
Supplemental Analysis of Achievement Data (over time) on Iowa Students Who Are Deaf or Hard of Hearing



FFY 2004 (2004-2005) through FFY 2008 (2007 – 2008)

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Executive Summary

In partnership and with guidance from the Hearing Coordinating Council, the Iowa Department of Education (IDE) has engaged in analyses of service provision and academic achievement of students in Iowa who are Deaf or Hard of Hearing. Questions around longitudinal performance and around performance of students with cochlear implants remained unanswered after the October 2008 meeting.

This report addresses questions around performance over time, and about performance of students with cochlear implants, in Reading and Mathematics as measured by the Iowa Test of Basic Skills (Grades 3-8) or the Iowa Test of Educational Development (Grade 11).

The National Percentile Rank presents some issues around appropriateness of analyses. In addition, longitudinal data are difficult to analyze because some children have data in every grade starting from Grade 4, others have data in every grade starting in Grade 6, and so forth.

The IDE was conservative in their analyses, taking one cohort and examining trend, and using visual analyses more so than statistical manipulation.

Results show:

- Different performance for Reading and Math
- Reading:
 - Students starting below proficient tend to remain below proficient
 - About one-half of the students who were proficient at time 1 were not proficient at time 3, although students starting at or above the 60th percentile tend to score proficient at each testing point
 - Students advanced in Reading remained proficient but performance declined over time out of the advanced range
- Mathematics:
 - Students starting below proficient tend to remain below proficient
 - About one-third of the students who were proficient at time 1 were not proficient at time 3
 - Students starting in the advanced range, while small in number, on average remained in the advanced performance level over time, although some students showed significant declines in performance to below proficient levels at time 2 and then back into the proficient range at time 3
- When all students in the sample are combined by grade, in Reading:
 - Performance goes down between Grades 3 and Grade 11

- The percentage of students scoring proficient or higher goes down after Grade 5
- When all students in the sample are combined by grade, in Mathematics:
 - Performance goes down between Grades 3 and Grade 11
 - The percentage of students scoring proficient or higher goes down after Grade 5
 - There is less drop off in Mathematics when compared to Reading
- Degree of hearing loss does not predict performance: students with more significant losses were not, on average, lower performing from students with less significant losses
- Regardless of degree of hearing loss, performance declined over time
- Students with implants were not more proficient as a group compared to students without implants
- Students with implants were lower performing on average in Reading, but their declines over time were less severe than students without implants
- On average, both students with and without implants were more proficient in Mathematics. Students with implants were lower performing on average but showed more improvement over time.

Introduction

Data on *Iowa Students who are Deaf or Hard of Hearing* (Iowa Department of Education, 2008), and the *Addendum to Data on Iowa Students who are Deaf or Hard of Hearing* (Iowa Department of Education, 2008), were presented to the Hearing Coordinating Council in Fall of 2008.

Additional questions about longitudinal performance were raised by the Hearing Coordinating Council.

This report summarizes how the data were analyzed, and presents results over time (longitudinal for select cohorts) and by grade (cross-sectional).

Data Sources Used

Achievement data (national percentile rank in Reading Comprehension and national percentile rank in Math Total), for 2004-2005, 2005-2006, 2006-2007, and 2007-2008 were matched with students from the initial data pull (N=3,231 with IEPs in the 2006-2007 school year).

Students were dropped from the sample if (a) students did not have data in the degree of hearing loss field, or (b) students did not have achievement data for any of the years for which data were drawn.

Analysis

Several options were considered for analysis of the data. The original question from the Hearing Council was about performance over time.

A complication was that the data were in national percentile ranks. Percentile ranks are ordinal data (capture relative status like 1st, 2nd, 3rd place) but are not equal interval in nature (the gap between the 5th and 15th percentile is larger than the gap between the 45th and 55th percentile, even though the difference is 10 points. This phenomenon occurs because percentile ranks are based on the normal curve and the area under the normal curve at a given point on the x-axis. Hence, it is very difficult and somewhat inappropriate to average percentile ranks or to try and engage in anything but descriptive analyses around modes, medians, and general distribution of the percentile ranks). Hence, our analyses are conservative, and we engaged in analyses that we felt (a) contributed to an understanding of the answer to the general question about growth over time, and (b) were defensible applications of a given statistical metric.

We operationalized performance over time in three ways.

The first analysis was, "how much growth did individual students show over time." We had several options for conducting this analysis: have a Time 1 data point for each student without controlling for their grade level, a Time 2 data point, a Time 3 data point,

and a Time 4 data point. This “aggregate” of data without controlling for grade was rejected because we have no data to support that growth over time would be the same if the data started at Grade 4 and ran through Grade 7 or if the data started at Grade 9 and ran through Grade 12: the grade from which trend is generated might be a very important covariate.

Hence, the decision was made to provide a longitudinal analysis first for the class of 2013, and then seek additional input from the Hearing Council. Even this analysis presented with challenges. First, because we really ought not to “pool” the percentile ranks, we really could not come up with “average” trend. We decided then to look at general growth of each student, using a graph of each student’s performance over time. This would allow the Council to see for themselves the shape of the students’ trends as an aggregate. In order to have graphs that were interpretable, that were not “spaghetti,” we had to create different levels of initial performance. Hence, we have three depictions for Reading, and three for Math. The first graph is the performance of students whose Grade 4 performance was not proficient. The second graph is performance of students whose Grade 4 performance was proficient. The third graph is performance of students whose Grade 4 performance was advanced.

We also were able to pool data by grade: performance of all children in the pool who had Grade 3 achievement data, all children who had Grade 4 achievement data, all children who had Grade 5 achievement data, and so forth. We did not include Grades K, 1, 2, 9, 10, and 12 because schools are not required to report academic performance at those grade levels. For this aggregate analysis, we can examine the general shape of the distribution and see if, from Grade-to-Grade, the distributions look different. General group trends can be observed, but the data do not represent individual change. For this analysis, we created hi-low bar charts. This analysis was borderline appropriate because we do rank order the percentile ranks to determine the percentile rank that represented performance better than 10 percent of the range of scores at each grade level tested, better than 25 percent of the range of scores at each grade tested, 50 percent, 75 percent, and 90 percent. These scores are depicted in box plots, and the spread of the box plots relative to the proficiency line are informative in terms of addressing the question, at each grade level, what percentage of students were above or below the proficiency mark, and by how much?

