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CONTRIBUTING FACTORS TO HIGHER ACHEIVEMENT IN BOTSWANA SECONDARY SCHOOLS

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An Analysis of Educational Gains of

Female and Male Students

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Prepared for:

ADVANCING BASIC EDUCATION AND LITERACY (ABEL) PROJECT
Contract No.: DPE-5832-Z-00-9032-00

United States Agency for International Development
Office for Education and Women in Development
Washington, DC

1993

This study stems from the Botswana Teacher, Classroom, and Achievement Study, supported by USAID via Creative Associates International, Inc. I am especially appreciative of the encouragement and support given by Bruce Fuller, May Rihani, Barbara Reese, Margaret Keiley, Steve Raudenbush, Wing-Shing Chen, David Chapman, Wes Snyder, Patricia Perry, Elizabeth Blake, and David Cownie. This is the second report on a study of gender issues of Botswana teachers and students. Address correspondence to: 39 Bellis Circle, Unit B, Cambridge, MA 02140.

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SUMMARY

Background

In 1988, the Government of Botswana and USAID began studying classroom environments and teacher behaviors to determine what really happens in Botswana schools and what practices might boost student achievement. This evaluation process was part of a national effort to assess the consequences of the implementation of educational reforms since the mid-1980s (see Fuller and Snyder 1991 for details). With encouragement from USAID's Women in Development Office, this research was broadened in 1990 to focus on the differences between female and male teachers' pedagogical practices and the relationships between the different pedagogies and student achievement.[1] The Government has made every effort to equalize opportunities in all schools, for male and female students. Botswana is a democratic, nonracist country with an excellent human rights record. The country is working to provide sound economic opportunities for all, and it attempts to reach out to help all of its people. This series of studies is intended to evaluate the effectiveness of the Government policy and provide documentation to support any modifications to that policy.

This report presents the results of the second study based on the IEES Botswana classroom study. In the first study, which concentrated on the gender differences in teaching behaviors in the classroom, gender differences were found to exist among teachers. Differences in social status, school treatment, teaching behaviors, and instructional tools used were identified. Overall, however, both female and male teachers in Botswana were found to follow certain basic routines in their classrooms, including the use of a limited number of questions and infrequent use of instructional guidance. This second report emphasizes female persistence at the secondary level and factors that might contribute to female achievement. It focuses on the relationship between teaching and learning when teacher gender is considered.

[1] The larger research and evaluation project--the Botswana Teacher, Classroom, and Achievement (BTCA) Study--is currently directed by Shirley Burchfield, David Chapman, and Philemon Ramatsui. This effort is supported by USAID/Botswana and the USAID Education Office (Research and Development Bureau) in Washington. Florida State University provides back-up support through the IEES project.

To conduct the research, staff collected data from 350 teachers and 5,600 pupils from 44 Botswana junior secondary schools to assess, by gender, teacher behavior and student performance. Data were collected on the availability and use of instructional materials, the use of instructional time, the types of teacher activities, the language of instruction, and the level of pupil engagement and effort. Data collection consisted of pre-and post testing of junior secondary students at the beginning and end of the school year. Teacher and classroom observations, and a teacher survey were also conducted. Data were analyzed using ordinary-least-square (OLS) regressions and hierachical linear modeling (HLM).

Key Findings

Data analysis revealed several important findings related to the influence of teacher gender and student junior secondary school achievement.

- *In Botswana, more girls enroll in junior secondary school than boys.* Girls, however, do drop out of junior secondary school at a higher rate than boys.

- *Girls in junior secondary school outperform boys on English achievement tests, before and after instruction.* At least partially because English proficiency is required to succeed in math, there is a "spillover" effect on math achievement as well.

- *Having a female teacher is a strong and consistent contributing factor for gains on English achievement tests for male and female students.* Pupils with female teachers in the classroom gain almost two more correct answers on English exams than those pupils with male teachers. This occurs even though female teachers generally receive lower wages, are less likely to receive school housing, and have fewer chances for in-service training than male teachers.

- *Teacher training provided at the Educational Centers is affecting student math achievement.* Schools where larger percentages of the teachers were trained at the Educational Centers have higher average math score gains than schools where smaller percentages of teachers were trained at the Educational Centers.

- *Female teachers appear to be more "traditional in teaching*, i.e., they use more written assignments, more closed-ended questions, and more monitoring of students in class.

Implications

The research findings suggest the following implications:

- *Time in school makes a significant difference in explaining learning gains.* The structure of labor demand in Botswana allows for considerable periods of discretionary time for many youths. Strategies that raise the amount of time spent in school will likely boost achievement.

- *Having a higher percentage of female teachers at the school/form level is significantly related to higher student English achievement.* The relationship exists for both female and male students--almost equally. At this stage, however, it cannot be positively stated that more female students attending schools and female students outperforming male students are due to having female teachers.

- *English proficiency tends to correlate positively with higher math performance.* The spillover benefits of English proficiency on math performance are notable. Certain student/family background characteristics and previous levels of schooling could be fruitful ground for further study.

- *Having a higher percentage of teacher training completed at the Educational Centers seems to have an effect on the average school math gain.* It is clear that the Educational Centers are affecting student math achievement through the training of teachers. It would be useful to know what particular skills or methods learned from the Centers are boosting the achievement advantage.

- *Girls' dropout rate at the junior secondary school level is affected by factors other than achievement.* Girls' gains in English and math help refute the hypothesis that girls enroll in junior secondary school because they are not needed in the labor market but drop out because of poor performance. Social and family pressures may contribute significantly to a girls' decision to drop out of junior secondary school.

I. INTRODUCTION

Background

In Botswana, the educational system has been rapidly expanding since independence in 1966. In junior secondary schools alone, the student body has grown from 2,000 in 1966 to 30,000 in 1990 (Snyder and Ramatsui 1990). Under the Government's support and with assistance from the World Bank, the African Development Bank, and USAID, educational construction and reform programs accelerated in the mid-1980s. Teachers were trained, the curriculum was revised, new instructional programs were developed, opportunities were offered more equitably for all children, and resources were more evenly distributed.

For the past few years, an increasing number of research reports have captured the general mood of educational development in Botswana. A detailed qualitative account of life inside the classrooms (Prophet and Rowell 1989) and a broader contextual quantitative analysis of teaching practices and student achievement (Fuller and Snyder 1990) have presented a context for understanding the teaching and learning in Botswana. There is an increasing concern about the gender inequality in school attainment and performance. A recent survey study of Botswana households (Fuller, Keiley, and Singer 1992) found that economic and social aspects of the home influence girls' school attainment and performance. Limited literature is available, however, on classroom activities in Botswana and the gender issues of teaching and learning. Gender differences in teaching behavior that might influence students' achievement have remained largely unexamined in Botswana.

These earlier Botswana studies and some Government statistics presented three preliminary findings that were examined in greater depth in this second phase analysis: female junior secondary school students fall behind male junior secondary school students in almost all subjects; female students drop out more than male students toward the end of junior secondary schools; and teacher gender differences in classroom behaviors, school treatment, and social status have some impact on student learning. This report confirms some of these previous findings but negates others. In our randomly selected sample of 5,600 students, more girls enrolled in junior secondary schools (Forms 1 and 2) than boys (54 percent for girls versus 46 percent for boys), and many of these female students left toward the end of their junior secondary schooling. A popular explanation for the larger female

enrollment is that boys of the junior secondary level are more in demand in the labor market, but girls have nowhere else to go other than to school. These higher enrollment and dropout rates might suggest two further hypotheses: more girls are in junior secondary schools not necessarily because of their interest in learning but because they are passively allocated to school where they might belong temporarily; and junior secondary school girls possibly drop out because of poor performance in school as well as social and family pressure. Descriptive statistics collected for this report give evidence that would allow the rejection of the above hypotheses. In our sample, girls actually outperformed boys in achievement exams and demonstrated a consistent capability and advantage in tests given both before and after the instructional year.

This report examines three research questions:

- Are female junior secondary pupils doing better in both English and math exams than male junior secondary students?
- Is there any difference in learning gains between girls and boys in junior secondary schools?
- Are teacher gender differences reliable predictors in explaining the differences between girls' and boys' learning gains?

Implications for future policy are also provided.

