Test Feasibility Survey
PAKISTAN: Education Sector

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October 29, 2002

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I. Introduction

As a preliminary effort in the process of obtaining data on the quality of education provided by schools in Pakistan, a feasibility study was conducted during June and July of 2002 aimed at building the needed knowledge and capacities to conduct more extensive testing in the future. This document provides background information for the feasibility test instrument, the rationale behind the test design, a description of the test content, a formal validation of each individual test and notes on issues that arose during the test's administration and preliminary data analysis. Thus, the document serves as a composite review and test validation base for future assessment work in Pakistan that can directly feed into the ongoing project on National Assessment.

The document is organized as follows. Section II summarizes previous assessments of primary education undertaken in Pakistan over the past two decades. These studies provide a contextualization for the current efforts. Section III details the justification behind conducting the present study. Section IV provides an overview of the assessment instrument, discussing both the test design and content. Section V covers the procedural and implementation issues faced during the administration of the test instrument and a diverse range of concerns related the interpretation of the results. This section includes a summary of the actions that were taken, or that should be taken in the future, to address these issues and concerns. Section VI presents a detailed assessment of the testing instrument using methods derived from Item-Response Theory to examine the validity of each question (henceforth item) as well as the precision of the test taken in it's entirety. Finally, section VII outlines the kinds of results that can be studied with such a testing exercise. However, we strongly caution against the use of the results presented here for drawing *any* conclusions about learning outcomes in Pakistani schools given the non-random nature of the sample and the small sample size of 245 test takers.

In addition, the appendices provide the educational frameworks referenced for literacy and mathematics (appendix 1), the actual test instrument with its scoring key and preliminary analysis on its discrimination and potential problems (appendix 2) and results from the detailed item-response analysis carried out on each question (appendix 3).

II. Previous Studies

Since 1984, at least 19 assessments of primary education in Pakistan have been conducted. These efforts gained momentum after the World Declaration on Education for All (EFA) in 1990 and again with the joint UNESCO-UNICEF global initiative for Monitoring Learning Achievement in 1996. The studies have been both national and provincial in scope and focused on various competencies/content areas. UNESCO (2001) provides an excellent summary of previous assessment work in Pakistan and the summaries below draw from this document.

A. Early Studies – 1980s

The first two major assessments of primary education in Pakistan were the World Bank's Primary Education Project in 1984 and the BRIDGES project of the Harvard Institute of International Development in 1988-89.

The Primary Education Project study compared Science and Mathematics achievement of 3,300 students of grades 4 and 5 in a representative sample of project and non-project schools in Punjab, Sindh and the North-Western Frontier Province (NWFP). Shah (1984) summarizes the results. In all three provinces, girls scored higher in sciences while boys scored higher in mathematics. However, achievement for all groups was low and based on these results, the author suggests that schools should primarily focus on ensuring that students acquire basic competencies rather than increasing peripheral luxuries in the curriculum. Interestingly, the correlation between professional teacher qualifications and test outcomes was fairly weak, with a significant positive correlation only in one province.

The BRIDGES project collected student achievement data from a random sample of about 11,000 students in grades 4 and 5 and 1,000 teachers from 500 schools using the same instrument as the Primary Education Project study described above. One concerning result was a decline in both Science and Mathematics scores between 1984 and 1989. The study also collected information on student and teacher background characteristics and classroom practices, in an effort to relate these teacher characteristics to student outcomes.

B. Later Studies – 1990s

Testing activity in Pakistan increased significantly during the 1990s as a result of the Education For All (EFA) declaration and the associated UNESCO-UNICEF initiative. These studies focused on a broad variety of topics. The results are briefly overviewed below.

Mirza and Hameed (1994) explored the effectiveness of various school types. These types were: 1) mosque school, 2) two teacher primary school, 3) five teacher primary school, 4) primary section with middle school and 5) primary section with high school. Three test instruments were administered. The first two covered Mathematics, Science, Social Studies and Dinyat (the study of the practical laws and ideology of Islam). The third attempted to assess students' behavior as measured by classroom participation, motivation, cooperation and socialization, discipline, cleanliness, carefulness and regularity and punctuality. The sample consisted of 15,991 students in grades 3 and 5 from 472 schools selected from the four provinces of Balochistan, M.W.F.P., Punjab and Sindh. Mosque schools had the lowest gross achievement and gross behavior scores. Primary sections of middle schools performed best on the achievement score and primary sections of high schools ranked first for behavior. Five teacher primary schools were the most cost-effective in terms of cognitive achievement. However overall, the correlation between achievement scores and per-student cost was extremely weak.

Pervez (1995) attempted to determine the degree to which students possess basic competencies. The testing instrument was a semi-structured questionnaire covering life skills, reading competence, writing competence, counting and arithmetic, mental arithmetic and Holy Qur'an. The sample consisted of a representative sample (multi-stage, systematic-random sampling design) of 1,241 rural and 1,341 urban 11-12 year olds. One of the unique characteristics of Pervez's study was the use of a household rather than school based sampling frame. Thus, children from the appropriate age group were sampled from households irrespective of whether they were currently enrolled in school or not- as a result, the test outcomes are a snapshot of learning achievement for the entire age-specific population, rather than a selected school-going group. Perhaps as a result of this unique sampling frame, only 20.7% of children were competent at levels considered basic. The competency for letter writing was the lowest whereas numerical skills, arithmetic, rote-reading and writing from dictation were deemed acceptable. As a result, Pervez (1995) concludes that Pakistani schools should shift away from teaching only rote-memorization-based skills.[1]

The national survey conducted by the Multi-Donor Support Unit for the Social Action Program in 1995 aimed at determining the critical variables impacting academic achievement at the primary school level. Basic information was collected on 527 schools throughout the country.

[1] Since the document does not provide detailed breakdowns by the schooling status of the child, we are unclear for the basis of this statement.

Academic achievement in mathematics, general knowledge and comprehension was tested for 914 teachers and 11,563 students in grade 5 (although data from the Sindh province was later discarded). The test instruments were based on textbook materials for grades 3 and 4. The survey found student performance to be satisfactory. There were three interesting correlations reported from this study:

1. First, in general, teacher qualifications improved student scores (teacher performance varied across provinces from a high of 91% in Punjab to a low of 77% in the Northern Areas (FANA)).. This effect was particularly pronounced in rural areas where trained teachers accounted for a 12% increase in student scores.
2. Students taught in mixes settings or by female teachers generally outperformed their peers.
3. Private school consistently scored better than government schools.

The NGO Action Aid Pakistan conducted an assessment of Mathematics, Urdu and General knowledge on 965 students in 50 schools sampled from six districts in the four major provinces and AJK. In addition, the study included focal group sessions as well and interviews with community leaders. Private schools performed significantly better than NGO and government schools in all categories. The difference between NGO and government schools was negligible. These results matched the opinions expressed in focal groups and interviews.

Khan et al (1999) assessed learning achievement in Science, Mathematics, and Language (Urdu) for grade 4 students. The test instruments were based directly on the curriculum. In total, the sample consisted of 145 schools and 2794 students from 28 districts (he sample was not random). The results mirrored earlier studies. Girls performed better in Science and Urdu whereas boys excelled further in Mathematics. Urban students scored higher on all three sections than rural students. Children Sindh ranked first followed by Punjab and NWFP and significantly lower FATA, FANA, AJK and Balochistan.

Arif et al (1999) explored the factors expounded by head teachers, teachers, learning coordinators, parents and students for low educational outcomes. Additionally an achievement test in Social Studies, Mathematics and Urdu was given to 200 students. Generally head teachers criticized the standard of teaching, absenteeism of teachers, and lack of support provided to students at home. Teachers predominantly blamed low performance of the lack of adequate facilities and physical resources. Learning coordinators also focuses on the lack of physical

resources in addition to teacher absenteeism and, poor school administration and non-cooperation between teachers and the community.
Studies by Haque et al (2000), the Bureau of Curriculum Development and Extension Servicess, N.W.F.P, (1999) and the Bureau of Curriculum and Extension Centre, Balochistan, (2000) have similarly explored the factors responsible for poor performances. Questionnaires in these studies were submitted to head teachers, teacher and learning coordinators along with achievement tests for students. Complaints were similar to those found by Arif et al (1999).