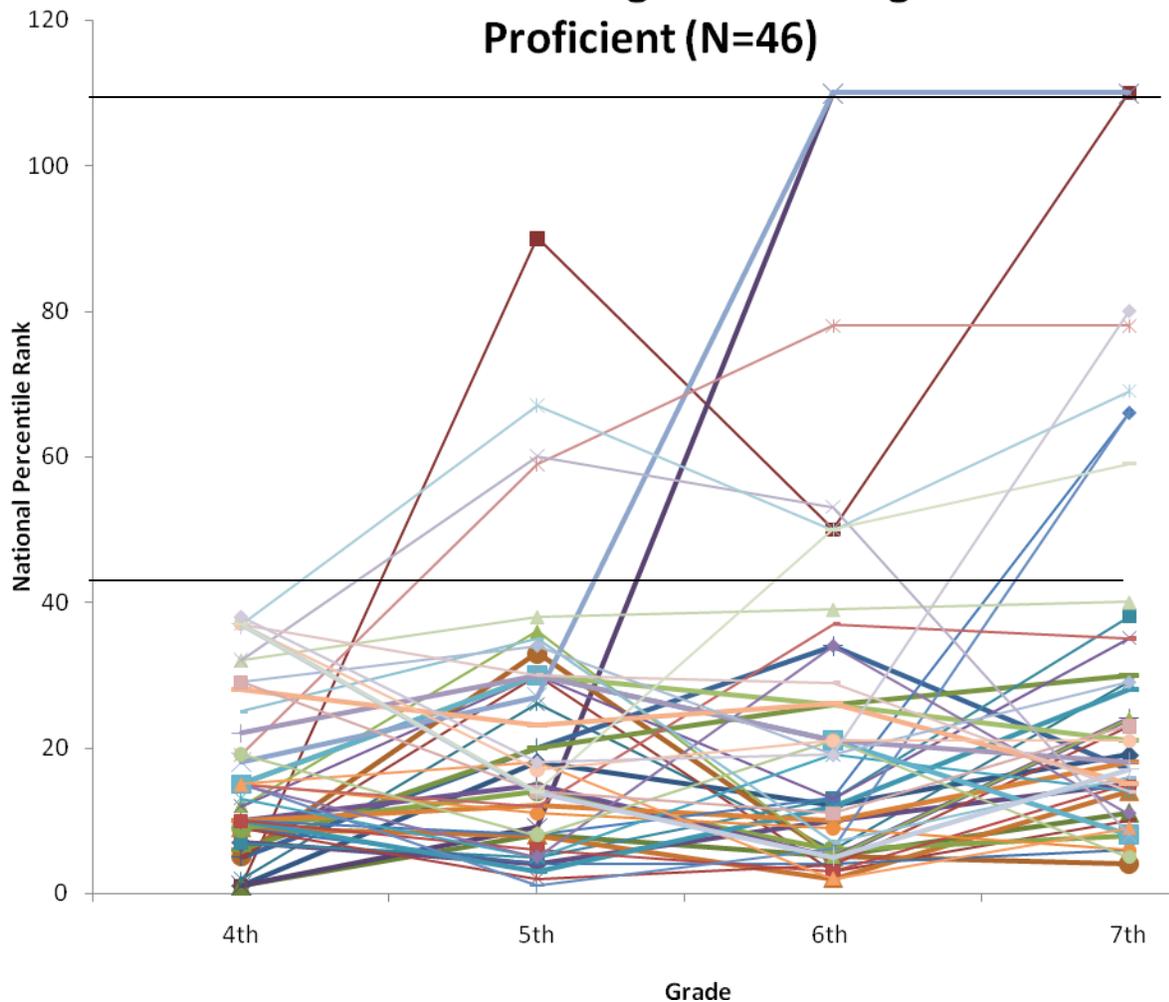
We faced another challenge in that we anticipated that the Council would want information on academic performance over time by degree of hearing loss. In order to conduct this analysis, we operated under the assumption that it would be, as in the first longitudinal analysis, important to control for the grade from which the trend generated. In addition, because in theory we should not statistically manipulate percentile ranks, we decided as a compromise that a slope generated using each child’s longitudinal data, would give us a very rough measure of improvement. By generating a slope index and an intercept for each child, we get a rough estimate of their general performance level in percentile rank, and the rate and direction of their performance (steeper or flatter, improving or declining). We then categorized children by degree of hearing loss in the better ear, and found the median percentile for children in that category of loss. This

does not necessarily represent performance of the median student-it represents the point at which one-half of the percentile ranks were higher, and one-half were lower, at that grade level. The class of 2013 was used. Hence, we have more data on this metric for other cohorts, but did not report out until we received further guidance from the Hearing Council. In addition, we decided to take some statistical liberty and take an average of slope and an average of intercept, by degree of hearing loss. This analysis gives a sense of the average direction and general performance by each group, but beyond that should be interpreted with caution.

