An experimental study of the effects of Cognitive Tutor® Algebra I on student knowledge and attitude

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Introduction

In the 2000/2001 school year, the Moore, OK Independent School District conducted a thorough study aimed at understanding the effectiveness of the Cognitive Tutor Algebra I program on students in their junior high school system. To allow the most rigorous test of the effectiveness of this course, the study was conducted as a true experiment, with students randomly assigned to either the Cognitive Tutor Algebra I course or a traditional Algebra I course. To control for teacher effects, some teachers taught both traditional and Cognitive Tutor courses. Dependent measures included the ETS Algebra I end-of-course exam, course grades and a survey of attitudes towards mathematics.

With its use of experimental design, same-teacher controls and measures of both content knowledge and attitudes on a large group of students, this study represents one of the most thorough investigations of the effects of a mathematics curriculum conducted to date.

Participants

Participants were students in Moore Independent School District attending one of five junior high schools: Brink, Central, Highland East (abbreviated "HEast"), Highland West (abbreviated HWest) and Moore West (abbreviated "West"). Cognitive Tutor Algebra I was used at four of the junior high schools among eight teachers (two at each school). A traditional Algebra curriculum was used at all five schools. Some teachers taught both Cognitive Tutor and traditional classes. Students in these classes were in ninth grade. In addition, honors students taking traditional Algebra I in eighth grade were surveyed about their attitudes towards mathematics. Throughout this report, we refer to teachers by their school name and a letter. Table 1 summarizes the schools, teachers and classes participating in the study.

Teacher	**Section (period)**	**Curriculum**	**Number of students**			
			ETS	**S1 Grade**	**S2 Grade**	**Attitude**
Brink A	01 (2)	Traditional	26	29	27	27
	05 (1)	CT	18	20	19	18
Brink B	08 (4)	Traditional	25	23	25	25
	09 (6)	CT	22	23	22	21
Brink C	02 (2)	Traditional		27	22	18
	06 (3)	Traditional		19	19	16

	07 (1)	Traditional		22	20	20
Brink D	03 (4)	Traditional		19	20	20
	04 (5)	Traditional		24	27	26
	10 (1)	Honors				27
	11 (3)	Honors				27
	12 (6)	Honors				27
Central A	01 (1)	CT	15	16	15	14
	02 (3)	CT	16	20	21	17
	03 (5)	Traditional	23	24	24	23
Central B	04 (2)	CT	18	20	20	20
	05 (3)	Traditional	13	17	16	16
	06 (4)	Traditional		18	20	18
	07 (5)	CT	20	22	22	22
	08 (6)	Traditional		20	19	14
Central C	09 (6)	Traditional		22	22	18
Central D	10 (1)	Honors				14
	11 (2)	Honors				17
HEast A	02 (2)	CT	16	17	19	17
	07 (5)	CT	15	18	17	16
HEast B	03 (3)	CT	14	19	19	
	05 (2)	CT	15	18	16	41
	08 (5)	CT	8	19	13	
HEast C	01 (1)	Traditional	19	25	21	18
	04 (3)	Traditional	15	25	19	16
	06 (5)	Traditional		20	16	11
	11 (2)	Honors				25
	12 (6)	Honors				14
HEast D & E	09 (1)	Traditional		28	28	
	10 (2)	Traditional		27	24	
HWest A	01 (1)	Traditional	13	20	14	12
	03 (2)	CT	16	16	20	18
	04 (3)	Honors				30
	05 (4)	CT	13	22	18	16
	07 (5)	CT	17	18	23	18
HWest B	02 (5)	CT	16	23	24	22
	04 (6)	Traditional		30	25	22
	06 (1)	Traditional	14	22	20	19
West A	07 (1)	Traditional	18	24	20	17
	08 (4)	Traditional		20	18	18
West B	01 (3)	Traditional	19	23	23	21
	02 (6)	Traditional		20	19	19
West C	04 (3)	Traditional		30	25	24
	05 (4)	Traditional	22	25	25	17
	06 (5)	Traditional		23	25	23
West D	03 (5)	Traditional	23	25	26	25
	09 (2)	Honors				19
	10 (4)	Honors				19
total			469	887	842	982

Table 1: Classes and students participating in the study. Note that not all classes provided data for all measures. Within a class, numbers of students contributing to a measure may differ due to student absence during data collection, or transfer to a different class or school. HEast D taught two classes for the first semester. HEast E took over those classes for the second semester. Thirty-three attitude surveys received were identified as being from HEast A Cognitive Tutor sections, but sections were not marked, so surveys were split evenly between the two sections.

Method

In the summer of 2000, teachers who were to use the Cognitive Tutor program took a standard three-day course required of all teachers beginning that program. A fourth day of training was given to these teachers in the fall of 2000. For all teachers in the study, the period studied was the first in which they had used the Cognitive Tutor curriculum. Teachers using the traditional curriculum used McDougal Littell's Heath Algebra 1 as their textbook.

At all schools except West, ninth grade Algebra I sections were randomly assigned to use either the Cognitive Tutor or traditional curriculum. Teachers were then assigned to sections. To the extent possible, each teacher was assigned to at least one Cognitive Tutor and one traditional class. Due to a scheduling error, teachers at HEast taught either Cognitive Tutor or traditional classes but not both.

