

Offering a First Year Algebra Course in Illinois Middle Schools

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Problem

Results from the 2003 Trends in International Mathematics and Science Study (TIMSS) indicate that United States eighth-grade students continue to be in the middle of the international field in mathematics. Based on the TIMSS results, there is a call for a rigorous, challenging mathematics curriculum in the United States middle schools (Schmidt, 2004). School districts nationwide are in the process of making decisions about what a challenging middle school mathematics curriculum entails. Some have interpreted this call as a need to “push down” algebra into eighth-grade (Seeley, 2005).

When referring to algebra in eighth-grade, many people mean an Algebra course. Algebra as a course is typically American as many other countries use an integrated approach to teaching mathematics (Begg, 2000; Kaput, 1998). For the purposes of this paper, “Algebra” will refer to the equivalent of the high school first year Algebra course. The algebra content strand will be indicated with all lower-case letters. The questions and issues related to middle school students engaging in algebra versus Algebra must be the topic of another project. This study investigates when and how Illinois middle schools offer an Algebra course to their students.

Research Questions

- How do Illinois school districts offer Algebra to their middle school students?
- What are the issues involved in offering Algebra to middle school students?

Methodology

This study is an extension of the work I was doing for my school district. My district was in the process of evaluating and making changes to the way we offer the high school first year Algebra course to our eighth-grade students. As part of my responsibility to

evaluate and propose change, I contacted school districts in the area or districts of similar size to find out how they offered an Algebra course to their middle school students. I also posted questions on the Illinois Council of Teachers of Mathematics List Serve. At that point, I was contacted by a representative from the Illinois State Board of Education (ISBE) with a suggestion to expand my inquiry statewide.

Sample selection

I already had approximately 15 responses from the phone conversations and List Serve. To expand my study I used the Directory of Illinois Schools link from the ISBE website to select schools. My goal was to include at least one school district from each Regional Office of Education (ROE) to have a statewide sample. Because I was interested in middle school mathematics, I used only the 779 districts that were unit districts or K (pre-K) – 8. I then separated the 779 districts into unit districts and elementary districts. I sorted the unit districts into three groups by size: large (9,000+), medium (1000-8999) and small (under 1000). The K-8 districts were sorted into two size groups: large (1000+) and small (under 1000). Stratifying the population was done to guarantee that a variety of district types would be included in the study. A random sample was then taken from each of the five strata. This resulted in a sample of 93 school districts.

Ten Regional Offices of Education were not represented after the first round of surveys was complete. I went back to the groups from which the sample was selected and reorganized the groups by ROE. A second sample was selected from those ten ROE's so that all 56 Regional Offices of Education were represented in the survey. Data were collected from 67 out of 779 districts or 8.6% of the Illinois school districts that have grades 7 and 8.

Phone interviews were used to conduct the study. The phone interview protocol can be found in the Appendix. District administrators such as superintendents, principals, curriculum directors, and math coordinators, as well as one teacher and one secretary were available to respond to the interview questions. One problem with data collection was that some district representatives were not able to answer all questions. This resulted in incomplete data for some categories.

Data analysis

Data were analyzed using both quantitative and qualitative methods. Data from the phone interviews were analyzed using SPSS software. This enabled the data to be analyzed for the following: percent of districts offering an Algebra course to middle school students, percent of students in the Algebra course, criteria for students to be placed in Algebra, the grade tracking begins, the number of tracks, whether or not students earn high school credit, and the average number of minutes in middle school versus high school class periods. Data with respect to the district's percent of students from low-income homes and the percent of students in the district who meet and exceed state standards were obtained from the ISBE website and were included for all districts.

Phone interviews were then analyzed to reflect trends in the data. Data from surveys were grouped to identify typical course-taking patterns in middle school as well as what courses students typically take as they enter high school. Trends were also identified in the curriculum for middle school students who do not take Algebra. Finally, programs containing an innovative component such as increasing math time during the students' regular day, having 100% of the eighth-grade students in Algebra, and teacher professional development were identified and described.

