers were actively recruited to participate in the academy More than 50% of participants worked in high-poverty schools (defined here as a school in which 70% or more of the student population qualified for free or reduced-price lunch). A majority of these high-poverty schools are located in highly rural areas in New Mexico and Arizona; the remaining schools are urban schools located in the Albuquerque metropolitan area. All of the schools primarily served large populations of Hispanic and/or native American students

The participants in the summer mathematics academy identified and continue to document barriers to reforming their classroom practices. Barriers to reform are defined to be anything that may impede teachers from implementing the mathematics curriculum, instructional strategies and/or assessment formats aligned with notions of mathematics education reform as previously outlined (see NCTM, 1989, 2000; NSF, 1996). Qualitative methods were used to identify major patterns and themes related to the impediments to reform as described by the teachers (Miles and Huberman,

1984; Strauss and Corbin, 1990). Data sources included a series of surveys, journal entries and written reports completed by participants

All qualitative data were analyzed by an iterative coding process (Emerson *et al*, 1995) Analysis began by reading each of the participant's responses to survey questions, journal entries and written reports. Codes were generated during this initial review of the participants' texts Relationships among the codes were explored in subsequent readings of participants' responses and broad themes emerged This process continued until consistent themes were achieved

In particular, the participants discussed how an overwhelming workload and resistance to change by administrators, colleagues, parents, students, and others hampered their efforts to implement standards-based curriculum and instruction in their classrooms and at their schools. A brief overview of the research in each of these areas is followed by the comments of the participants

Overwhelming workload

Research overview: In a study of effective schools in urban districts (Kitchen, in press, b), a teacher who worked at a highly effective school that primarily served African American students in a high-poverty, inner-city community discussed how the conditions had deteriorated at the school since her childhood:

> I love my job but it's hard It's really hard [ ] I'm doing it because I grew up around here I went to a school right down the street I had fabulous teachers who always cared about me personally and led me to believe that I could do whatever I wanted to do so that's what I wanted to do But it's a lot harder now than it was when I was in school

This committed teacher of more than forty fourth-graders wanted to make a difference in her students' lives, like her teachers had done for her While she clearly loved her job, she understood the challenges she faced to meet her students' needs.

The formidable job that this teacher alluded to included working with children who lived in dire poverty and who faced tremendous social challenges Teachers of the poor not only work in dilapidated facilities (Ingersoll, 1999) at highly bureaucratic schools (Kaestle, 1973) where a custodial attitude towards children (Winfield and Manning, 1992) is commonplace, but must also work with children who face a myriad of difficult social circumstances. This combination of difficult work conditions has led to the intensification of teachers' work in the US (see Apple, 1990). It is not uncommon for teachers in the US to have heavy teaching loads, many extracurricular responsibilities, and a variety of administrative duties. Loucks-Horsely *et al.* (1998) highlighted some of the district mandates and daily constraints imposed upon teachers such as standardized testing. They also pointed out that teachers routinely face a number of daily constraints such as limited amounts of time to teach (e.g. often shortened by interruptions), the requirement to assign grades to students on a regular basis, and lack of planning periods shared with colleagues Teachers also

devote significant time to classroom management; almost half of the students surveyed in one study said that their teachers spent more time working to keep order in the classroom than helping students learn (Johnson *et al.*, 2002). This appears to be particularly true at high-poverty schools where the focus of the classroom tends to be on managing students and the transmission of low-level skills (Haberman, 1991; Knapp and Woolverton, 1995)

Teachers talk about their work at schools that serve high-poverty communities: The participants in the University of New Mexico Mathematics Academy pointed to their overwhelming workload as the primary barrier to reforming their classroom practices and implementing innovative instructional strategies One teacher wrote that it is difficult to devote time and energy to reforming her classroom practices because of:

> Too much paperwork, grading, no prep time (because of team meetings and parent conferences), too many meetings, parent conferences make it difficult to *want* to change, I'm just too tired

She continued by writing that:

> Inservices are nice, but more time, more prep time, more grading time would make reform in math much more applicable! Otherwise you're too tired to care!

The intensification of teachers' work has become a distinguishing characteristic of US schools (see Apple, 1990). This was reflected in many of the teachers' responses. For example, one teacher wrote:

> I am in charge of student council, astronomy club, class of 2004, curriculum committee, outdoor club for girls, [.] free time, what free time? It makes it hard to do research and stay upbeat about teaching.

Another teacher summarized her frustrations both with her heavy workload and lack of general support:

> [   ] I'm not sure there is any encouragement from the home. Most students do *no* homework [.] No changes are being made by administration - basically, if the teachers don't do it, it doesn't happen. I personally don't have any more to give than I already give. We as a staff *teach teach teach*, with no administrative support, parental or community support

Another defining aspect of schooling in the US is that competent and/or novice teachers are frequently relied upon to supervise a variety of extracurricular activities. One teacher wrote about the constant changes with which she had recently dealt:

> My teaching assignment has changed 3 times in 6 weeks, and may change one more time next week. I need consistency [...] I was also given the task of preparing syllabi for five subjects within two-to-four days.

