This study examines reading and mathematics academic growth of deaf and hard-of-hearing students instructed through an American Sign Language (ASL)/English bilingual model. The study participants were exposed to the model for a minimum of 4 years. The study participants’ academic growth rates were measured using the Northwest Evaluation Association’s Measure of Academic Progress assessment and compared with a national-normed group of grade-level peers that consisted primarily of hearing students. The study also compared academic growth for participants by various characteristics such as gender, parents’ hearing status, and secondary disability status and examined the academic outcomes for students after a minimum of 4 years of instruction in an ASL/English bilingual model. The findings support the efficacy of the ASL/English bilingual model.

American Sign Language/English Bilingual Education

American Sign Language (ASL)/English bilingual instruction for deaf students is not a new concept. In the 1970s, a number of papers and presentations encouraged the use of ASL/English bilingual education with deaf students, (Erting, 1978; Kannapell, 1974; Stokoe, 1975; Woodward, 1978), but it was not until the late 1980s and early 1990s that schools began implementing this type of instruction and researchers began examining the relationship between the two languages. Thus far, even when researchers have tested different aspects of ASL and English ability, each investigation has consistently shown that scores on ASL and English tasks are positively correlated (Hermans, Knoors, Ormel, & Verhoeven, 2008; Hoffmeister, 2000; Padden & Ramsey, 1998, 2000; Strong & Prinz, 1997). In addition to the positive correlation between ASL and English skills, recent research has investigated the cognitive aspects of ASL and English bilingualism and found cognitive benefits for balanced deaf bilinguals (Kushalnagar, Hannay, & Hernandez, 2010). These research studies indicate the potential of educating deaf students bilingually, but research has yet to describe how students’ long-term academic growth and achievement are impacted by an ASL/English bilingual education.

ASL and English bilingual classrooms are still in their infancy. Some of the oldest deaf bilingual programs in the United States only date back to the late 1980s and early 1990s. It is imperative for research to take place in these classrooms and educational settings to describe how bilingual education is being applied for deaf students and what the outcomes are for students being educated when ASL/English bilingual models are used for instruction. There is a need for quantitative and qualitative research to examine students enrolled in ASL/English bilingual programs with a focus on students’ academic and nonacademic outcomes.

Use of ASL and English has been explored in the context of reading and language arts instruction and...
has focused predominantly on strategies used in early intervention and elementary education programs. Strategies using ASL and English, such as chaining and sandwiching, have been examined and found to benefit reading comprehension (Bagga-Gupta, 1999; Bailes, 2001; Erting, Thumann-Prezioso, & Benedict, 2000). The use of ASL before and after reading English texts, what Bagga-Gupta (1999) calls event chaining, has also been reported as improving deaf students’ reading comprehension (Andrews, Winograd, & DeVille, 1994; Miller and Rosenthal, 1995). Whereas understanding the instructional strategies occurring in bilingual education programs for deaf students is essential, it is important to see how deaf students’ academic growth is impacted by such ASL/English bilingual strategies. Research on hearing students’ bilingual education also demonstrates the need to look at instruction over time and not just a 1- or 2-year period because the language demands of school take time for students to acquire and learn (Cazden, 2001; Cummins, 2000).

**Deaf Students’ Academic Achievement**

Every 10–20 years, deaf education committees and advisory councils are established to address the low reading and/or mathematics achievement of deaf students. Results from these group reviews indicate that instructional strategies and communication systems have been developed to bridge the achievement gap between hearing and deaf students, yet over the years little progress has been made. The majority of deaf students are still arriving to school without the same language skills and background knowledge as their hearing peers (Erting, 2001). The median reading achievement of 18-year-old deaf students remains that of a typical 9-year-old hearing student (Traxler, 2000). Achievement in the area of mathematics is also troubling in deaf education (Pagliaro, 2010). Deaf students are behind mathematically before they even enter kindergarten (Kritzer, 2009) and they remain behind with 50% of deaf students performing between the fifth and sixth grade level in mathematics by the time they graduate high school (Traxler, 2000). The bottom line is that academic achievement remains an area of concern for deaf education, and once instructional strategies are developed and being used, research to see the long-term success of such strategies should be in place.

A recent study (Anita, Jones, Reed, & Kreimeyer, 2009) of deaf students academic status and progress was conducted over a 5-year period. Deaf students, including those with mild to profound hearing loss, who were in general education classrooms for a minimum of 2 hr per day, were included in this study. The results from the standardized tests showed over the 5-year period that 63–79% of students scored average or above average in mathematics and 48–68% scored average or above average in reading (Anita, Jones, Reed, & Kreimeyer, 2009). On average, the deaf students scored one-half a standard deviation below the hearing norms (Anita, Jones, Reed, & Kreimeyer, 2009). The results of this study add to the body of knowledge in deaf education, but because the students were from a wide geographic area and were receiving various types of educational delivery, the results do not inform classroom instructional strategies. The study does not identify what types of language, communication, instructional strategies, curriculum, or support services these students received and how these factors might affect academic achievement of deaf students. Additionally the study’s limited scope of deaf students, those who were in a general education class for two or more hours a day results in an exclusion of a large portion of deaf students.