Punjab Literacy Watch (1999) tested students from 31 schools (16 boys public schools, 14 girls public schools and one co-educational private school), 822 boys and 549 girls, to determine competency in Mathematics and Urdu. For the choice of schools, District Educational Officers from two districts in each of Northern, Central and Southern Punjab were asked to select equal numbers of good, average and weak schools. The test instruments were designed based on the complete common curriculum. Students did well on simple and mechanical mathematical problems and tasks like joining letters into works, making sentences and comprehension. In contrast, students performed poorly on geometry, fractions, decimals, and problems involving thinking or application of knowledge as well as grammar, letter writing and arrangements in alphabetical order.

This somewhat bewildering array of tests and outcomes is summarized in the table below. A surprising fact that emerges from the summary below is that although a large number of assessments have been undertaken in Pakistan, there has been little (if at all, any) coordination between the different testing bodies, and as a result, there is no systematic reporting of information. For instance, UNESCO (2000) in their document on Assessing Learning Achievement specifies that a `good survey' should include at the very minimal, careful documentation of the sampling methodology (with standard errors), as well as instrument construction and validation. As our summary below shows, only in a very few cases are we able to learn these essential test-characteristics from available documentation.[2] As a result, there is almost no comparability of these different tests- while they each provide an individual snapshot that can be used to understand variation *within* the testing sample, they cannot be used to further our understanding of changes in achievement over time (for instance, we have no idea whether

[2] We are currently in the process of trying to contact each individual author to update this review, but in a number of cases, instruments have been discarded and published documents remain the only source of information.

students score higher in one Urdu test compared to another because of learning or because of differences in the test instrument).

Test Summary Table

Year of Test	Subjects Tested	Sample Size (schools)	Sampling Methodology	Test Outcomes Mean % (standard error)	Test Available?	Test Validation Documents Available?	Source
1984	Science Mathematics	3,300	Representative. Grades 4 and 5.		No.	No.	Shah (1984)
1988-9	Science Mathematics	11,000 (500)	Grades 4 and 5.		No.	No.	BRIDGES project at Harvard Institute for International Development (1989)
1994	Mathematics Science Social Studies Dinyat	15,991 (472)	Grades 3 and 5.		No.	No.	Mirza and Hameed (1994)
1995	Life Skills Knowledge Rote Reading Reading with Comprehension Writing from Dictation Writing Letter Numeracy and Arithmetic Mental Arithmetic Reading of Holy Qur'an	2582	Multi-stage, systematic-random sample design. All children ages 11-12.	26.1 63.7 26.8 61.7 18.1 69.6 67.7 44.2	No.	No.	Pervez (1995)
1995	Mathematics General Knowledge Comprehension	11,563 (527)	Grade 5.	45.6 74.4 69.1	No.	No.	MSU (1995)
1999	Mathematics Urdu General Knowledge	965 (50)	Grade 4.	60 71 75	No.	No.	Action Aid Pakistan (1999)
1999	Science	2794	Grade 4. Sample	72	No.	No.	Khan et al (1999)

Year of Test	Subjects Tested	Sample Size (schools)	Sampling Methodology	Test Outcomes Mean % (standard error)	Test Available?	Test Validation Documents Available?	Source
	Mathematics Urdu	(145)	not proportionate to universe.	58 72			
1999	Mathematics Science Social Studies Urdu	200 (20)	Grade 3 and 5.		No.	No.	Arif et al (1999)
1999	Mathematics Science Social Studies Urdu	160 (20)	Sample 10 male, 10 female schools (80 students each). Grades 3-5.		No.	No.	Research Team of Bureau of Curriculum Development and Extension Services, NWFP (1999)
1999	Mathematics Urdu	1371 (31)	DEOs selected equal numbers of good, average and weak schools.		No.	No.	Punjab Literacy Watch (1999)
2000	Sindhi Mathematics Science Social Studies Islamiyat	300 (20)	Randomized sample 10 male, 10 female schools (150 students each). Grades 3-5.		No.	No.	Haque et al (2000)
2000	Mathematics Science Social Studies Urdu	801 (20)	10 male, 10 female schools. Grades 3-5.		No.	No.	Research Team of Bureau of Curriculum and Extension Centre, Balochistan (2000)

Source: UNESCO (2001)

Other Assessments Table

Author(s) / Research Organization	Title	Date	Sponsoring Organization
Institute of Education and Research University of Punjab	(Not known)	1996	Primary Education Project From EDI (1999)
North West Educational Assessment Programme	(Not known)	1996	PEDP (NWFP) From EDI (1999)
Bureau of Curriculum and Extension Wing, JAMSHORO, Sindh	(Not known)	1997	SPEDP From EDI (1999)
Primary Education Directorate, QUETTA, Balochistan	(Not known)	1998	BPEDP From EDI (1999)
Bureau of Curriculum and Extension Wing, JAMSHORO, Sindh	(Not known)	1998	SPEDP From EDI (1999)
Test Development Centre, Education Department, LAHORE	(Not known)	1999	Punjab Middle Schooling Project From EDI (1999)
Directorate of Education, Gilgit	Baseline Achievement of Class 4 Students in Northern Areas, Pakistan	2000	NAEP

Source: UNESCO (2001)

III. Rationale for Further Study

Given the number of educational assessment studies conducted over the last two decades, it may be suggested that further research is unwarranted and duplicative. However, this is not the case. There are several compelling reasons to continue, and indeed expand, such research.

First, there have been important developments in the educational sector in Pakistan during the last 5 years. In particular, private schooling in Pakistan, particularly at the primary level is a large and increasingly important sector, both in absolute terms and relative to public schooling. There has been some recent work on this phenomenon (Andrabi, Das and Khwaja), but there remain serious analytical issues related to efficiency and equity aspects (both on income and gender dimensions) that cannot be addressed based on existing data. Simultaneously, there is urgent popular and official pressure to create a new regulatory environment for such schools. To provide an empirical basis for such a regulatory framework new research on learning achievement would be extremely timely. Till now, Action Aid Pakistan (1999) represents the only recent direct attempt to evaluate different school types. However the study was extremely limited with only 1 private school being tested in Urdu and General Knowledge (14 were tested in Mathematics). The multi-donor support unit study (1995) also evaluated government, private and NGO/Trust schools although this distinction was not the primary focus of the study.

Second, collecting new data allows for the methodological flexibility that is critical to avoid the analytical pitfalls plaguing other studies. While these methodological details are discussed in greater detail elsewhere, one such example of this flexibility is the ability to test the same students twice at two separate time periods. To understand the importance of this flexibility, consider a situation where there are two types of schools with children from two different backgrounds (the *peer selection effect*). Pupils in schools with good peers will score higher, everything else being equal, compared to pupils in schools with bad peers. Given the better performance, the school with better peers may charge more, and although it would appear that higher test scores imply greater fees, this in itself has nothing to do with school quality, but is related to the quality of *household inputs*. One way to identify the impact of public spending would be to examine *changes* in test scores over time in the same school rather then test scores at one given time in different schools. In the example above, if household inputs are fixed over time, the differences in test scores will eliminate this variable, and we will be left with the correct relationship between fees and school quality. These methods, often referred to as Value-Added

Assessment Systems, have recently become popular and are currently used in Tennessee's innovative yearly assessment program (see Sanders, 1998).

Third, the test proposed has unique elements not found in previous assessments. Most importantly, the inclusion of English represents a significant departure from previous assessment work. Data on English literacy has the potential to provide an interesting new explanatory variable for further research for several reasons. First, English literacy may be closely linked with school fees and may serve as an important signaling mechanism indicating quality for both employers and parents. Second, there exist serious reasons to doubt that parents, especially low income and less educated ones can judge English proficiency of their children adequately. Most children have access to only their class textbook and do not have any reading material at home or in school other than that. They are also not exposed to spoken English. Finally, the Government of Pakistan has made English compulsory from kindergarten and started a new cadre of English language teachers. Most schools do not have this post filled as yet but clearly English is expected to figure importantly in Government policy henceforth.