Section I. Performance over Time by Cohort

Because percentile ranks cannot be statistically manipulated, in order to depict growth, each student's trend over time was graphed. However, in order to reduce the clutter in the graphs, students were selected based on where their Grade 4 performance was in 2004-2005

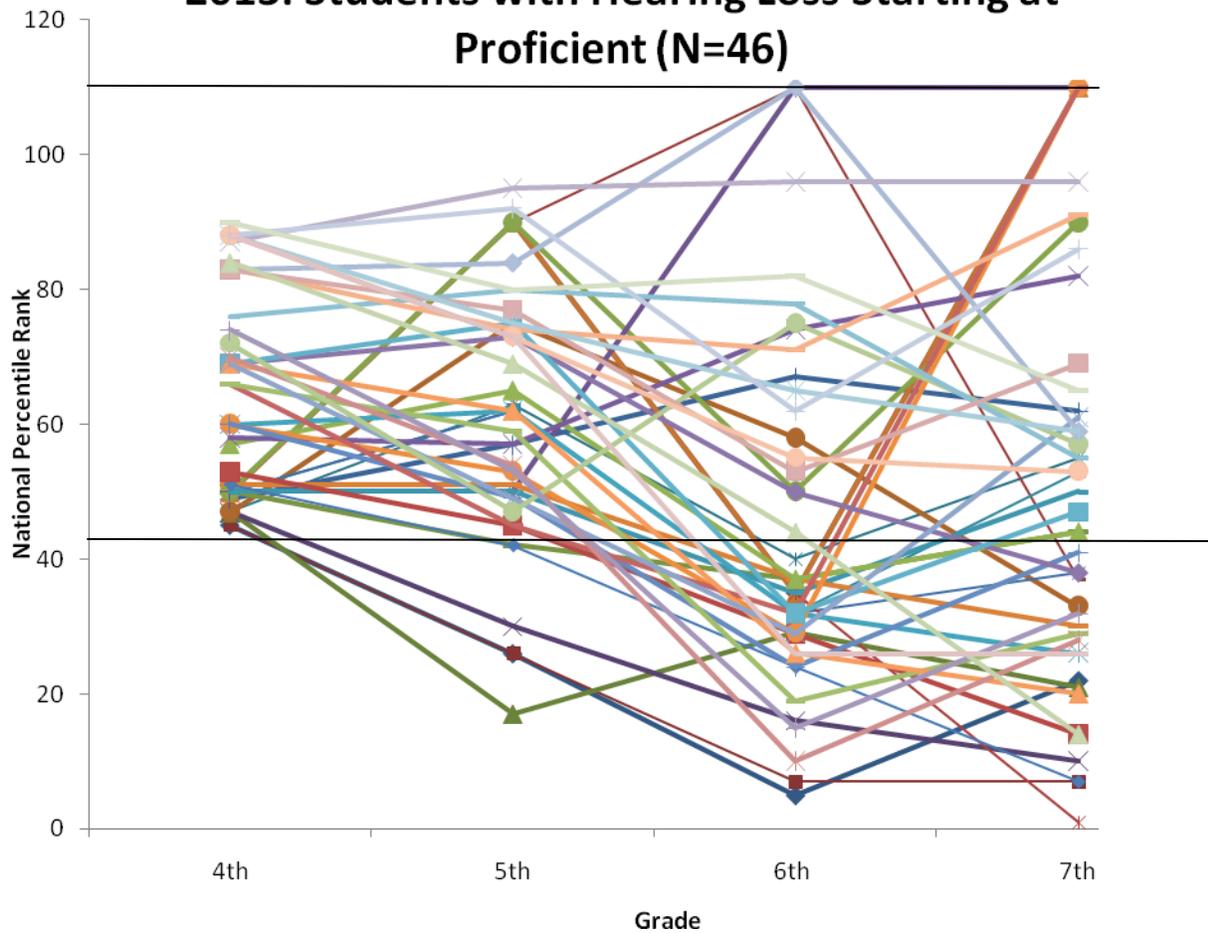
Longitudinal Performance in Reading, Class of 2013. Students with Hearing Loss Starting at Below Proficient (N=46)



Note: "110" was coded for missing data.

Each line represents an individual student. Forty-six students had Grade 4 performance (2004-2005) below the 41st percentile. Of the six students whose performance in Grade 7 (2007-2008) was above the 41st percentile, four students generally improved over time, while two students improved substantially only between Grades 6 and 7.

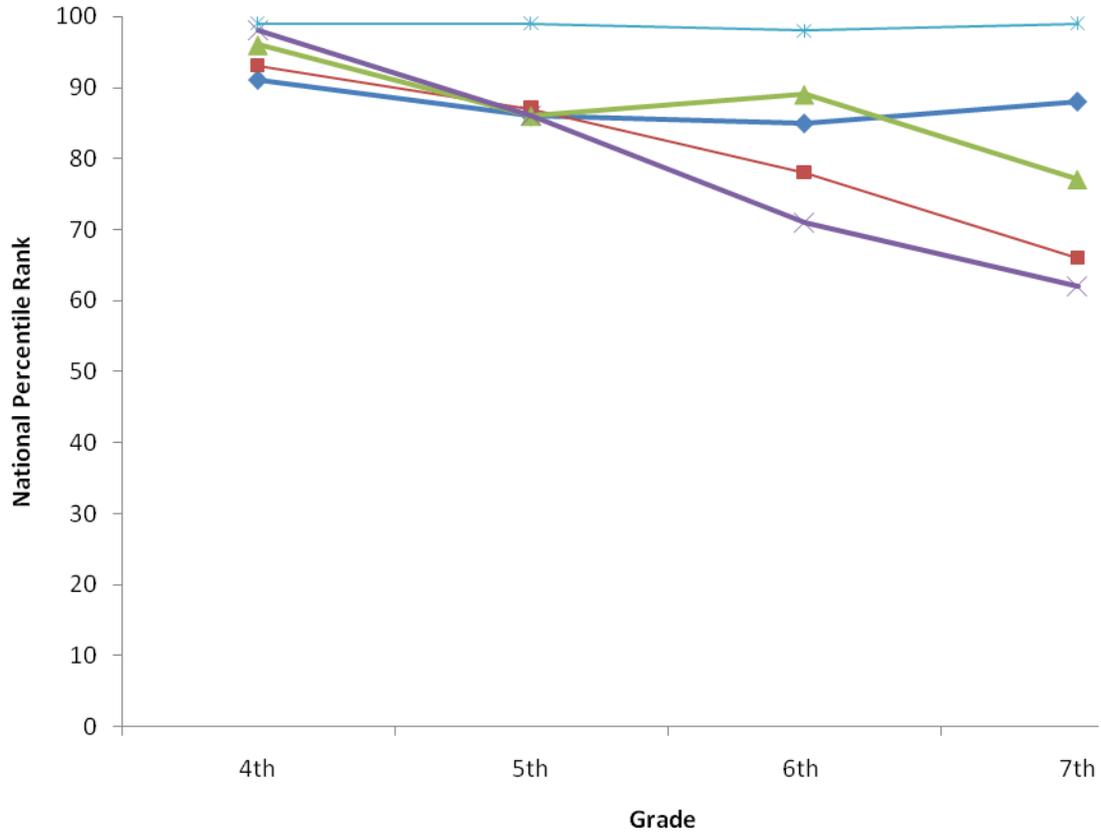
Longitudinal Performance in Reading, Class of 2013. Students with Hearing Loss Starting at Proficient (N=46)



Note: "110" was coded for missing data.