**Need for Model-Specific Studies**

There is a need for data to inform the role that the instructional model may play in academic achievement for deaf and hard-of-hearing (DHH) students. As noted above, there are few studies that address student outcomes that relate to specific educational models for deaf students. Those that are available often have a small number of participants making generalizability difficult. Thus, when data are available, it is critical that these be shared with the larger educational community in order to facilitate dialog on the role a chosen educational model may play in student success.

**Longitudinal Database**

A database with 13 years of academic assessment results for a school that uses an ASL/English
bilingual model to serve students is available and used for a longitudinal study focusing on reading and mathematics achievement of DHH students. In this study, the longitudinal reading and mathematics achievement results of DHH students are compared with their national grade-level and achievement-level peers. In addition, differences between students with characteristics that may have an impact on results are studied.

The study addresses the following research questions:

1. To what extent does the academic growth in reading and mathematics of DHH students educated using an ASL/English bilingual model differ from a national comparison group consisting primarily of their hearing grade-level peers?
2. To what extent are characteristics (gender, at least one deaf parent, or a secondary disability) a factor in academic growth in reading and mathematics for DHH students educated through an ASL/English bilingual model?
3. After a minimum of 4 years of education through an ASL/bilingual model, what percentage of DHH students score in the average or above average range in reading and mathematics?

The intent of the study is not to compare student results between educational settings or models for deaf students but rather to provide information on the progress of students within an ASL/English bilingual setting that uses a bilingual model when compared with their hearing grade peers thus starting the conversation on what works for DHH students and the role the bilingual model may play in student success.

Metro Deaf School

The current longitudinal research study was conducted at Metro Deaf School (MDS) and Minnesota North Star Academy, two ASL/English bilingual charter schools for DHH students in Minnesota and Western Wisconsin that merged in 2009 to become MDS.

Metro Deaf School, initially a prekindergarten-to-eighth-grade program, opened in 1993 as one of the first charter schools in the United States. Minnesota North Star Academy, a high school, opened as a sister school to MDS in 2004. During the summer of 2009 MDS and Minnesota North Star Academy merged to become one school, MDS, serving students pre-kindergarten through high school or ages 3–21. The school is located in the city of Saint Paul, Minnesota, and draws students from over 20 surrounding school districts. Enrollment numbers average 100 students with approximately 50% annually qualifying for free and reduced lunch and 25% identifying themselves as minorities. Historically, approximately 40% of students have documented secondary disabilities on their Individual Education Programs (IEP). Students’ home languages, signed and spoken, vary greatly from native ASL users to no sign language and from native English users to little or no English used in the home. Students’ degree of hearing loss and use of amplification also varies, yet the majority of the students are audiologically described as having a severe to profound hearing loss in their better ear.

Metro Deaf School follows an ASL/English bilingual education for DHH students. Following this philosophy, all teachers and specialists (i.e., social workers, speech therapists, and transitional specialist) participate in a 2-year ASL/English bilingual education professional development program. The professional development has included participation in the Center for ASL and English Bilingual Education Research’s (CAEBER) intensive in-service model for ASL and English bilingual education developed by Dr. Steve Nover, currently at Gallaudet University. The project resulted in the adoption of a train-the-trainer model of professional development where staff members serve as mentors and lead the bilingual professional development efforts. Since 2003, MDS has supported three cohorts through the 2-year CAEBER program.

Metro Deaf School students are instructed in all content areas with the ASL/English bilingual model serving as the educational framework for all grade levels. In addition to monitoring academic and content area development, students’ ASL and English language development is supported and monitored at all grade levels. ASL specialists, a bilingual specialist, and speech language pathologists work closely with classroom teachers and students. Previous research has
been conducted at MDS and provided descriptions of the ASL/English instructional strategies of the classrooms (Bailes, 2001).

Younger children were immersed in the attending and signing modes, and as they became more fluent in ASL, attention was gradually shifted towards a balance between these modes along with reading and writing. Yet, English was never ignored in any grade level, and there was abundant evidence of its use among teachers and students alike (Bailes, 2001, p. 151).

Overall, great latitude is given to teachers as to the types of instructional strategies they employ for all content areas as long as the overall teaching and learning follows an ASL/English bilingual framework.