Fourth, there exist practical difficulties to using previous data and assessment instruments because of poor institutional memory and reporting. Finding the specific instruments used, the precise schools tested and the detailed score results is impossible for many studies. The lack of validation documents in particular makes it extremely difficult to gauge the validity of the test results. Without such documents it is impossible to determine whether poor performance is due to the quality of the test, problems with administration or the students' level of knowledge. This limits the usefulness of historical work for future research and suggests the need for new studies that would lead to the creation of a carefully validated and documented item pool for future testing requirements.

Finally, continued educational assessment research has capacity building functions. An explicit goal of this project is to develop this exercise as a collaborative effort between the World Bank team, Pakistani academicians and educationalists, and the educational administration in the country itself. In particular, the development and administration of a test instrument will provide a valuable opportunity for capacity building that can aid in the educational monitoring efforts in the country.

IV. The Test Instrument

Our description of the test instruments as well as the testing environment is organized as follows: In sections IV.A and IV.B we provide an overview of the aims of the test instruments as well as the general principles used in the overall selection of test items. In Section IV.C we then outline the basic structure of the three tests, with specific emphasis on the content domain and a discussion of our instrument in the context of testing frameworks that have been developed by other organizations. The specific questions, scoring keys, and question-specific comments are presented in detail in Appendix 2.

What should we test?

Schools serve multiple purposes and teach a diverse range of subjects, skills as well as morals and attitudes (see Box 1). As such, measuring their output is difficult and controversial. The test instrument developed here attempts to roughly quantify a small set of a school's output. Accordingly, the test only includes sections on English, Urdu, and mathematics. Although far from measuring the total "output" of a school, or even the educational development of students, such an instrument is still useful for numerous purposes.

BOX 1: MUTIPLE SCHOOL EFFECTIVENESS

Schools serve a multiplicity of functions involving individual, institutional, community, national and international levels. As a consequence, assessing quality or effectiveness is both difficult and controversial. For example, one school may develop students with a strong sense of civic responsibility whereas another might excel at producing talented scientists. Since any assessment instrument implicitly supports a conceptualization of effectiveness, determining which roles to measure is an important consideration during the test construction stage. Cheng (1997) classifies the potential school functions into five types: *technical/economic functions*, *human/social functions*, *political functions*, *cultural functions*, and *educational functions*. In turn, these functions create five corresponding measures of school effectiveness.

Technical/Economic School Effectiveness: The degree to which schools contribute to the technical or economic developments. This ranges from the individual level—skills and job training—all the way to the international level—the high quality forces needed for efficient economic cooperation and competitions.

Human/Social School Effectiveness: The extent to which schools contribute to human and social development throughout society. Schools provide such things by promoting psychological development for individuals, nurturing human relationships within the institution, supporting the social needs of the community, facilitating social integration in society and fostering international social cooperation and friendship.

Political School Effectiveness: The ability of schools to contribute to political developments at different levels of society. This includes promoting civic responsibility and attitudes within the citizenship, providing a venue for political discourse, serving the political needs of the community, encouraging democracy throughout society, and securing peace and stability at the

international level.
Cultural School Effectiveness: The degree to which schools contribute to cultural transmission and development of society. At the individual level, this consists of the socialization with values, norms and beliefs. At higher levels, schools serve as an epicenter for cultural transmission, reproduction and understanding.
Educational School Effectiveness: The extent to which schools contribute to the development and maintenance of education. This type of effectiveness refers to the role of schools in teaching students how to learn to learn rather than simply the educational attainment of pupils. Similarly, at higher levels the ability refers to the self-reinforcing power of schools—schools beget more support and resources for educational systems. For example, schools increase the supply of teachers.

IV.A Rational for Testing Urdu, English and Mathematics

The inclusion of Urdu and mathematics—the staple subjects of previous assessments—was made for primarily three reasons. First, literacy and mathematics are two important competencies supplied by primary schools. Second, literacy and mathematics are generally more standardized than other subjects and hence lend themselves to greater cross-school comparability.[3] Third, most subjects besides Urdu and mathematics are based almost exclusively on rote-memorization at the primary school level. Hence, the chosen subjects have the additional benefit of testing reasoning and logical analysis as well as critical and complex thinking.

The inclusion of English separates this assessment from most previous studies. The primary ground for its inclusion is that it can be considered a core competency. However, there are also more subtle reasons. For instance, there may be a specific connection between English achievement and private school fees. This suggestion is motivated by the prevalence of schools advertising English language instruction. English instruction may also serve as an important signaling mechanism indicating quality for both employers and parents. For these reasons, the assessment of English achievement is particularly interesting.

IV.B Development and Selection of Test Items - Overall

The principles and frameworks prevalent in the learning assessment literature have been useful as guiding principles for designing the test but they have not been treated as rigid structures that the test must conform to. Many of the frameworks are formulated in the context of developed countries and thus are not entirely well suited for settings in which the national distribution of

[3] For example, due to the nature of the subject matter, the progression of social studies and life sciences can easily diverge significantly from curricular guidelines. Indeed, even the curricular guidelines for social studies indicate a substantial degree of flexibility, stating “much of the learning of pupils in the early years should be based on direct experience and practical activities, achieved as far as possible through the exploration of their immediate environment.”

achievement is dramatically dispersed (even across the same grade). In the design of the pre-test, we chose not to administer a criterion-referenced test since an explicit goal in the future for such tests would be to relate test outcomes to educational inputs (such as teacher quality) that we believe are important. As such, it is important that the test measure learning with high precision levels *at all levels of knowledge*- while a criterion-referenced test would distinguish sharply between students who meet (do not meet) the specified criteria, it may not yield any information of those below (or above) the critical level.

The use of a norm-referenced test creates special needs in the case of Pakistan: although the test will be administered to Pakistani children who have all completed the fourth grade, there is wide variation in learning across schools and provinces, and it is expected that many of the children tested may not be familiar even with the content of the first grade curriculum. This places special demands on test construction even if a norm-referenced test is used.

Specifically, to use a norm-referenced test properly, we need to first know what the lower and upper limits of learning in the grades to be tested are; this is particularly important in the case of value-added assessment, where the test has to try and cover children at all levels of knowledge in the population. Because of the huge differences in learning across schools, it is important to ascertain carefully the questions that can be used in a norm-referenced test. This pre-pilot phase will help identify the lower and upper limits of learning in the population as well as provide a careful analysis of the validity and reliability of the instrument used. The data from this phase will thus enable construction of a more optimal instrument for future testing.

The choice and structure of content for English, Urdu, and Math was based on an attempt to optimize on the following:

- <u>Breadth of content</u>: The test should cover the general range of content taught to children by the time they reach fifth grade.
- <u>Range of difficulty</u>: The range of difficulty should be varied across skills (questions) as well as within each skill (question) to better capture variation in achievement.
- <u>Distribution of ability type</u>: The test should call upon the different cognitive abilities relevant for understanding the content in question (e.g. For math: conceptual, procedural and problem solving).

- Variation in type of questions: Depending on the content being tested, there should be some variation in type of questions: MCQ, short answer, long answer. Each type connotes a different level of prerequisite skill as well.

In addition to these general optimization principles, other rules followed for wording and compiling each question included the following criteria:

- Easy to understand: Questions that are confusing will create noise. Thus, formats that are familiar to children should be used and understanding the question should not require an ability greater than that which is being tested by the question.
- Easy to administer: Questions that required additional materials can be discriminatory. Such questions should only be considered if they are feasible to administer properly.
- Unbiased instrument with respect to socio-economic status: References to items that children from particular socio-economic backgrounds will have no exposure to can create bias. Such references should be avoided.