Empirical studies of teacher behaviors in general have demonstrated that many teachers display uniform and simple pedagogical routines in classrooms, reinforcing passive social roles for pupils. The first report on teacher behaviors in Botswana classrooms presented a similar picture of the educational setting. One of the objectives of this particular study was to study the behaviors of female teachers to determine if they offer learning advantages to female pupils. We must note that learning here is interpreted as learning gain over a period of time rather than a better performance on a single exam. Another objective of this study was to determine what policy levers can be manipulated to alter the quantity or quality of effective materials and pedagogical practices that may have a significant impact on student learning.

B. Methodology

This report is based on data collected through a larger study from the Botswana Teacher, Classroom, and Achievement Study. Data were collected through interviews and observations of a sample of 350 teachers and 5,600 pupils from 44 junior secondary schools in 1989, representing 40 percent of all such schools in Botswana. Twenty-seven percent of the classrooms were in towns, and 72 percent of the sample were in villages. After eliminating some entries due to coding errors, the final sample consisted of 314 teachers and about 4,700 *matched* pupils (i.e., 87 percent of all pupils who sat for both pre-tests and post-tests).

The method for observing and recording teacher behaviors was adapted for Botswana from Jane Stallings' observational protocol (see Fuller and Snyder 1991; Stallings and Freiberg 1991). Trained research assistants observed teachers and classrooms in the 44 junior secondary schools to assess the following:

- availability, basic use, and complexity of the instructional materials in the classroom;
- management and allocation of instructional time;
- amount of teacher-dominated instructional time versus the amount of time for full-class discussion, group work, or individual exercises (seatwork);
- task demands, particularly reading or writing exercises, placed on pupils;
- the frequency with which teachers ask questions of students and the form of these questions;
- the language of instruction used by teachers; and
- pupils' level of engagement and effort during lessons.

In addition, a survey questionnaire was distributed to all sampled teachers in order to measure the teachers' background, characteristics, school attributes, personal attitudes, and other related issues. The combination of teacher social and personal background with teacher classroom performance allowed a multi-dimensional analysis of the relationship of these to student achievement.

Student achievement in English and math was also evaluated. In January of 1990, a 38-item English exam and a 34-item math exam were given as pre-tests to all Form 1 and 2[2] pupils. Identical exams were administered 10 months later in the same year.

To analyze the data, research staff did the following:

- reviewed data of male and female pupils (in Forms 1 and 2) on both pre- and post-tests in English and math to confirm existence of an achievement gap by student gender and by the amount of time they spent in schools;

- conducted an expanded analysis of the teacher behaviors in classrooms included in the first study to identify the confounding factors that might influence student achievement (in this step, the focus was on teacher gender difference in classroom behaviors, school characteristics, and personal perceptions of school teaching);

- merged student and teacher data, and aggregated them to each form level within each school (this method allows an analysis of school/form indicators affecting school quality); and

- used ordinary-least-square (OLS) regressions and hierarchical linear modeling (HLM) to separate out the amount of variance explained at both the individual student level and the school/form level to find what factors may account for the varying differences among schools in terms of school achievement.

C. Organization of This Report

The report is divided into two additional chapters. Chapter II presents the major study findings. Chapter III presents implications for Botswana and others interested in promoting girls' achievement in junior secondary school. A list of references is provided at the end of the report. Complete sets of statistical tables and figures are included as Appendices A and B.

[2]Forms 1 and 2 are equivalent to grades 8 and 9 in the United States educational system.

II. FINDINGS

Learning in Junior Secondary School

School is a place where students go to learn and advance. It should not be surprising that pupils in Botswana junior secondary schools appear to make significant learning gains over the school year. Evidence has been scarce in developing countries as to whether time in school is significantly related to higher achievement (Lockheed, Verspoor, and others 1991), and a United States study shows that students learn surprisingly little (at least academically) during their secondary school years (Willms 1985). Nevertheless, this Botswana study demonstrates that learning does occur in junior secondary schools (see Figure 1). Pupils answered almost 2.5 additional questions correctly on the English post-test than on their pre-test (with the mean number of questions correctly answered changing from 14.5 correct to 16.9). They gained almost three more correct answers on the math post-test relative to the pre-test (mean of correct answers moving from 12 on the pre-math to 14.9 on post-math exams). Time spent in school is an influencing factor on learning.

One may be concerned about the simple familiarity with the post-tests. To address this concern, pre-test scores in Forms 1 and 2 were compared. The researcher consistently found a statistically significant difference between the two grades. On the English pre-test, Form 2 pupils correctly answered 1.2 more questions than did Form 1 pupils (the first time they had seen the test). On the math pre-test, Form 2 pupils correctly answered 2.5 more items than Form 1 pupils did. The learning gain in math seems to be larger than the gain in English (9 percent for math versus 6.6 percent for English).

Girls Outperform Boys on English and Math Tests

Results of the English pre-test and post-test indicate that female pupils are consistently performing better than their male counterparts (see Table 1 and Figure 2). In the English pre-test, girls, on average, have almost a two percent lead over boys (female mean=14.71, male mean=14.08, full score=38). This difference actually widened slightly 10 months later when the identical English post-test was administered. These figures show that girls not only outperform boys in English tests but also make a slightly greater learning gain in English over

the year than boys do. Between the two tests, the average gain in items answered correctly is more than 2.5 items. Girls appear to have gained a bit more than boys during the school year, although the gain is of only 85 percent statistical significance level ($t=1.46$, $p=0.15$). As for the math pre- and post-tests, girls again seemed to surpass boys (see also Table 1 and Figure 2). The gain comparison between boys and girls is not statistically significant, but the results seem to contradict a previous study stating that girls fall behind boys in Botswana junior secondary schools on the school-leaving examination (Kahn 1988). Our study also leads us to believe that English achievement may well have a "spillover" effect on math learning since almost all classes, including math, are taught in English in Botswana, and math textbooks as well as national exams are written in English.

The Influence of Pupil-Level Factors on Achievement

To determine if student gender explained any variation in the achievement gains within each grade level, pupil-level OLS models were constructed with form level and pre-tests as the control variables. The pre-tests served as the variable for evaluating basic literacy and numeracy skills at the beginning of the school year. The form level variable is actually used to measure the time students spend in school under the assumption that higher grade students are older and spend a longer time in school. The pre-tests may also be sensitive to a variety of family background and earlier school effects for which direct measures[3] are not available. The base English and math levels for both girls and boys, however, have informed us that gender and grade-level differences exist at the beginning of the school year. Female pupils seemed to have a better background in English and math learning when they entered Form 1.

Understanding how pupil-level variables help explain variation in pre-tests requires further examination. The English pre-test results listed in Table 2 clearly suggest that controlling for grade level, girls had 0.7 more items correct than the boys. By the same token, controlling for student gender, one may predict 0.6 more items will be correct on the test for students in Form 2 level than Form 1 level. On the math pre-test, the parameter estimate associated with Form level is high; and--2.3 more items will be correct in Form 2

[3] A mistake was made when additional social-class background questions were placed at the end of the English exam. Most students failed to reach this page. Thus we are limited to the pre-test measures as proxies for antecedent factors that are captured by earlier school performance.

than in Form 1, controlling for the gender and pre-English test (see Table 2). The female advantage seen in the math pre-test, however, is not statistically significant. As mentioned earlier, math classes are taught in English, and textbooks and national exams are written in English. The "spillover" effect is obviously demonstrated in both English and math pre-tests in that the scores are highly correlated, even controlling for student gender and time spent in school. It is most likely that English literacy level supports higher performance in math exams written in English.

Gender and School/Form-Level Effects on Learning Gains

Holding pre-tests constant, does learning occur in the junior secondary school in Botswana? If so, are there any gender differences in learning gains? To answer these questions, three factors on the post-tests were regressed: pupil gender, grade level, and control level pre-tests respectively (see Table 3). In the English post-test, any one of the explanatory variables explains a significant portion of the variation. The data show that, even given the female advantage in English at the beginning of the school year, girls still make a significantly higher gain in English than boys do. In Form 1, girls, on average, answered 0.5 more items correctly than boys did on the English achievement assessment over the school year, partialing out the effect of the English pre-test and the grade level. The negative coefficient associated with the Form variable suggests, however, that there is a slowdown for all pupils in English gain as they enter the Form 2 level, holding gender and pre-English test constant. Pupils in Form 2 seemed to learn less English than pupils in Form 1 during the same school year. It is difficult to explain why this is the case. One possible reason might be that the senior pupils may be more pressured to consider an after-graduation job so that they could support family and community and therefore they are less likely to focus on learning in school than those in Form 1. The study by Fuller, Keiley, and Singer pointed out that girls often leave junior secondary school (grades 8-9) due to pregnancy and marriage. By age 19, 49 percent of all females are either mothers or experiencing their first pregnancy. The external and family pressures on both boys and girls may be a distraction from better achievement gain at higher grade levels.