Results

Frequencies were obtained with respect to district enrollment, district type, percent of students in the district who meet and exceed state standards (percent meets and exceeds), and the district's percent of students from low-income homes (percent low-income) to describe the data set. As previously stated, data were collected from 67 out of 779 districts or 8.6% of the Illinois school districts that have grades 7 and 8. District enrollment information was obtained from the Directory of Illinois Schools. The sample's district enrollment ranged from 121 students to 38,936 students, with a mean enrollment of 4173 students. One district with an enrollment of 426,812 was not used in the enrollment frequencies.

Twenty-one of the 67 districts (31%) were K-8 districts while 46 (69%) were unit districts. Statewide, 49% of the districts that have seventh and eighth-grades are K-8 districts, while 51% of the districts are unit districts. The percent meets and exceeds standards for all state tests ranged from 43% to 90% with a mean of 68%. This is high compared to the state mean of 62%. Finally, the sample's percent low-income ranged from 1% to 85% with a mean of 32% which is low compared to the 39% low-income in the public schools statewide.

Frequencies

The results of the study follow and are presented in question and answer form. Most questions are taken from the phone interview protocol. The results are presented as summative and descriptive statistics. Some discussion or clarification is also included.

Does your district offer Algebra to seventh and eighth-grade students?

- Of the school districts surveyed, 88% (59 out of 67) reported that they offer an Algebra class to their seventh or eighth-grade students. Seven of the eight districts

that do not offer Algebra to middle school students were small unit districts with enrollments under 1000. The other district was a K-8 district with an enrollment of 121 students.

Approximately what percent of your students take Algebra?

- Fifty-two districts reported a percentage of students enrolled in Algebra. The percentage of students enrolled in an Algebra course in seventh or eighth-grade varied from 5% to 100%. The mean was 31% in Algebra; the median and mode were 25% in Algebra. Based on the results, over half of the school districts have 25% or fewer of their seventh and eighth-grade students in an Algebra course.

The results are presented in Table1.

Table 1*.

Percentage of students in Algebra	Number of Districts	Percentage of Districts Reporting that Percentage
5%	2	4%
10%	4	8%
15%	4	8%
20%	9	17%
25%	10	19%
30%	3	6%
33%	8	15%
40%	2	4%
50%	6	12%
70%	1	2%
75%	1	2%
100%	2	4%
Total number of districts reporting percentage	52	

*5 values were rounded to the nearest 5%

When are students placed into the Algebra track?

- Fifty-seven of the 59 schools providing an Algebra course reported a year when tracking began. The results indicate the grade-level when students are tracked into different mathematics courses and are as follows:

Sixth-grade 14%

Seventh-grade: 54%

Eighth-grade: 32%

- The vast majority of districts, 86% (50 out of 58), reported having 2 mathematics tracks. Eight (14%) reported having 3 mathematics tracks.
- A number of district representatives indicated that the district was evaluating the number of tracks and/or the year in which tracking begins. Districts that mentioned this indicated that they were considering the elimination of a track. and/or postponement of tracking until eighth-grade.

How is the Algebra course structured?

- Thirty-one districts reported the number of minutes per day for Algebra in middle school and high school. The mean number of minutes per day in the middle school classes was 46.5 minutes. The mean number of minutes per day in the high school classes was 48 minutes. Only three districts (10%) reported more time per day was spent in the middle school classes. Fourteen districts (45%) reported that the middle schools and high schools have the same length class period. Fourteen districts (45%) reported that the middle school Algebra class length is shorter than the high school period. The range of less class time in middle school goes from 1 less minute to 13 fewer minutes with a mode of 10 minutes, median of 9 fewer minutes, and a mean of 2.7 fewer minutes spent in Algebra class in middle school than in the equivalent high school

course. This translates to 5 to 65 minutes less time per week for 45% of the middle school students in Algebra.

This raises a few questions and concerns. How are middle school students, who are younger than their high school counterparts, expected to cover the same quantity and quality of content in substantially less time? A second concern raised by many administrators was related to the state testing. District administrators reported a dilemma among middle school teachers who must cover the Algebra course content as well as prepare their students for the ISAT test; yet, they have less time than the high school teachers who are just teaching the Algebra course.

