OSSE
DC Office of the
State Superintendent
of Education

October 15, 2008

Kerri L. Briggs, Ph.D.
Assistant Secretary of Elementary and Secondary Education
U.S. Department of Education
400 Maryland Avenue, S.W.
Washington, D.C. 20202-6400

Dear Dr. Briggs:

The District of Columbia is excited to submit for your review the enclosed DC Growth Model Proposal. A growth model will be particularly valuable in the District of Columbia where the majority of students historically have scored well below proficiency. This new approach will better demonstrate the progress that schools, districts, and the state are making toward the goal of 100% proficiency by 2013-2014. Over the past months, the District has received invaluable assistance from several experts in the area of growth and value-added models including U.S. Department of Education peer reviewers.

The District of Columbia student data tracking systems have a long history resulting, in part, from the District's ability to closely monitor enrollment and achievement data. Because of the District's size, on-site internal and external enrollment audits of all public schools have been conducted each October for the last six years. The audits physically track the enrollment of every student enrolled in the DC public schools. In addition, external observers monitor the state assessment administrations in every public school in the District each spring.

As a result, the District is uniquely able to ensure the accuracy of student achievement data across years. Longitudinal achievement data from the District were used in some of the earliest large-scale studies of growth and value-added studies including those by the New American Schools in 2002-2003. In 2007-2008, the District of Columbia was fortunate to receive $5.7 million from an Institute for Education Sciences grant to support the District of Columbia Statewide Longitudinal Data System. The District made the commitment to invest $19 million over five years to further improve the state data systems and create an integrated data warehouse. To match student data over time, the District will rely on the Levenshtein algorithm to validate that students' records were properly merged. The matching algorithm is described in Appendix B of this proposal.

441 4th Street, NW, Washington, DC 20001
www.osse.dc.gov

Again, we are excited about the growth model proposal and we look forward to the formal feedback and to working closely with the U.S. Department of Education to continue to improve and refine the model. The District of Columbia remains committed to developing state-of-the-art systems to support high quality data-driven decision- making and improved student achievement.

If you have questions about these submissions, please contact Bill Caritj in the OSSE Division of Assessment and Data Reporting at 202-741-0256 or at bill.caritj@dc.gov.

Sincerely,

Deborah A. Gist
State Superintendent for Education

Attachments

cc: Kimberly A. Statham, Deputy State Superintendent
Susan Rigney, U.S. Department of Education
Patrick Rooney, U.S. Department of Education
William H. Caritj, State Director of Assessment

Submission for the U.S. Department of Education

NCLB Growth Model Pilot Program

Washington DC

October 15, 2008

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Submission for the U.S. Department of Education NCLB Growth Model Pilot Program

District of Columbia
Growth Model Proposal

Introduction

In 2008, the District of Columbia submitted a proposal for implementing a growth model for all schools. The U.S. Department of Education (ED) peer review suggested that the original proposal had two major problems. First, the original model proposed would have required a vertical scale, and at the time the proposal was submitted, that scale was being developed. Second, the peers had concerns regarding the District's ability to merge student records over time.

In the past year, the District has invested significant time in researching these issues. Our research has resulted in a different growth model that has no requirements for a vertical scale and, at the same time, can be used as a model that includes 100% of the tested students—no other state can make this claim. Second, we have identified an empirical method that can be used to reliably merge student records over time. This is a groundbreaking method that we have investigated internally and found to be invaluable as a tool for connecting student scores over time to create a longitudinal data file.

Our proposal is unique in many ways and our plans to include a growth model are based on sound techniques for measuring student growth and for reliably creating the longitudinal data file. The highlights of this proposal include:

- A unique growth toward the standards (GTS) model that forms student projections probabilistically. This prevents us from making claims beyond what the data can support since it is impossible to know if a student is truly "on track" or not. This model differs vastly from the current models implemented for the growth model pilot program.

- A method for merging student records based on the Levenshtein algorithm. This method for merging is a unique quality control procedure that is not in use in any other State education agency.