The correlation between math pre- and post-tests is stronger ($r=0.60$) than the observed pre-post correlation for English. Although the gender difference in math gain is not statistically significant, time spent in school shows a significantly positive relationship with

the gain. It appears that there is more math learning gain by boys and girls than English learning gain over the school year. Table 3 shows that coefficients of the Form variable and the math pre-test variable in the math post-test are higher than those in the English post-test. The reasonable hypothesis is that math as a learning subject seems to be more associated with in-school factors. This association suggests two things: 1) students learn math in schools with little influence from the external environment; and 2) mastery of the "inflexible" information included in math and science is more connected to the teacher's teaching and training and less connected to the students' environment outside of school. In-school factors may include teacher training, teaching methodology, and instructional technology. Unlike English, math has limited external influences. Any success in math achievement seems to be more attributable to the school's instructional process than success in English achievement.

Level of English Knowledge

Level of English knowledge is likely affected by social status, cultural binding, and family influence. The frequency of positive and negative external influences on English learning should be high. Therefore, the school role of affecting the English gain is viewed to be relatively smaller. One may reasonably speculate that social and school factors are mixed or confounded in their influence on English gain. Had students' background variables been inserted in the final model of predicting the English gain, the hypothesis that external factors may be more likely to influence students' English gain than math gain may have been tested.

The Influence of Teacher-Level Factors on Achievement

Teacher Background and Characteristics

With the 1990 data, there was a final sample of 314 teachers, 60 more teachers than in the 1989 data. Of the final sample, 36 percent were females. The teaching profession is one of the few wage-sector jobs available to young women. In Botswana junior secondary schools, the ratio of female teachers to male teachers is relatively high compared to many other developing countries. Job tenure for female teachers averages 3.8 years, 0.8 years less than the male teachers. These young teaching professionals were attracted due to the rapid expansion of junior secondary education in the 1980s. Most of them received at least two years of training.

An analysis of the statistics allowed several comparisons between male and female teachers. Similar percentages of male and female teachers teach in rural schools and come from other countries (sixty-seven percent of the male teachers teach in rural schools, and 65 percent of the female teachers teach in rural schools; thirty percent of the male teachers are expatriates, and 26 percent of the female teachers are expatriates).

There are more significant differences between male and female teachers in two other categories. Sixty-eight percent of the female teachers have a diploma, while 59 percent of the males teachers have a diploma. While 35 percent of the male teachers are math teachers, 25 percent of all of the female teachers teach math (see Table 1 and Figure 3).

Female teachers come from more affluent family backgrounds than their male counterparts. The social class index variable and the number of years of education of their fathers demonstrated that female teachers are consistently better off than the male teachers (see Table 1 and Figure 3).

Gender Inequity for Teachers Seen in Schools

Even though a higher percentage of female teachers hold diplomas and are better off than the male teachers, researchers identified significant differences in the way that Botswana's school management decides on the provision of housing, training staff, and salary level for male and female teachers (see Table 1 and Figure 4). Schools provided 77 percent of the male teachers with school housing, but only 59 percent of the female teachers received housing. Male teachers are more likely to be trained at the Educational Center or to receive other forms of in-service training than female teachers. Educational officials also are more likely to visit male teacher classrooms than female teacher classrooms. This kind of inspection is often associated with the evaluation and promotion process. Female teachers with higher ratios of qualification make less money on average than their male counterparts. It is obvious that there is some room for improvement in terms of equalizing benefits and entitlement among male and female teachers.

Similarities and Differences in Pedagogical Behaviors

As can be seen in Table 1, gender differences in pedagogical behavior are not sharp. Female teachers tend to use fewer instructional materials but in general tend to ask slightly more questions in class. Pupils are likely to get more written assignment and more lecture talk if they have female teachers. These differences are not statistically significant, however.

One thing that might explain the limited difference in teacher behavior by gender is the centralized education system (national curriculum and national exams), which leaves little room for individual innovation in the classroom. Included later in the report are the results of the between-classroom analysis performed after aggregating these measures to the form level within each school.

A graphic presentation of some pupil-level and teacher-level factors that affect pupil achievement is provided in Figure 5.

School/Form Level OLS Findings

As we aggregate variables to the Form level within each school (The total of form classes within schools in the sample is 81), we are actually examining the between-school/form variation. Once again, our focus is on gender issues.

As a result of an earlier study, the researcher made several observations:

- *Ethnic and gender characteristics of teachers were unrelated to pupils' behavior.* In other words, there was no systematic pattern found in pupils' behavior that was related to teacher ethnicity and gender.

- *Utilization of instructional materials varied in core subjects such as English, Setswana, and math.* For example, textbooks were more frequently used in English and Setswana classes and also in most Form 2 classes, but exercise books were more frequently used in math classes.

- *Teaching behavior, i.e., the use of questions, class-time management, and methodology, differed only slightly by gender, subjects taught, training, and ethnic background.* African teachers with more training were more likely to ask open-ended questions in class.

This study was intended to address the central question: Is teacher gender a factor in the students' achievement in core subjects and persistence in junior secondary school?

To measure variation of learning gains and present an explanation of these gains, the researcher modeled five different areas with teacher gender as a control variable: Questions and Writing, Teacher Background, Confidence and Satisfaction, Class Preparation, and School Indicators. It is evident that English and math gains are predicted by different factors. Teacher gender is a consistent and strong factor related to English learning but not to math. Controlling for gender, some teacher background variables and pupils' performance in class play significant roles in explaining math gain but not English gain. This finding reinforces previous research that shows that key subjects such as math and English require different

tactics and methodologies. Tables 4 and 5 show pre- and post-tests and learning gains in both English and math exams. In English, pupils with female teachers consistently learned more than those with male teachers, controlling for the effects of other factors. The trend is clearly shown in Table 4. In the pre-test at the beginning of the school year, students with male teachers had actually done remarkably better than students with female teachers holding other variable effects constant. At the end of the school year when the post-test was administered, however, the result was reversed.

Reviewing math gain for pupils with female teachers, we again find a "spillover" effect from English gain onto math gain, although this gain is not statistically significant (see Table 5). The strong positive teacher gender coefficients associated with the pre-math exam when compared to those of the post-math lead to negative coefficients for the gain. This means that students with female teachers achieve more math learning than students with male teachers (not statistically significant, however). This again may be due to the "spillover" fact that most of the curriculum and exams are written in the English language.

Interaction of Student-Level and School-Level Factors on Achievement

Hierarchical Linear Modeling (HLM)

Once it was discovered that both individual student-level factors and school/form-level factors have some effect on student English and math achievement, hierarchical linear modeling (HLM; also called Multi-Level Analysis) was used to identify useful information about two things: 1) how much variation in student achievement lies in the individual and school/form levels (also called within and between unit levels); and 2) how reliable the sampled school/form mean achievement score is as an estimate of the true population school/form mean. In other words, if the error of the estimation is large, the sampled mean cannot represent the real population mean. HLM requires a nested data structure. For example, students are grouped in classes, and these classes are nested within schools. The Botswana data set qualifies for two-level analysis with an individual student level and a school/form level (For theory of HLM, see Bryk and Raudenbush 1992). The results in Tables 6-7 that were generated from the HLM computer program developed by Stephen Raudenbush more accurately inform the researcher about where the variances and covariances are as well as what school factors are more useful in terms of predicting student achievement.