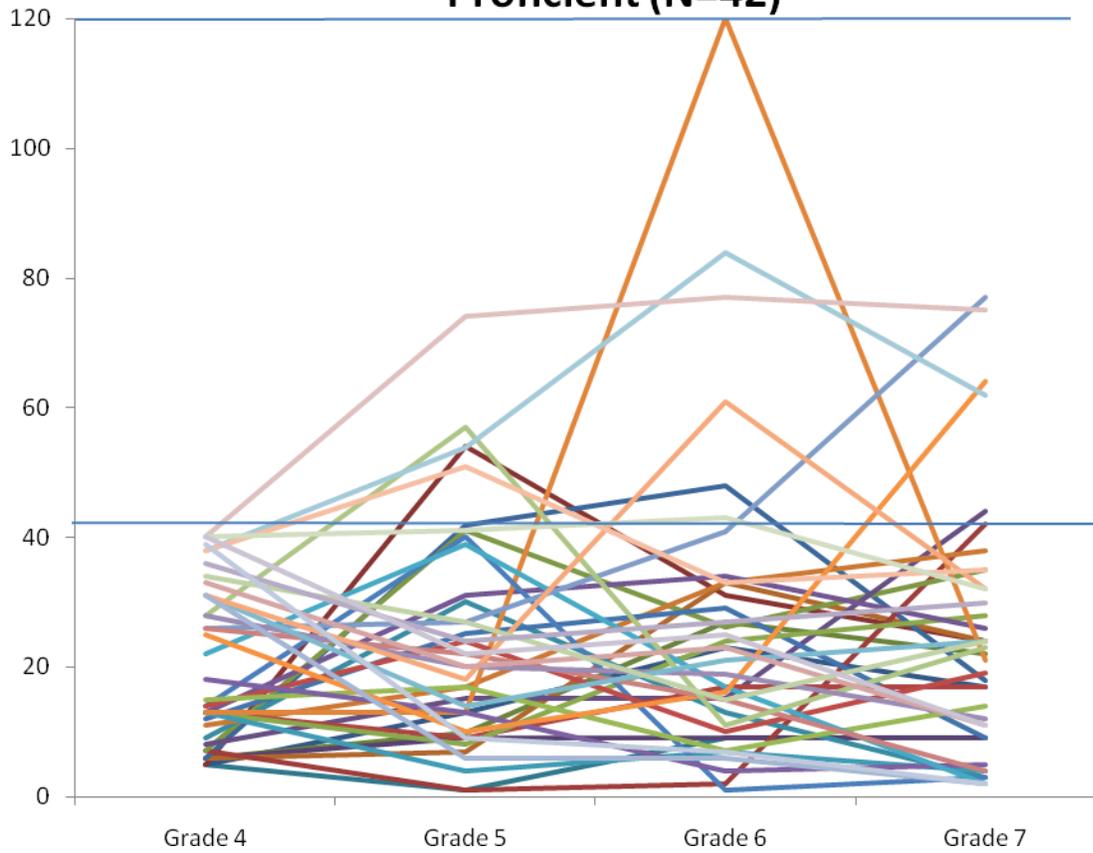
Each line represents an individual student. Forty-six students had Grade 4 performance (2004-2005) at or above 41st percentile. Generally, students starting above the 60th percentile remained above the 41st percentile over time. Other students had considerable variability in performance, with 19 scoring not proficient by Grade 7.

Longitudinal Performance in Reading, Class of 2013. Students with Hearing Loss Starting at Advanced (N=5)



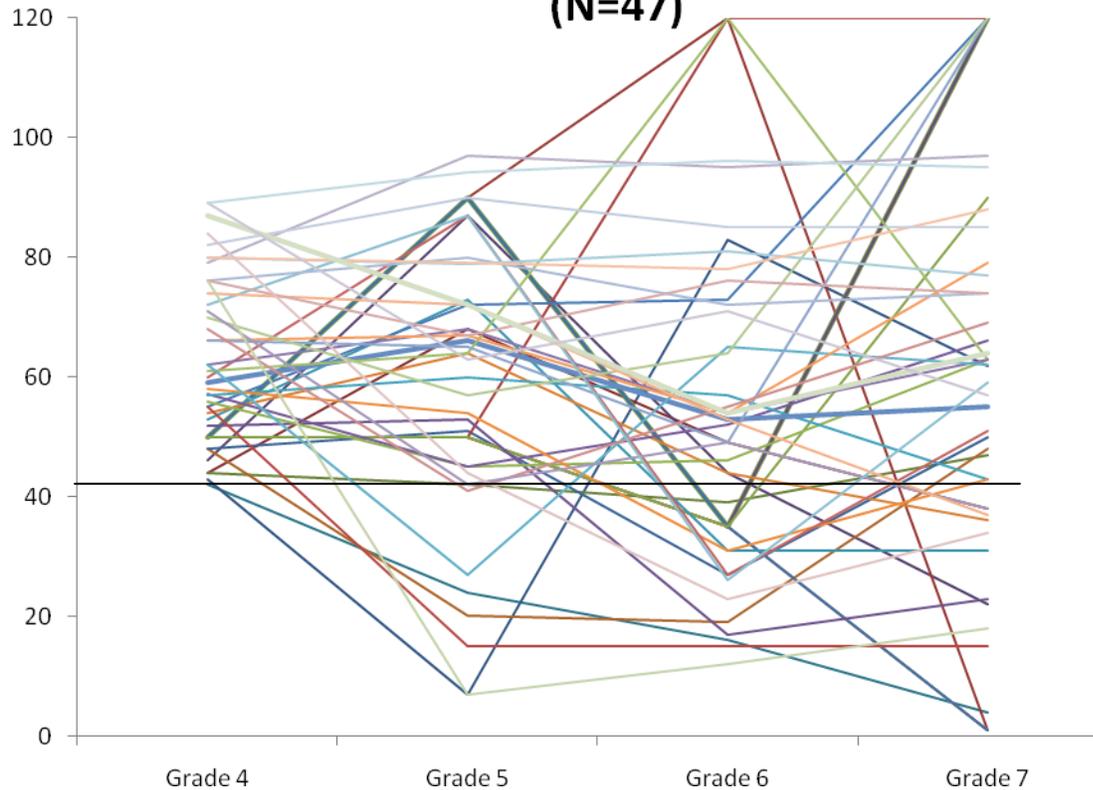
All students advanced in Grade 4 were above proficient in Grade 7 although four of five students moved from the advanced range to the proficient range.