Students taking Algebra I in ninth grade were then assigned to classrooms using the school's standard class scheduling system. In accordance with district policy, students were discouraged from transferring to a different section of the course during the school year. At the end of the school year, students were administered a survey of their attitudes towards mathematics, and some students were administered the ETS Algebra I End-of-Course test. All students taking a Cognitive Tutor course were asked to take the exam. To reduce costs, not all traditional students took the ETS exam. To maximize within-teacher comparisons, one of the traditional classes taught by a teacher who was also teaching a Cognitive Tutor class was randomly selected to take the ETS exam. In addition, two traditional classes from HEast and one traditional class from each of the West teachers were randomly chosen to take the ETS exam.

Results

Content Knowledge

ETS Algebra End-of-Course Assessment

The ETS Algebra End-of-Course Assessment consists of 25 multiple-choice and 15 constructed-response questions, with each type of question accounting for 50% of the student's score. Questions assess students' understanding of algebraic concepts, processes and skills. Scores are reported on a 0-50 scale that combines results on the three sub-areas.

In order to isolate the effects of curriculum on ETS scores, we need to consider whether students who were classified as using a particular curriculum in fact used that curriculum for the full school year. Student transfers pose two problems (see, for example, Smith, 2000). First, it is difficult to attribute learning gains to one curriculum or another when a student has been exposed to two or more curricula during the school year. Second, if students are allowed to transfer between curricula, then the perceived superiority of one curriculum over another can encourage students to transfer. If an advantage for the perceived-superior curriculum is then found, the advantage may be due to the fact that students motivated to do well were more likely to transfer to that curriculum, rather than any inherent superiority of the curriculum.

To avoid these kinds of analysis problems, we classified students based on their enrollment status at the end of the first semester and at the time that the ETS end-of-course exam was taken. These classifications, shown in Table 2, show that 94% of students taking the ETS test did, in fact, stay with a single curriculum, taught by the same teacher, throughout the school year. Since there are so few exceptions and it is not clear how to treat these different situations, the analyses reported here will consider only those 444 students who used a single curriculum with a single teacher for the whole school year and took the ETS test.

Classification	**Number of students**
Cognitive Tutor	224
Traditional	220
CT first semester, traditional second semester	0
Traditional first semester, CT second semester	4
CT both semesters, different teachers	3
Traditional both semesters, different teachers	4
Transferred to school in S2, placed in CT	8
Transferred to school in S2, placed in traditional	6
No registration	2

Table 2: Classification of students taking the ETS exam. "No registration" refers to students who were not able to be matched with class registration data. Both of these students used the traditional curriculum.

For the national population taking the ETS assessment in 2001, the mean score on this test was approximately 18, with a standard deviation of 9. Although students at Moore scored slightly below this mean, we do not have any information about the population taking the test nationally, so it is difficult to compare the results at Moore to the general population taking the test.

Table 3 shows mean scores on the ETS test for students in each curriculum. Analysis of variance shows the difference between curricula to be significant, $F(1,442)=8.8$, $p<.01$.

	Traditional	Cognitive Tutor
ETS EOC Score	15.1 (5.5)	16.7 (5.7)

Table 3: Means scores on the ETS end-of-course assessment, by curriculum. Standard deviation is in parentheses.

A view of student performance by school allows us to see whether the advantage for Cognitive Tutor students is consistent across schools. A 4x2 ANOVA (excluding Moore West) shows that this is the case. There is a significant effect of school, $F(3,352)=4.0$, $p<.01$ and curriculum, $F(1,352)=6.6$, $p<.02$. There is no interaction between the factors, indicating that the advantage for the Cognitive Tutor students was consistent across schools (see Figure 1). Furthermore, students at Moore West (all of whom used a traditional curriculum) performed close to the average for students in a traditional class.