HLM Models of English and Math Gains

The coefficient of fixed effect (same as in ANOVA analysis) displayed in Table 6 indicates that the best point estimate for the true English gain in the real population (individual level) after one year is 2.26 with a standard error of 0.23. This means that we can say with 95 percent confidence that the true average English gain in Botswana junior secondary schools falls between 2.71 and 1.81 points (t-statistic=9.9). In HLM random effect estimation, the estimated variances of the English gain were split at individual and school/form levels (3.6 and 19.4 respectively). This indicates that most of the variation in the English gain is at the individual student level. Sixteen percent of the variance in the school/form level deserves our attention, however (chi-square statistic=713, p-value=0.0001). In terms of average English learning gain, there is significant variability among these school/forms. A similar base model was examined for math gain (see Table 7). The 95 percent confidence interval of average math gain for each school is estimated to be within 1.5 and 2.18 (t-statistic=10.2). This means that the average gain for each school may vary significantly. The estimated split variance component for school/form level is only about 10 percent. Ninety percent of the variance in math gain lies at the individual student level.

Random Mean Variation of Gains Across School/Form

At the aggregate level, the average student-level gains for each school/form level are viewed as varying across all the school/forms. In other words, mean gains are hypothesized to be different across school/forms, and individual student scores are centered around each school mean. There may be school factors that explain the variation among schools. There are four School/Form level predictors selected for the final model (see Table 6-7, Model 1): teacher gender, training at the Educational Center, urban setting of schools, and teacher tenure. This model provides coefficient estimates and hypotheses tests for the fixed effects and the variances (error terms) of the random effects. For English gain, the results of the fixed effect indicate that the percentage of male teachers within each school/form is negatively related to student English learning gain controlling for teacher training, school location, and teacher tenure. The schools with more female teachers on average have a higher student English achievement than those schools with more male teachers. Also, holding teacher training and school location constant, the relationship between the tenure of teachers and the average achievement for each school/form is almost statistically significant.

In terms of random effects, we see that the variance component associated with school level becomes smaller than that of the base model. Here, the variance indicates the deviation of a school mean from the grand mean. In other words, it shows that 86 percent of the variance is still unexplained after parameter estimation with all predictors in the model. There is a 14 percent reduction in overall school/form variance with this model.

Examining math gain results from the HLM fixed effect (see Table 7), we see that training at Education Centers seems to have a positive effect on the math gain at the school/form level (t=2). This indicates that the schools with more trained teachers have higher math gain scores than those with fewer trained teachers, controlling for gender, location, and tenure. The relationship between location of school and the school's average math gain is approaching significant (t=1.72). Variance reduction at the school/form level is very small (3.5 percent), leaving a large proportion of the variance unexplained. This suggests that while teacher gender is an influencing factor, there are other factors not identified in this study that are even more significant variables in influencing student performance in junior secondary school.

Random Coefficients of Relationship Within School/Forms

As reported earlier in this report, female students outperformed male students on English tests, and controlling for English pre-test and time spent in school, female students learned more English over the year than their male counterparts (see Table 3). Now at the aggregate level, is the female advantage in English learning the same among all school/forms? In other words, are there some school/forms that have a stronger relationship between student gender and English achievement than others? If the relationship varies across school/forms, can we explain the variability with the school/form predictors? In HLM modeling, the strength of the individual level (Level 1) relationship is demonstrated in the slope coefficient as with any OLS regression. Each school/form is seen as an independent unit that carries its own slope coefficient. The hypothesis is that these slopes are different among schools. At the aggregate level (Level 2), predictors are used to predict the slopes of the level 1 relationship. As shown in Table 6 (Model 2), none of the predictors at level 2 account for the variance of the level 1 relationship. It is interesting to see that when the relationship between student gender and achievement exams is aggregated to the school/form level, it almost disappears.

This means that there are no significant differences in the relationship between student gender and achievement among these schools (at school/form level).

In modeling the slope of the relationship between student gender and achievement for math gain at each school, the training at Educational Centers is consistently significant. Table 7, Model 2 shows two important relationships: 1) The average math gain score for each school is dependent on the training status of teachers: the higher the percentage of teacher training that is done at the Educational Centers, the more likely the average math gain score at a school will be higher; and 2) The percentage of teachers trained at the Educational Centers is a contributing factor to the varying strength of the significant relationship between student gender and the math gain among schools: the higher the percentage of teachers trained at the Educational Center, the more likely there is a stronger relationship between student gender and math achievement gain. In other words, the gap between male and female students in math achievement might be widened as a higher percentage of teachers are trained at the Educational Centers. It is premature, however, to state unequivocally that female students will benefit more than male students in learning math from more highly trained teachers.

Summary

The research indicates the following answers to the study questions.

Are female junior secondary pupils doing better in both English and math exams than male junior secondary students?

Yes, although the findings are more significant in English than in math. Data show that girls in the first year of junior secondary school scored higher than the boys at the same level on the English pre-test and post-test. This difference in scores was statistically significant. In math, girls also scored higher than boys on the pre-test and post-test during the first year of junior secondary school, although the difference in scores was much smaller.

Is there any difference in learning gains between girls and boys in junior secondary schools?

Again, yes, but with different outcomes in English and math. In English, girls showed a slightly greater learning gain than boys over the instructional year. Boys gained 2.28 points on the English test; girls gained 2.49 points. In math, boys made a minimally higher gain.

Boys gained 1.95 points on the math test; girls gained 1.93 points. The gain comparison was not statistically significant.

Are teacher gender differences reliable predictors in explaining the difference between girls' and boys' learning gains?

Teacher gender appears to be a reliable predictor in explaining differences between girls' and boys' learning gains in English. Male or female pupils with female teachers consistently learned more in English than those with male teachers when other teacher and student variables were held constant. In addition, schools with more female teachers on average had higher student English achievement than those schools with more male teachers. Male and female students with female math teachers also achieved more in math than students with male teachers, but the comparison was not statistically significant.

It should be noted, however, that teacher gender accounted for about 14 percent of the variance. Unidentified predictors accounted for 86 percent of the variance in student gains.

III. IMPLICATIONS

More female students are enrolled in junior secondary schools than male students. This may indicate that social and economic development in Botswana has created an increasing labor market for male teenagers of the age cohort who are more likely to leave schools earlier to meet the demand. For those males who do stay in school, girls do appear to make larger learning gains in English.

The research findings suggest the following implications:

- *Time in school makes a significant difference in explaining learning gains.* The structure of labor demand in Botswana allows for considerable periods of unemployment for many youths. Ways of organizing schooling that raise the amount of time spent in school will likely boost achievement further.

- *Having a higher percentage of female teachers at the school/form level is significantly related to higher student English achievement.* The relationship exists for both female and male students--almost equally. At this stage, however, it cannot be positively stated that more female students in schools and female students outperforming male students are due to having female teachers.

- *English proficiency tends to correlate positively with higher math performance.* The spillover benefits of English on math performance are notable. It would be useful to know why girls' rate of literacy acquisition is higher than that of boys, and which factors can be manipulated via education policy or school-level practices. Certain student/family background characteristics and previous levels of schooling could be fruitful ground for further study.

- *Greater pedagogical complexity may, in some cases, actually suppress pupil achievement.* The correlation between female teachers, with their traditional style of teaching, and higher student achievement suggests that traditional approaches to teaching may be at least equally as effective if not more effective in some settings than more complex, innovative teaching styles. Because this finding may vary by academic subject, further research is needed.

- *Girls' dropout rate at the junior secondary school level is affected by factors other than achievement.* Girls' gains in English and math help refute the hypothesis that girls enroll in junior secondary school because they are not needed in the labor market but drop out because of poor performance. Social and family pressures may contribute significantly in a girl's decision to drop out of junior secondary school.

- *Having a higher percentage of teacher training completed at the Educational Centers seems to have an effect on the average school math gain.* It is clear that

the Educational Centers are affecting student math achievement through the training of teachers. It would be useful to know what particular skills or methods learned from the Centers are boosting the achievement advantage.

Since the implementation of a student allocation program based on residential proximity in the two-year junior secondary school in 1986, the Botswana government has achieved a great improvement in equalizing school resources, enrollment opportunities, and school responsibilities (Kahn 1988). This study demonstrates, however, that the micro-level accounts of gender gaps witnessed among teachers and students within schools are worth noting. Narrowing the gender gap in junior secondary school achievement can mean improving equity and effectiveness of teaching and learning. The overall gap in the core subject achievement between girls and boys deserves broad attention. It would be important and useful to know why boys underperform girls across the nation. In Botswana, certain innovative programs could be developed within as well as outside of schools that involve communities, parents, and local businesses. On the other hand, countries where girls' enrollment and achievement at the secondary level are not as high as the boys' enrollment and achievement levels might want to research the economic, social, and educational environment in Botswana to identify ways to educate more girls.