Longitudinal Performance in Math, Class of 2013. Students with Hearing Loss Starting at Below Proficient (N=42)



Most of the students starting below proficient in Grade 4 in 2004 ended up below proficient in Grade 7 in 2007. Note: 120 represents missing data.

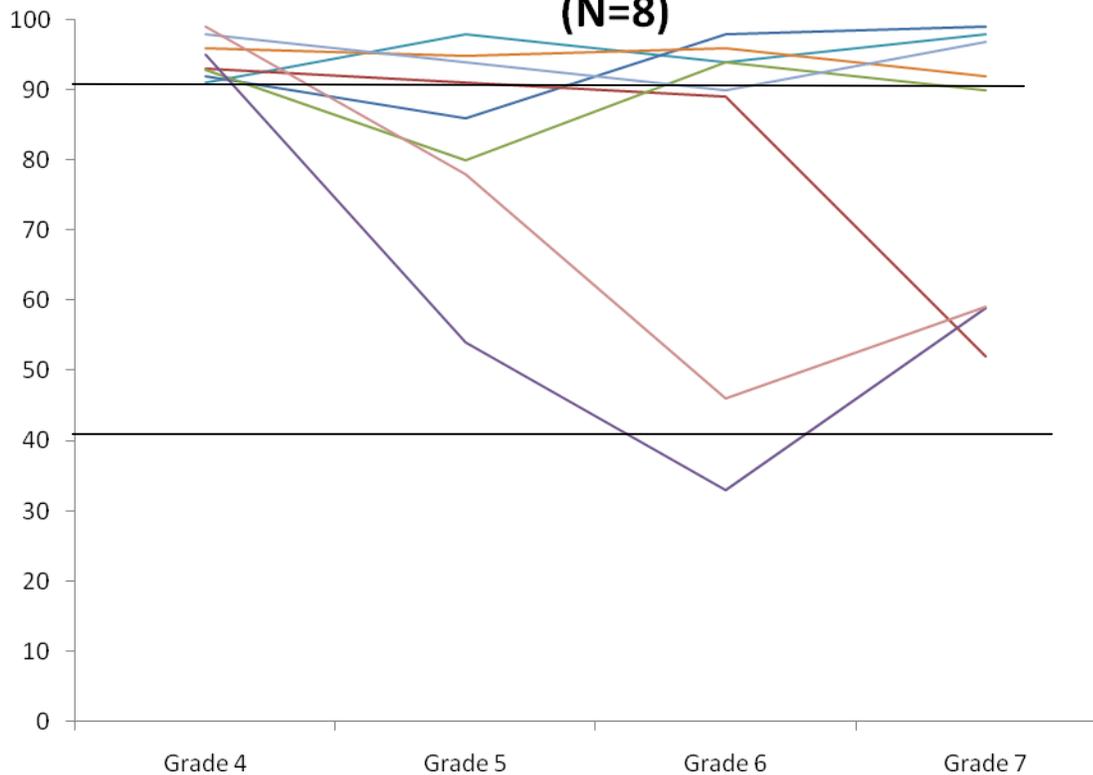
Longitudinal Performance in Math, Class of 2013. Students with Hearing Loss Starting at Proficient (N=47)



Note: the scores of 120 represent missing data.

Most of the students in Grade 4 in 2004 ended up proficient in Grade 7 in 2007. Eleven students scored proficient in Math in Grade 4 and were not proficient in Math in Grade 7.

Longitudinal Performance in Math, Class of 2013. Students with Hearing Loss Starting at Advanced (N=8)



All students advanced in Grade 4 in 2004 remained proficient in Grade 7 in 2007, although one student fell to below basic in Grade 6 in 2006 (the light purple line).

Section III. Performance Over Time by Grade (Aggregated)