The initial version of the test followed the curricular standards for grade 4 closely. However, it was quickly noted that the performance of children was considerably below what the curriculum stated it should be, thus further validating the choice of a norm-referenced test (rather than a criterion-referenced test based on the curriculum). For the first week of testing (6 schools) parts of the test were reconstructed after each test to minimize the problems discussed above and improve the precision of ability/learning estimates across the range of students. Although all the content of the final version was checked for consistency with the Pakistan's curricular standards (see appendix 2) and some material was added based on emphasis in the curriculum, the instrument is designed to test basic competencies rather than comprehensive knowledge of specific curricular items. The content for the portions of the test specific to grade 4 (the medium and difficult sections) follows frameworks prevalent in the learning assessment literature (see appendix 1).

IV.C Development and Selection of Test Items

Urdu & English

Literacy frameworks used by other assessments (see appendix 1) categorize the different purposes of reading and writing that should be assessed. However, these frameworks assume that the pupil will have the basic ability to do *some* reading and writing. We have not made this assumption while constructing the instrument. Hence both the English and Urdu sections begin with the alphabet and progress through the basic elements of writing: word construction, grammar, vocabulary, sentence construction, and conclude with a reading comprehension and essay exercise.

The instruments included in the Urdu and English sections were adapted from a variety of sources[4]. The two sections cover a comparable range of content and difficulty: Both sections begin with alphabet recognition and end with an essay question and the tests maintain consistency in content, structure and intellectual demands. Table I below summarizes the content areas of the Urdu and English sections.

TABLE I: CONTENT AREAS FOR URDU AND ENGLISH

Content Areas	Urdu		English	
	Type	*Qs**	*Type*	*Qs **
Alphabets	Written: Complete chronological order of alphabets	1	Verbal: Write alphabets read aloud Written: Complete chronological order of alphabets	1 3
Word Recognition	Written: Match words with pictures	**2**	Verbal: Write words read aloud Written: Match words with pictures	2 **4**
Word Construction	Break words into alphabets Join alphabets to form a word	3 4	Write words read aloud Complete word for each picture Create words from given alphabets	2 5 9
Grammar	Match words with antonyms Write plural for singular words Fill blanks for gender agreement Cloze passage	**6** 7 8 **9**	Math words with Antonyms Fill blank words in sentences Cloze passage	**6** **7** **8**
Vocabulary	Fill blank word in sentence	**5**	Fill blank word in sentence Create words from given alphabets	**7** 9
Sentence Construction	Use words in sentences	10	Use word in sentences	10
Comprehension		11		11
Essay		12		12

Note: *Multiple-choice questions are indicated in bold. Some questions are listed for more than one content area.

Note however, that the starting items of the English section are easier than the Urdu since competency in English may be lower: For instance, the first question in English requires

[4] Many questions in the Urdu section were adapted from instruments included in Kizilbash (1997). Other than tests and exams administered by teachers in schools, we were unable to find suitable instruments for the English component and in addition to designing questions ourselves, web-based resources for educationists were used to fill this gap. Based on Dr. Catherine Snow's (Harvard School of Education) suggestion a cloze passage (every fifth word or so blanked out) was included in the English section (source: www.tut-world.org) and Urdu section.

recognizing 3 alphabets read aloud and writing them. No knowledge of alphabetical order or the ability to recognize other alphabets is required. In Urdu on the other hand, the first question involves filling the right Urdu alphabet in the blank and students need to know both how to write the missing alphabet as well as recognize other alphabets and know the alphabetical order. Apart from this difference in difficulty of the early items, the standard test format between the two languages allows the student to familiarize herself with the test in Urdu, before proceeding to the section on English. Finally, while difficulty increases with each section of the test, there is also a range of difficulty within each test section. Thus for example, the section on vocabulary includes both easy and difficult words to aid in discriminating between different students.

Development and Selection of Test Items - Mathematics

For the Mathematics test, we have adapted frameworks used by other assessments that outline the content domains to be assessed. The five major domains that are identified under these outlines are[5]:

- Number sense, properties, and operations (40%);
- Measurement (20%);
- Geometry and spatial sense (15%);
- Data analysis, statistics, and probability (15%); and
- Algebra and functions (15%).

While we have followed a similar pattern, greater emphasis is placed in our math test on the first major domain- Number sense, properties and operations. During the initial fielding of the test instrument in 6 schools, it was noted that performance in math was lower than expected, and the test was not providing adequate information for children at the lower end of the knowledge distribution. Thus, additional items were added covering the first domain to obtain finer partitions of knowledge for this subset of test-takers. The content and cognitive demand of the final test is summarized below:

TABLE II: CONTENT AND COGNITIVE DOMAIN FOR MATHEMATICS WITH QUESTION EXAMPLES

Content Domains (example Qs from test)	**Cognitive Domains** (example Qs from test)

[5] See Appendix 1 for a detailed description

a) Number Operations (1-5) b) Measurement (15) c) Geometry (22) d) Algebra (11 and 20) e) Data Analysis (21)	1. Conceptual Understanding (4 and 11) 2. Procedural Knowledge (5, 10, 13) 3. Problem Solving (9, 12, 14)

The more advanced content domains such as algebra have only been conceptually tested-. Where as, more rudimentary elements such as addition, subtraction, multiplication and division have been tested both procedurally and through problem solving.

As with the English and Urdu tests, the range of difficulty varies within math skills tested (e.g. Addition: single digit, two digit, three digit with carry, decimal with carry) as well as across math skills tested (counting to percentages and fractions). In addition to better capturing variation in achievement, the test design could also be useful in identifying particular `stumbling blocks' for students with regard to particular skills (for example, difficulty with `division') or particular levels of difficulty (for example, difficulty with 2 digit division/multiplication). The order of questions and progression of content is based on the order in which particular math skills are taught to students in Pakistani schools (as indicated by the state curriculum) and is summarized in the table below:

TABLE III: CONTENT AREA AND RANGE FOR MATHEMATICS ITEMS

Content Area	Range of skills tested	Q*
Counting	Count objects, compare numbers, complete chronological order of numbers, addition of objects, translate numbers in words, tell time, retrieve count from word prob.	**1**,**2**,3,4,6,7,8,9
Addition	1 digit no carry- 3 digit with carry, word problem	5, 9, 10, 12
Subtraction	1 digit - 3 digit with carry, word problem	5, 9, 10, **14**
Multiplication	1 digit by 1 digit - 3 digit by 2 digit with carry, word prob.	5, 13, **14**, 18,19
Division	1 digit by 1 digit- 3 digit by 2 digit, word prob., LCM, HCF	5, 9, 13
Decimals	Addition, subtraction	10
Fractions	Read chart, conversion to mixed fractions, addition of fractions, subtraction of fractions	**15**, 16, 17
Data Analysis	Read Bar chart, read chart in fractions, read chart in percentages	**15**, **21**
Deductive	Complete Sequence, weight comparison	11, **20**

Note: *Multiple-choice questions are indicated in bold. Some questions are listed for more than one content area.

The careful design of the test instruments based on the pre-assessment in the first six schools combined with a large number of interviews with teachers and children has allowed us to estimate with fairly high precision, the knowledge of children at all levels of learning. However, several problems were noted in the design and implementation of the tests, some of which are specific to the educational environment in Pakistan and we outline these briefly below. While we have tried to address some of these issues in the instruments themselves, these problems need to be further discussed in the context of the national assessment exercise and we hope that the documentation here ensures that future tests better accommodate these issues in the design and administration of the instrument.

V. Procedural/Implementation Issues and Other Concerns

The first set of problems that we outline arises from the multiplicity of native languages currently used in Pakistan. Specifically, we address the issue of the language that should be used to provide instructions in different tests and the implication that restricting our tests to Urdu and English has for the potential uses of such assessments. Lastly, we briefly note some problems that arose in the formatting of test questions.

A. The Interpretation of Literacy Scores

The exclusive use of Urdu in our test instrument places limits on the interpretation of literacy scores. Functional literacy, in terms of the ability of individuals to participate in society, may diverge significantly from Urdu literacy if Urdu is used primarily as a ‘second-language’ in the region considered. This limits the use of the literacy score in certain types of analysis. For example, using Urdu literacy as a proxy for human capital may underestimate human capital in areas where Urdu is not the primary language. This would suggest the expansion of the test-instrument to include testing in the vernacular, particularly, Pashto and Punjabi.