- Full color, variable information score reports that will be sent to parents communicating the results of the growth model in a clear and transparent way.

These three factors will ensure that a technically rigorous model for growth is implemented and, at the same time, report the results of the growth model in a simple and user-friendly way. The District highly values transparency, and this is evidenced in our proposal and our planned use of the model. That is, we have provided a full technical description of the model for review, technical description of our merging methods, samples of our score reports, and a complete description of how the growth model will be applied for accountability.

However, the idea of transparency differs across audiences. For those who are technically inclined, a complete technical description of the growth model is provided with substantive examples of how it operates. Other audiences, such as parents and teachers, tend to be more interested in how this information can be used to support better classroom practices and student achievement. Therefore, we have made a significant investment in the variable information score reports that portray the results of the growth model in a manner that translates statistical information into information that can be used for instructional planning.

These aspects of our proposal are provided in complete detail in the sections that follow. This proposal is organized as follows. We first provide some background on the State assessment system and our current methods for determining Adequate Yearly Progress (AYP). Subsequently, we indicate how our proposed use of the growth model meets each of the Seven Core Principles.

There are two attachments to this proposal that are heavily relied on and often referenced. The first is a manuscript that brings full transparency to the growth model and how it will be applied in the District. Experiments with the growth model have already occurred using the 2007 to 2008 data for all grades in reading and mathematics, and the results of those analyses are provided for the peer review. That document referenced as Appendix A is a standalone manuscript that brings full transparency to the growth model and its application in the District. Second, we provide a manuscript, referenced as Appendix B, which comprehensively describes the Levenshtein algorithm and how it is applied to form reliable longitudinal data files. We have already worked with this algorithm to assess the degree to which this method is useful for the District and have found that its use exceeds our expectations in terms of joining different yearly data files to form a longitudinal database.

These issues make our proposal extremely valuable for the ED pilot program. To date, no growth model for No Child Left Behind (NCLB) purposes forms projections in the manner we do. Second, this will be the first wide-scale application of the Levenshtein algorithm for merging student records to form a longitudinal data file. This is a significant opportunity to demonstrate how many of the challenges often encountered in tracking students over time can be resolved. Last, no other state has implemented full-color, variable information score reports specifically for their growth model.

The culmination of these issues is a growth model proposal that we believe is well-conceived and practical and can serve as a model for other states given the many unique practices we implement.

Background

State Assessment Background

The District of Columbia implemented new standards-based assessments in reading and mathematics in 2005-2006. Standard-setting for the new assessments was completed in July 2006. In fall 2007, the State assessment system's classification was raised to "approval expected" pending final approval of the technical report for the State alternative assessment. The DC CAS-Alternative Technical Report was submitted in January 2008. Technical reports for the general assessment were completed for both 2006 and 2007 as well as the other technical studies (e.g., validity and reliability) needed for Critical Elements 4 *et seq* of the Standards and Assessment Peer Review.

The District of Columbia data tracking systems have a unique history resulting, in part, from the District's ability to closely monitor enrollment and achievement data. Because of the District's size, on-site internal and external enrollment audits of all public schools have been conducted each October for the last six years. The audits physically track the enrollment of every student enrolled in the DC public schools. In addition, external observers monitor the State assessment reading and mathematics administrations in every public school in the District each spring.

As a result, the District is uniquely able to ensure the accuracy of student achievement data across years. Longitudinal achievement data from the District were used in some of the earliest large-scale studies of growth and value-added studies including those by the New American Schools in 2002-2003.

In the fiscal year 2008 budget, the District of Columbia invested $3 million to create an integrated statewide longitudinal data warehouse. Overall, this investment is $19 million over five years in addition to a three-year $5.7 million grant from ED.

Our Current Accountability Plan

The District currently uses only two methods for making AYP decisions: status and safe harbor. We currently do not use uniform averaging, confidence intervals, or an index system. As in most states, if the District is permitted to use the growth model, it will be applied as the third step in our AYP process after safe harbor.