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APPENDICES

APPENDIX A

Tables

Table 1
Botswana Pupil and Teacher Sample: Descriptive Statistics

Variables	Male	Female	t-statistics/ chi-square
PUPILS (n=4930)	2540 (46%)	3044 (54%)	
English pre-test (38 items)	14.08	14.71	5.03***
English post-test	16.35	17.22	6.76***
English Gain	2.28	2.49	1.46
Math pre-test (34 items)	12.82	13.05	1.67
Math post-test	14.76	14.96	1.32
Math gain	1.95	1.93	-0.15
TEACHERS (n=314)			
Percent in rural schools	67%	65%	0.08
Percent with diploma	59%	68%	3.04
Father education (yrs)	7.6	8.8	1.61
Social class index	3.06	3.72	3.05**
Percent expatriates	30%	26%	0.52
Percent math teachers	35%	21%	6.74**
Confidence index	36.1	34.2	-1.48
Satisfaction index	25.4	22.7	-1.59
Teaching Behaviors			
Number of instructional materials	6.29	5.96	-0.92
Number of written assignments	7.45	8.07	0.79
Number of teacher questions	9.27	11.4	1.7
% Time, engaging students	52%	50%	-1.28
% Time, monitoring exercises	20.3%	22.5%	0.4
School Indicators			
% Provide a house	77%	59%	11.9**
% In-service training	19%	16%	0.34
% Training at edu. center	28%	23%	0.76
Salary level (US$)	$13,561	$11,901	-3.18**
Inspector visit to class (at least once)	48%	34%	5.6*

* $p<0.05$ ** $p<0.001$ *** $p<0.0001$

Notes: The social-class index is a continuous variable indicating how many rooms are in their current house. This indicator of teacher SES is highly correlated with other indicators.

Table 2

Influence of Pupil-Level Factors on Pre-Test Achievement
(OLS regressions, unstandardized β and t statistics)

	English Pre-test (1)	Math Pre-test (2)
Pupil gender (female 0, male 1)	-0.69 (-3.69)***	-0.14 (-0.69)
Form (grade level)	0.61 (3.29)***	2.28 (11.85)***
Gender Form (interaction term)	0.06 (0.24)	0.11 (0.38)
English pre-test		0.24 (15.0)***
Math pre-test	0.22 (15.0)***	
Intercept	11.7	8.3
F-statistics	83***	142***
df	4101	4101
Adj. r^2	.074	0.12

* $p<0.05$ ** $p<0.001$ *** $p<0.0001$

Table 3

Influence of Pupil-Level Factors on Post-Test Achievement
(OLS regressions, unstandardized β and t statistics)

	English Post-Test (1)	Math Post-Test (2)
Pupil gender (female 0, male 1)	-0.50 (-3.97)***	-0.15 (-1.2)
Form (grade level)	-0.5 (-3.9)***	1.18 (8.8)***
English pre-test	0.44 (30.8)***	
Math pre-test		0.62 (44.8)***
Intercept	10.9	6.26
F-statistics	329***	829***
df	4102	4102
Adj. r^2	0.19	0.38

* $p<0.05$, ** $p<0.001$ *** $p<0.0001$

Table 4

School/Form Level OLS Models: Teacher Gender Influence on English Gain (unstandardized β and the significance level)

	Pre-English	Post-English	Gain English
Model 1: Questions and Writing			
Open-ended questions	0.32	0.27	0.08
Pupil asked to write	1.28***	0.9	-0.26
Pupil in passive activity	-0.67	-1.28***	-0.38
Form	0.93	0.08	-0.99**
Percent of male teachers	1.16	-0.92 (t=1.9)	-1.67**
	(r^2=23%, p=0.002)	(r^2=19%, p=0.01)	(r^2=18%, p=0.02)
Model 2: Background			
Additional materials available	0.29	0.53	0.05
In-service training	0.71	0.83	0.54
Overall teacher tenure	1.2	0.76*	0.4
Percent of male teachers	1.52*	-0.8	-1.9**
	(r^2=9%, p=0.19)	(r^2=13%, p=0.04)	(r^2=13%, p=0.03)
Model 3: Confidence and Satisfaction			
I am good and confident	0.03	0.006	-0.02
Satisfied with teaching career	-0.05*	0.01	0.06*
Overall teacher tenure	0.25	0.73*	0.44
Percent of male teachers	1.36*	-0.74	-1.75**
	(r^2=12%, p=0.04)	(r^2=12%, p=0.04)	(r^2=20%, p=0.001)
Model 4: Class Preparations			
Number of assignments (last 4 wks)	0.04*	0.007	-0.03
Teacher preparation for class	-0.009	-0.009	0.002
Size of class	0.001	0.001	0.001
Percentage of male teachers	1.25*	-0.98	-1.87**
	(r^2=13%, p=0.03)	(r^2=6%, p=0.35)	(r^2=12%, p=0.04)
Model 5: School Indicators			
School provides house (yes)	-0.24	-0.27	0.37
In-service training	0.68	0.89	0.6
Inspector visit (at least once)	-0.55	0.67	0.03
Percentage of male teachers	1.58*	-1.07	-2.3**
	(r^2=7%, p=0.21)	(r^2=5%, p=0.37)	(r^2=12%, p=0.37)

* p<0.05, ** p<0.001 *** p<0.0001

Table 5

School/Form Level OLS Models: Teacher Gender Influence on Math Gain
(unstandardized β and the significance level)

	Pre-Math	Post-Math	Gain Math
Model 1: Questions and Writing			
Open-ended questions	-1.28***	-1.05*	0.28
Pupil asked to write	0.15	-0.13	-0.21
Pupil in passive activity	0.04	-0.77	-0.66*
Form	2.4***	2.83***	0.29
Percent of male teachers	0.94	0.28	-0.56
	(r^2=49%, p=0.001)	(r^2=47%, p=0.001)	(r^2=7%, p=0.41)
Model 2: Background			
Additional materials available	-0.81	0.61	1.16*
In-service training	-0.84	0.80	1.74*
Overall teacher tenure	0.04	0.20	0.16
Percent of male teachers	1.79*	1.54	-0.19
	(r^2=9%, p=0.16)	(r^2=4%, p=0.49)	(r^2=15%, p=0.02)
Model 3: Confidence and Satisfaction			
I am good and confident	0.02	0.07	0.04
Satisfied with teaching career	-0.04	-0.02	0.02
Overall teacher tenure	0.15	0.009	-0.13
Percent of male teachers	1.72*	1.14	-0.46
	(r^2=8%, p=0.16)	(r^2=5%, p=0.36)	(r^2=8%, p=0.18)
Model 4: Class Preparations			
Number of assignments (last 4 wks)	0.03	0.03	0.007
Teacher preparation for class	-0.004	-0.009	-0.004
Size of class	0.000	0.000	0.000
Percentage of male teachers	1.69*	1.2	0.35
	(r^2=7%, p=0.21)	(r^2=4%, p=0.52)	(r^2=1%, p=0.92)
Model 5: School Indicators			
School provides house (yes)	0.20	0.67	0.61
In-service training	-0.87	0.86	1.8*
Inspector visit (at least once)	-0.17	-0.05	0.07
Percentage of male teachers	1.71*	1.1	-0.53
	(r^2=7%, p=0.26)	(r^2=4%, p=0.55)	(r^2=11%, p=0.08)

* $p<0.05$ ** $p<0.001$ *** $p<0.0001$

Table 6
Two-Level Models, English Gain (HLM)

Fixed Effect	Base Model Coeff.	SE	t	Model 1 Coeff.	SE	t	Model 2 Coeff.	SE	t
For Student Level Intercept									
Intercept	2.26	0.23	9.9	3.20	1.2	2.63***	3.21	1.2	2.64***
Teacher gender				-1.9	0.8	-2.5**	-1.9	0.8	-2.5**
Training at center				-0.7	0.8	-0.8	-0.7	0.8	-0.9
Urban				0.53	0.5	1.09	0.53	0.5	1.08
Teacher tenure				0.57	0.3	1.84	0.56	0.3	1.9*
For Student Level Gender Slope									
Intercept							0.59	0.85	0.69
Teacher gender							-0.1	0.53	-0.2
Training at center							-0.5	0.56	-1.0
Urban							0.13	0.36	0.36
Teacher tenure							-0.01	0.2	-0.05
Random Effect									
Variances									
Between school/form♦									
(Intercept)	3.61			3.09			3.09		
% explained	16%			15%♦♦♦			----		
(Slope)							0.21		
Within school/form♦♦	19.4			19.4			19.4		
% explained	84%			----			----		

* $p<0.05$ ** $p<0.001$ *** $p<0.0001$

♦ Variance between school/form is the variance between all schools included in this study.