On the other hand, this limitation does not significantly affect the value of Urdu literacy scores for other potential questions. Since Urdu literacy is a core competency in Pakistan’s curricular standards, Urud literacy scores provide valuable information on educational attainment in different schools. Thus, the decision to test in the vernacular as opposed to (or in addition to) testing in Urdu must be based on the aim of the test instrument- if the main aim of the test instrument is to assess *functional literacy*, vernacular testing would be essential, but if the primary focus is on *learning in schools* (or value-added learning), restriction to testing in Urdu would yield significant insights.

B. Literacy Bias in Mathematics

Pakistan's linguistic fractionalization also has implications for the language used in providing instructions for the test instrument. For our pre-assessment, we chose Urdu and English primarily due to high uniform exposure from early childhood and to ensure compatibility with the Pakistan Education Ministry in their Strategic Framework for National Education Assessment 2001. Despite the fact that our tests were administered in areas where Urdu is *not* a second language, the use of two languages for instructions raised important issues in the Math assessment as a result of the interaction between language skills and math skills in the design of the instrument. This interaction was noted in two different areas of the test: the medium of instruction, and the design of questions that required conceptual translations between language and math.

Medium of Instruction: All language statements (including instructions) in the mathematics section were either in Urdu or English depending on the language of instruction. The need for separate languages arises from a peculiarity of schools in the sub-continent. Specifically, in `English-medium' schools exposure to mathematical terminology may be only in English, and the use of only Urdu terminology would lead to problems in comparisons across schools: For instance, all children in English (Urdu) medium schools are familiar with the English (Urdu) *but not* the Urdu (English) concept of the "lowest common multiple" of two numbers.
Although an effort was made to limit unneeded verbiage in the mathematics section of the test, significant portions still required a basic level of literacy. The choice to include written instructions with mathematical terminology and some word problems is intentional, and is intended to test the ability of the student to mathematically interpret common (verbal) situations. However, this prerequisite of basic literacy, although reasonable, may bias the use of test scores as a measure of students' skills and competencies in mathematics, if language skills are poor[6]. Future tests need to carefully consider the implications of using verbal statements in mathematics exams, specially in the context of students who may not have attained any degree of literacy by the time the test is administered. This problem is further compounded in regions where the

[6] For example, Howie and Plomp (2001) find a relationship between the number of first language speakers in a class and pupils' achievement in mathematics in their analysis of South African school level TIMSS data. Similarly, The SAP National Survey (1995) found similar literacy effects when testing teacher skills. Both male and female teachers from urban and rural areas scored worse on narrative questions as compared to numerical questions.

vernacular language is different from Urdu- in these cases, test designers need to assess the degree to which the use of vernacular instructions would help in ensuring that the test instrument is valid as a measure of learning in mathematics.

Vocabulary Sets: A second, perhaps subtler problem was the requirement of *different levels of vocabulary* in the translation of language to mathematical statements, depending on the medium of instruction. One item that led to such a problem was the translation of numbers in words to numbers in numerals. The choice of one particular number, “65” raises a direct issue, since in English, to write numbers in words till “100” requires memorization of each number till the “20” as well as the specific numbers “30”, “40” etc. In Urdu however, this requirement requires the memorization of *all numbers till “100”*: and it is common to find students with the same mathematical skills who differ along this particular dimension. Particular care needs to be taken that when instructions and items are translated, the *size of the required vocabulary set* is the same in all languages used for test administration.

Thus, the testing of Math in Pakistan raises special problems through the interaction of the subject matter with language skills. Our recommendations for future tests in this regard are to assess with some care (potentially through the development of a more extensive item-bank) the use of the medium of the test instrument, with particular emphasis on the second issue raised above- the *levels* of language skills required by the math instrument should ideally be independent of the particular language used.

C. Question and Answer Format

During the initial testing rounds, there was some concern regarding the format of test questions. Teachers felt that questions might be unfair, since students were not used to the particular question-answer format used. As a result, efforts were made to format questions in collaboration with the teachers, in a simple and straightforward manner. To assess the importance of formatting in test scores, a simple experiment was carried out, where students in a large school were randomly divided into two groups. For the first group, the test was administered with no guidance and following standard guidelines. For the second group, an additional instructor was detailed to provide assistance for `problematic questions’. The comparison of scores of the first and second groups shows no significant difference, leading us to conclude that the format of the test was not related to test scores of students[7]. However, we feel that the formatting of test questions requires greater attention in future assessments. Prior to the design of such an assessment, it would be important to assemble a data-base of tests currently used in different schools to check for differences in the use of common test formats. The final format of the test instrument could then account for these differences, potentially through the choice of a subset of formats that are common to all schools.

VI. Assessment of the Instruments using Item Response Theory

This section undertakes a detailed validation exercise for the assessments carried out in Pakistan. In doing so, we hope to assess the content of the test, and statistically examine the validity of the test for examining various issues regarding learning achievement in Pakistan. For this section of the document, we will rely almost entirely on methods derived from Item-Response Theory to examine the validity of each question (henceforth item) as well as the precision of the test taken in it's entirety. As explained previously, this test was specifically designed to provide information on the ability/knowledge of children from all points of the distribution- how precise is our test then, in distinguishing between different ability/knowledge[8] levels? For a brief introduction to Item Response theory (to the extent needed to understand this section) and Item-by-Item analysis refer to Appendix 3.

[7] One particular formatting problem arises with the popular `matching' questions used in tests in Pakistan. This item requires students to `match' two words from different columns, for instance:

Q. Match the opposites	
Good	Smart
Stupid	Bad

This sort of question has two problems: First, our preliminary results indicated that students were confused by this style of question, manifested by dramatically lower performance compared to levels seen for the same question formatted in alternative ways. Second, the answers for each match depends on the availability of remaining unmatched words. Since each match is not independent of the others, the informational content provided by every new match is reduced. This dependence between two test answers would then invalidate standard test response assessments.

[8] Through this document, we use the words ability and knowledge interchangeably, although the terms have very different meanings in economics and Item Response. While in the former, ability is a measure of the student's learning, in economics ability is an intrinsic attribute of the individual that remains fixed over time. We attempt to satisfy both strands by using `ability/knowledge' but our functional definition of either is a measure of the student's level of learning.

How well do the tests estimate student ability/knowledge?

The first three graphs that we present shows the characteristics of the overall test. Each graph shows two plots of the 'test-information' and the `test-standard error' at different levels of the knowledge distribution[9]. There are two important inferences that we can draw from these graphs:

1. The standard error of our ability estimates are extremely low. Comparable tests for other countries (Sweden, Togo and Zambia have been compared) are characterized by much higher at the lower and upper ends of the ability distribution (almost double that of our tests). While we clearly need to undertake this assessment exercise with larger sample sizes and a more representative sample, we feel that this pre-assessment has been extremely valuable in demarcating the bounds of the knowledge distribution in terms of the items that may be used in a norm-referenced assessment.
2. Nevertheless, the graphs show that our estimates around the middle of the distribution are far better than at the ends-this can also be clearly seen in the graphs presented in the appendix, where for most test items, item information is maximized around the middle ranges of the knowledge distribution. As a result, an important focus of a more extensive assessment should be the development of items that discriminate at each end of the distribution.