The results of our proposed growth model will be applied separately for reading and mathematics, they will align with the same Annual Measurable Objectives (AMOs) established for status, and all students will be expected to be proficient in 2014.

The Seven Core Principles and the Washington DC Growth Model Program

Core Principle 1: 100% Proficiency by 2014 and Incorporating Decisions about Student Growth into School Accountability

"The accountability model must ensure that all students are proficient by 2013-14 and set annual goals to ensure that the achievement gap is closing for all groups of students."

1.1 How does the State accountability model hold schools accountable for universal proficiency by 2013-14?

The State will maintain the same AMO and intermediate steps that were approved in the August 2006 revision of the State Accountability Plan resulting in the goal of universal proficiency in 2013-14. These objectives apply to the State, Local Educational Agencies (LEAs), and schools. The current status model and safe harbor determinations will be applied first in all cases. The growth model determinations will apply after these determinations are applied.

The exact same AMOs used for status will be used for the growth model; hence, this model will also require 100% of DC students to be proficient in 2013-2014. In many previously submitted plans, some percentage of students might not be proficient in 2014 but instead might be on track to proficiency in 2017. Our model does not operate in that manner. We view 2014 as the end of the timeline, and schools are held accountable for these goals until legislative changes permit otherwise. The methods by which the AMOs are applied to the DC growth model are described under Core Principle 1.3.

1.2 Has the State proposed technically and educationally sound criteria for "growth targets" for schools and subgroups?

The model proposed is a GTS model. As such, the growth target for every student is the same: proficiency. Our model differs from most submitted GTS models in that our model asks, "What percentage of students is on track to proficiency **next year**?" Many submitted models allow for students to be on a three- or even four-year trajectory. In many respects, allowing such a long timeline precludes educators from having a sense of urgency regarding student achievement.

As comprehensively described in Appendix A, our model generates the probability that each student will be proficient in the next school year. In theory, low probabilities are designed as a call to action leading parents and teachers to act to improve a student's performance. For example, if a parent or teacher learned that his or her student has only a 28% chance of being proficient next year, and if this probability were accompanied with some diagnostic information regarding that student's test performance, then parents or educators can act on that information for the benefit of the student.

In fact, this is exactly the theory of action our model follows. We derive each student's probability of becoming proficient in the next school year. Subsequently, this statistical information is conveyed to parents and educators using the variable information score reports described under Core Principle 5.2 to provide diagnostic information and improve student performance.

1.3 Has the State proposed a technically and educationally sound method of making annual judgments about school performance using growth?

Under the proposed method, State, district, and school AYP determinations would first follow all rules currently employed under the District's accountability plan. The current status model and safe harbor determinations will be applied first in all cases. The growth model determinations will apply after these determinations are applied. The growth model determinations will be used as a final control to decrease false negatives (e.g., schools on a trajectory to proficiency that do not achieve safe harbor).

The table below shows annual measurable objectives for reading and mathematics from 2001-2002 to 2013-2014. Intermediate goals have been set to measure whether schools make AYP toward meeting the goal of 100% proficiency by 2014 as is called for in the NCLB legislation. As shown in the table, the goals for the percentage of students who must achieve proficiency rise every other year.

Table 1:
AYP: Annual Measurable Objectives for Reading and Mathematics
(Percentage Scoring at Proficient or Above Level)

Reading

Grade/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Elementary	21.05	21.05	34.21	34.21	47.37	47.37	60.53	60.53	73.69	73.69	86.85	86.85	100
Secondary	15.38	15.38	29.48	29.48	43.58	43.58	57.69	57.69	71.79	71.79	85.90	85.90	100

Mathematics

Grade/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Elementary	10.42	10.42	25.35	25.35	40.27	40.27	55.21	55.21	70.14	70.14	85.07	85.07	100
Secondary	10.81	10.81	25.68	25.68	40.54	40.54	55.41	55.41	70.27	70.27	85.14	85.14	100

In the District, AMOs were determined using the method prescribed in the NCLB legislation and subsequent regulations. Using stakeholder input, the decision was made to have two-year increases in proficiency goals on the way to universal (100%) proficiency. The growth proposal takes a similar approach by aligning the growth targets to the established proficiency goals (i.e., AMOs). Each year, schools will be required to grow at a rate that will at least follow the trajectory to reach 100% proficiency by 2013-2014.