Unique Opportunity

Metro Deaf School, with its longitudinal database of academic test results, provides a unique laboratory for investigating academic achievement of students who have been taught using the bilingual model. The school has administered reading and mathematics tests consistently since the 1997–1998 school year, building a rich longitudinal database; thus, data are available to address the academic progress of students educated within a specific deaf education model. Moreover, the longitudinal database provides an opportunity to not only compare progress of students in a bilingual model of educational delivery with their hearing peers but also determine if there are differences in progress for the students instructed within this bilingual setting that can be attributed to individual or family characteristics such as gender, having a deaf parent, or having a secondary disability. The results from this study can inform policy and practice as practitioners and deaf education leaders consider academic progress and educational delivery methods.

Methods

Participants

Study group. The participants in the study were DHH students who attended MDS (or one of the two schools that merged to form the current MDS—hereafter MDS) between 1998 and spring 2011. There were a total of 174 possible participants for reading and 141 possible participants for mathematics. These were students who had attended the school and for whom Northwest Evaluation Association (NWEA) data were available. All study participants had IEPs that indicated they were DHH. A subset of students is comprised of students who had secondary disabilities listed on their IEPs (i.e., visual impairment, developmental delay). Our working definition of a secondary disability is any of the 13 federal disability categories listed on a study group participant’s IEP other than DHH, which was considered the primary disability of the study group participants.

Participants were selected for this study from the universe of students described above based upon their meeting three criteria: (a) enrollment at MDS for at least 4 years, (b) a minimum of five spring NWEA Measures of Academic Progress (MAP) reading or mathematics test records with no more than one consecutive missing spring test record, and (c) an initial NWEA Rasch unIT (RIT) score that was in the NWEA reported range established for the national norm group (in few occasions students’ scores were lower than RIT scores established for the norm group. These students were not included in the study group). A RIT is “a unit of measure that uses individual item difficulty values to estimate students achievement. RIT scores create an equal-interval scale.” (Northwest Evaluation Association, n.d.).

The participation criteria ensured students had consistent exposure to the ASL/English bilingual delivery model for a minimum of 4 years, with no more than 1-year exposure to a different educational delivery model. A minimum of 4 years of exposure could occur at any time during the students’ years of enrollment at MDS.

Most study participants met the criteria inclusion in the analysis of both reading and mathematics data; however, there were some students who did not meet the criteria for one of the content areas; thus, the number of study participants varies by content area.

Study group demographic information data and the grade levels of study participants at initial testing grade are presented in Tables 1–3.
Two comparison groups were formed from the NWEA 2008 norming study. National norming studies are conducted by NWEA and provide growth and status norms for all the subtests. The results are based on data from over 2.8 million students representing 6,905 schools in 1,123 school districts located in 42 states (Northwest Evaluation Association, n.d.).

To address the first research question concerning academic growth over time, the study group’s growth was compared with students in NWEA’s 2008 norm group (comparison group). The comparison group was comprised of students with the same academic achievement starting point (RIT score) and grade level. In this manner, each individual student’s data in the study group were compared with a group of “like students” in the norm group (e.g., a student in the study group with a low initial score was compared with students in the norm group with low initial scores).

The comparison group is comprised of predominately hearing students.

For the second question, academic growth over time was compared among study participants with comparisons made by gender, parent hearing status, and the presence of a secondary disability (as listed on the student’s IEP) for those in the study group.

To address the third research question concerning the end-of-study relative ranking (average, below average, above average) when compared with their grade-level peers, the study group participants’ National Percentile Ranking was determined using the 2008 NWEA norming study criteria.

### Instrument

The NWEA MAP for reading and mathematics has been administered to MDS students since 1997. The NWEA is administered at least annually to MDS students in grades two through twelve unless their IEP indicates they are exempt from testing or, if in second grade, they are not at a reading-readiness level or if by 11th grade they have met the 11th grade ceiling score (mean score for end-of-10th-grade norm group).

The NWEA MAP is a computer-adapted testing instrument that customizes tests to individual students. Each student receives a unique test, which is developed via computer for him or her as the test is being administered. Each test question presented to a student provides some information about the trait that is being measured. The closer each item is in difficulty to the student’s actual level of functioning, the more information it provides for that student. Scores are recorded using a Rasch Interval Unit or RIT (Oregon Department of Education, n.d.). It should be noted that the NWEA reading test has a decoding section in which some test items address skills that are related to letter sounds. It is acknowledged that this may put deaf students at a disadvantage and affect overall RIT scores. Any accommodations listed on a student’s IEP were honored and implemented.