What criteria are used to place students into Algebra?

- Fifty-four districts reported criteria used to place students in Algebra. Teacher recommendation (83%) was the most common criteria used while Algebra readiness tests were among the least commonly used criteria (24%). The results are presented in Table 2.

Table 2

CRITERIA	Number of Districts	Percentage of Districts Reporting that Criteria (Districts could choose all that apply)
Teacher Recommendation	45	83%
Standardized Test Results	37	68%
Math Class Grades	33	61%
5 th Grade ISAT Scores	20	37%
Algebra Readiness Test	13	24%
Parent Recommendation	9	17%

The majority of school districts (46%) used a combination of 3 criteria to place students in the Algebra course. Thirty percent of districts use only one or two criteria;

24% use a combination of four or five criteria. Some districts also indicated that, although they use other criteria, if a parent requests that his or her child be placed in the Algebra course, the request is granted.

The prevalence of the use of Teacher Recommendation rather than the use of an Algebra Readiness Test as criteria to place students into Algebra raises some concerns. What criteria do teachers use when recommending students for the Algebra course? Do they recommend students who work hard, do homework, and are well behaved in class? If so, a portion of the students who have potential in Algebra are being overlooked. It is possible that an Algebra Readiness Test could identify those students.

Do students receive high school credit for the class?

- Three of the 59 districts enable middle school students to earn high school credit for the Algebra course they take in middle school. Although students in the majority of districts do not receive high school credit, district administrators reported that many students do enroll in the next course in the high school sequence – usually Geometry or Algebra 2.

Are there any relationships among the variables?

- Data were normally distributed. Spearman's rho correlations were run to determine the relationship between the differently scaled variables. Those variables include: 1) percent in Algebra, 2) total number of criteria used to place students in Algebra, 3) year tracking begins, 4) number of tracks, and the demographics: A) percent low-income, B) percent meets and exceeds on state tests, C) unit or K-8 district, and D) district size. Significant correlations were found at the .01 level for the percent in Algebra and district type ($r = .360$). This indicates a low positive relationship between K-8 districts and the

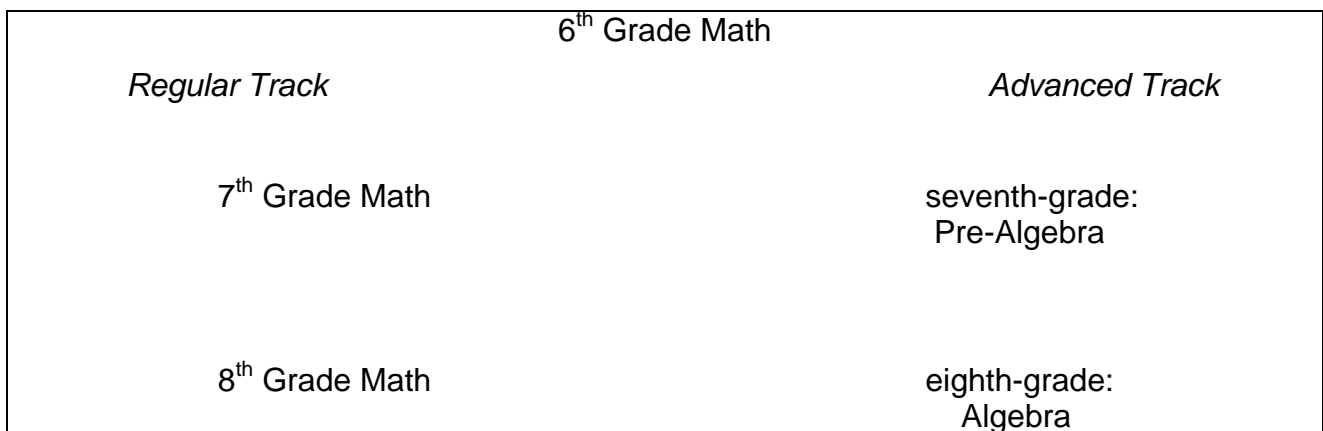
percent of students in Algebra. A second significant correlation at the .01 level was the percent in Algebra and percent meets and exceeds on state tests ($r = .412$). This indicates that there is a low positive correlation between districts where students do well on state tests and the percent of students in an Algebra course in middle school.

