

This will be interesting; I hope it
will have been useful for you,
and I look forward to reading
the final paper.

TABLE OF CONTENTS

List of Tables and Figures.....	2
Introduction.....	3
Research question and Motivation	3
Literature Review	3
Summary of results	7
Methodology	8
Populations	8
Survey sample population.....	8
Coverage error	9
Enrollment for Lincoln Academy:	10
Enrollment for Carmalt Academy:	10
Mode of Data Collection.....	11
Measured variables	11
Sample Size.....	12
Pilot Questionnaire	13
Pilot Post-Survey Processing and Results.....	13
Revised Questionnaire	16
Post Survey Processing.....	17
Carmalt Academy	17
Lincoln Academy.....	17
Results	18
Analysis of Population	18
Carmalt Academy	18
Lincoln Academy.....	18
Analysis based on random samples	19

Sample selection.....	19
Carmalt Academy	19
Lincoln Academy.....	19
Random sample results	20
Carmalt Academy	20
Lincoln.....	20
Bibliography.....	21
Appendices	22

LIST OF TABLES AND FIGURES

Table 1: Results from students with highest correct and most incorrect responses.	13
Table 2: Results from students with highest correct and most incorrect responses.	14
Table 3: Results from questions	15

INTRODUCTION

What do elementary school children know about Architecture?

The primary question of interest is “What do children in grades 3-5 know about architecture?” While the question of architectural knowledge is broad, there are two approaches that will be used to narrow the focus of our survey. First, as there is a purpose for this survey (a project funded by the National Endowment for the Arts), we will first look at what architectural knowledge is taught in this program. Second, as there is an existing body of educational research and testing, we will look at what knowledge is already covered by other research and exclude these topics from our survey.

RESEARCH QUESTION AND MOTIVATION

The question of children’s existing knowledge about architecture is relevant to the growing international network of K-12 architectural educators. These educators work in architecture centers, museums, historical organizations, universities, and K-12 schools. They run a range of architectural programming including tours, in-school programs tied to standards, extracurricular programs, informal education programs, and college-preparatory programs. The current movement to connect architectural educators began in 2004 in conjunction with the National American Institute of Architects Convention in Chicago. Since then, architectural educators have convened more frequently, now meeting once a year at the annual Association of Architecture Organizations/Architecture+Design Education Network (most recently held November 2010 in Chicago). A recurring topic is the lack of “research” that supports what these architectural educators are doing, especially with respect to reporting to granting organizations about the learning that occurs from their programming. While some research exists that supports some areas of K-12 architectural education, there has been no comprehensive work to compile research and filter relevant topics that relate to specific architectural content.

More specifically, this survey is needed at this time to fulfill the grant requirements of the National Endowment for the Arts, who funded the Architecture Building Communities program through Architecture Explorations at Carnegie Mellon University.

LITERATURE REVIEW

One area of existing educational testing is state testing; in Pennsylvania, this is the Pennsylvania System of School Assessment (PSSA). PSSA tests are given in reading, writing, mathematics, and science. These subjects each are broken down into reporting categories, which represent themes within each domain. For example, the reporting

categories for mathematics are: numbers and operations, measurement, geometry, algebraic concepts, and data analysis and probability. Of these, measurement and geometry are of the most interest to us. At this point, is unclear if we will be able to get the data on the reporting category level.

The proposal to develop an Architectural assessment survey or tool is of tremendous interest to K-12 architectural educators, including those in attendance at the AAO/A+DEN conferences. Since published surveys on children architectural comprehension was limited, we chose to expand our search to include a review comprehension tools and surveys for architectural related fields. These fields include knowledge and skills that influence architectural comprehension.

