Introduction—Comparing learner performance in southern Africa: A natural experiment

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Published online: 25 October 2012
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Over the past two decades, the education policy discussion worldwide has shifted, from increasing educational attainment to improving “educational quality”—that is, toward increasing student learning at each level of schooling (Hanushek and Woessman 2008; UNESCO 2005). An accelerated pace of international and national testing around the world has contributed to this shift. Despite widespread acceptance of the notion that improving student performance may have a high economic and social payoff, policy analysts in all countries have surprisingly little hard data on which to base educational strategies for raising achievement (UNESCO 2005).

A major problem in drawing policy conclusions from analyses within one country or one state or region is that many key macro-educational policy variables, such as teacher recruitment, teacher training, and school supervision, are fairly uniform within such political units. One way to overcome the limits of single-country educational policy research is to undertake comparative studies of neighboring countries (or regions) with apparently similar socio-economic conditions, but significant differences in student performance and, possibly, educational policies. Examples include the United States and Canada, Finland and Norway, and Costa Rica and Panama; on the latter, see (Carnoy, Gove, and Marshall 2007). Some have used the term “natural experiment” for a situation where national social conditions are similar but policies and outcomes differ (Knight and Sabot 1990). In southern Africa, we have such a ready-made comparative case: South Africa and Botswana. The peoples inhabiting the region near the border are of the same language and culture, but students’ school performance, and, for historical reasons, the educational conditions and policies in the two countries, differ substantially.

A second problem inherent in such research is the difficulty to identify the effects of school resources on student achievement. For one, much of the variation in student achievement across and even within schools is explained by the socio-economic background differences of students (Rothstein 2005). Further, the distribution of school resources is highly correlated with the family resources students bring to those schools (Barbarin and Richter 2001); students are not randomly assigned to schools, and neither are

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teachers. One step to reducing such selection bias, and to estimating relationships that approach causality between classroom inputs and student outcomes (Schneider, Carnoy, Kilpatrick, Schmidt, and Shavelson 2007), is to relate classroom resources to student learning *gains* rather than to a single test given at one point in academic time.

Yet a third problem is that most models estimating how inputs affect learning outcomes are not based on any theory of knowledge transmission in school settings (Levin 1980).

In recent years, researchers have made progress in addressing the latter two of these issues. They have dealt with causality in the teacher characteristics-student outcomes relation by using longitudinal studies that measure a student's achievement across grades and various teachers (Clotfelter, Ladd, and Vigdor 2007; Hill, Rowan, and Ball 2005; Lankford, Loeb, and Wyckoff 2002). Fuller, Hua, and Snyder (1994) carried out a pre- and post-test study in English and mathematics in 53 junior secondary schools (8th and 9th grades) in Botswana in 1990, but were not able to link individual teachers with individual students.

Policy researchers are also beginning to delve into the learning process rather than just using teacher characteristics as proxies for the process (Carnoy, Luschei, Marshall, Naranjo, and Sorto 2007; Marshall and Sorto 2012; Stigler, Gonzales, Kawanaka, Knoll, and Serrano 1999). Cheryl Reeves (2005) developed a model of learning and measured student mathematics gains in grade 6 in 24 schools in the Western Cape Province. She carried out detailed observations on teacher-student interactions, including measures of opportunity to learn.

With these methodological advances in mind, we set out to understand why students in one African country's primary schools seem to be performing at a higher level than students in another. As noted, our innovative approach is to exploit a "natural experiment". The children attending school in the border region of two southern African neighbors, Botswana and South Africa, as in many border regions of the world, are very alike linguistically and culturally¹, yet they attend schools that have been subject to different political and policy histories. Botswana has been an independent country since 1966, developing its social and educational institutions under a democratic non-racial government. South Africa pursued a policy of "separate development", enforced with great violence, in which most black Africans were required to live in "homelands", segregated from white South African territory. One of these, Bophutatswana, was located along the Botswana border, had its "own" Bantu education, and was ultimately swept up by the conflict with the apartheid South African state. These different histories caused school and classroom contexts to differ in the way teachers are trained (even today), in the social organization of the schools, including teacher culture, and in the way teachers interact with the curriculum.