Trends in the data

When are students placed into the Algebra track? What is the math sequence that they take?

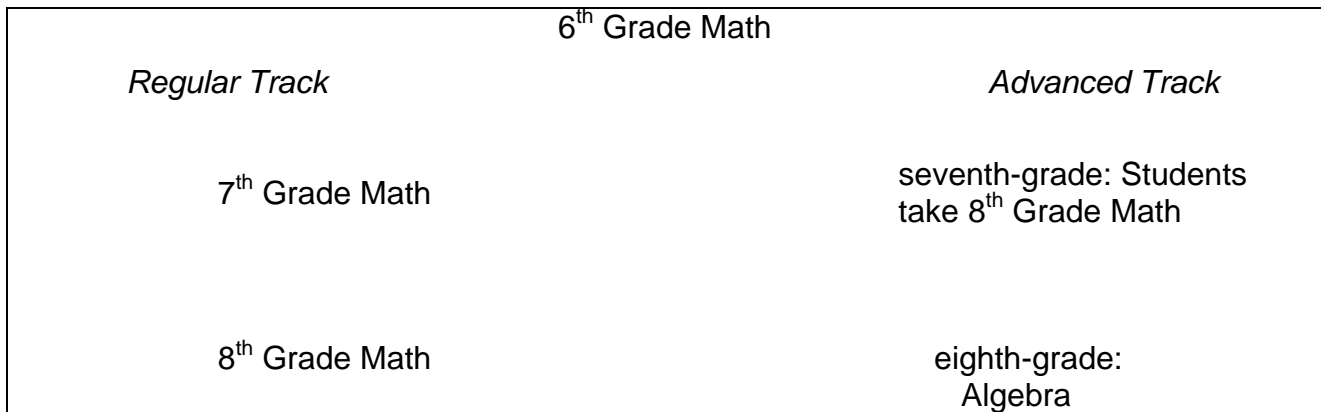
- Fifty-four percent of the districts indicated that they begin mathematics tracking in seventh-grade. The most typical course sequence described was where all students take the same mathematics courses through sixth-grade and then in seventh-grade split into 2 tracks: Regular and Advanced. The Regular Track sequence is Regular 6th, 7th, and 8th Grade Math. The Advanced Track sequence is Regular 6th Grade Math, then Pre-algebra in seventh-grade, followed by Algebra in eighth-grade. See Figure 1.

Figure 1.



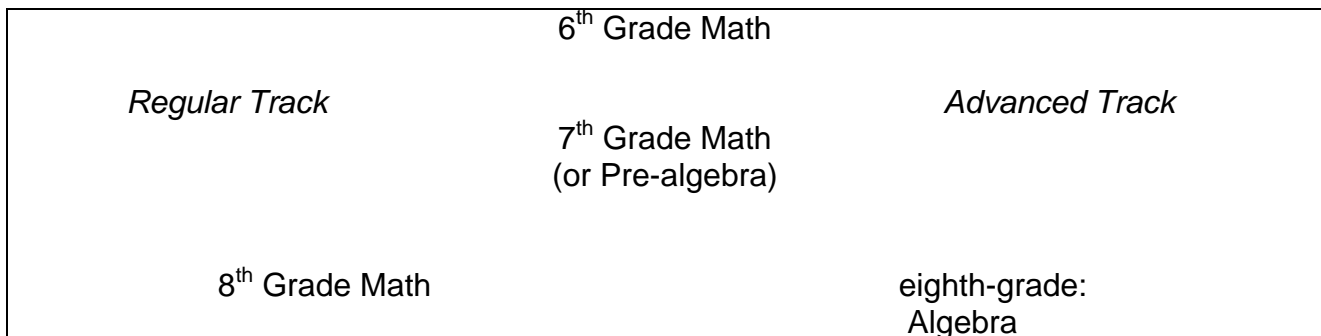
- A variation in this sequence occurs after sixth-grade. After all students take 6th Grade Math, the Advanced Track students take 8th Grade Math in seventh-grade followed by Algebra in eighth-grade. See Figure 2.