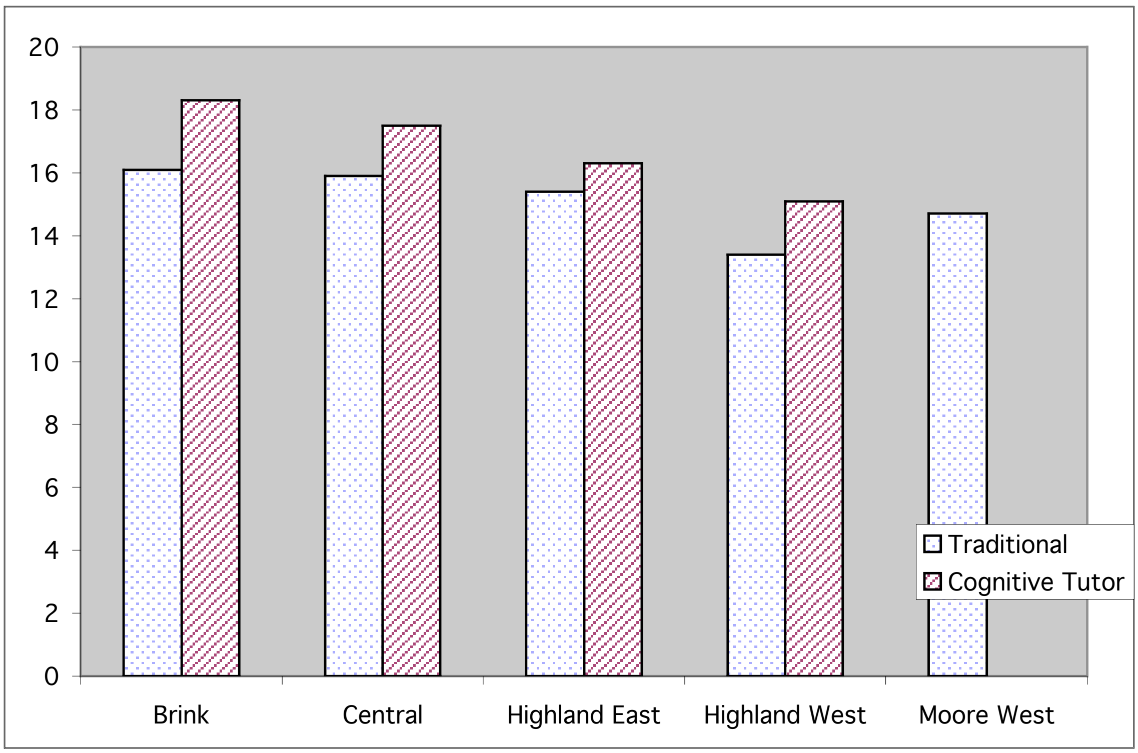

Figure 1: Performance on ETS Algebra end-of-course assessment, by school

There is strong evidence that teacher quality has significant and long-lasting effects on student achievement (Sanders and Rivers, 1996; Mendro, et. al., 1998). Since this study includes teachers who taught with both the Cognitive Tutor and a traditional curriculum, we can control for the influence of teacher as well as examine whether some teachers are more effective than others when using the Cognitive Tutor curriculum.

For these analyses, we consider only those six teachers who taught both the Cognitive Tutor and the traditional curriculum. A 6x2 ANOVA reveals the expected significant effect of teacher, $F(5,253)=3.3$, $p<.01$ as well as a significant effect of curriculum, $F(1,250)=6.5$, $p<.02$. These results are displayed in Figure 2. There is a marginally significant interaction between the two factors, $F(2,253)=2.0$, $p<.08$, indicating that the advantage of the Cognitive Tutor curriculum was not entirely consistent across teachers.

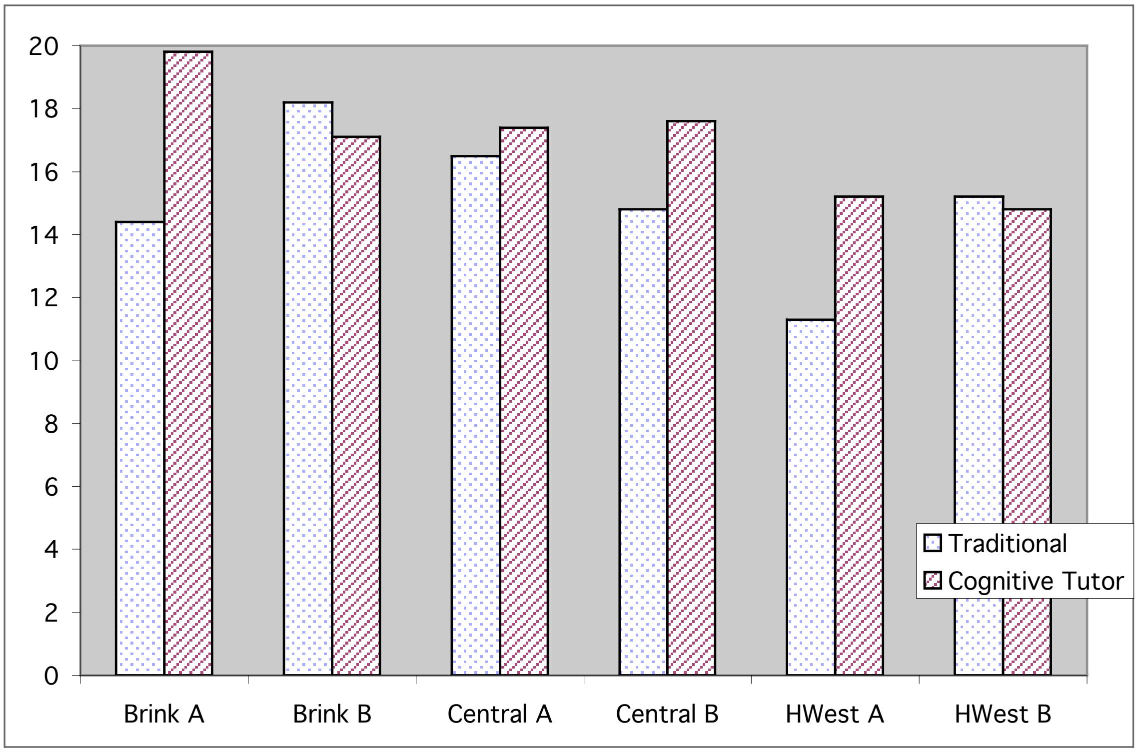

Figure 2: Performance on ETS Algebra end-of-course exam, by teacher (considering only teachers who taught both courses)

Course Grades

As with the analysis of the ETS assessment scores, it is desirable to identify students who were exposed to a single curriculum, taught by a single teacher. Of the 1,048 students who were registered for Algebra 1 during the school year, 272 used the Cognitive Tutor course for the full year, with the same teacher. 544 used the traditional course for the full year, with the same teacher. The complete breakdown of enrollment statistics for the group is shown in Table 4.