- Measuring scale
- Art – drawing, sculpture
- Creative thinking
- Math
- Science – Physics
- Geography
- Geology
- Spatial understanding
- Pattern recognition
- History, social studies
- Engineering
- Environment
- Urban Planning
- Computers, technology, electronics

Many school districts provide math, reading, science, and social studies achievement tests at critical grades. According to a 2010 news release published by The National Assessment Governing Board, “NAEP is the only nationally representative measure of what American students know and can do.” While the NAEP does not include an Architectural assessment, we are able to review achievement measurement guidelines for subjects whose knowledge corresponds with aspects of Architecture. Unfortunately, Pittsburgh was not included in the summary results of U.S. urban centers for fourth and eighth grade public school students, however a review of the national and large city math, reading, science, and social studies proficiency percentages provides insight to probable proficiency levels in other urban locations. Based on the fourth grade public school achievement results, many urban locations include a third or more fourth grade students who are not proficient in reading. (National Assessment Governing Board, 2010)

National Assessment Governing Board. (2010, May 20). *Several Urban Districts Post Gains But Most Score Below Nation in Nation's Report Card for Reading*. Retrieved January 2011, from National Assessment Governing Board: <http://www.nagb.org/newsroom/release/release-052010.htm>

WestEd, under contract with The National Assessment Governing Board identifies a Technology and Engineering Literacy Framework. Their report identifies the importance of elementary and secondary technological knowledge and defines technology as “any modification of the natural world done to fulfill human needs or desires.” (WestEd, Contract # ED08CO0134)

U.S. comprehension, recognition, and examination result targets were separated into fourteen categories and identified for grades 4, 8, and 12. Many of the comprehension goals match those for architecture, especially those identified in table 2.3 "B. Effects of Technology on the Natural World."

National Assessment Governing Board. (2010, May 20). *Several Urban Districts Post Gains But Most Score Below Nation in Nation's Report Card for Reading*. Retrieved January 2011, from National Assessment Governing Board: <http://www.nagb.org/newsroom/release/release-052010.htm>

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Quellmalz, E., Davenport, J., Timms, M., & Buckley, B., & WestEd. (2009). *Quality Science Simulations for Formative and Summative Assessment*. Retrieved January 2011, from SimScientists Publications: http://www.simsScientists.org/downloads/Quellmalz_NCNE4-09.pdf

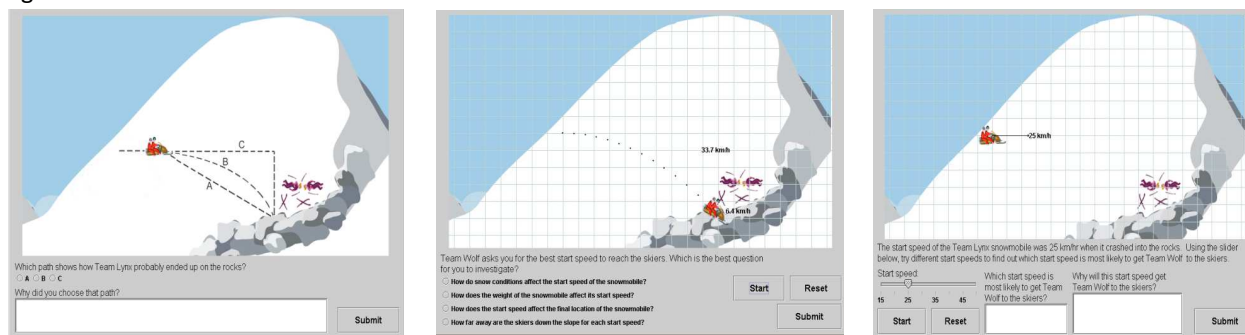
WestEd. (Contract # ED08CO0134). *Technology and Engineering Literacy Framework for the 2014 National Assessment of Education Progress: Pre-Publication Edition*. Retrieved January 2011, from NAEP Technology and Engineering Framework and Test Item Specifications: <http://www.edgateway.net/cs/naepsci/view/lib/249>

These should all be folded back into a references section at the end (of course!) and cited as appropriate in the paper...

(similarly elsewhere...)