♦♦ Variance within school/form is the variance among individuals within a particular school.

♦♦♦ The result is arrived at by using (3.61-3.09)÷3.61. This is interpreted as % reduction of school level variance.

Table 7
Two-level Models Math Gain (HLM)

Fixed Effect	Base Model Coeff.	SE	t	Model 1 Coeff.	SE	t	Model 2 Coeff.	SE	t
For Student Level Intercept									
Intercept	1.84	0.18	9.1	0.22	1.0	0.22	0.14	1.02	0.14
Teacher gender				-0.4	0.62	-0.6	-0.4	0.63	-0.6
Training at center				1.30	0.65	2.0*	1.34	0.66	2.04*
Urban				0.70	0.41	1.72	0.70	0.41	1.72
Teacher tenure				0.03	0.25	0.10	0.04	0.25	0.14
For Student Level Gender Slope									
Intercept							-1.0	0.83	-1.2
Teacher gender							-0.05	0.51	-0.1
Training at center							1.12	0.54	2.06*
Urban							-0.18	0.35	-0.5
Teacher tenure							-0.2	0.20	-1.0
Random Effect									
Variances									
Between school/form•									
(Intercept)	2.08			2.01			2.06		
% explained	10%			39%•••			----		
(Slope)							0.17		
Within school/form••	18.6			18.6			18.54		
% explained	90%			----			----		

* $p<0.05$ ** $p<0.001$ *** $p<0.0001$

• Variance between school/form is the variance between all schools included in this study.

•• Variance within school/form is the variance among individuals within a particular school.

••• The result is arrived at by using (3.61-3.09)÷3.61. This is interpreted as % reduction of school level variance.

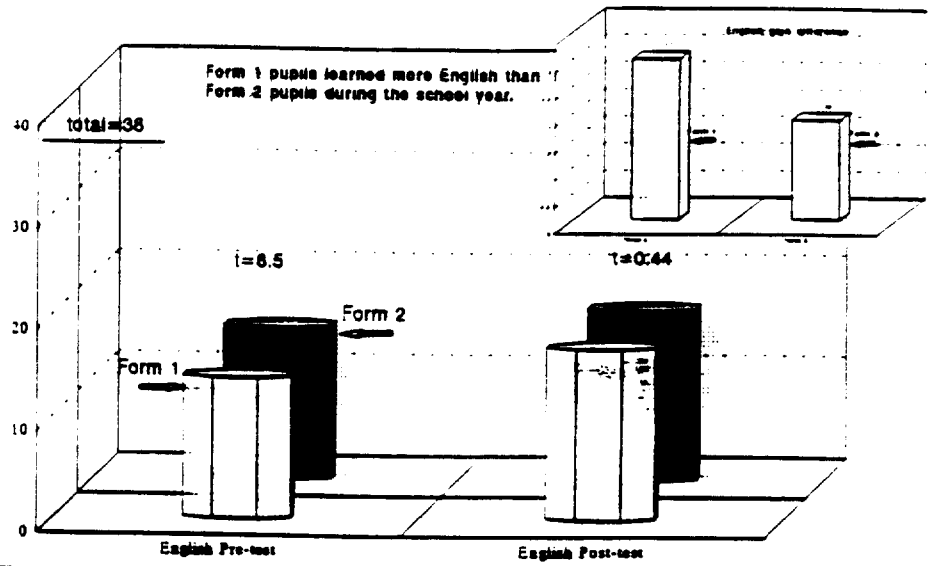
APPENDIX B

Figures

Figure 1

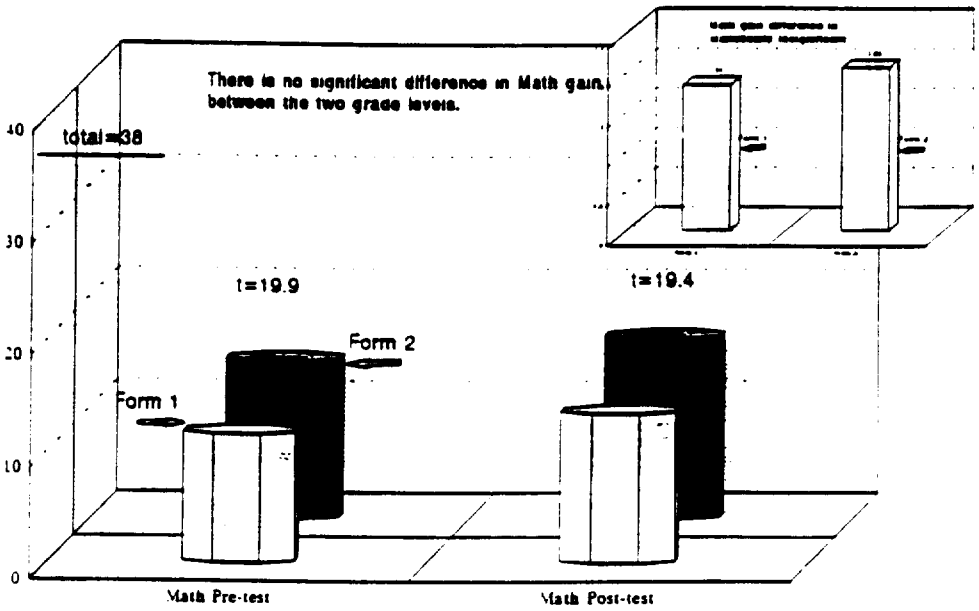
Grade-Level Difference in Botswana Student Achievement