Classification	**Number of students**
Cognitive Tutor	272
Traditional	544
CT first semester, traditional second semester	3

Traditional first semester, CT second semester	9
CT both semesters, different teachers	3
Traditional both semesters, different teachers	62
Transferred to school in S2, placed in CT	10
Transferred to school in S2, placed in traditional	15
Transferred (or dropped) out after CT in S1	27
Transferred (or dropped) out after traditional in S1	78
No grade either semester	25

Table 4: Classification of all students who were registered for Algebra 1 in 2001.

Using course grades as a measure of student knowledge can be problematic. Grades may reflect some factors that are only tangentially related to mathematical ability (such as the student's level of effort, enthusiasm and class participation), and grades are subject to conscious and unconscious bias on the part of the teacher. However, grades may also reflect higher-level problem-solving skills that are not well measured on a standardized test, so they may be taken as a proxy for the teacher's perception of students' overall abilities.

The Moore school district assigns grades of A, B, C, D and F. These grades were collected in both the first and second semesters of school. Grades were then converted to a standard numeric score (A=4; F=0). The results are shown in Table 5.

	Traditional	**Cognitive Tutor**
First Semester	2.61 (1.16)	2.82 (1.20)
Second Semester	2.36 (1.30)	2.44 (1.27)

Table 5: Grade point averages for all traditional and cognitive tutor students. Standard deviation is in parentheses.

Although grades are generally higher in the Cognitive Tutor classes, the difference only reaches statistical significance for the first semester grades, $F(1,809)=5.9$, $p<.02$.

Since grading is subjective and since not all teachers taught both curricula, it makes sense to look at grades for only those teachers who taught both curricula. This analysis controls for differences between teachers in the strictness of their grading.

When we restrict the analysis to only those teachers who taught both curricula, the differences are statistically significant for both semesters' grades: $F(1,357)=9.8$, $p<.01$ for the first semester and $F(1,352)=7.4$, $p<.01$ for the second semester. This data is presented in Table 6.

	Traditional	**Cognitive Tutor**
First Semester	2.70 (1.20)	2.94 (1.10)
Second Semester	2.36 (1.30)	2.67 (1.19)

Table 6: Grade point averages for students whose teachers taught both curricula. Standard deviation is in parentheses.

Student Factors

The registration data allows us to look at differential performance of males and females as well as students from different ethnic groups. The data on performance by sex is shown in Table 7. Although Cognitive Tutor students show an advantage in all cells of the comparison, the data is somewhat contradictory. There are significant effects of sex on all three dependent measures, but the direction of the effect is different for ETS scores than for course grades. Specifically, boys outscore girls on the ETS exam, but girls receive higher grades. This difference most likely reflects better performance by girls on factors not directly assessed in the ETS exam.

There is also a marginally significant interaction between sex and curriculum on ETS scores ($p<.06$), indicating that there is a tendency for the advantage of the Cognitive Tutor curriculum to be greater for boys than for girls. There is no such interaction in the grade data. Although this suggestion of an interaction is troubling, it is of only marginal significance. There is also a suggestion that this interaction may be due to a teacher effect. If we restrict the data to students whose teachers taught both a Cognitive Tutor and a traditional class, the effects of sex and curriculum persist and any suggestion of an interaction goes away, for all dependent measures.

	ETS		**Semester 1 grade**		**Semester 2 grade**	
	Traditional	**Cognitive Tutor**	**Traditional**	**Cognitive Tutor**	**Traditional**	**Cognitive Tutor**
Male	15.4 (6.2)	18.0 (6.0)	2.5 (1.2)	2.8 (1.1)	2.2 (1.4)	2.5 (1.3)
Female	14.9 (4.7)	15.6 (5.2)	2.9 (1.0)	3.1 (1.0)	2.6 (1.2)	2.7 (1.1)

Table 7: Results for all students, by sex.

Table 8 shows results on all dependent measures for students, divided by ethnic background. Analyses show a significant effect of ethnicity for all dependent measures but no interaction between ethnicity and curriculum, indicating that the Cognitive Tutor course is equally effective for students of all ethnic backgrounds.

	ETS		**Semester 1 grade**		**Semester 2 grade**	
	Traditional	**Cognitive Tutor**	**Traditional**	**Cognitive Tutor**	**Traditional**	**Cognitive Tutor**

Asian	15.8 [N=11]	20.9 [N=7]	3.1 [N=11]	3.9 [N=7]	3.2 [N=11]	3.7 [N=7]
Black, non-Hispanic	11.3 [N=12]	13.8 [N=11]	2.3 [N=12]	2.4 [N=11]	1.8 [N=12]	2.1 [N=11]
Hispanic	15.1 [N=9]	13.6 [N=7]	2.8 [N=9]	2.9 [N=7]	2.4 [N=9]	2.6 [N=7]
Native American	15.3 [N=40]	17.1 [N=39]	2.4 [N=40]	3.0 [N=39]	2.3 [N=40]	2.7 [N=39]
White, non-Hispanic	15.0 [N=143]	16.8 [N=160]	2.7 [N=141]	3.0 [N=158]	2.4 [N=143]	2.5 [N=160]
Other	22.2 [N=5]	[N=0]	3.6 [N=5]	[N=0]	3.6 [N=5]	[N=0]

Table 8: Results for all students, by ethnic background. Number of students in each cell is indicated in square brackets.