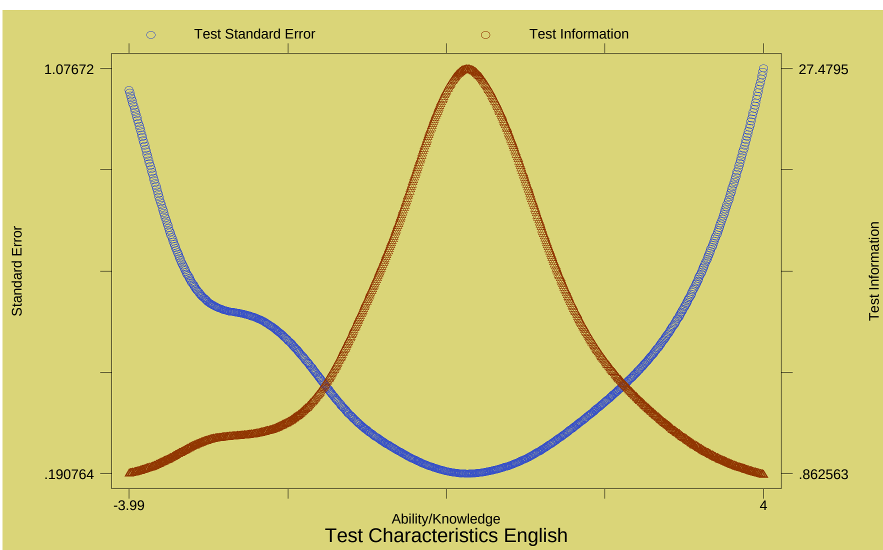


Figure 1a: Test Characteristics of the English Instrument

[9] Note that a significant advantage of using IRT methods is that the informational content of the test is a function only of the item parameters, and *not* the specific sample that was tested.

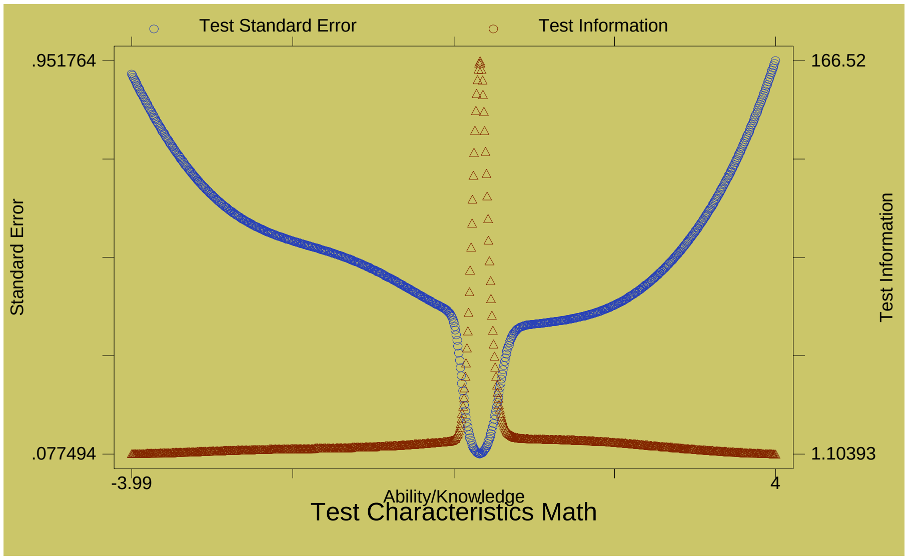


Figure 1b: Test Characteristics of Math Instrument

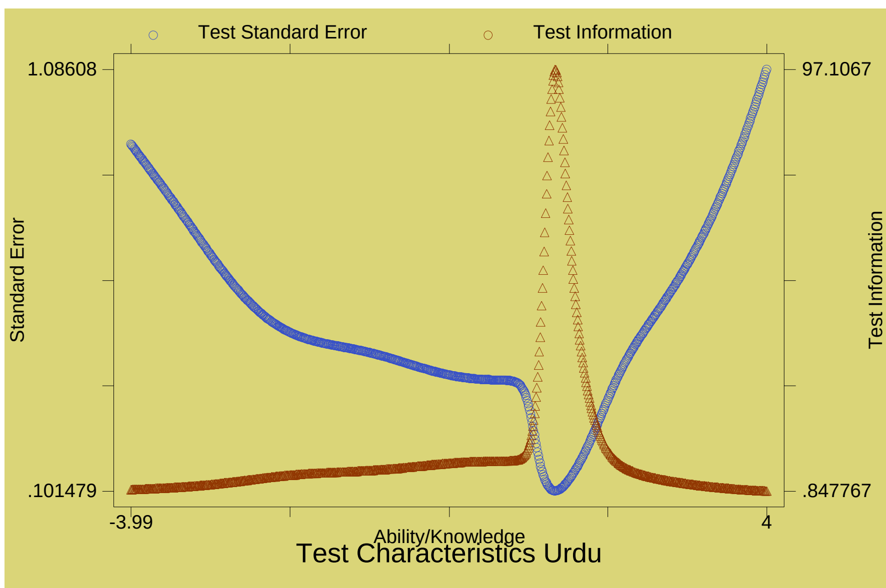
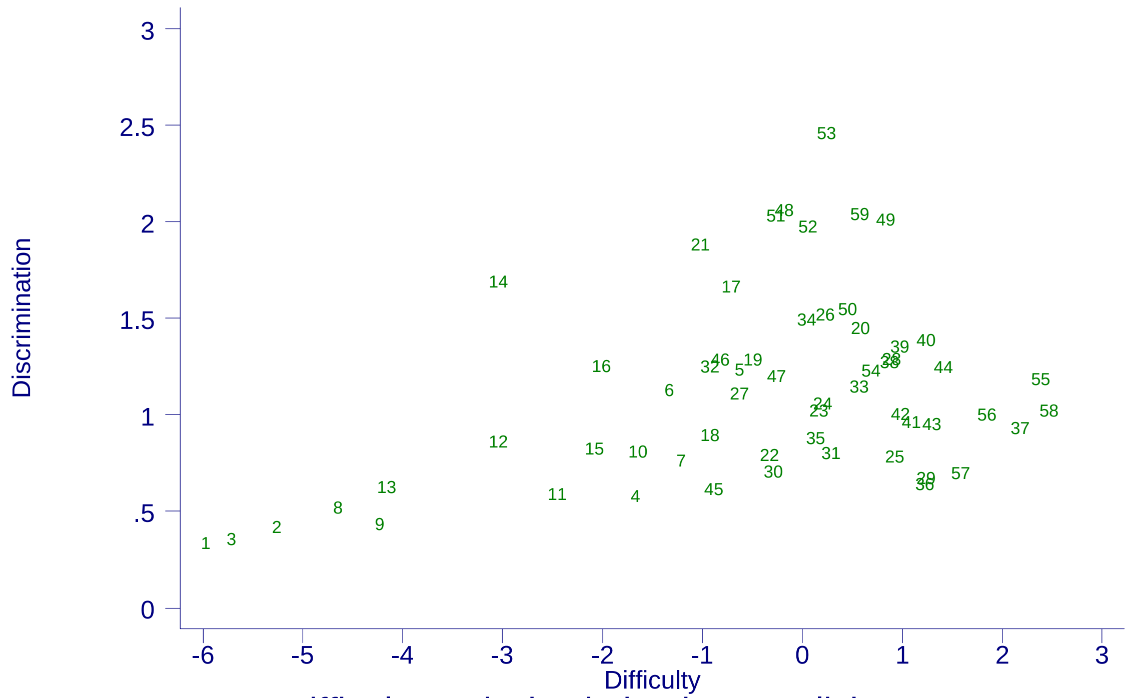


Figure 1c: Test Characteristics of the Urdu Instrument

A deeper understanding of the standard error and test information curves is provided by the next three graphs, one for each subject, that isolate the discrimination and difficulty of each item in the test. Recall that the `discrimination' of an item is a measure of the ability of the item to distinguish between different groups of test takers, while the difficulty of the item measures the knowledge required by a test taker to answer the question with a 50% chance of providing the correct answer (Appendix 3 provides a detailed discussion of these concepts). Thus, an extremely well designed test would have questions with high discrimination at different levels of difficulty. The high discrimination would allow each question to distinguish sharply between two groups of test takers, while the differing difficulty would ensure that the discrimination occurs at each point of the knowledge distribution in the sample. The three graphs below show the characterization of each item by difficulty and discrimination, where the numbers in the graph correspond to the items in the test. For all tests, we find that the difficulty of the items is spread over a large range (note that since difficulty and knowledge are measured on the same scale, a test with difficulty ranging from –4 to +4 would separate out more the 99% of all test-takers). However, specific problems do arise with each test. First, for the English test, there are no items with difficulty greater than 3, and this suggests that some new questions with higher difficulty levels be included in the exam. For the math test, item 33 is too difficult for the test takers- a difficulty of 13 implies that only .001% of the sample has a 50% chance of providing the correct answer. Further, all the items with extremely high discriminatory powers are all concentrated at the same level of difficulty, suggesting that the information of the test can be increased by retaining these items, but changing the level of difficulty appropriately. Finally, for the math test as with the English, some items with higher difficulty need to be introduced, while more items similar to items 30, 31 and 32 need to be introduced at different levels of difficulty.