Figure 2.



- Thirty-two percent of the districts indicated that all students take the same mathematics courses through seventh-grade. Typically seventh-grade students take Regular 7th Grade Math or Pre-algebra (depending on the district) and then split into 2 tracks: Regular 8th Grade Math and Algebra. See Figure 3.

Figure 3.



- A variation on this course-taking sequence places all eighth-grade students in some type of Algebra course: Algebra or Algebra A which is the first-semester course. Eighth-grade students in Algebra A complete the sequence with Algebra B during their freshman year. See Figure 4.

Figure 4.

6 th Grade Math	
<i>Regular Track</i>	<i>Advanced Track</i>
	seventh-grade: Pre-algebra
eighth-grade: Algebra A	eighth-grade: Algebra
freshman year: Algebra B	freshman year: Geometry

- Fourteen percent of the districts indicated that they began mathematics tracking in sixth-grade. The districts that begin tracking in sixth-grade all include a “gifted,” “advanced,” or “accelerated” track. Typically, the course-taking sequence for the advanced track in sixth-grade includes: 6th Grade Advanced Math or Regular 7th Grade Math, Pre-algebra in seventh-grade and Algebra in eighth-grade (see Figure 5). Three districts described a course sequence in the gifted track. The course sequence is: sixth-grade Pre-Algebra, seventh-grade Algebra, eighth-grade Geometry (high school course).

Figure 5.

<i>Regular Track</i>	<i>Advanced Track</i>
6 th Grade Math	sixth-grade: Advanced 6 th Grade Math or Regular 7 th Grade Math
7 th Grade Math	seventh-grade: Pre-algebra
8 th Grade Math	eighth-grade: Algebra

- Fourteen percent of the districts reported having three mathematics tracks. No typical course taking pattern exists for these districts. Two districts begin tracking in sixth-grade, four begin tracking in seventh-grade, and two begin tracking in eighth-grade. By eighth-grade, half of the districts with three tracks offer: Regular 8th Grade Math, Pre-algebra, and Algebra. Three of the other districts offer Geometry as one of the three tracks.

What is the curriculum for the students who are not in the algebra program?

- When asked about the curriculum for students who are not in the algebra program, the majority of respondents gave the name of a basal textbook (or book publisher) that was being used, gave a course name such as “Regular 8th Grade Math” or “Pre-algebra,” or indicated that it was a “traditional” program. Ten respondents indicated that the district uses or was switching to the Connected Mathematics Project (CMP). Seven district representatives responded that they were “evaluating the program,” “in transition,” or “looking at this area.” Seven district representatives referred to “standards” or “standards-based” when referring to the curriculum.

What do the students do as freshmen in high school?

- The majority responded that the students successfully taking Algebra in eighth-grade typically go on to the next course, either Geometry or Algebra 2, as freshman in high school. Many indicated that students needed a “B” or better to go on to the next course. Some districts have a placement test that students must pass in order to go on to the next course. A typical high school sequence after successfully completing Algebra in eighth-grade is: Geometry, Algebra 2, Trigonometry / Pre-Calculus, Calculus / AP Calculus / AP Statistics.

- Students who do not successfully complete Algebra in eighth-grade typically repeat the course again as freshman. No districts reported a percentage of students who repeat Algebra as freshmen.
- Students who take Regular 8th Grade Math or Pre-algebra as eighth-graders follow various high school paths statewide. According to district administrators, the possibilities as freshmen are: Algebra (followed by Geometry, Algebra 2...), Algebra A (the first semester of Algebra that is taught as a full-year course and is followed by Algebra B, the second semester of Algebra that is taken sophomore year), Basic Algebra (slower than Algebra), Pre-algebra, Practical Math, Basic Math, Applied Math, or General Math.

Innovative programs

Addressing the issue of class time

- A few districts developed programs to address the issue of middle school class time. One district (68% meets & exceeds, 35% low-income, district enrollment of 450) provides an 85 minute block period for the Algebra class every other day and an additional 20 minutes daily for Algebra. This gives Algebra students 125 minutes of Algebra every two days; an average of 62.5 minutes per day. Recall that the mean number of minutes per day in middle school Algebra classes was 46.5 minutes.