### Comparison groups

Two comparison groups were formed from the NWEA 2008 norming study. National norming studies are conducted by NWEA and provide growth and status norms for all the subtests. The results are based on data from over 2.8 million students representing 6,905 schools in 1,123 school districts located in 42 states (Northwest Evaluation Association, n.d.).

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### Table 1  Study group student demographic information

<table>
<thead>
<tr>
<th>Content area</th>
<th>n</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Students with secondary disability on IEP (%)</th>
<th>Students with at least one deaf parent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>61</td>
<td>39</td>
<td>61</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Math</td>
<td>64</td>
<td>42</td>
<td>58</td>
<td>35</td>
<td>37</td>
</tr>
</tbody>
</table>

*Note. IEP = Individual Education Programs.*

### Table 2  Grade level of students at initial testing period for reading

<table>
<thead>
<tr>
<th>Initial grade at testing</th>
<th>n</th>
<th>Percent of total study group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two</td>
<td>27</td>
<td>44</td>
</tr>
<tr>
<td>Three</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Four</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Five</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Six</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Seven</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Eight</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nine</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>All grades</td>
<td>61</td>
<td>100</td>
</tr>
</tbody>
</table>

### Table 3  Grade level of students at initial testing period for mathematics

<table>
<thead>
<tr>
<th>Initial grade at testing</th>
<th>n</th>
<th>Percent of study group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two</td>
<td>34</td>
<td>53</td>
</tr>
<tr>
<td>Three</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Four</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Five</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Six</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>All grades</td>
<td>64</td>
<td>100</td>
</tr>
</tbody>
</table>

*Comparison groups.* Two comparison groups were formed from the NWEA 2008 norming study. National norming studies are conducted by NWEA and provide growth and status norms for all the subtests. The results are based on data from over 2.8 million students representing 6,905 schools in 1,123 school districts located in 42 states (Northwest Evaluation Association, n.d.).

To address the first research question concerning academic growth over time, the study group’s growth was compared with students in NWEA’s 2008 norm group (comparison group). The comparison group was comprised of students with the same academic achievement starting point (RIT score) and grade level. In this manner, each individual student’s data in the study group were compared with a group of “like students” in the norm group (e.g., a student in the study group with a low initial score was compared with students in the norm group with low initial scores).
Procedures

Study group selection. A list of all students who had attended MDS between fall 1998 and spring 2011 was provided by the school administration. Students on this list were compared with the NWEA database stored by the school’s external evaluators, Lange Research Evaluation, Inc. A database was constructed with each potential study participant’s enrollment and test information reviewed to determine if they met the study criteria of enrollment years and requisite number of tests. Those who did not meet the criteria were removed. The database indicated the students’ grade level at initial testing and also the year each test was administered.

Each student’s IEP was reviewed to determine if the student had another disability (termed secondary disability) in addition to being deaf or hard of hearing (D/HH). The school administrator reviewed the master study group database and entered each study participant’s gender and parents’ hearing status.

Analysis

Growth measure. The Growth Index (GI) method as developed by McCall, Kingsbury, and Olson (2004), was used to determine academic growth for this study. The GI is a measure of individual student growth compared with growth exhibited by students in NWEA’s normed database that started in the same grade with the same score (comparison group).

Moreover, individual student growth is determined by calculating a gain score using spring-to-spring RIT scores. Academic growth exhibited by students in NWEA’s normed database (comparison group) is similarly determined by calculating a gain score using spring-to-spring comparison group mean RIT scores as reported by NWEA. The comparison group gain score is also referred to as “typical” growth. The individual student GI then is the difference between the gain score determined for an individual student and the gain score determined for the student’s NWEA comparison group.

A positive GI means that the student’s growth was greater than typical growth and a negative GI means that the student’s growth was less than typical growth. A GI of zero represents typical growth (McCall et al., 2004). Furthermore, this technique is an effective measure of the academic growth for individual students and also for groups of students, as the GI is not biased by initial academic achievement or grade level. McCall et al. indicate that the GI shows the amount of unexpected growth of the student from one year to the next. A positive value for the growth index indicates that the student has grown more than typically seen, while a negative value indicates less growth than typically seen (typical growth values come from a nationwide study including more than one million students; p. 2).

The Growth Indices defined above are the metric used for analysis. Further, maximum likelihood estimation (Myung, 2003) was used to inform statistical differences in Growth Indices between combinations of students. Chi-square tests of model comparisons were used to select random effects models for this study, which allowed for varying intercepts and slopes. In addition to the statistical comparison test validating the model selection, the random effects model is appropriate because not all students begin at the same point or change at the same rate. By allowing the intercept and slopes to vary, this is taken into account. Analyses of difference techniques were performed to compare subgroups within the study groups. Statistical analysis software of SPSS™ was used for all analyses.