Discussion

The results presented here are unequivocal. Students using the Cognitive Tutor curriculum outscore students using the traditional curriculum on the ETS Algebra end-of-course assessment and on their course grades. These results are consistent across teachers and across schools, and the advantage for the Cognitive Tutor holds for students of both sexes and all ethnicities represented in the data.

Furthermore, these effects are not only statistically significant, but they are fairly substantial. Expressed in standard deviation units, the effect size for Cognitive Tutor students over traditional students on the ETS test is 0.29. Several recent studies (Darling-Hammond, 1999; Wenglinsky, 2000) have suggested that the strongest components of teacher effects have to do with teacher education and professional development and only indirectly with practices. The curriculum effect that we are examining in this study has to do with teacher practices (along with a small amount of professional development) and so would be expected to be relatively small compared to between-teacher effects, which include both types of influences. Taken in this context, the effect sizes we see are impressive. For comparison, the effect size of the most effective teacher over the least effective in the ETS data is 0.76.

Because of the magnitude of teacher effects, the data showing that these results hold even when controlling for teacher are particularly telling. The results from teachers who had taught both curricula still favor the Cognitive Tutor. While there is danger in reading too much into this data, the lack of a significant interaction does indicate that all teachers benefit equally from using the Cognitive Tutor curriculum. To the extent that we can take the suggestion of an interaction seriously, it is interesting to note that the strongest advantage for the Cognitive Tutor curriculum was found in the three teachers who had the worst results from their traditional classes (HWest A, Brink A and Central B). If we take the traditional class results as reflecting the performance that these teachers had been getting with their students before using the Cognitive Tutor curriculum, then we might conclude that the Cognitive Tutor curriculum had the most benefit for those teachers who had been least effective with their students in the past.

Attitudes towards mathematics

The survey used to assess attitudes towards mathematics was based on one developed by Fennema and Sherman (1976). It contained 24 items representing subscales devoted to students' confidence in mathematics and their feelings about the usefulness of mathematics. For example, an item on the confidence scale was "I think I could handle more difficult math." An item on the usefulness scale was "I use mathematics in many ways outside of school." Students rated their agreement with each item on a five-point scale.

Table 9 shows the mean results on the two subscales (confidence and usefulness) of the attitude survey. Note that since the attitude survey was completed anonymously, students were classified based on the curriculum they were using at the time of the survey. However, the content data analysis showed relatively little transfer between curricula, so it is unlikely that the results would be different had we been able to exclude students who used more than one curriculum.

An analysis of variance shows that the effect of course is significant for the confidence scale, $F(2,979)=60.5$, $p<.0001$ and the usefulness scale, $F(2,979)=36.3$, $p<.0001$. Planned comparisons show that students in the honors classes were significantly more confident of their mathematical abilities than students in the other two classes and that the Cognitive Tutor students were significantly more confident in mathematics than students in the traditional classes. Planned comparisons of the usefulness scale show the same pattern of results, with honors students believing that mathematics is more useful than students in the other two groups, and Cognitive Tutor students significantly more likely to rate mathematics as useful than students in the traditional class.

	Traditional	**Cognitive Tutor**	**Honors**
Confidence	3.2 (1.0)	3.5 (0.9)	4.0 (0.8)
Usefulness	3.6 (0.9)	3.8 (0.8)	4.1 (0.7)

Table 9: mean scores on attitude subscales, by course. Standard deviations are in parentheses

Breaking down the data by school allows us to examine whether the overall pattern is repeated in each school. A 4 (school) by 3 (course) analysis of variance (excluding Moore West) of the confidence results reveals a significant effect of school, F(3,768)=10.0, p<.0001 and course, F(2,768)=32.2, p<.0001 but no interaction between the factors, F(6,768)=0.8. As shown in Figure 3, the lack of interaction reflects the fact that, in each school, honors students were more confident than Cognitive Tutor students, who were, in turn, more confident than student in the traditional course. The main effect of school reflects the fact that, overall, confidence is mathematics was higher at Brink and Highland West which, in turn, rated confidence higher than Central and Highland East.