English Pre- and Post-Tests



Form 2	14.94	16.8
Form 1	13.91	16.9

Math Pre- and Post-Tests

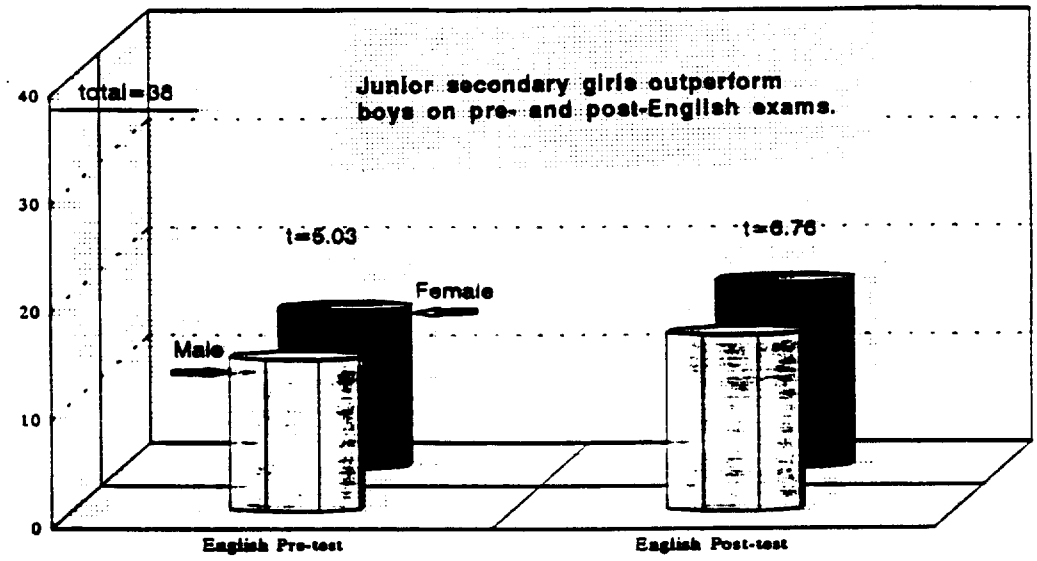


Form 2	14.18	16.26
Form 1	11.63	13.47

Figure 2

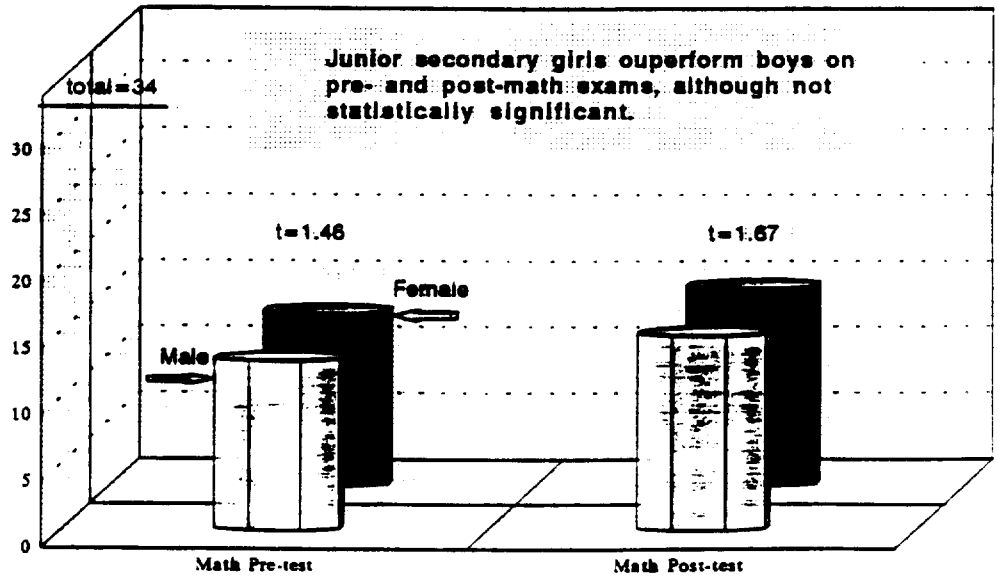
Gender Difference in Botswana Student Achievement

English Pre- and Post-Tests



Female	14.71	17.22
Male	14.08	16.35

Math Pre- and Post-Tests

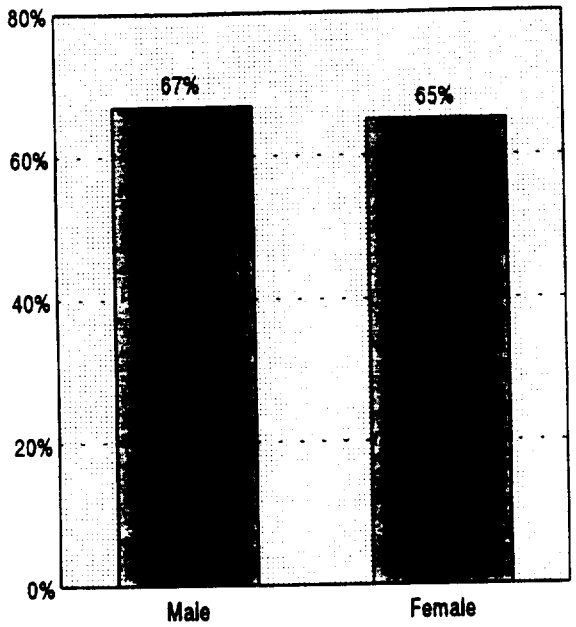


Female	13.05	14.96
Male	12.82	14.76

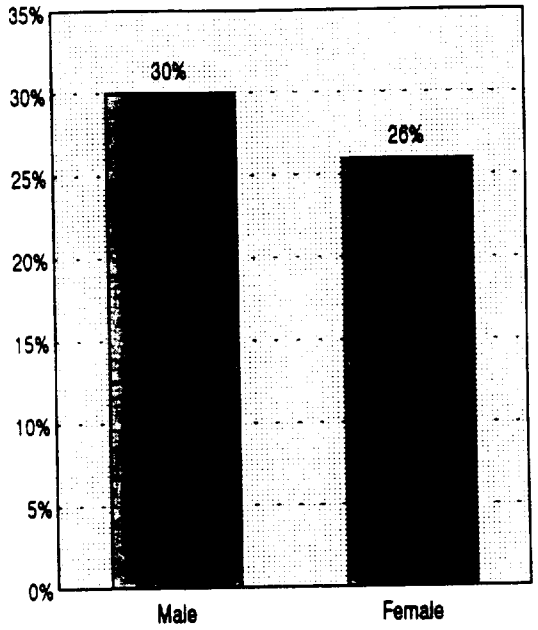
Figure 3

Descriptive Statistics By Male, Female Teachers

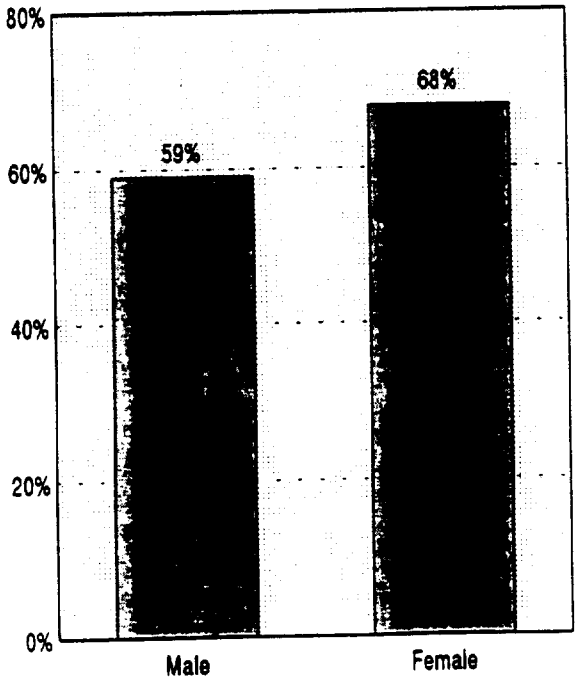
Percent in Rural Schools



Percent Expatriates



Percent with Diploma



Percent Math Teachers

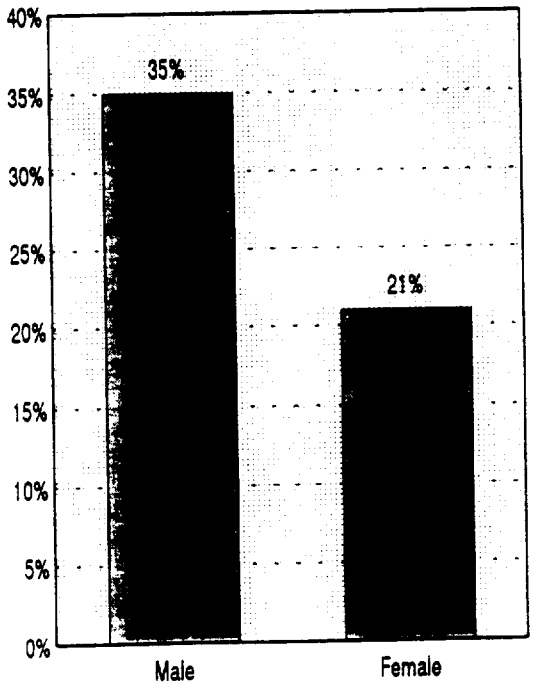
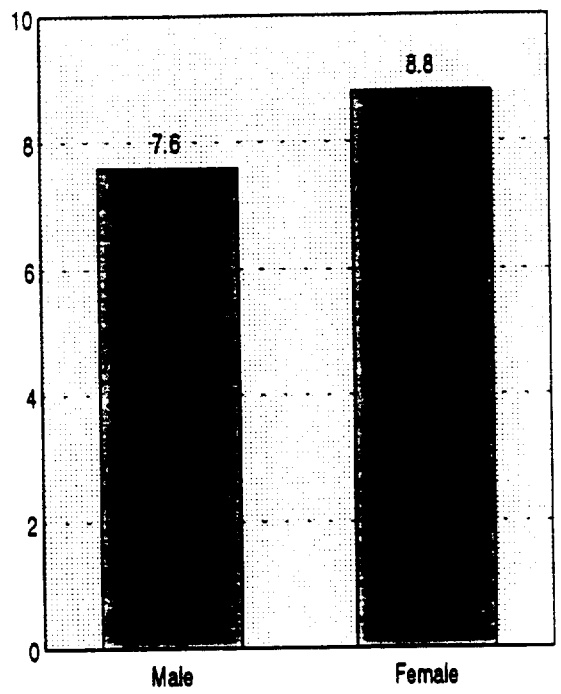