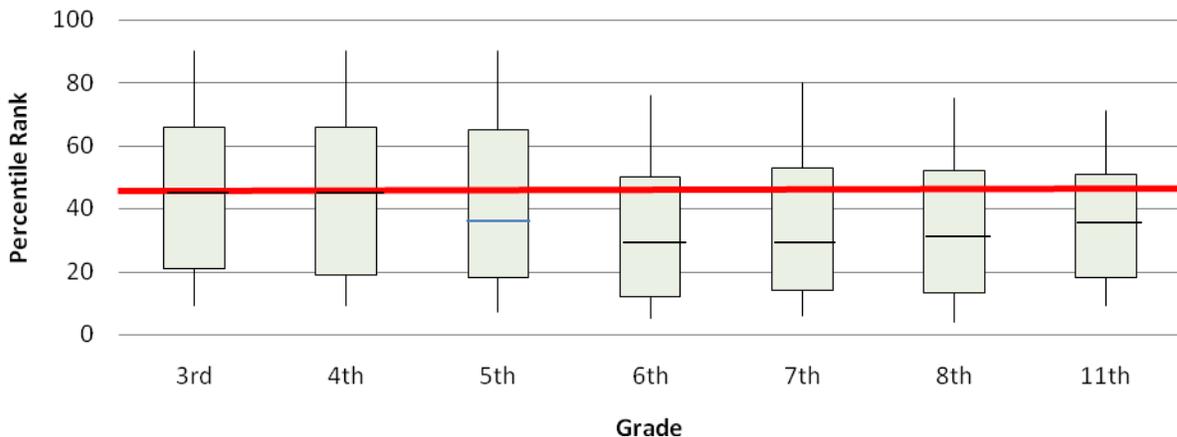
The chart below represents data aggregated by grade across school years. For example, data on Grade 3 Reading in 2004-2005 was combined with data on Grade 3 Reading in 2005-2006, 2006-2007, and 2007-2008. The data aggregated were national percentile ranks, and data were aggregated for Grades 3, 4, 5, 6, 7, 8, and 11. The data are not longitudinal by cohort, and statistical manipulation of these data is questionable. Nevertheless, the graph depicts the shape of the distribution of scores by grade collapsed over time.

The hi-lo graph is interpreted using the following rules:

- The low point of the vertical line for each grade represents the 10th percentile; the high point of the vertical line for each grade represents the 90th percentile.
- The shaded box represents the 25th through 75th percentiles.
- The solid line represents the 50th percentile (the point at which one-half of the students are above or below).

When in Grades 3 and 4, one-half of the students scored above the proficiency mark (41st percentile), while when in Grades 5, 6, 7, 8, and 11, more than one-half of the students scored below proficient. When *No Child Left Behind* is realized, all distributions of all subgroups would be above the 41st percentile (the low point of the vertical line would be well above 41 on the Y-axis).

Distribution of Reading Percentile Ranks by Grade (Students Aggregated by Grade not Cohort)



Sample Sizes: Grade 3=197, Grade 4=383, Grade 5=372, Grade 6=362, Grade 7=364, Grade 8=232, Grade 11=42

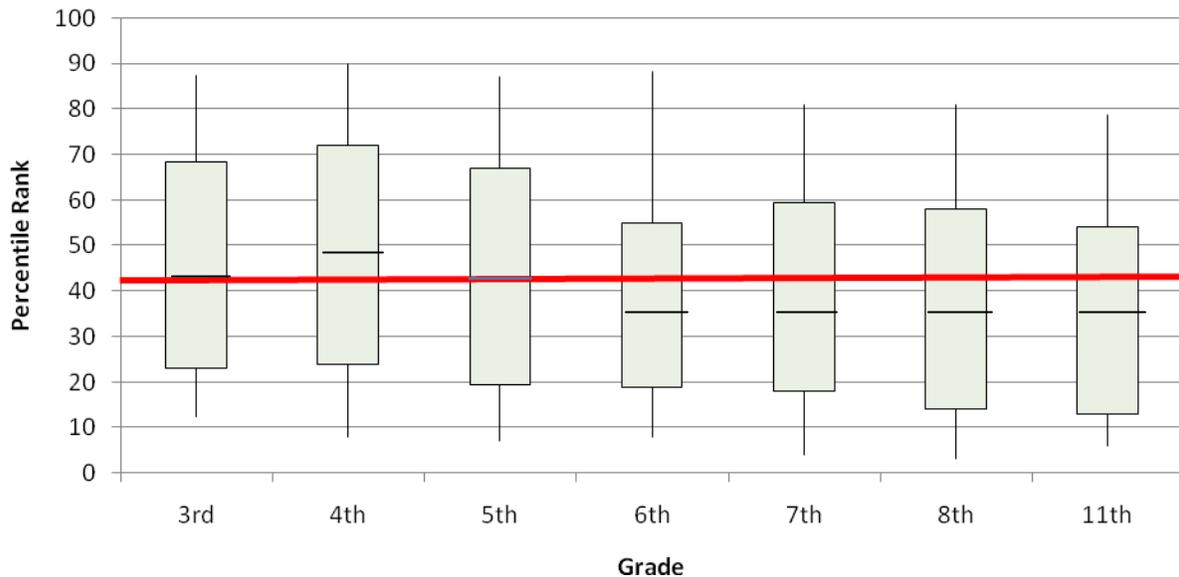
The chart below represents data aggregated by grade across school years. For example, data on Grade 3 Math in 2004-2005 was combined with data on Grade 3 Math in 2005-2006, 2006-2007, and 2007-2008. The data aggregated were national percentile ranks, and data were aggregated for Grades 3, 4, 5, 6, 7, 8, and 11. The data are not longitudinal by cohort, and statistical manipulation of these data is questionable. Nevertheless, the graph depicts the shape of the distribution of scores by grade collapsed over time.

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- The shaded box represents the 25th through 75th percentiles.
- The solid line represents the 50th percentile (the point at which one-half of the students are above or below).

In Grades 3, 4, and 5, one-half of the students were above the proficiency mark (41st percentile), while in Grades 6, 7, 8, and 11, more than one-half of the students scored below proficient. When *No Child Left Behind* is realized, all distributions of all subgroups would be above the 41st percentile (the low point of the vertical line would be well above 41 on the Y-axis).