Figure 2a: Difficulty and Discrimination of the English Test



Difficulty and Discrimination: English

Figure 2b: Difficulty and Discrimination in Urdu

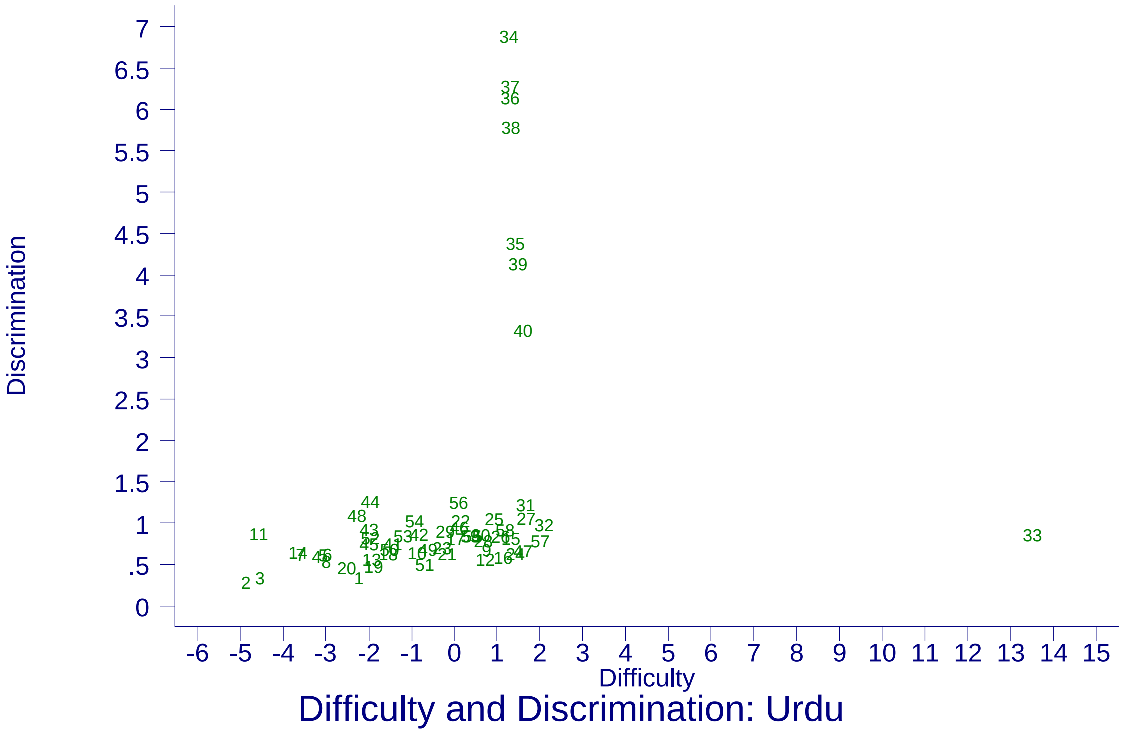
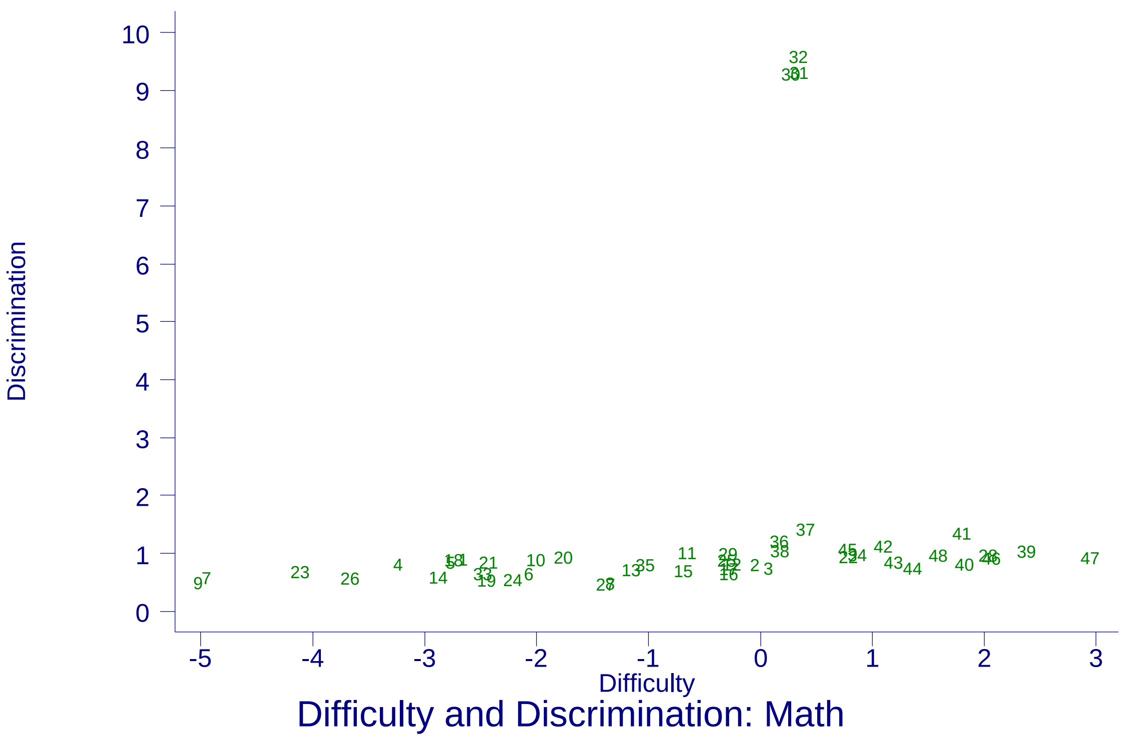