The WestEd Foundations of 21st Century Science Assessments developed an interactive computer based student assessment program. During the test, students used numerous skills such as math, analytical, and memory to complete tasks.

The example provided in a paper by Quellmalz et. al. includes a colorful and seemingly user friendly assessment tool. While providing a high level computer assessment tool is not feasible with a constrained schedule, the tool identifies positive aspects of a survey, such as use of color, images, and child friendly goals, that could prove to be child friendly and potentially improve our response rate. The paper also includes information regarding child cognitive abilities.



(Quellmalz, Davenport, Timms, & Buckley, & WestEd, 2009)

Quellmalz, E., Davenport, J., Timms, M., & Buckley, B., & WestEd. (2009). *Quality Science Simulations for Formative and Summative Assessment*. Retrieved January 2011, from SimScientists Publications: http://www.simsScientists.org/downloads/Quellmalz_NCNE4-09.pdf

David Uttal, a researcher at the Northwestern University has done numerous studies on children's spatial representations and mapping. One such study is: Young Children's Representation of Spatial Information Acquired from Maps, by Uttal and Henry Wellman in *Developmental Psychology* 1989, vol. 25, no. 1, pp 128-138. In this, Uttal and Wellman discuss children's abilities to find objects in a space based on prior-knowledge of a map. They present several theories of children's mental representations of mapping and how it applies to the physical space. While this is focused on younger children than our target for this survey, it may provide insight into how questions could be asked.

In a similar vein, Liben and Yekel published *Preschoolers' Understanding of Plan and Oblique Maps: The Role of Geometric and Representational Correspondence in Child Development*, 1996, 67, 2780-2796. This study, while still using subjects younger than our target, looks specifically at floor plans (both traditionally and with an oblique projection). While it demonstrates that preschoolers have considerable difficulty on mapping tasks, it provides a question format that may be more applicable to a pencil and paper test than the Uttal and Wellman article.

Learning Through the Arts, National Assessment 1999–2002 Final Report to The Royal Conservatory of Music (2003) by Rena Upitis and Katharine Smithrim. This was a three-year study on children who started in grade 4, who were followed through grade 6. The overall concept for the study is that the Learning Through the Arts curriculum (LTTA) (generalized to the idea of arts education), helps learning in other subjects, specifically mathematics. The executive summary includes this analysis: While there were no differences at the end of the three years on mathematical tests of geometry and of applications of mathematical concepts, the Grade 6 LTTA students scored significantly higher on mathematical tests of computation and estimation than students in the two types of control schools, equivalent to a difference of 11 percentile points in raw scores." While this is a longitudinal study, it does use students in the age range we are targeting, and may provide some baseline data of what students are typically expected to know at this age.

In addition, there are numerous academic standards (most currently the Common Core standards movement) which will provide guidance of what American students are expected to know (whether or not they know it is not answered here). The standards are available at <http://www.corestandards.org/> and to date include two subjects: Math and English Language Arts. There are also federally recognized standards (although be careful not to call them NATIONAL STANDARDS – as each state has their own standards).

SUMMARY OF RESULTS

We will write this section after we have results.



METHODOLOGY

POPULATIONS

Lincoln Academy and Carmalt Academy in Pennsylvania.....

SURVEY SAMPLE POPULATION

The sampling Frame is the class rosters and school enrollment records for 3rd, 4th, and 5th grade students at Lincoln Academy and Carmalt Academy in Pennsylvania.

The target population is the third, fourth, and fifth grade students at two Pittsburgh Public School Academies: Lincoln Academy and Carmalt Academy. In theory, the target population does not differ from the sampling frame as we will be conducting a census, however, a errors will likely affect this theorized perfect overlap.

We anticipate a very limited coverage error. It is very likely that our sampling frame has an almost perfect alignment with our target population. School federal and state regulations (especially those under the No Child Left Behind Act) require well kept records of class rosters, school enrollment and attendance rates. Utilizing the class roster and school enrollment records for 3rd, 4th, and 5th graders at Lincoln Academy and Carmalt Academy (target population) should identify almost all students likely to be present when we administer the questionnaire.