Based on the trend of the observed data and tests for significance of intercepts and slopes, a linear growth model was selected for all analysis (linear growth model: GI = mX + b where m is the slope of the linear model; X is the number of years; and b is the intercept). Therefore, two statistical metrics are determined and presented for each analysis. The first metric is the intercept of the linear growth model (b in the equation), which is the mean value of first available spring-to-spring GI. The intercept is a measure of the Study Group’s academic starting point for the study. The statistical test for the intercept is, “different from zero,” which is determined by the significance level ($p < 0.05$). (Recall that a GI of zero means that the study group academic growth was the same as the norm group).

The second metric is the slope of the linear model ($m$ in the equation), which represents the change in
academic growth from year to year. A statistically significant positive slope value \( (p < 0.05) \) means that academic growth increases relative to the comparison group from year to year; zero slope means the same growth; and a negative slope means decreasing growth. The linear growth model also provides a means to estimate number of academic years required for the study group to exceed the performance of the comparison group, which occurs when the mean GI is greater than zero.

**Results**

Results of the ASL/English Bilingual Study are presented below. The GI model analysis technique described above is used to present results. The results are organized by research question and content area and followed by a summary of results.

**Question 1: Academic Growth—Study Group and Comparison Group**

One of the most important first steps to ascertaining academic growth was to determine the study group’s beginning reading and mathematics growth levels compared with the comparison group. Means of the first GI values were calculated and served as the beginning reading and mathematics growth levels for both the study group and the comparison group (i.e., the intercept of the model described above).

Once beginning growth levels were determined, academic growth in reading and mathematics of the study group and of the comparison group were calculated as the change in mean GI from year to year (i.e., slope of the model). Using the mean of first GIs (beginning growth level) and the change in mean Growth Indices from year to year (academic growth over time), it was possible to estimate the number of years the study group needed to exceed academic performance of their comparison grade-level peers.

**Beginning growth levels.** When analysis is conducted for the entire study group, the mean of first reading GI values was negative \( (p < .05) \), which indicates that the study group’s beginning growth level was significantly below the comparison group’s beginning level. Similarly, the mean of first mathematics GI values was negative \( (p < .05) \), indicating that the study group’s beginning growth level for mathematics was also significantly below that of the comparison group. In other words, for both reading and mathematics, the comparison group demonstrated more academic growth in the first year for which test results were available than the study group.

A summary of the study group’s beginning growth levels when compared with the comparison group is presented in **Table 4**.

**Academic growth over time.** Whereas the findings noted above indicate that for the initial testing period, the study group’s mean growth levels were below that of the comparison group, the study group’s subsequent reading growth relative to the comparison group increased over time. The study group’s reading mean GI increased gradually with each year of instruction and is projected by the linear model to become positive after 8.2 years. This indicates that the study group’s academic growth resulted in outperforming the comparison group after 8 years.

The study group’s mean mathematics Growth Indices increased more rapidly. The study group’s mathematics mean GI is projected by the linear model to become positive after approximately two and a half years. This indicates that the study group’s academic growth in mathematics resulted in outperforming the comparison group after approximately two and a half years.

**Table 4  Study group’s academic beginning growth level in relationship to comparison group**

<table>
<thead>
<tr>
<th>Content area</th>
<th>( n )</th>
<th>Difference in mean GI between study group and comparison group</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>61</td>
<td>(-4.9)</td>
<td>.00004*</td>
</tr>
<tr>
<td>Mathematics</td>
<td>64</td>
<td>(-4.0)</td>
<td>.002*</td>
</tr>
</tbody>
</table>

*Note. Negative values mean that on average the study group’s beginning growth level (first spring-to-spring testing period) was lower than the comparison group. GI = Growth Index. *Significant at the \( p < .05 \) level.
Table 5 presents the summary of the statistical results of the Growth Indices for reading and mathematics together with the predicted number of years it would take the study group to outperform the comparison group.

Question 2: Academic Growth for the Study Group by Characteristics

Question 2 addresses characteristics of DHH students as factors in academic growth. For Question 2, academic growth of study participants is compared within the study group by gender, parent hearing status, and the documented presence of a secondary disability. In other words, growth levels of study group males as calculated using the GI method were compared to the growth levels of study group females. As with Question 1, it is important to ascertain the beginning growth level for students in order to determine the academic growth over time.

**Beginning growth levels—gender.** Gender was not found to be a discriminating characteristic of DHH students for beginning growth level in reading. The mean of first reading GI values for males and females was not significantly different, indicating no observable difference in the beginning growth level based on gender.