Figure 2c: Difficulty and Discrimination in Math

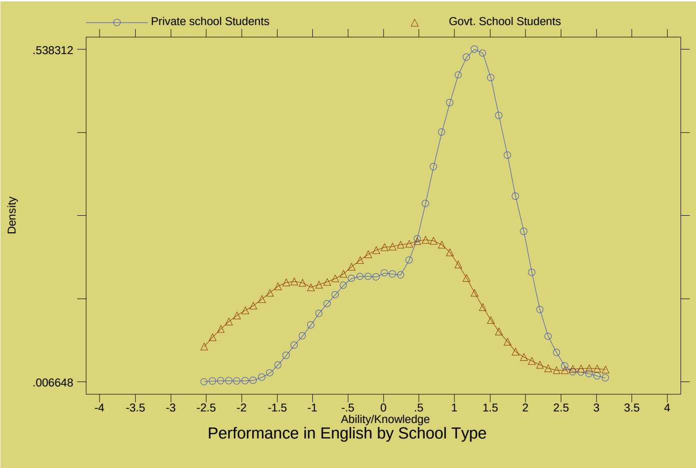


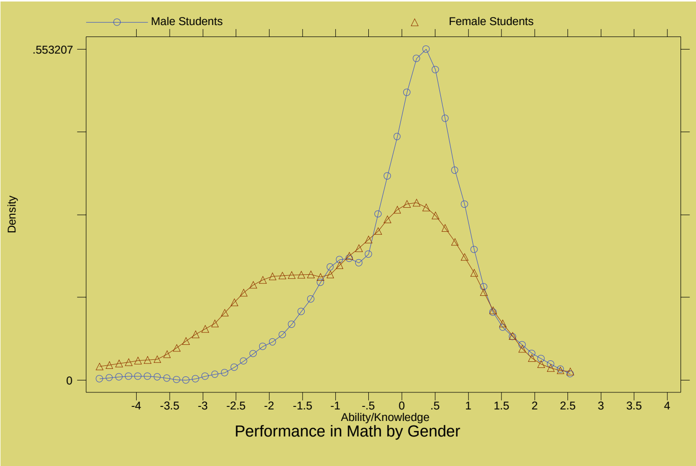
VI. Preliminary Analysis

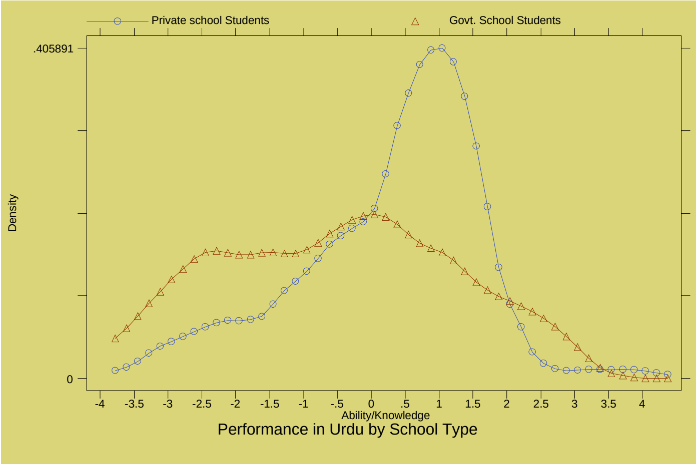
As we stress in the introduction, this pre-assessment is not extensive enough (small sample of 245 students) nor appropriately designed (sample was not randomly selected) to yield any information about comparisons regarding learning differentials across different kinds of learning environments, or by student characteristics. Nevertheless, a simple comparison of learning outcomes by the type of school and the gender of the student yields some more information regarding the content of the test, and suggests ways in which the test can be further improved in future assessments. The table below shows the performance of students disaggregated by gender and school type in the three tests. For each test, we present the percentage of questions that students responded correctly to, the IRT scaled score across the categories under consideration as well as graphs of the scaled score distributions.

	Urdu		English		Math	
	Raw Scores	IRT Scaled Scores	Raw Scores	IRT Scaled Scores	Raw Scores	IRT Scaled Scores
Female students	55.8%	-0.32	58.6%	-0.21	54%	-0.66
Male students	56.9%	-0.35	55.4%	-0.20	62.3%	-0.03
Private School Students	63.3%	0.28	73.3%	0.85	61.8%	-0.02
Government School Students	47.9%	-1.14	34.2%	-1.55	57.9%	-0.31

Interestingly, gender differentials are almost non-existent in the languages, but are significant in Math. On the other hand, across different school types, while private schools are outperforming government schools, the difference is the largest for the languages and smallest for Mathematics. This differential across the subject types needs to be investigated further, and if robust to a larger, random sample, calls for language tests that encompass a far wider range of items than their equivalent in mathematics.







Figures 2a-c: Distribution of Student Scores across School Types

Conclusion

This document provides a detailed description of the testing environment in Pakistan as well as documentation and analysis of a pre-pilot test carried out in private and public schools in Pakistan. The analysis of this test shows that while there are some areas for improvement, on the whole the test has performed extremely well in its ability to distinguish between students of different caliber. Nevertheless, valuable lessons were learnt, relating to the issues of testing in a linguistically fractionalized region and these should be carefully noted, especially with regards to the upcoming national assessment program.

BIBLIOGRAPHY

Action Aid Pakistan. (1999) "Comparative Analysis of Public, Private and NGO Schools."

Arif, Charagh, Saima Chaudhary and Uzma Gilani. (1999). "Learning Achievement of Grades 3 and 5 Children in Rural Primary Schools." Punjab Curriculum Development and Research Centre. October, 1999.

Balochistan Bureau of Curriculum and Extension Centre. (1999) "Learning Achievement of Grade 3 and 5 Children in Rural Primary Schools of District Pishin, Balochistan." December, 1999.

Bracey, Gerald W. (2000) "The TIMSS 'Final Year' Study and Report: A Critique." *Educational Researcher*. 29(4): pp. 4-10

Cheng, Yin Cheong. (1997) "Monitoring School Effectiveness: Conceptual and Practical Possibilities and Dilemmas in Developing a Framework." Paper presented at the Asia-Pacific Economic Cooperation Education Forum on School-Based Indicators of Effectiveness (Quilin, China, April 13-16, 1997).

EDI (1999). "Basic Skills Assessment – A Pakistan Case Study." Theme 3 at EDI Seminar helt at Bhurban (February 7-10, 1999).

Haque, Manzoorul, Sharif Kalhoro and Shoukat Saeed. (2000) "Baseline Survey of Learning." Sindh Bureau of Curriculum Development and Extension Wing. May, 2000.

Howie, Sarah J. and Tjeerd Plomp. (2001) "English Language Proficiency and Other Factors Influencing Mathematics Achievement at Junior Secondary Level in South Africa." Paper presented at the Annual Meeting of the American Educational Research Association (Seattle, WA, April 10-14, 2001).

IAE. (2001a) "TIMSS Assessment Frameworks and Specifications 2003." http://timss.bc.edu/timss2003i/t03pdf/T03_AF_BookFull.pdf

IAE. (2001b) "Frameworks and Specifications for PIRLS Assessment 2001." http://timss.bc.edu/pirls2001i/pdf/PIRLS_frame2.pdf

Khan, Habib, Seyed Shah, Mirza Ahmad, Nasir Amin, Humala Khalid and Ahmad Malik. (1999) "Measuring Learning Achievement at Primary Level in Pakistan" Pakistan Ministry of Education (Academy of Educational Planning and Management), Islamabad, 1999

Kizilbash, Hamid (1997) "Working with Rural Primary Teachers: Final Report on Improving the Quality of Rural Primary School Teachers in Pakistan." Ali Institute of Education, Lahore, Pakistan.

Mirza, Munawar and Abdul Hameed. (1994) "Differential Achievement of Primary Age Students and the Cost Effectiveness by School Type." Primary and Non-Formal Education Wing, Ministry of Education.

Multi-Donor Support Unit for the Social Action Programme. (1995) "Determinants of Primary Students Achievement – National Survey Results." Islamabad, July 1995.

N.W.F.P. Bureau of Curriculum Development and Extension Services. (1999) "Learning Achievement of Grade 3 and 5 Children in Rural Primary Schools." December, 1999.

NAEP. (undated) "Mathematics Framework for the 1996 and 2000 National Assessment of Educational Progress." http://nces.ed.gov/transfer.asp?location=www.nagb.org/pubs/math96-2000.pdf

NAEP. (undated) "Reading Framework for the National Assessment of Educational Progress: 1992-2000)." http://nces.ed.gov/transfer.asp?location=www.nagb.org/pubs/read92-2000.pdf

NAEP. (undated) "Writing Framework and Specifications for the 1998 National Assessment of Educational Progress." http://nces.ed.gov/transfer.asp?location=www.nagb.org/pubs/writing.pdf

PAKISTAN. (undated) "Strategic Frameword for National Education Assessment 2001"

Pervez, Muhammad. (1995) "Basic Competencies of Children in Pakistan." UNICEF: Islamabad, March 1995

Punjab Literacy Watch. (1999) "Levels of Pupil Achievment in Primary Schools of Punjab: A Sample Study." UNESCO. October, 1999.

Sanders, W. (1998). *Tennessee Value-Added Assessment System* [Online]. Available: http://www.shearonforschools.com/TVAAS_index.html

Shah, Mubarik Hussain. (1984) "National Achievement Tests (Protocol Analysis)." Primary and Non-Formal Education Wing, Ministry of Education. Islamabad.

UNESCO. (2001) "Learning Achievement in Primary Schools of Pakistan: A Quest for Quality Education." UNESCO, Islamabad, in collaboration with the Ministry of Education Curriculum Wing. March, 2001