According to the principal, teachers in the district identified the need for more time in Algebra class so that students could be successful. Creative scheduling was done to accommodate the need for more class time for the Algebra students. The philosophy of the district is that first-year Algebra is a foundation course and a good foundation is needed for students to be successful in higher-level mathematics. This is the first year for the additional time in class and the district is “excited about it.”

- A second district (78% meets & exceeds, 5% low-income, district enrollment of 13,325) requires students who have taken Algebra in eighth-grade to take a four week summer Algebra course in order to be in the Geometry course as freshmen. The summer Algebra course is taught by a high school teacher. This district identified a need to have more time for the eighth-grade students to solidify their understanding of algebraic skills and concepts. This program has been in effect for one year.

100% of the students in Algebra

- Two districts indicated that 100% of their students take Algebra in eighth-grade. One district (90% meets & exceeds, 1% low-income, district enrollment of 2255) has implemented all students taking Algebra for the past 8 years. The program consists of three tracks. Students in the gifted track take Algebra in seventh-grade and Geometry in eighth-grade. The standard and advanced track students take first semester Algebra in seventh-grade and second semester Algebra in eighth-grade. The standard and advanced tracks differ in that the advanced track covers information in more depth.
- A second district (76% meets & exceeds, 36% low-income, district enrollment of 335) is in its third year of having 100% of the students in Algebra as eighth-graders. In order to do this, the district aligned the curriculum with state standards, developed course outlines, changed the order of topics to address state testing, and adopted a new textbook series to add consistency to the mathematics program. According to the district's director of curriculum, the state testing, especially at the high school level, prompted these changes. To implement this program, all students, including those with IEP's, take Pre-algebra in seventh-grade. In eighth grade, the students take either first-year Algebra or first-semester Algebra A followed by either Geometry or

second-semester Algebra B in high school. The district does not offer any basic or general high school mathematics classes. For this district, the program has been very successful as measured by state testing.

Addressing the issue of teacher qualifications

- One district (43% meets & exceeds, 85% low-income, district enrollment of 426,812) is in its second year of an Algebra Initiative with a goal to “prepare elementary teachers to deliver a high-quality Algebra course to any well-prepared 8th grade student in their school.” This district collaborated with area colleges to develop a two or three course sequence that focuses on algebraic content as well as pedagogy. After completing the course sequence, teachers also must pass an examination to become certified to teach Algebra in eighth-grade.

Discussion

A number of Illinois school district administrators acknowledged that they were in the process of evaluating their middle school mathematics programs. In the *Principles and Standards for School Mathematics*, the National Council of Teachers of Mathematics (NCTM) recommends that middle school students learn “significant amounts of algebra and geometry throughout grades 6, 7, and 8” (NCTM, 2000, p.212). The NCTM *Standards* also propose that the content strands be focused and integrated as opposed to being taught as fragmented pieces of mathematics. As districts investigate making changes to their mathematics curriculum it would be wise to ask, “Are we providing a challenging, ambitious mathematics curriculum to all our middle school students?”

According to the course-taking trends seen in this study, students entering Algebra in middle school skip courses that are required for students in the Regular Track. Often this course is 7th Grade Math; occasionally it is 8th Grade Math. A course titled “Pre-

algebra” at times seems interchangeable with 7th Grade Math. Pre-algebra is also a course that, in some districts, is taken by students in the Algebra track but not taken by students in the Regular track.

These trends raise many questions. Are these courses, 7th Grade Math, 8th Grade Math and Pre-algebra, substantially different courses? Do they introduce new material? Do they facilitate students’ development of geometrical and algebraic understanding so that the students who do take these courses are prepared to be successful in Algebra and higher level mathematics? What kinds of courses do prepare students to be successful in Algebra?