- Student body
 - Lincoln (K-8) = 455 students
 - Carmalt (K-8) = 621 students
- Assuming equal number of students per grade level
 - Lincoln = 51 students / grade
 - Carmalt = 69 students / grade
- 3 grade levels at each school
 - Lincoln = 153 students in 3rd – 5th grades
 - Carmalt = 207 students in 3rd – 5th grades
 - Total population = 360 students
- Attendance rates – reduction of sample size

- Lincoln = 90% attendance rate required for admission
- Carmalt = 94% reported attendance rate
- Other unavailability – further reduction of sample size
 - Assume worst case is 1 student per class
 - Estimated class size 18 students
- Final Estimation of Expected Respondents for Census
 - $((153 \times .90) + (207 \times .94)) \times (17/18) = 314$ students

COVERAGE ERROR

We might encounter a coverage error if a new student recently enrolls in the school before we administer the questionnaire. As an example, if a new student enrolls the day before we administer the questionnaire, this student will not be anticipated and could be identified with an undercoverage error. To reduce the probability of such an error, we will personally administer all questionnaires and bring additional copies during the survey days. Additional copies of the questionnaire will allow us to administer it to students not listed on the class roster.

Additionally, we might encounter an error that falls into the ineligible units category. As an example, if a student was listed on the class roster, but his/her family moves out of state immediately before or during our survey time, the child will qualify as an ineligible unit. This child is no longer a student of Lincoln Academy and Carmalt Academy and no longer a resident of PA. While the results from this child's questionnaire will still identify his/her knowledge of Architecture, he/she no longer falls within our target population. To reduce the probability of this error, we can compare class rosters before and after we administer all questionnaires and identify any changes in enrollment.

Another example of an ineligible unit can include a child visiting the classroom from another school or grade level who happens to be in the classroom the day we administer the questionnaire. Again, comparing class rosters and attendance records before and after we administer the questionnaires will reduce the likelihood of such an error.

Another error we could encounter are non response errors. We cannot force all children to participate. Sometimes children need a "time out" or may have a "bad day." With this scenario, we could try talking to the child, asking the teacher to ask the child to participate, or return another day to inquire if the child is in a better mood and will complete the questionnaire.

We also might encounter non response errors from English as a Second Language students who have difficulty with the wording of some questions. We do not anticipate non response errors due to language associated problems based on the enrollment data of the two schools, the limited percentage of 6th through 8th graders who score below basic in reading standardized exams, and Carmalt's Magnet school status.

Enrollment for Lincoln Academy:		Enrollment for Carmalt Academy:	
Total Students:	455	Total Students:	582
African-American:	444 (97.58%)	African-American:	278 (47.77%)
American Indian:	1 (0.22%)	American Indian:	2 (0.34%)
Asian:	0 (0.00%)	Asian:	6 (1.03%)
Hispanic:	1 (0.22%)	Hispanic:	6 (1.03%)
Multi-Racial:	8 (1.76%)	Multi-Racial:	43 (7.39%)
White:	1 (0.22%)	White:	247 (42.44%)
Male Students:	240 (52.75%)	Male Students:	317 (54.47%)
Female Students:	215 (47.25%)	Female Students:	265 (45.53%)
(Pittsburgh Public Schools, 2010)		(Pittsburgh Public Schools, 2010)	

Pittsburgh Public Schools. (2010). *Pittsburgh Carmalt PreK-8*. Retrieved January 2011, from School Information: <http://www.pps.k12.pa.us/144320101158067/site/default.asp>

Pittsburgh Public Schools. (2010). *Pittsburgh Lincoln K-8*. Retrieved January 2011, from School Information: <http://www.pps.k12.pa.us/lincoln/site/default.asp>

Additionally, our degree of interviewer involvement should reduce non response errors since we will be present to answer any questions or provide clarification to the children.