Gender differences were found for beginning mathematics growth levels. The mean of males’ first mathematics GI values was significantly lower (p < .05) than the mean for females, indicating that males in the study group started at a lower mathematics growth level than females when considering the initial or starting year.

**Beginning growth levels—At least one deaf parent.** No statistical differences were found in beginning reading or mathematics growth levels for students with at least one deaf parent compared with students with no deaf parent.

**Beginning growth levels—secondary disability.** No statistical differences were observed in beginning reading or mathematics growth levels for students with a secondary disability listed in their IEP compared with students without a secondary disability.

Summary tables of the study group’s beginning growth levels for reading and mathematics by student characteristic comparison are presented in Tables 6 and 7.

### Table 5  Study group’s academic growth over time in relationship to comparison group

<table>
<thead>
<tr>
<th>Content area</th>
<th>Change in mean GI per year</th>
<th>p value</th>
<th>Number of years to positive GI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>0.6</td>
<td>.02*</td>
<td>8.2</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1.6</td>
<td>&lt;.00001*</td>
<td>2.5</td>
</tr>
</tbody>
</table>

*Significant at the p < .05 level.

### Table 6  Study group’s reading beginning growth level by student characteristics

<table>
<thead>
<tr>
<th>Group characteristic analyzed</th>
<th>Difference in mean Growth Index (GI) between characteristic analyzed</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n = 24)</td>
<td>.70</td>
<td>.81</td>
</tr>
<tr>
<td>Females (n = 37)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf parent status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least one deaf parent (n = 28)</td>
<td>.40</td>
<td>.89</td>
</tr>
<tr>
<td>No deaf parents (n = 33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documented secondary disability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With a secondary disability (n = 25)</td>
<td>−1.90</td>
<td>.51</td>
</tr>
<tr>
<td>With no secondary disability (n = 36)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
When the reading and mathematics results were analyzed over time, the results indicate that there were no significant differences in the academic growth between males and female study participants.

Similarly, when reading and mathematics results for the study group were analyzed by the parental hearing status of the study group participants, there was not a significant difference in academic growth for those with at least one deaf parent and those who had no deaf parent.

Results indicate less growth in reading for study group participants with a secondary disability when compared with study group participants without a secondary disability. Results were similar for mathematics where academic growth for the study group participants with a secondary disability was lower than for those without a secondary disability.

Summary tables of the study group’s academic growth over time for reading and mathematics by student characteristic are presented in Tables 8 and 9.

Question 3: Percentile Ranking for Study Group at Last Test Period

The final research question addresses the study group’s achievement levels after a minimum of 4 years continued exposure to the ASL/bilingual model. The study group participants’ last recorded score was reviewed to determine their academic standing when compared to the norm group for their respective grade levels. When the study group’s first RIT score is reviewed, 28% in reading study group were at or above average and 19% in the math study group were at or above average (average is defined for the NWEA MAP as between the 33rd and 67th percentile and above average is greater than 66th percentile).

Results for reading indicate that after a minimum of 4 years, 41% of the study group were in the average or above average range in reading ($n = 61$) and 55% of

### Table 7  Study group’s mathematics beginning growth level by student characteristics

<table>
<thead>
<tr>
<th>Group characteristic analyzed</th>
<th>Difference in mean Growth Index (GI) between characteristic analyzed</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males ($n = 27$)</td>
<td>−6.4</td>
<td>.01*</td>
</tr>
<tr>
<td>Females ($n = 37$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf parent status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least one deaf parent ($n = 23$)</td>
<td>.60</td>
<td>.81</td>
</tr>
<tr>
<td>No deaf parents ($n = 41$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documented secondary disability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With a secondary disability ($n = 22$)</td>
<td>−3.1</td>
<td>.24</td>
</tr>
<tr>
<td>With no secondary disability ($n = 42$)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at the $p < .05$ level.

### Table 8  Study group’s reading growth over time by student characteristics

<table>
<thead>
<tr>
<th>Group characteristic analyzed</th>
<th>Change in mean Growth Index (GI) per year</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males ($n = 24$)</td>
<td>.30</td>
<td>.60</td>
</tr>
<tr>
<td>Females ($n = 37$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf parent status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least one deaf parent ($n = 28$)</td>
<td>.69</td>
<td>.19</td>
</tr>
<tr>
<td>No deaf parents ($n = 33$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documented secondary disability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With a secondary disability ($n = 25$)</td>
<td>−1.3</td>
<td>.02*</td>
</tr>
<tr>
<td>With no secondary disability ($n = 36$)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at the $p < .05$ level.
the study group were in the average or above average range in mathematics ($n = 64$). When the study group last test data are disaggregated by secondary disability status, we find that 50% of students without a documented secondary disability ($n = 36$) are in the average or above average range in reading compared to 32% for those with a secondary disability ($n = 25$) and 71% of study group participants are in the average or above average range for math ($n = 42$) compared with 23% of study group participants with a documented secondary disability ($n = 22$). Nationally, 66% of students are in the average or above average group for both reading and mathematics.