We were further motivated to undertake the study because the results of international student performance studies in the early 2000s showed that pupils in Botswana achieve at significantly higher levels than students in South Africa. On both the TIMSS and SAC-MEQ II studies, which tested 8th and 6th graders respectively, the bottom 80% of

¹ It is important to note that whereas all the students in our sample of schools in both countries are by definition "Africans", apartheid in South Africa left a legacy of racial classification that divided people into categories of African, Coloured, Indian, and White. Apartheid further classified black Africans into ethnic groups that constituted the basis for the homeland policy. The black consciousness movement of the 1970s popularized the view that all people designated as Africans, Indians, and Coloureds suffered racial discrimination and oppression and should collectively be termed "black". To track whether racial redress has occurred, the South African census still collects data differentiating between White, Indian, Coloured, and African, but education statistics are not collected using these categories. These nomenclatures remain in use (and we refer to them where necessary in this study while recognizing their socially-constructed character), although in theory differential privileges are no longer associated with them.

Botswana students by social class background scored significantly higher than students in South Africa. SACMEQ III, conducted in 2007, shows similar results. Even so, Botswana students scored considerably lower on the SACMEQ than students tested in many other African countries. The test results from the most recent SACMEQ III, compared to those from a decade ago, show little change in the scores of either Botswana or South Africa. Thus, although most students in both countries are learning at rather low levels, schools in Botswana seem to be preparing them better than are schools in South Africa.

Botswana and South Africa are not poor countries in terms of their per capita incomes. According to World Bank data, measured in purchasing power parity (PPP) dollars (dollars adjusted for the prices of a typical consumer basket of goods in different countries compared to the United States), the average gross domestic product (GDP) per capita in South Africa in 2009 was more than \$10,000 and in Botswana, more than \$13,000. These are levels of GDP/capita in the range of Lebanon, Chile, or Argentina for Botswana, and Brazil and Costa Rica for South Africa.

Botswana and South Africa also spend similar amounts per student on education compared with other countries at the same levels of GDP per capital. Based again on estimates we made from World Bank data, in PPP dollars, Botswana spent about \$1,600 per primary school student, and South Africa about \$1,300. Costa Rica and Brazil spent somewhat more per student than South Africa, Chile about the same as Botswana, and Argentina somewhat more than Botswana. But the differences are not large. Furthermore, young people in these two southern African countries almost universally attain grade 6.

We reasoned that this set of circumstances, where two different state-administered and state-financed school systems supply education to similar students but produce different academic outcomes, could help us understand how possibly different levels of “teacher skills” and different “schooling environments”, including educational policies, result in learning differences.

Simply put, our study asks the following questions:

- Do children in Botswana learn more during grade 6 than similar children in South Africa?²
- Do children in Botswana learn more because Botswana schools have “better” resources (teachers, smaller class sizes), or because the resources are “better organized”—that is, used more efficiently—than in South Africa?
- What does our analysis suggest for policy makers to improve student learning in the two countries?

We use a production function methodology that has little resemblance to the traditional input-output models of the past. This methodology also responds to many of the criticisms regarding selection bias and empirically capturing the schooling process. We apply an underlying theory in which student learning is a complex function of multiple factors: the human and cultural capital that students bring to the school, the teacher’s capacity to teach the subject matter (teacher content knowledge and pedagogical content knowledge), the cognitive demands teachers make of students in the classroom, the amount of time spent on the subject matter (curriculum) mandated by the state, the quality of the teacher’s pedagogy in the classroom, and classroom peer conditions influencing learning, such as average

² We selected schools along a strip on either side of the border. Throughout the study, we refer interchangeably to the North West province/North West/South Africa and to South East Botswana/Botswana. The size, representativeness, and comparability of the sampling frame allow for generalization from the part to the whole.

student socio-economic background, number of students in the class, and an index of school violence. We measure these variables and show how each of them is related to students' learning during their sixth grade year in school. Our theory of change is based on the view that any efforts to improve student learning would necessarily have to address a combination of factors but also focus on those specific features that appear to influence student learning most.