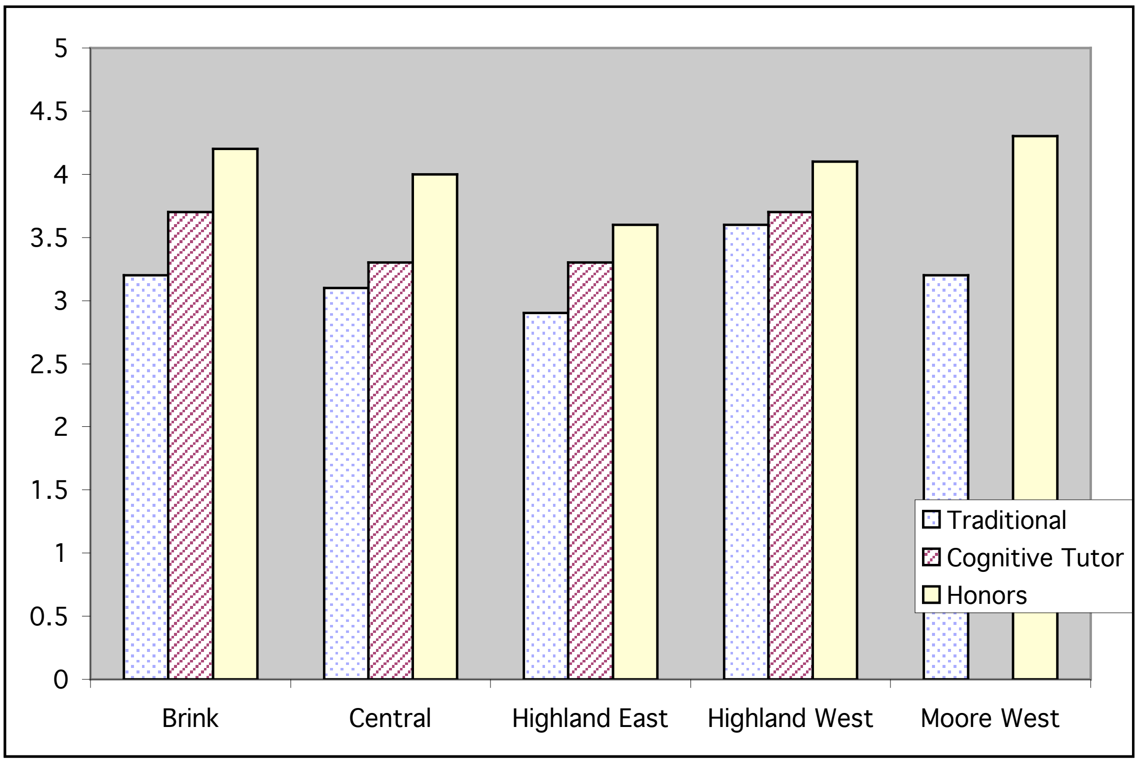

Figure 3: Ratings of confidence in mathematics, across schools.

The data on usefulness is similar (see Figure 4). A 4x3 ANOVA reveals significant effects of school, F(3,768)=10.6, p<.0001 and course, F(2,768)=12.9, p<.0001 but also an interaction between the two factors, F(6,768)=3.7, p<.01. The interaction reflects the fact that the pattern of result is not consistent across schools. At Highland East, students in the traditional classes were more likely than Cognitive Tutor students to think that mathematics was useful, while at Central, students in the Cognitive Tutor class were as likely as those in the honors class to rate mathematics as useful.

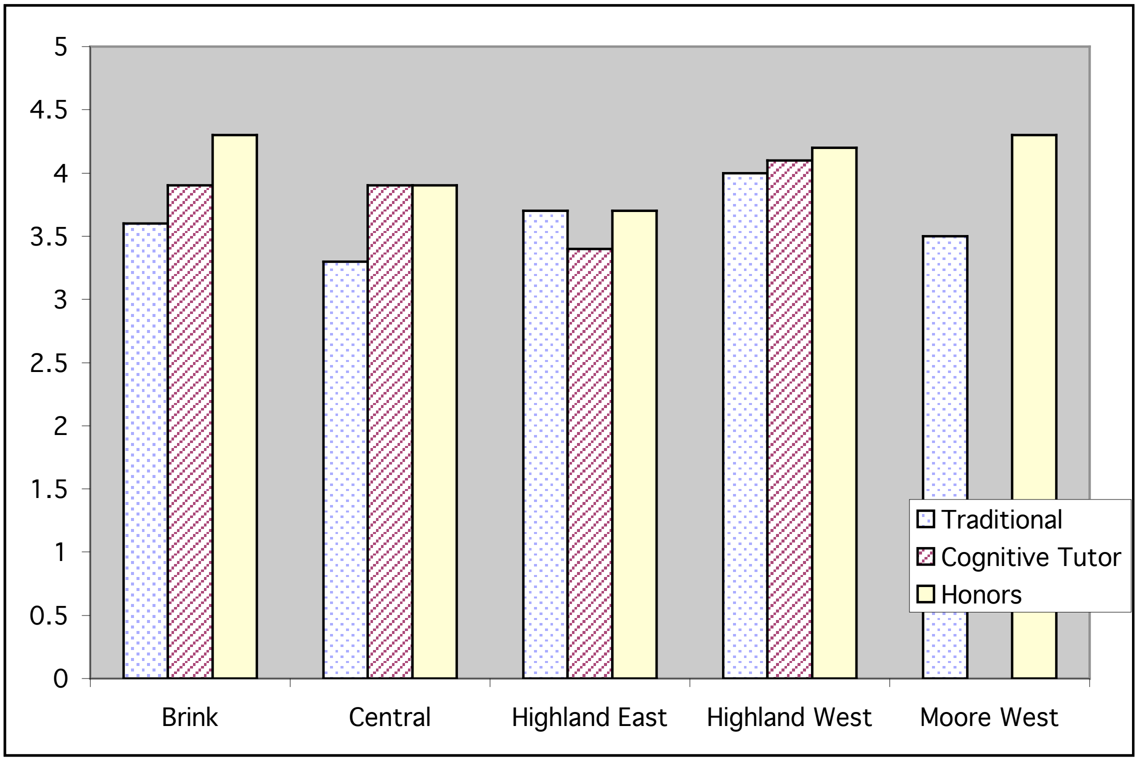

Figure 4: Ratings of usefulness of mathematics, across schools

Six teachers from three schools ("Brink A," "Brink B," "Central A," "Central B," "HWest A" and "HWest B") provided attitude data for both Cognitive Tutor and traditional classes. This allows us to examine whether the effect of the curriculum on student attitudes is independent of teacher. A 6x2 ANOVA on the confidence ratings show a significant effect of teacher, $F(5,350)=6.6$, $p<.0001$. Although students in Cognitive Tutor classes are slightly more confident in their mathematical abilities than traditional students of all but one teacher, this effect does not rise to significance and there is no significant interaction between teacher and curriculum (see Figure 5).