Results and Summary

In general, the study group’s initial reading and mathematics levels of academic growth were less than those of the comparison group, which consisted predominately of hearing grade-level peers. However, over time the study group’s levels of academic growth in both content areas increased and exceeded the performance of the comparison group within a number of years of exposure to the ASL/English bilingual delivery model (8.2 years for reading and 2.5 years for mathematics).

When characteristics of study group participants were examined to determine the role gender, deaf and hearing parent status, and secondary disability status played in academic growth, males’ beginning growth levels in mathematics were lower than that of females, but there was no statistical evidence that males’ mathematics or reading levels of growth over time differed from females. Although there was no statistical difference in the beginning growth for students with and without secondary disabilities, when reading and mathematics growth over time were analyzed, the students without a secondary disability had accelerated rates of growth when compared with students with a secondary disability. There was no statistical difference found for students’ beginning growth or growth over time when academic growth was analyzed by parent hearing status.

Lastly, 41% of study group participants were in the average or above range after a minimum of 4 years exposure to the ASL/bilingual model and 55% of the study groups were in the average or above average range in mathematics after a minimum of 4 years exposure to the ASL/bilingual model. The percentage of study participants in the average or above average range was higher for those with no documented secondary disability.

Discussion

The main goal of this study was to explore the reading and mathematics growth patterns of deaf students educated in an ASL/English bilingual instructional model. When exploring deaf students’ academic growth, the results were compared with a nationally normed group that consisted primarily of hearing peers who started at the same academic level. Hearing peers serve as the comparison group because the assessment used to measure academic progress is normed on the hearing student population. If deaf students’ academic growth patterns differ from hearing students, this is not a problem; hearing students are not necessarily considered the ideal by which deaf students’ progress should be measured. The primary goals are to determine the long-term academic results for students served in an ASL/English bilingual model and to better understand how ASL/English bilingual deaf students progress academically over time.

<table>
<thead>
<tr>
<th>Group characteristic analyzed</th>
<th>Change in mean Growth Index (GI) per year</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males ($n = 24$)</td>
<td>.88</td>
<td>.08</td>
</tr>
<tr>
<td>Females ($n = 37$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaf parent status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least one deaf parent ($n = 23$)</td>
<td>.52</td>
<td>.35</td>
</tr>
<tr>
<td>No deaf parents ($n = 41$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documented secondary disability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With a secondary disability ($n = 22$)</td>
<td>$-1.6$</td>
<td>.002*</td>
</tr>
<tr>
<td>With no secondary disability ($n = 42$)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at the $p < .05$ level.
Efficacy of ASL/English Bilingual Model

The findings support the efficacy of the ASL/English bilingual model as an effective instructional delivery model for DHH students. The academic growth of the study group was initially slower than the comparison group, but after a period of time, they outperformed the comparison group that was comprised of primarily hearing students. This has import when considering the ASL/English bilingual model as one of the precepts is that learning a new language takes time, but that with time students will become competent in reading and mathematics. The difference between the number of years it took the study group to outperform the comparison group is noteworthy in that it took considerably more time for study group students to outperform in reading than it did in mathematics. This is consistent with other second language findings where English language learners are competent in mathematics earlier than in reading.

We assert the difference between the two content areas is related to the school’s instructional model. Students’ mathematics instruction is presented through ASL, a fully accessible visual language. Others might inquire if students’ mathematics assessments through the NWEA MAP were simply computational in nature and did not require mathematics language used in word problems. NWEA’s Measure of Academic Progress assessment includes both direct computation and word problems.

Not surprising, more years of instruction were required in reading for participants to demonstrate measurable growth. Many DHH students in ASL/English programs are taught ASL as a first language and English as a second language. These reading results align with findings in other bilingual studies suggesting academic proficiency in a second language requires a minimum of 4–5 years.

Whereas academic growth was the focus of this study, the level of performance students reached after several years in the ASL/English bilingual setting was also explored. Of note are the findings that suggest that study group students appear to break through the often-discussed plateau where DHH students’ academic growth is stymied resulting in stagnant growth. The findings from this study suggest that those instructed in the model make continual progress thus breaking through the plateau at some point in their schooling. Although cause and effect were not the purpose of this study, the findings do raise the possibility that the approach has merit and is one that should be considered when schools, parents, and advocates consider placement of DHH students.