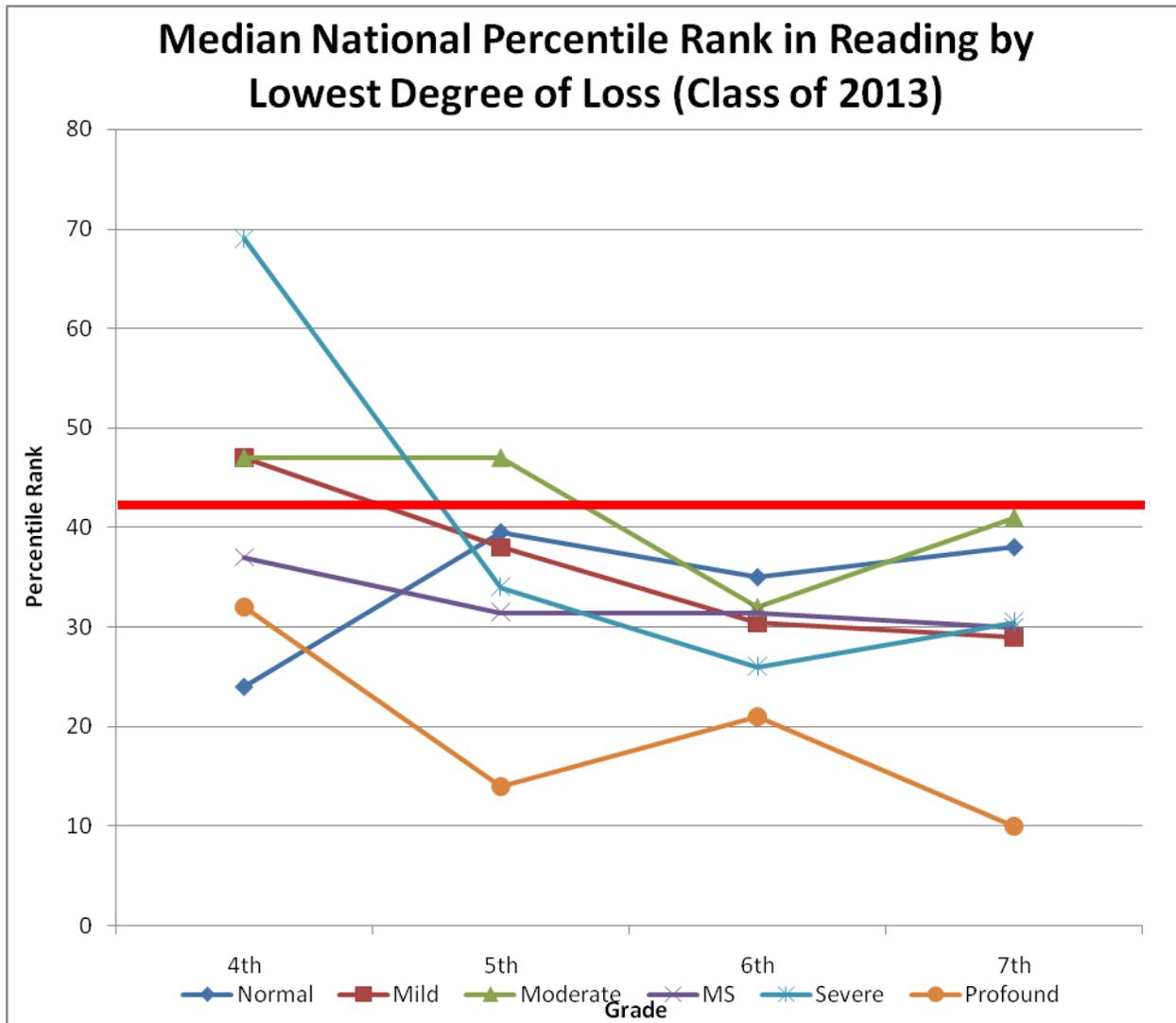
Distribution of Math Percentile Ranks by Grade (Students Aggregated by Grade not Cohort)



Sample Sizes: Grade 3=196, Grade 4=384, Grade 5=359, Grade 6=359, Grade 7=363, Grade 8=233, Grade 11=38

Section IV. Performance Over Time by Degree of Hearing Loss

Students were coded by the lowest degree of hearing loss in either ear. The median percentile ranks for each group are graphed below. The performance represents the median of the same group of students in Grades 4 (2004-2005) through 7 (2007-2008). Forty-first percentile represents proficient performance; however, the data do not reflect “the median student.”