Since the growth model yields the percentage of the students likely to be proficient in year $t+1$, given the observed scores for students in school j in year t, this percentage can be compared to the State AMO for the following year to make AYP decisions.

For example, under the current status model, if 50% of School A's (an elementary school) students are proficient or above in reading in 2009, School A will not meet AYP for 2009 because the AMO is 63.5%.

Safe harbor determinations will next be used to establish how School A is performing. If School A does not achieve safe harbor, the growth model will be applied.

Suppose the growth model predicts that 80% of students in School A are on track to be proficient next year (i.e, we are projecting that 80% will be proficient in 2010). This projected number is compared to the 2010 AMO, which is 73.69%. In this case, School A would make AYP under growth.

This method is proposed because it is internally consistent with what the projections are stating about a school. That is, the projections form an estimate of next year's performance. Logic dictates that this projected percentage should be compared to next year's AMO and not the current AMO.

The same methods and calculations will be used to make annual judgments about the performance of subgroups and the District. Appendix A shows how the projected percentage of students on track to proficiency for all students and each student group is determined.

Core Principle 2: Establishing Appropriate Growth Targets at the Student Level

"The accountability model must establish high expectations for low-achieving students, while not setting expectations for annual achievement based upon student demographic characteristics or school characteristics."

2.1 Has the State proposed a technically and educationally sound method of depicting annual student growth in relation to growth targets?

The proposed District growth model, as detailed in Appendix A, depicts a student's likelihood of becoming proficient in the following school year. Technically, a projection can only be made probabilistically. Many of the growth models submitted extrapolate a student's future score and make the claim that the student is "on track." From a technical perspective, this is indefensible. There are at least two sources of error that would confound that estimate: projection error and measurement error.

Our model only forms a projection for students and their likelihood of future proficiency because these are the only claims the data can actually support. While this is statistically appropriate, we do this for a second and more important reason. If our model claimed that a student was "on track" to be proficient next year but he or she does not achieve proficiency, educators and parents will tend not to rely on the model since it will appear on its face to make false claims regarding the potential future status of student achievement.

The District model is a regression model that does not bring in any demographic information regarding students. The model uses the most current year's level of proficiency as the outcome variables and the prior year scaled score as the covariate.

When forming projections, every tested student in grades 3 to 7 is included in the model, both students scoring above and those scoring below proficiency. In addition, each student is held to the same high expectation of proficiency. If a student has a single test score in grades 3 to 7, then a projection is made for that student so that the model is applied to all grades 3-8.

The growth model is proposed only for students in grades 3-8 and will not include students in high school. Because of the way our testing system is designed, we do not measure students in grade 9. Forming projections from grade 8 to grade 10 is very difficult because it spans a large time period. It can be easily done statistically, but from a substantive (educational) perspective, we question whether such estimates are meaningful. This does not preclude the high schools from being included in the State Accountability Plan. Indeed, they are included in status and safe harbor. But, it does preclude the high schools from having the additional benefit of the growth model results.

Core Principle 3: Accountability for Reading/Language Arts and Mathematics Separately

"The accountability model must produce separate accountability decisions about student achievement in reading/language arts and in mathematics."

3.1 Has the State proposed a technically and educationally sound method of holding schools accountable for student growth separately in reading/language arts and mathematics?

As with status calculations, separate growth determinations would be completed for reading and mathematics. Examples of how our AYP decisions are made are provided under Core Principle 1.3.

Core Principle 4: Inclusion of All Students

"The accountability model must ensure that all students in the tested grades are included in the assessment and accountability system. Schools and districts must be held accountable for the performance of student subgroups. The accountability model, applied statewide, must include all schools and districts."