The findings related to the study group participants’ academic rankings in reading and mathematics relative to the national norm group also support the efficacy of the model. The findings indicate that a critical mass of students were performing in the average to above average range by virtue of their last test score (it should be noted that some students had more exposure to the model and some less exposure). Although the study group did not reach the 66% cutoff that would have been comparable to the national norm group, the percentages in the average or above average ranges were impressive given the high percentage of DHH students that never reach that level especially for those students without documented secondary disabilities. It provides information professionals should consider when making decision on viable educational delivery models.

Role of Characteristics in Academic Growth

One of the interesting findings that emerged from the study is the role various student characteristics played in the academic success of the study group. Prior to the study the authors hypothesized that parents’ hearing status would be a factor in student success—specifically, that students with deaf parents who had early exposure to ASL would outperform their peers who had hearing parents with varying levels of ASL proficiency. The findings indicate that the parents’ hearing status was not a significant factor. Although there are many family characteristics that can affect student progress, parental hearing status being only one of them, the findings do provide a perspective that can assist in further discussions on the role of home language use. It also brings to the fore the role the school language use in an ASL/English bilingual model may play in mitigating any debilitating effects of late exposure to ASL.

The role of secondary disability in academic progress is one that was expected. Anecdotal reports from teachers suggest that a student’s hearing status may be less of a factor in academic progress than secondary
disabilities such as vision impairment, specific learning disabilities, and behavioral disorders. There was a significant difference in academic growth for students who had an IEP-listed secondary disability and those students whose IEPs are only focused on the students’ hearing disability. The finding is notable and is one that should result in further study. There are implications for how academic results for DHH students are interpreted. Caution is necessary when reviewing aggregate results for DHH students as the results may be influenced by secondary disabilities more than the students’ hearing status. There are also implications for practitioners who must be proficient not only in instructing DHH students but also in areas relating to other disability categories.

Implications for Policy and Practices

The results from this study provide a starting point for understanding the implications of academic progress when considering instructional models and for exploring empirical academic results for students educated using ASL/English bilingual model. As noted in the introduction, there is a need for disaggregated testing results for DHH students and for analyzing these data by instructional model. In order for that to occur, national testing companies will need to provide data that identifies DHH students so that comparison analysis can be conducted. We were fortunate to have a longitudinal database where the procedures for test administration and the assessment were consistent over a long period of time. Some of the approaches used in this study can inform testing companies, universities, and schools as they strive to use data for decision making and developing a better understanding of how instructional models affect student growth.

If legislators and school administrators are making policy and funding decisions for special education, then they need to have data and academic results from these programs. Whereas some groups are lobbying for a one-size-fits-all model to deaf education, research demonstrates a variety of paths for a D/HH students to develop academically. Students and parents need educational choices to be available to them and researchers and policy makers need to continue collecting data and monitoring these educational options.

Language and communication remains a hot topic in deaf education with very emotional arguments being made to support each perspective, yet little empirical data are being collected. There is a need for collecting and analyzing longitudinal data on various types instructional methodology.

Limitations

This study is limited to students from one school in one region of the country and cannot be generalized to the larger DHH student population. The study participants’ school is a charter school and as such is a school of choice for students and families. This is not a student’s local school district’s DHH program. Parents have to seek out information and decide to request their child be placed at this school. This process demonstrates a higher parent participation in the child’s education and may have an unintended impact on the study results.

This study looks empirically at results of students who were educated using the ASL/English bilingual model at one school; we encourage other ASL/English bilingual programs to do so as well as programs and schools using other instructional philosophies to educate DHH students.

The MAP assessment does have a strong phonological component for earlier reading levels. The phonological questions on the assessment are often challenging for student who do not have access to the spoken English phonemes. These types of questions are greatly reduced as students’ reading skills develop into the middle and high school reading levels. Because of these phonological questions, it is difficult to get an accurate reading score for earlier reading levels with DHH students. This is not to argue for or against the need for some phonological knowledge in the reading process, but the assessment questions related to phonemics knowledge are aimed toward hearing students and how they develop decoding skills relating sound to print. The process of decoding print for DHH students might be equally as effective but it may not follow the same strategies and techniques as hearing students. This is still an area where further research is needed.

Future Research

As noted in the introductory sections, there are still few longitudinal studies that can inform policy and practice in areas related to deaf education and corresponding
instructional models; however, there is considerable discussion in the community about what is the best approach. Whereas this study provides specific findings related to one school employing one instructional approach, its larger purpose can be seen as adding to the research database to inform methods and approaches to examining academic growth of DHH students. There is considerable need for more studies of this type, funding for the studies, and support to schools educating DHH students so that the data bank that can inform policy and practice becomes substantial thereby having an impact on decisions so critical to the students.

Conflicts of Interest

No conflicts of interest were reported.

References