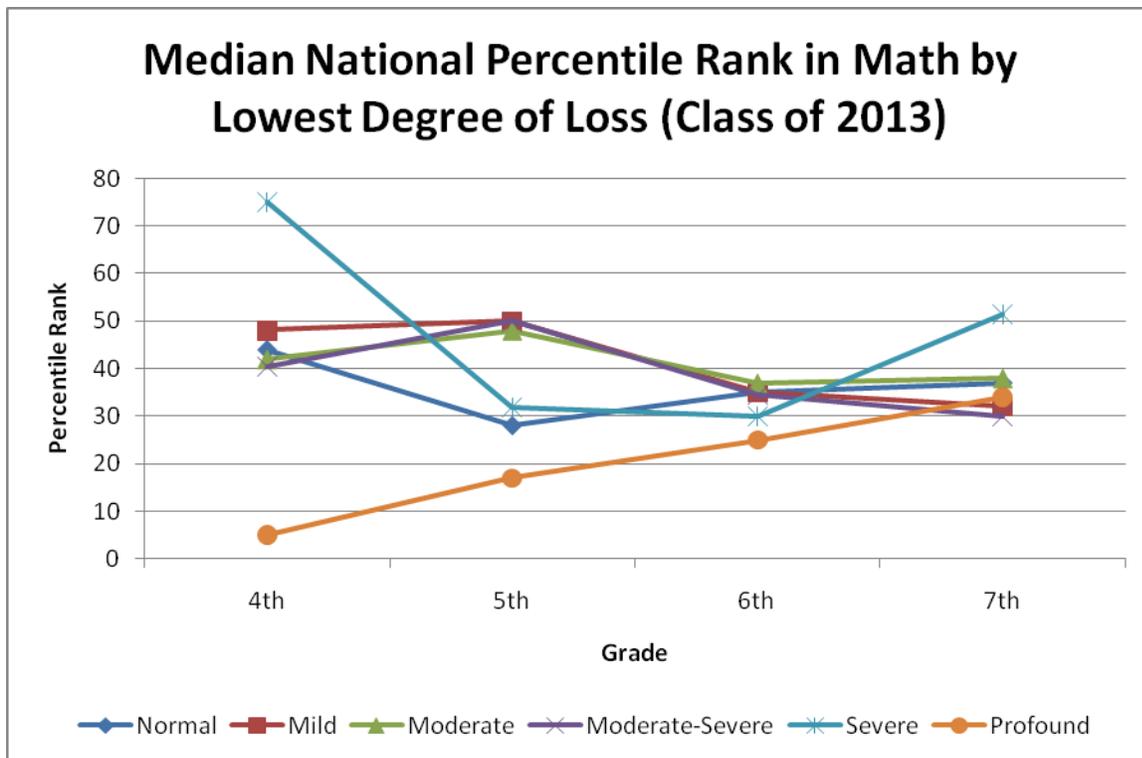


Slopes of performance for each student and the Y-intercept for each student were also calculated. The slope indicates the direction of performance over time, with a positive slope representing improved performance and a negative slope representing declining performance. The intercept represents the point on which the slope passes through the Y-axis. The combination of slope and intercept is informative in that the two statistics taken together provide information about general performance on the Y-axis (achievement) but add information about the general direction of performance (improving or declining).

The average of slopes for individuals within each degree of hearing loss, and the average of intercepts, are summarized in the table below.

Lowest Degree of Loss	Average of Slope	Average of Intercept
Normal	-1.19	44.66
Mild	-3.33	45.44
Moderate	-4.77	58.08
Moderate-Severe	-0.43	44.97
Severe	-2.1	42.58
Profound	5.99	14.67
Grand Total	-2.12	45.60

The data depicted in the graph on Page 12 and the data in the table above suggest that groups of students with differing degrees of hearing loss perform differently on the Iowa Tests. Students with normal hearing in at least one ear are not the highest performing students, nor do these students have the highest average growth. Most groups' performance declined over time (from Grade 4 to Grade 7), and the students with profound loss, while small in number, were both the lowest performing and showed the most gain on average.



Row Labels	Average of Math Slope	Average of Math Intercept
Normal	-2.99	49.11
Mild	-4.34	56.42
Moderate	-1.28	47.18
Moderate- Severe	-1.67	43.98
Severe	0.77	40.93
Profound	8.47	6.31
Grand Total	-2.18	47.97

The trend analysis depicts that, for one cohort of students with hearing loss, as they progress through school, achievement declines in both Reading and Math.

Section V. Proficient/Not Proficient by Implant Status

Overview

Teachers of Students who are Deaf or Hard of Hearing provided State Identification Numbers for students known to have had cochlear implants. Data on proficiency in Reading and Math were analyzed two ways. First, a straight percentage, for each school year starting in 2004-2005, of students proficient by implant status, was completed. This analysis was necessary because of the small numbers of students with implants and the variance in numbers of students “starting” at a given grade level. The second analysis was an analysis of trend over time without considering grade level at entry point.

Reading

The percentage of students, by presence or absence of cochlear implant, who were proficient, is summarized in each table below. Each table is a school year.

School Year 2004-2005

Implanted?	Not Proficient	Proficient	Total with Data
No	58 (48.7%)	61 (51.3%)	119
Yes	1 (33.3%)	2 (66.7%)	3

School Year 2005-2006

Implanted?	Not Proficient	Proficient	Total with Data
No	338 (53.3%)	296 (46.7%)	634
Yes	19 (76.0%)	6 (24.0%)	25

School Year 2006-2007

Implanted?	Not Proficient	Proficient	Total with Data
No	429 (59.3%)	294 (40.7%)	723
Yes	20 (66.7%)	10 (33.3%)	30

School Year 2007-2008

Implanted?	Not Proficient	Proficient	Total with Data
No	354 (56.8%)	269 (43.2%)	119
Yes	22 (73.3%)	8 (26.7%)	30

Trend Examination:

Implanted	N	Average of Reading Slope (desired is 0 or greater)	Average of Reading Intercept (41 is proficient)
Yes	31	-0.15	33.29
No	750	-1.16	42.64
Grand Total	781	-1.12	42.26

Students with implants started below proficient on average but lost about .5 percentile ranks across four years. Students without implants started proficient on average and lost about four percentile ranks across four years.

Summary:

The data overall suggest that students with implants perform more poorly on Reading when compared to students without implants, but students with implants do not “lose” test performance as rapidly as students without implants.

Math

The percentage of students, by presence or absence of cochlear implant, who were proficient, is summarized in each table below. Each table is a school year.

School Year 2004-2005

Implanted?	Not Proficient	Proficient	Total with Data
No	52 (44.1%)	66 (55.9%)	118
Yes	1 (25.0%)	3 (75.0%)	4

School Year 2005-2006

Implanted?	Not Proficient	Proficient	Total with Data
No	316 (50.1%)	315 (49.9%)	631
Yes	14 (56.0%)	11 (44.0%)	25

School Year 2006-2007

Implanted?	Not Proficient	Proficient	Total with Data
No	381 (52.8%)	341 (47.2%)	722
Yes	15 (50.0%)	15 (50.0%)	30

School Year 2007-2008

Implanted?	Not Proficient	Proficient	Total with Data
No	316 (50.6%)	309 (49.4%)	625
Yes	13 (43.3%)	17 (56.7%)	30

Trend Analysis

Implanted	N	Average of Math Slope (0 or steeper is better)	Average of Math Intercept (41 is proficient)
Yes	31	3.57	34.01
No	749	-0.07	42.81
Grand Total	780	0.07	42.46

Students with cochlear implants start at a lower performance level than students without implants, but improve at a much higher rate than student without implants. Students with implants start on average below proficient but improve about 12 percentile ranks over the course of four years, while students without implants start on average above proficiency and maintain at that level across four years.

Summary:

The performance of students with cochlear implants is not as discrepant from performance of students without implants, in Math. The percentages of students with implants who are proficient in Math each year, while a small number, is about the same proportion of students proficient as students without implants. In addition, when trend and intercept of performance is considered, students with implants, while lower performing on average at time 1, show more growth over time when compared to students without implants.