4.1 Does the State's growth model proposal address the inclusion of all students, subgroups and schools appropriately?

The description of our model in Appendix A shows how every student with a test score is included in forming the projections used to make the AYP decisions. To be clear, every student included in the DC-CAS status model is also included in the growth model projections. Our model as proposed is the only growth model that can make this claim, as all other State proposals would exclude some students if they had patterns of missing scores.

This is possible because the conditional probability of future success is obtained by examining growth of a cohort of students and then applying those probabilities to the current student group.

All NCLB subgroups are also reported. The method by which the subgroups are included is described in Equation 6 of Section 4 in Appendix A.

The growth model, participation, status, and safer harbor determinations would be calculated independently. As in the status model, all groups would be required to meet the 95% participation rate. If a group does not achieve the 95% participation rate criterion, this group will not achieve AYP regardless of the status or growth model determinations.

Core Principle 5: State Assessment System and Methodology

"The State's NCLB assessment system, the basis for the accountability model, must include annual assessments in each of grades three through eight and high school in both reading/language arts and mathematics, must have been operational for more than one year, and must receive approval through the NCLB peer review process for the 2005-06 school year. The assessment system must also produce comparable results from grade to grade and year to year."

5.1 Has the State designed and implemented a statewide assessment system that measures all students annually in grades 3-8 and one high school grade in reading and mathematics in accordance with NCLB requirements for 2005-06, and have the annual assessments been in place since the 2004-05 school year?

In 2006-2007, the District of Columbia implemented a new system of standards-based assessments in reading and mathematics called the District of Columbia Comprehensive Assessment System (DC-CAS). This is a criterion-referenced test made up of constructed-response and multiple-choice questions and is based on the

District of Columbia standards. Accommodations for the DC-CAS such as accommodations for English language learners and an alternate assessment (DC-CAS Alternate Assessment) for students with IEPs have also been developed.

All students in grades 3-8 and in grade 10 participate in the assessment and are tested in reading and mathematics as well as composition in grades 4, 7, and 10; science in grades 5 and 8; and biology in grades 9 through 12 (if students took a biology class).

The status and safe harbor systems required by NCLB and presented in the State Accountability Plan will continue to apply to all students in grades 3-8 and 10. The proposed growth model as described in Appendix A will be applied to grades 3-8.

5.2 How will the State report individual student growth to parents?

The State will develop transparent, clear, and easily understood student score reports for the families of students taking the DC-CAS. These reports will contain both status and growth information. To develop the reports, we will begin by asking what actions we would want parents to take using the information presented in the reports. We will then develop graphical displays and text that will not only present data but also offer instructional recommendations that parents may be able to use to improve their students' learning during the following year.

These reports will be fully customized, enhanced color booklets. They will present data on how students performed on the DC-CAS in the current and previous years and provide families with the likelihood that their student will be proficient in the following year. Reports will be developed using technology that allows for complete variability and will provide each family with fully customized information on how their student is performing on specific content areas and the next steps they can take to help their student improve in the strands they are struggling with.

Figure 1 provides an example of how we may provide families with status information. The student's scale score and performance level are clearly highlighted using either a yellow (proficient) or red (below proficient) arrow, and the chart indicates how the child scored in the range of all possible scores. Descriptions of each performance level are provided in family-friendly language that allows families to see what is expected at each level of achievement. The school and State average scores are also shown so families are able to see how their student's score compared to the average of all students taking the assessment. The language under the chart further explains how the student performed and compares the student's score with the school and State averages.