Confrey discusses four components that facilitate successful learning of algebra, “the importance of a functional approach with contextual problems, the use of multiple representations, the importance of student methods and interactions, and the systemic or community approach to change” (Confrey, 1998, p.37). Standards-based mathematics programs incorporate these elements. Reyes et. al. found that students who used standards-based middle school mathematics curriculum materials demonstrated higher achievement on the Missouri state tests (MAP) compared to similar control-group students. Specifically, students scored significantly higher in the areas of algebra and data analysis (Reys, Reys, Lapan, Holliday, & Wasman, 2003). When discussing how to close the mathematics minority achievement gap, Holloway notes that success for all students in mathematics can only occur when “schools provide students with a rich standards-based curriculum, aligned and articulated across grade levels, that supports high expectations for all students” (2004, p.86). A number of Illinois school district administrators mentioned aligning curriculum to standards, or indicated that they used standards-based curriculum material. There is a need to investigate the prevalence,

implementation, and results of using standards-based curriculum materials in Illinois school districts.

Conclusion and Recommendations

As school districts in Illinois make decisions about the middle school mathematics curriculum, a number of issues arise. Changes made in the middle school curriculum must be supported by the K-5 mathematics curriculum. Districts need to examine the degree to which the emphasis is on developing mathematical understanding as opposed to developing procedural skills in the elementary grades. In the K-5 curriculum, all mathematics content strands, including algebra, must be developed (NCTM, 2000).

The issue of tracking also needs to be addressed. According to Graeber (1995), “Researchers agree that grouping by ability or by achievement at the elementary and middle school level is undesirable.” In an effort to provide a challenging middle school mathematics curriculum, the trend among Illinois middle schools is the elimination of multiple tracks or postponement of tracking.

Two issues came to the forefront in this study: the criteria used to place students into Algebra and the time constraint in middle school Algebra classes. With respect to the criteria used to place students into Algebra, it seems reasonable to suggest that some type of algebra readiness test be used to accurately identify students. If teacher recommendation is used, districts should develop a teacher checklist based on those student characteristics that research supports as being indicators of success in Algebra.

As seen in this study, many middle school students in Algebra have less class time than their high school counterparts. All efforts should be made to accommodate a longer class period for middle school students in Algebra. In many cases this will take creative scheduling on the part of the middle schools.

This study lays a foundation by describing the frequencies and trends in Illinois with respect to offering an Algebra course to middle school students. In reality, more questions arose from this study than answers. In addition to investigating the use of standards-based curriculum, the following questions should be addressed:

- What are seventh and eighth-grade students who are not in Algebra really studying?
- Is there a need for a Pre-algebra class? If so, why is it not offered to all students?
- Does the course sequence of Pre-algebra followed by Algebra integrate or isolate the mathematics content strands?
- What are districts doing K-8 to prepare students to be successful in Algebra and higher level mathematics?
- There is a need to collect course-taking data with respect to students who took Algebra in middle school. How many students repeat first year Algebra? How many take four additional years of high school mathematics?

As a final note, Cathy Seeley, president of the National Council of Teachers of Mathematics, asks educators to seriously consider the reasons for offering algebra to middle school students. She suggests that “Far more important than *when* students study algebra is *what* they study and *whether* they are taught in a way that helps them learn it and use it for the long term” (Seeley, 2005, p.3).

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APPENDIX

DISTRICT _____ Phone _____

Contact: _____

ISBE Algebra Study - Interview Protocol

1. Does your district offer an algebra course to 7th / 8th grade students? YES NO

2. How many middle or jr. high schools does your district have? _____

3. When are students placed into the “algebra track?” What is the math sequence that they take?

4. What criteria are used to place students into the algebra course?

Rubric	Matrix	Checklist	
Algebra readiness test		Standardized test	Math grades
Teacher recommendation		Parent recommendation	ISAT math score

Other:

5. Approximately what percent of your students take algebra? _____

6. What is the curriculum for the students who are not in the algebra program?

7. How is the algebra course structured?

Equivalent to high school class Longer class periods Taught as an early bird class

Regular class period that is shorter than the high school class

8. Do students receive high school credit for the class? YES NO

9. How successful is the algebra program? How do you know? (Clarify: What do the students do as freshmen in high school?)

10. Other thoughts or comments.