Classrooms are also part of schools and are embedded in educational systems and larger societies and political cultures. Besides deepening the traditional production function analysis by measuring classroom processes, our study has another advantage: we observe classrooms and schools that are part of two different systems of education with very different histories. We gathered data from principals on their schools, on issues such as absenteeism and school violence; we then cross-checked those data with responses to similar questions on the student and teacher questionnaires.

Moreover, through the use of interviews and secondary data, we have been able to analyze important differences in the "culture of schooling" in the two countries that might explain some of our results. One clear difference is that the histories of Botswana and South Africa, and of their education systems, differed radically in the 1970s and 1980s. Botswana gained independence in 1966 and was able to pursue the development of its educational system as a national policy (Evans and Yoder 1991). South Africa's apartheid system systematically denigrated education for black Africans and produced a major struggle for equality in which educators were in the front lines (Hyslop 1988; Kallaway 2002). As a result of this different history, the roles of teachers' unions in Botswana and South Africa are very different, and these differences have potentially important impacts on teachers' perceptions of their classroom and school roles. In addition, teacher training in the two countries has been shaped by significantly different policies in the past 40 and even 15 years, and this too has influenced the availability of primary school teachers and who the current teachers are in the schools we sampled.

Our research focuses on mathematics learning. We chose mathematics performance because comparisons across countries of mathematics knowledge and teaching should be fraught with fewer difficulties than comparisons of teachers' language skills and language pedagogy across language groups, even though language skills probably influence mathematics learning.

Our study provides an enormous amount of carefully gathered information on student background, student learning, teacher knowledge and pedagogical skills, school environments, and the amount of mathematics actually taught to students during their grade 6 year in the Botswana-South Africa border region. This information is useful in understanding the conditions in a broad range of South African and Botswana primary schools serving students of relatively modest socio-economic background, albeit confined to specific regions of the two countries. The systematic analysis of this information allows us to draw important conclusions regarding the role of teachers and teaching in students' learning.

The method we use and the data we collected make this a unique study of schooling. The details on learning, teacher skills, the schooling process, and the schooling environment give us insights into how students in the two countries learn mathematics, and what they learn, insights that go far beyond those in other studies of schooling, even most studies outside southern Africa. And the comparison of the schooling processes in a border area of two countries helps us draw much broader conclusions about school improvement strategies than are possible in single-country studies.

Our analysis produced four major findings:

- Grade 6 learners in Botswana have higher mathematics achievement gains than a very similar set of grade 6 learners in South Africa, but students in both countries are learning mathematics at relatively low levels and making relatively small gains during the grade 6 year.
- The pattern of learning mathematics is very similar in the two countries; that is, students in both countries are mainly learning how to do operations rather than learning the underlying mathematics or how to reason mathematically. They also learn—and do not learn—the same elements of the mathematics curriculum.
- The differences in achievement gains are explained by *the aggregation of relatively small differences* in teaching skills and the process of delivering education in the two countries. The results suggest that Botswana is able to produce higher achievement gains because it has somewhat better teacher resources (teachers with somewhat greater mathematics knowledge and somewhat better teaching skills) and delivers education somewhat more effectively (teachers teach more mathematics lessons during the year and stick more closely to the curriculum) than in South Africa.
- Although Botswana is able to produce greater grade 6 learning gains than South Africa, the production function estimates suggest that there is little room for gains in Botswana from improving teacher skills or opportunity to learn *in the range of inputs now available in low/moderate social class Botswana classrooms*. In South African schools, however, *it appears that much larger gains can be made from improving teacher skills and the opportunity to learn in the range observable in these schools*. Another way to interpret this is that even though teachers in Botswana schools are quite diverse in their mathematics knowledge, teaching skills, and the number of lessons they devote during the year to various items on our learner test, there is something more regularized about the process of teaching in Botswana schools that reduces the effect of that variation on learner academic performance. In South Africa's North West province, however, the variation in observed and unobserved classroom conditions appears to have a large impact on learner gains, probably because classroom processes are more heterogeneous in South Africa.