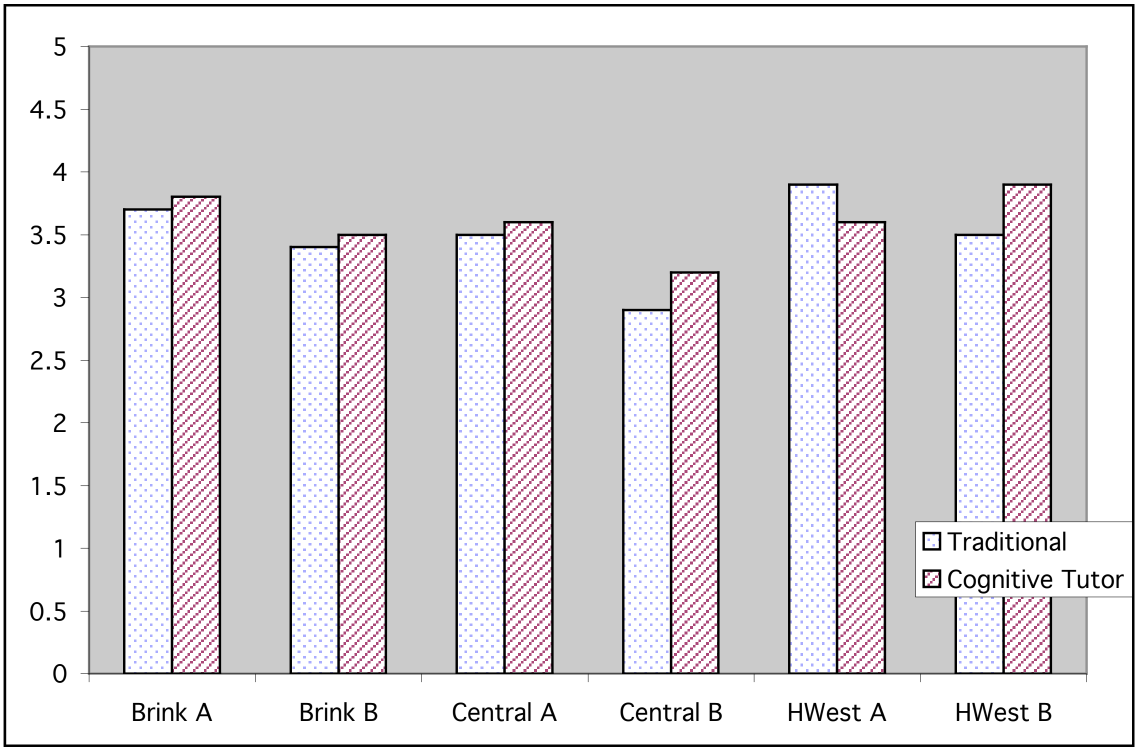

Figure 5: Student ratings of confidence in mathematics, across teachers who taught both Cognitive Tutor and traditional classes

In a similar analysis of usefulness ratings, the teacher effect is significant, $F(5,350)=3.9$, $p<.01$ as is the effect of curriculum $F(1,350)=9.9$, $p<.01$. There is also a significant interaction, $F(5,350)=2.4$, $p<.05$. As shown in Figure 6, this interaction reflects the fact that traditional students of the two Highland West teachers rated math as useful as Cognitive Tutor students of the same teachers, while at the other schools, Cognitive Tutor students rated math as more useful than students taking a traditional course with the same teacher.

The teacher data indicate that student attitudes towards mathematics are strongly influenced by their teacher. The influence of course is evident but not as strong. Cognitive Tutor students were more likely to think that math is useful than students in a traditional class taught by the same teacher, but this influence came through more strongly with some teachers than others. With respect to confidence ratings, the influence of the teacher overwhelmed that of the curriculum.