Figure 1

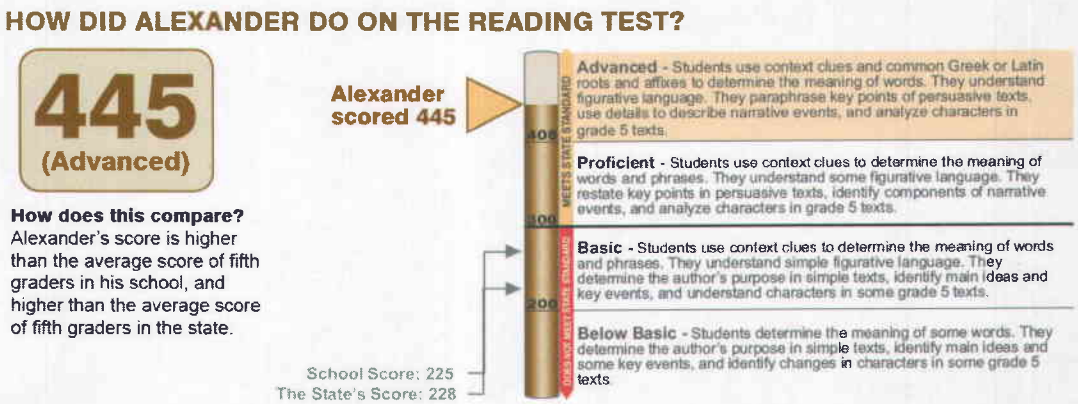
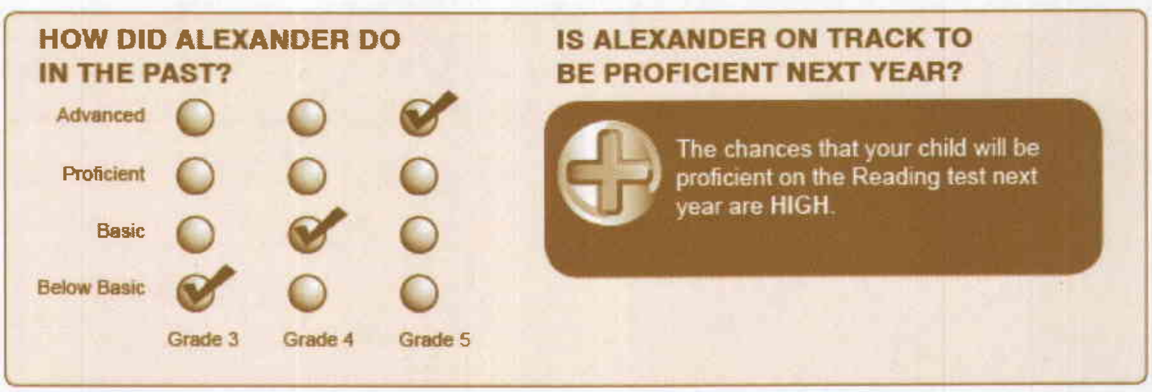


Figure 2 is an example of how we may show how students performed in previous years and their likelihood of reaching proficiency in the following year. This graphic displays the level at which the student performed in reading in all the years that he or she participated in the DC-CAS. The text on the right explains the chances the student will be proficient in the following year.