Organization of the special issue

In this issue, we present six aspects of the larger study:

- Linda Chisholm (Department of Basic Education, South Africa) and Bagele Chilisa (University of Botswana) set the policy context in the two countries and frame the other essays in “Contexts of Educational Policy Change in Botswana and South Africa”.
- Margaret Irving (Stanford University) analyzes the teacher labour markets in Botswana and South Africa, attempting to understand how very different reforms of teacher training have influenced primary school teacher supply and possibly the quality of the individuals recruited into teaching.
- In “Using Student Notebooks to Measure Opportunity to Learn in Botswana and South African Classrooms”, Cheryl Reeves (Cape Peninsula University of Technology) and Tenjiwe Major (University of Botswana) present the results for one of the most important findings of the study regarding the actual amount of mathematics teaching that teachers in the two countries do during the year.

- Nii Addy (Stanford University) follows up on the opportunity to learn analysis in “Comparing Teacher Roles in Curriculum Reforms: Cases from Botswana and South Africa” to try to understand how curriculum reforms may impact teachers’ use of time and the implications they may have for students’ opportunity to learn.
- The analysis of classroom videotapes in the two countries is fundamental to understanding classroom processes, and Ingrid Sapire (University of the Witwatersrand) and M. Alejandra Sorto (Texas State University at San Marcos), two mathematics education experts with long experience in developing countries, present their evaluation of these teaching practices in “Analyzing Teaching Quality in Botswana and South Africa”.
- In the final article, “Explaining Mathematics Achievement Gains in Botswana and South Africa”, Martin Carnoy (Stanford University) and Fabian Arends (Human Sciences Research Council), use the analyses described in the articles above to estimate the relationship of classroom and school inputs to student mathematics learning gains during their grade 6, and then use these estimates to try to explain why students in Botswana make greater gains than those in North West Province schools.

Together, the articles help us drill down into what is happening in southern African classrooms and why learners are likely to acquire more mathematical skills in some classrooms than in others. From both methodological and policy standpoints, we hope that the readers of *Prospects* will take away a better understanding of what it takes to come to grips with the complex world of teaching and learning. There are important lessons to be learned from this study. Perhaps the most important are that good teaching is essential to student learning and that good teaching does not simply happen; it requires assuring that teachers are provided adequate content and pedagogical knowledge and that everybody in education is held accountable to high standards.

This type of detailed study would not have been possible without the support of those who believe that good research can contribute to improving education. The Spencer Foundation has been playing a crucial role in southern Africa, developing research capacity in universities, and we have it to thank for its success in helping create the researchers who worked on this study and giving them (and us at Stanford) the possibility to advance the cause of good policy research. We thank the Spencer Foundation and hope that we have justified its confidence in us. The Stanford Center for Opportunity Policy in Education (SCOPE), which supported Stanford students working on the project, also helped to make this a unique international effort.

Thanks especially to the parents, teachers, principals, and learners who were willing to be part of this study, and also to department officials in South Africa and Botswana, and unions in South Africa, for giving us access to the schools. In Mafeking, in July 2011, we met with 70 of our 120 teachers in our Botswana and North West province samples who accepted our invitation to discuss the results of the study. As we, the researchers, had been with these teachers in their classrooms we were able to have a different kind of conversation with them about our results. As a consequence, they were unusually open with us. We hope that in presenting the results in these pages, we have been able to convey the very processes we are trying to measure.

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