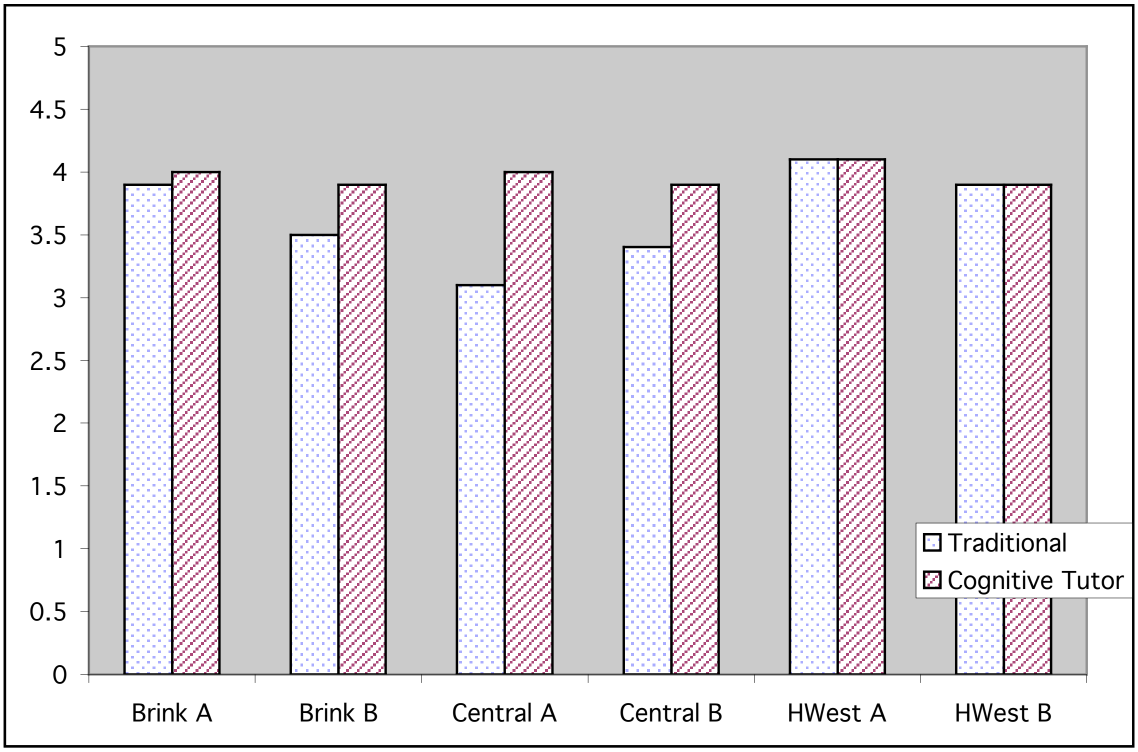

Figure 6: Usefulness ratings, by teacher

Discussion

Like the content knowledge results, those relating to student attitudes favor the Cognitive Tutor curriculum over the traditional curriculum. As would be expected, honors students have a more positive attitude towards mathematics than students in the general mathematics track. While there are some interactions with teacher and school, the results are fairly consistent. After completing the Cognitive Tutor course, students feel more confident about their mathematical abilities, and they are more likely to say that mathematics is useful outside of an academic context. These effects hold, even when controlling for the strong effects of teacher on student attitudes.

A questionnaire distributed along with the attitude survey to students in Cognitive Tutor classes provides more insight into how these students perceived the course. When asked whether the Cognitive Tutor Algebra I course was more, less or equally effective as other math courses they had taken, 63% of respondents indicated that they felt the course was more effective. Only 13% said it was less effective. Students were also asked to rate the helpfulness of certain aspects of the course on a five-point scale. These data, presented in table 10 show highly favorable ratings for the Cognitive Tutor software and somewhat less favorable ratings for the text-based portions of the course.

Print		Software			
Textbook	**Assignments**	**Worksheets**	**Grapher**	**Equation Solver**	**Hints**
32	49	65	70	80	63

Table 10: Percent of Cognitive Tutor students rating aspect of the materials as either “extremely helpful” or “quite helpful”

General Discussion

The data presented here make a strong case for the use of the Cognitive Tutor curriculum in the Moore Independent School District. Students using the Cognitive Tutor curriculum performed better than those using a traditional curriculum on various measures of content knowledge, and Cognitive Tutor students ended the course more confident of their mathematical abilities and more likely to think that mathematics is useful outside of the classroom.

Furthermore, teachers using the Cognitive Tutor curriculum ended the year enthusiastic about the experience. Seven of the eight Cognitive Tutor teachers returned a questionnaire distributed at the end of the school year. All seven responded “yes” when asked if they would recommend the Cognitive Tutor to others.

The fact that these results were obtained in a true experimental context eliminates many bias explanations for these results that might be used against a correlational or quasi-experimental design. Furthermore, the fact that the results were consistent, even when controlling for teacher, strengthens their validity.

The within-teacher portion of the experimental design might be criticized for allowing “contamination” between conditions. That is, the training and classroom experiences that teachers received in the Cognitive Tutor curriculum might also affect teaching style, practice and materials used the traditional classroom. While it is likely that such contamination did in fact take place, this only serves to strengthen the results. Any crossover between conditions would tend to decrease the difference found between the curricula, so the fact that we found significant differences despite this suggests that, if anything, this study underestimates the advantage of the Cognitive Tutor curriculum.

Another factor to consider is that the teachers in this study who used the Cognitive Tutor curriculum were doing so for the first time, whereas most of these teachers had previously used the traditional textbook (the study year was the third that the Heath

Algebra I textbook had been in use). Since the Cognitive Tutor curriculum introduces new teaching practices as well as new software, we would expect to see an adjustment period and find that teachers would be even more effective with the Cognitive Tutor curriculum in subsequent years. This predication is supported by the teacher questionnaire. When asked "at what point did you feel comfortable teaching with the Cognitive Tutor," one teacher said "after I completed training." Two more checked "after one month." One each said "after one quarter," "after 1/2 year," and "after one year," and one teacher still felt the need to make some adjustments at the end of the school year. This range of responses indicates that, despite the results achieved and the enthusiasm shown for the curriculum by the teachers, teachers may find room for improvement in their implementations of the Cognitive Tutor curriculum.

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