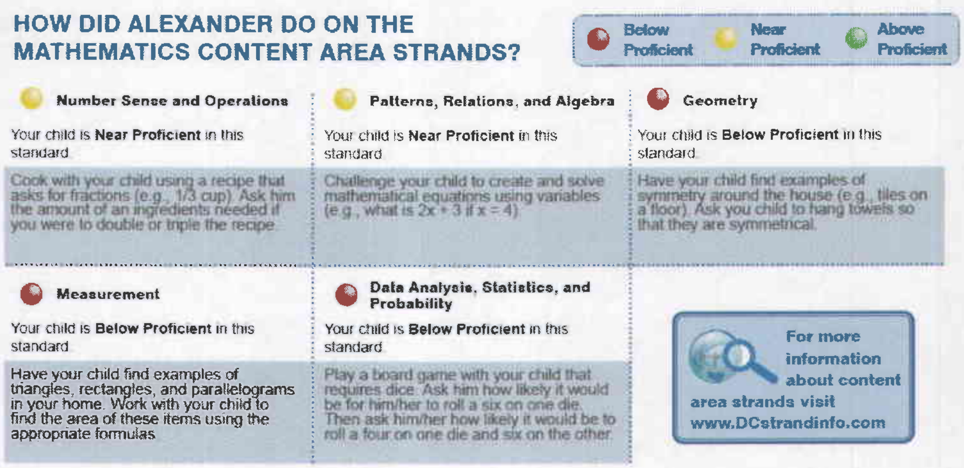
Figure 2



In the statistical model, we form specific probabilities. However, when communicating this information to parents, we generalize those probabilities in a manner that makes them more user-friendly. Instead of stating, "your child has a 31% probability of being proficient next year," we trichotomize those probabilities using the Wald confidence intervals. The three categories are low, average and high. Hence, if a student clearly has less than a 50% chance of being proficient, the language on the report will state that the student has a low chance. If the student clearly has better than a 50% chance, then the report will state the student has a high chance. If the probability cannot be statistically distinguished from 50%, then the report will state that the student has an average chance.

Parents could use this information to see how their student has progressed and how their student is projected to perform in the following year. This is designed to motivate parents to take actions to improve their student's chances of being proficient the following year. Figure 3 is provided so that parents can get some diagnostic information regarding their student from the DC-CAS. This is an example of how we may include data on how students performed on each content area strand so parents are able to see whether their student performs well and in which areas they may need some instructional remediation so that they can improve their chances of being proficient next school year. The colored circle shows how the student performed (below, near, or above proficient) on each reporting strand and the text below suggests activities parents could easily do with their students to improve their learning. The text is specifically written to help the student based on his or her performance. That is, the text is variable and is driven by the scores for each student. Different patterns of strengths and weaknesses would result in different instructional recommendations appearing on the reports.

Figure 3



The State may also choose to provide families with information on how their school is performing in comparison with other schools in the State. Using the calculations described in Appendix A, we could determine whether a school is a high or low performing school and whether it is expected to have high or low growth in the following year. This information would guide parents to hold discussions with school administrators on their school's curricular and instructional plans.

Images and descriptions provided in this proposal are examples of what we may choose to include in the reports as we are still in the design phase. The final design of the reports will be vetted with parents and key stakeholders in the District. Through focus groups and meetings, we will determine the status and growth information that is most useful for parents and ensure all language used in the reports is easily understandable.

5.3 Does the Statewide assessment system produce comparable information on each student as he/she moves from one grade level to the next?

Yes, all performance categories (e.g., basic, proficient) were vertically articulated during the standard setting process for both reading and mathematics. There is currently no vertical scale, but this is not needed for the model as described in Appendix A.

5.4 Is the Statewide assessment system stable in its design?

Yes. The District of Columbia implemented new standards-based assessments in reading and mathematics in 2005-2006. Standard-setting for the new assessments was completed in July 2006. In fall 2007, the State assessment system's classification was raised to "approval expected" pending final approval of the technical report for the State alternative assessment and full approval is expected in spring 2008.

Core Principle 6: Tracking Student Progress

"The accountability model and related State data system must track student progress."

6.1 Has the State designed and implemented a technically and educationally sound system for accurately matching student data from one year to the next?

The District will rely on the Levenshtein algorithm to merge and validate that students were properly merged over time. The matching algorithm is completely described in Appendix B of this proposal. That paper also shows how remarkably reliable the merges are.

The District first merges the year 1 and the year 2 data files using the unique student identifier. The Levenshtein algorithm is then used to validate that the merge using ID was performed correctly. Those students retained in the data must meet the following criteria:

- The unique student ID is the same in year 1 and year 2; and
- The Levenshtein normalized distance is greater than or equal to 0.7.

In our review of the data, all students with an LND < 0.4 are incorrect student merges, even though they share the same ID. By manually looking at the names, we can see that some incorrect merges occur. In the range of 0.4 to 0.7, there is some ambiguity in the merge; most of the names reveal incorrect merges and there are some questionable merges.