This teacher highlights yet another aspect of US schools; poorly defined work conditions, a common characteristic of schools that serve high-poverty communities. Such conditions clearly hamper a teacher's capacity to construct a classroom environment that is conducive to the implementation of progressive instructional strategies

Resistance to change

Research overview: More than a few researchers have found that high-poverty schools have struggled to implement and benefit from school reform efforts (Jackson and Davis, 2000; Little and Dorph, 1998; Olsen, 1994). Jackson and Davis (2000) found that barriers to school change included a loss of passion and focus by the leaders of the reform efforts, high turnover of school leaders, and political issues within and beyond the campus. In a large survey-study, completed by Johnson *et al.* (2003), district administrators and school principals complained that most of their time is devoted to district politics and bureaucracy. This made it difficult for them to support the implementation of standards-based reforms in schools

Newmann *et al.* (1998) defined a school's organizational capacity to include:

> teachers' professional knowledge and skills, effective leadership, availability of technical and financial resources, and organizational autonomy to act according to demands of the local context (p. 40)

These researchers conjectured that the strength of a school's organizational capacity correlates with its capacity to deliver high-quality instruction, which in turn impacts on student achievement. Other researchers have also addressed how a school must possess a certain level of prerequisite organizational capacity if school reforms are to be successful (Darling-Hammond, 1993; O'Day *et al.*, 1995). As previously discussed, it is not uncommon at high-poverty schools that teachers are under-qualified and teaching out of discipline and the schools possess poor facilities and lack financial resources. From this perspective, for mathematics education reforms to be supported at high-poverty schools, the schools must first possess a minimum threshold level of organizational capacity. Clearly, this includes strong administrative support for change.

Another area that is often neglected in the mathematics education literature is student resistance to learning (see for example Willis, 1981, who wrote about working class students' resistance to schooling that prepared them for the monotony of the production line). Through disruptive behavior, high truancy rates, disproportionate dropout rates, and passive disengagement (McKay and Wong, 1996; US Department of Education, 1998), students manifest resistance. Studies have demonstrated how the sociocultural context of schools can contribute to student resistance in both intended and unintended ways (McNeil, 1986; Powell *et al.*, 1985; Wehlage *et al.*, 1989). While student resistance to learning occurs across disciplines, Lubienski (2000) found that poor students, particularly poor female students, demonstrated greater resistance to a challenging, problem-solving approach to learning mathematics than their peers. Student resistance to teaching and learning is a challenge to the implementation of mathematics education reforms, yet is rarely considered in the preparation of prospective mathematics teachers (a colleague, Roy, see *references*, currently has a paper under review on this issue).

Teachers talk about their work at schools that serve high-poverty communities: Another major theme that emerged

from the survey was the lack of support from administrators, colleagues, parents, and even substitute teachers for reform One academy participant wrote:

> I don't feel that I am supported by my administration and veteran teachers On one hand, they say use manipulatives, and on the other they say you need two to three grades in the gradebook per week. Parents want their kids to *do* math traditionally also. I even had a substitute teacher criticize my teaching as *just playing*!

Many respondents also identified parents, and their beliefs that mathematics should be taught in a traditional manner, as an impediment to innovation This is interesting given that the communities served by the academy participants include many that had experienced brutally oppressive schooling Until recently in New Mexico, it was common for native Americans to attend boarding schools at which their cultures and languages were actively suppressed Hispanics were routinely punished for speaking Spanish in school. Despite this, many parents defended the traditional mathematics curriculum and instruction precisely because that is what they experienced.

In general, the participants found administrators at their respective schools unwilling to fund meetings and professional activities that would allow them to share professional development activities that would directly benefit their students This was summarized by one teacher:

> The mathematics program at our school is changing in very good and important ways. The problem that we are having is that it is only part of us. Our administration is unsupportive of time or money for 'department' meetings, education or professional development Because of this, we are left to do this on our own time which limits the number of teachers involved. There is never a time for the whole department to collaborate and so we are not on the same page [   ] Until we have administrative support to work as a team – the students will miss out [...]

The participating teachers also expressed their consternation with the top-down approach to leadership that was common at their schools In the following quotation, a teacher discussed how the administration functioned at her school:

> Horizontal and vertical alignment, standardized curriculum and even textbook alignment seem to be the 'new' focus within our district. When will the dictation end? Our push from the top down has created resentful attitudes in many areas [   ]

Many teachers also worked with students who have never been asked to communicate their mathematical reasoning in the classroom One teacher who worked at a high-poverty school with a large African-American population wrote:

> I tried groups, they only chat and play with the manipulatives, and they won't and don't do the 'math'! They wait for someone to do 'it' so they can copy (if no one in the group does it for the group, they just sit) Grades are *not* a motivator. Most of my eighth graders (ages 13 to 14) have received an F in math for the past 5 years [They say] "What's one more F?"