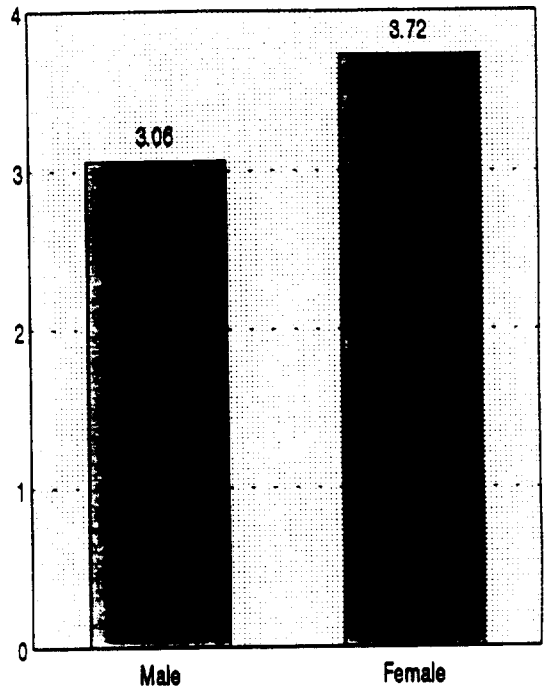
Figure 3 (continued)

Descriptive Statistics By Male, Female Teachers

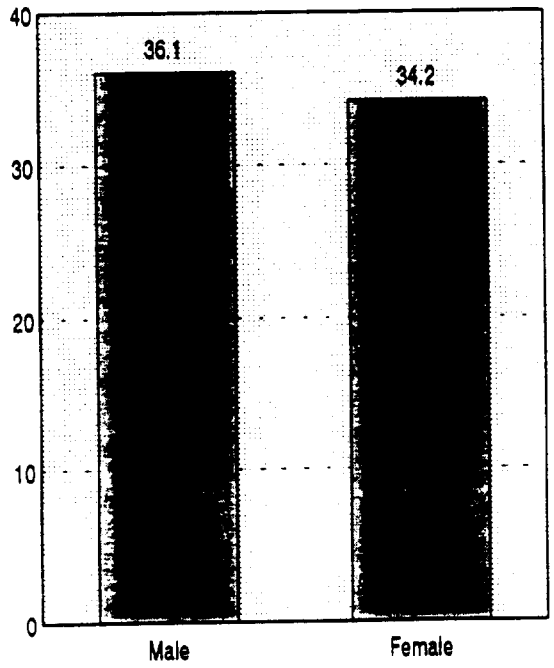
Father's Years of Education



Social Class Index



Confidence Index



Satisfaction Index

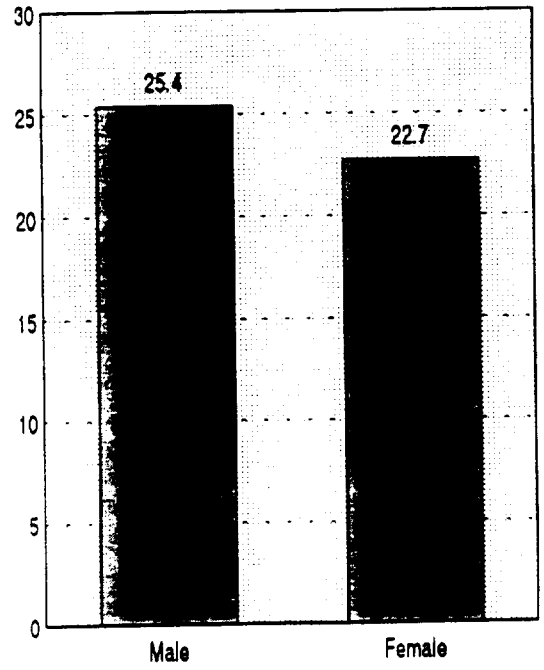
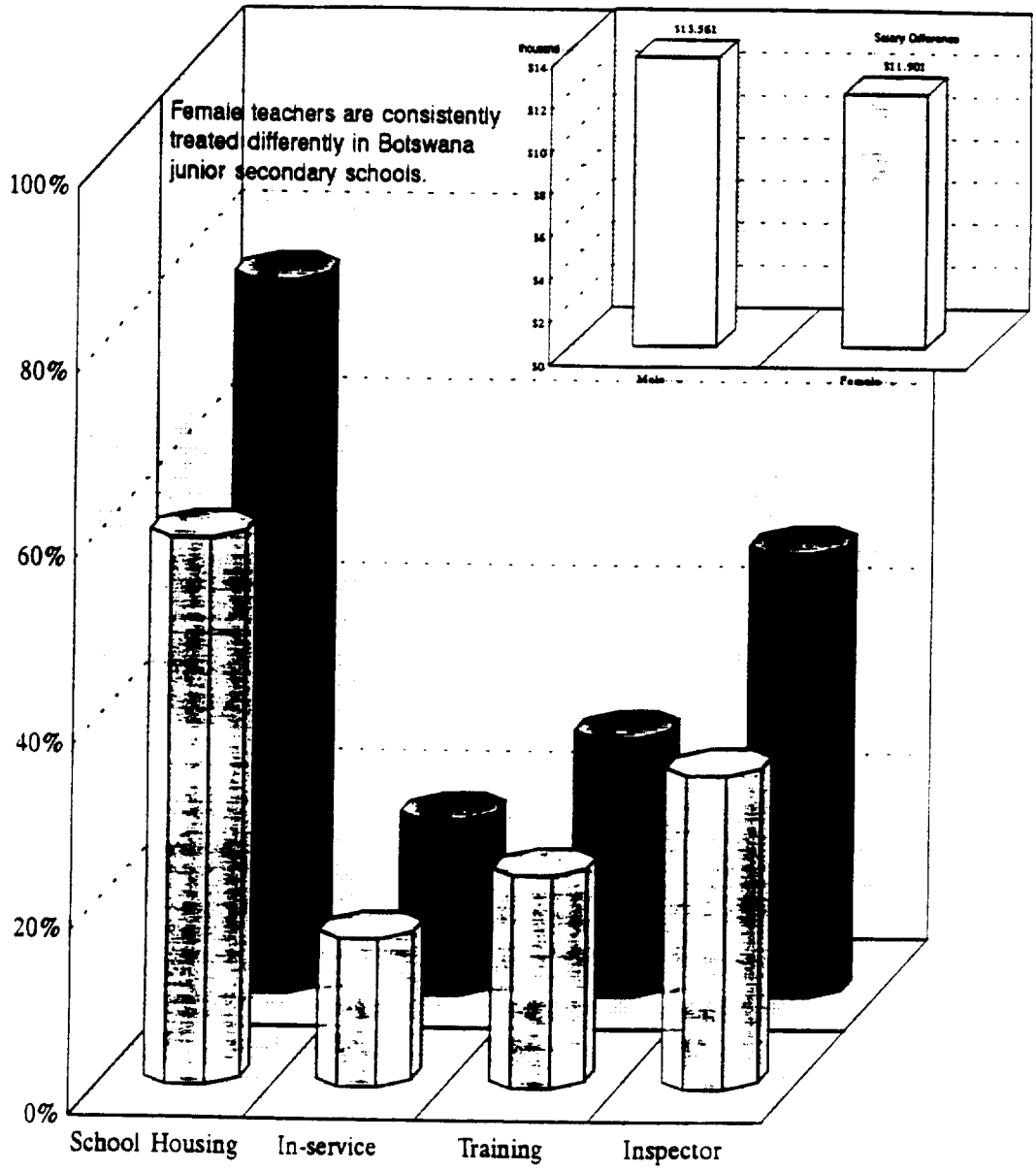


Figure 4

School Indicators

Teacher Gender Difference



	School Housing	In-service	Training	Inspector
Male	77%	19%	28%	48%
Female	59%	16%	23%	34%

Figure 5

Factors That Influence Pupil Achievement

Pupil-Level Factors

- Pre-test achievement level and unmeasured family background characteristics
- Time in school (grade level/form)
- Pupil gender
- Level of English knowledge

Teacher-Level Factors

- Teacher background, gender, and training levels
- Gender inequities
- Teacher effort and pedagogical behaviors
- Unidentified factors

Pupil Achievement (Post-test scores)

- English
- Mathematics