However, every student with an LND >= 0.7 is clearly the same student. We therefore chose LND = 0.7 as the cutoff point. In our view, the risk of joining incorrect records is greater than the risk of gaining a few correct merges alongside many incorrect merges, which would occur if the cutpoint for the LND were set any lower than 0.7.

Tables 2 and 3 show the number and percentage of students for reading and mathematics who were correctly merged from this process using data from 2007 to 2008. In all grades, the merge rates are high, with the lowest merge of 88.8% occurring for grade 7.

Table 2

Mathematics Table of mergeflag by ESTGRADE2						
mergeflag	ESTGRADE2 (Grade Enrolled)					Total
Frequency Col Pct	4	5	6	7	8	
Not Merged	481 10.50	468 10.18	498 10.71	512 11.17	492 9.96	2451
Merged	4101 89.50	4130 89.82	4154 89.29	4070 88.83	4449 90.04	20,904
Total	4582	4598	4652	4582	4941	23,355

Table 3

Reading Table of mergeflag by ESTGRADE2						
mergeflag	ESTGRADE2 (Grade Enrolled)					Total
Frequency Col Pct	4	5	6	7	8	
Not Merged	478 10.43	467 10.16	494 10.63	510 11.14	490 9.92	2439
Merged	4103 89.57	4131 89.84	4155 89.37	4069 88.86	4448 90.08	20,906
Total	4581	4598	4649	4579	4938	23,345

Tables 4 and 5 show the merge rates by ethnicity. Again, the merge rates are remarkably high. One merge rate for category "I" appears low, but this is an artifact of the small *N* size for that category.

Table 4

Mathematics Table of mergeflag by ETHNICITY2						
mergeflag	ETHNICITY2 (Ethnicity)					Total
Frequency Col Pct	A	B	H	I	W	
Not Merged	48 15.38	2041 10.30	256 12.04	2 50.00	102 9.28	2449
Merged	264 84.62	17,770 89.70	1871 87.96	2 50.00	997 90.72	20,904
Total	312	19,811	2127	4	1099	23,353
Frequency Missing = 2						

Table 5

Reading Table of mergeflag by ETHNICITY2						
mergeflag	ETHNICITY2 (Ethnicity)					Total
Frequency Col Pct	A	B	H	I	W	
Not Merged	46 14.84	2038 10.29	250 11.79	2 50.00	101 9.20	2437
Merged	264 85.16	17,773 89.71	1870 88.21	2 50.00	997 90.80	20,906
Total	310	19,811	2120	4	1098	23,343
Frequency Missing = 2						

These are the merge rates that occur using the unique student ID and validating using the LND statistic. However, we can improve these merge rates and increase the number of students that are merged from one year to the next as described in Section 6 of the paper in Appendix B. Our method for doing so is as follows:

- Concatenate the first three letters of the first name and the first three letters of the last name to create string 1 and string 2 variables. Merge the year 1 and year 2 files based on the string 1 and string 2 variables.
- Validate the merge using the Levenshtein normalized distance. For the validation, we use a very stringent set of criteria since this is a "salvage" effort and no unique student IDs are available. Therefore, the string 1 and string 2 variables are a concatenation of first name, last name, grade level, and school attended. Because the Levenshtein algorithm compares similar strings, we subtract 1 from the year 2 grade level so it would match the year 1 grade level.
- We retain only those students if the Levenshtein normalized distance is greater than or equal to 0.9.

After applying this procedure, we are able to recover 281 additional students to our data set. With the addition of these students, the frequencies are provided in Tables 6 through 9. In all cases, this brings the aggregate merge rate for all grades to 90% or better.

Table 6

Mathematics Table of mergeflag by ESTGRADE2						
mergeflag	ESTGRADE2 (Grade Enrolled)					Total
Frequency Col Pct	4	5	6	7	8	
Not Merged	425 9.28	420 9.13	446 9.59	472 10.30	420 8.50	2183
Merged	4157 90.72	4178 90.87	4206 90.41	4110 89.70	4521 91.50	21,172
Total	4582	4598	4652	4582	4941	23,355