The student resistance that this teacher experienced is a challenge to one of the central tenets of reform documents, to create a discursive classroom community For many students taught by academy participants, this was the first time in their academic careers that they were being asked to solve complex problems and share their mathematical thinking (Kitchen, in press, c)

Discussion

Some of the academy participants' narratives have been presented in which they identified some of the barriers they faced in implementing mathematics education reforms at high-poverty schools A major sociopolitical impediment to reform described by the teachers included an overwhelming workload Academy participants described the many responsibilities that they had at their schools. The teachers were so busy with paperwork, conferences, and their regular duties that implementing mathematics reforms in their classrooms was not a priority. They stressed the importance of having time to change their classroom practices One teacher described how her schedule changed so frequently at the beginning of the school year that she had to devote much of her time simply to writing syllabuses for her classes

Moreover, the teachers pointed to how highly capable teachers were often asked to perform many additional duties besides teaching. This may be particularly true at inner city and highly rural schools that are challenged to recruit well-qualified teachers. The teachers who attended the academy returned to their schools intending to implement a standards-based mathematics curriculum, instruction, and assessment Their own competence may have contributed to the difficulties they encountered trying to reform mathematics education at their schools and in their classrooms There is an additional problem that the academy participants and I have discussed on many occasions: "How do we engage those mathematics teachers who are not as vigilant about improving their practices in professional development activities? What are some of the leverage points that the mathematics education community can utilize to engage even the most resistant to change in meaningful professional development activities?"

The academy teachers also described the lack of support provided to them by administrators, their colleagues, parents, and others to implement mathematics education reforms As several teachers explained, administrators at their schools were not willing to provide the time and money needed to allow their mathematics departments to meet and create a vision for mathematics curriculum, instruction and assessment. Teachers also complained about how decisions were frequently made at their schools in undemocratic ways and that their expertise was seldom valued by administrators Johnson *et al.* (2003) reported similar findings.

Lastly, the academy participants struggled to deal with student resistance to mathematics education reforms Since many of the teachers were the sole academy participants from their schools, they were working in relative isolation in their efforts to engage students in challenging coursework that required students to collaborate and share their mathematical thinking. Their students were not accustomed to engaging in complex problem-solving activities on a

consistent basis Resistance by students to the creation of a discursive classroom is not unique to schools that serve high-poverty communities. Nevertheless, for many students, particularly students of color and poor students, school has been a place to experience failure rather than success (Wehlage *et al.*, 1989) Not surprisingly then, student resistance to learning, particularly learning that involves higher-order thinking and collaborative problem-solving, could be especially intense at schools that serve the poor (Lubienski, 2000). Teachers need practical assistance from tribal elders, community members, practicing teachers, and teacher educators to develop discursive classrooms at high-poverty, rural schools (Kitchen, in press, c).

The lack of support for and resistance to reform demonstrated by administrators, other teachers, parents and students as described by the participants, only magnifies the difficult work that needs to be accomplished. These findings directly challenge policy-makers and reform advocates to pay more attention to the real barriers to reform as identified by teachers, particularly in schools serving high-poverty communities. The findings suggest the need for the mathematics education community to prioritize improving teachers' work conditions as a means to support teachers to implement reforms at schools that serve high-poverty communities

Final remarks

The teachers' narratives highlight the many formidable challenges that the academy participants faced to implement progressive reforms at their schools Transforming the mathematics education culture requires facing the historical role of mathematics to sort people, reinforcing society's power structure that facilitates the selection of elites in society (D'Ambrosio, 1983; Apple, 1985; Gerdes, 1988) Research in right-wing, authoritarian nations provides exemplars of how traditional mathematics curricula and instruction were not viewed as a threat by those in power in Brazil (D'Ambrosio, 1991) and Guatemala (Kitchen, 2001) Do traditional mathematics curriculum, instruction and assessment help support and maintain hegemony by dominant elites? For those of us who believe that mathematics education reforms hold promise to provide more equitable opportunities for *all* students, this is not a trivial question. Nevertheless, I also believe that proponents of reform need to question the role of an education in mathematics, particularly at schools that serve high-poverty communities. Critical mathematics educators (Skovsmose, 1994) put forth that the study of mathematics should empower students as a means to achieve social, political and economic justice.

The academy participants' narratives suggest that working to improve the working conditions of teachers that serve high-poverty communities must be a priority to bring about mathematics education reforms. This will require policy makers, leaders in mathematics education, and others to collaborate to devise strategies to realize real improvements in mathematics education for the poor Furthermore, transforming the mathematics education culture to value the mathematical preparation of the majority over the achievements of a select few requires mathematics educators to connect with movements that promote mathematical literacy

for those who have historically been excluded in mathematics. For example, Moses' Algebra Project (Moses and Cobb, 2001) has worked to "drive a broad math literacy effort [for] the Black and poor students and the communities in which they live, the usually excluded" (p. 19) Finally, acknowledging that mathematics education is a political endeavor requires the mathematics education community to recognize that the reform movement should be situated in the context of the larger movement for social and political justice

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