Another type of error we could encounter are processing errors. An example of a processing errors that we could encounter includes coding error in our data entry derived from misunderstanding the child's handwriting or from a child who erases a lot thus making the responses illegible. To reduce this type of error, we should read the responses to the questionnaires before leaving the school and request clarification from the child after the survey or one of the days we return to the school to administer the questionnaire to a different classroom. Reviewing the responses and requesting clarification during a follow up visit will also help to reduce outliers and inaccurate data; responses that seem very out of the ordinary, those where it appears the child did not understand the question, or instances where it appears the child wrote the response to a particular question in the space for a different question.

We could also encounter processing error during the coding and data entry caused by a typographical error made by the person conducting the data entry. To reduce this type of error, we should review our work carefully.

Additionally, since there are two people in the team, we can each review the other's work to reduce this type of processing error.

MODE OF DATA COLLECTION

The survey will be administered in person via paper and pencil test at the schools. Paper and pencil will be used because it is an easily portable technology. It allows us to go into classrooms and easily administer without having to test students individually (if we interviewed them) or getting the students into a computer cluster (posing potential technological issues as well as scheduling availability for a limited resource). Additionally, this allows us to be in the classroom to administer the test and answer questions consistently. We will attempt to administer all of the tests in one day per grade, repeating the test on alternate days for students who were absent on the testing day.

MEASURED VARIABLES

As the primary research question is "What do children in grades 3-5 know about architecture?" we will look at several areas within this:

- What does an architect do?
- Visual literacy (ability to "read" a building and/or context)
- Mapping skills

Additionally, we will collect generic information about the student: school (Carmalt or Lincoln), grade, gender, home ZIP code, and usual mode of transportation to school (bus, car, or walk – this may affect their ability to answer some of the mapping questions).

For each of the three architectural knowledge topics, we may be able to devise a series of questions and then give the students a percentile score based on their responses. The first question, "What does an architect do?" may be able to be tested without coding issues (e.g. using multiple choice questions). The visual literacy and mapping skills will need to be coded. For visual literacy, Plester, et al. is the closest we've come so far in identifying existing research that uses photographs of the built environment in a study. The results of this study are published as Young Children's Ability to Use Aerial Photographs as Maps in the Journal of Environmental Psychology (2002) 22, pp. 29-47. Additionally, the subjects of this study were younger than our target population. However, the study offers one tested method of how to present photographs and ask children about them. A second article, Children's Journey to School: Spatial skills, knowledge and perceptions of the environment (British Journal of Developmental Psychology, 1999, 17, pp. 125-139), is more aligned with the mapping skills issues and targets a similar age range of students (ages 7-12). The students in the study were given a piece of paper with an outline of their school in the center of the paper and "asked to draw the area around their school, and also asked 'to show where you live, where you play, and the other places you go'." This provides a nice example of a coding scheme to assess the students' drawings, which we may be able to use for a similar task in our survey.

SAMPLE SIZE

- 314 Students
- Margin of Error = 2
 - Accurate within +/- 2 questions
- Standard Deviation = 8
 - Pilot Survey SD = 2
 - Increased due to more questions on test (14 to 35)
 - Increased due to biased sample
- Simple Random Sample Calculations
 - $n_o = 2^2 * SD^2 / ME^2 = 2^2 * 8^2 / 2^2 = 64$ students
 - $n = (N * n_o) / (N + n_o) = 314 * 64 / (314 + 64) = 57$ students

As we discussed before you are primarily interested in the census data but it will be interesting to see how accurate this sample of 57 students can be.

you might consider doing this separately in each school as well.

PILOT QUESTIONNAIRE

Statement about pilot questionnaire.

PILOT POST-SURVEY PROCESSING AND RESULTS

Statement about results...

A pilot study was conducted at.... On

One student answered every question correct and another missed one question.....

Two students answered five questions incorrect.....

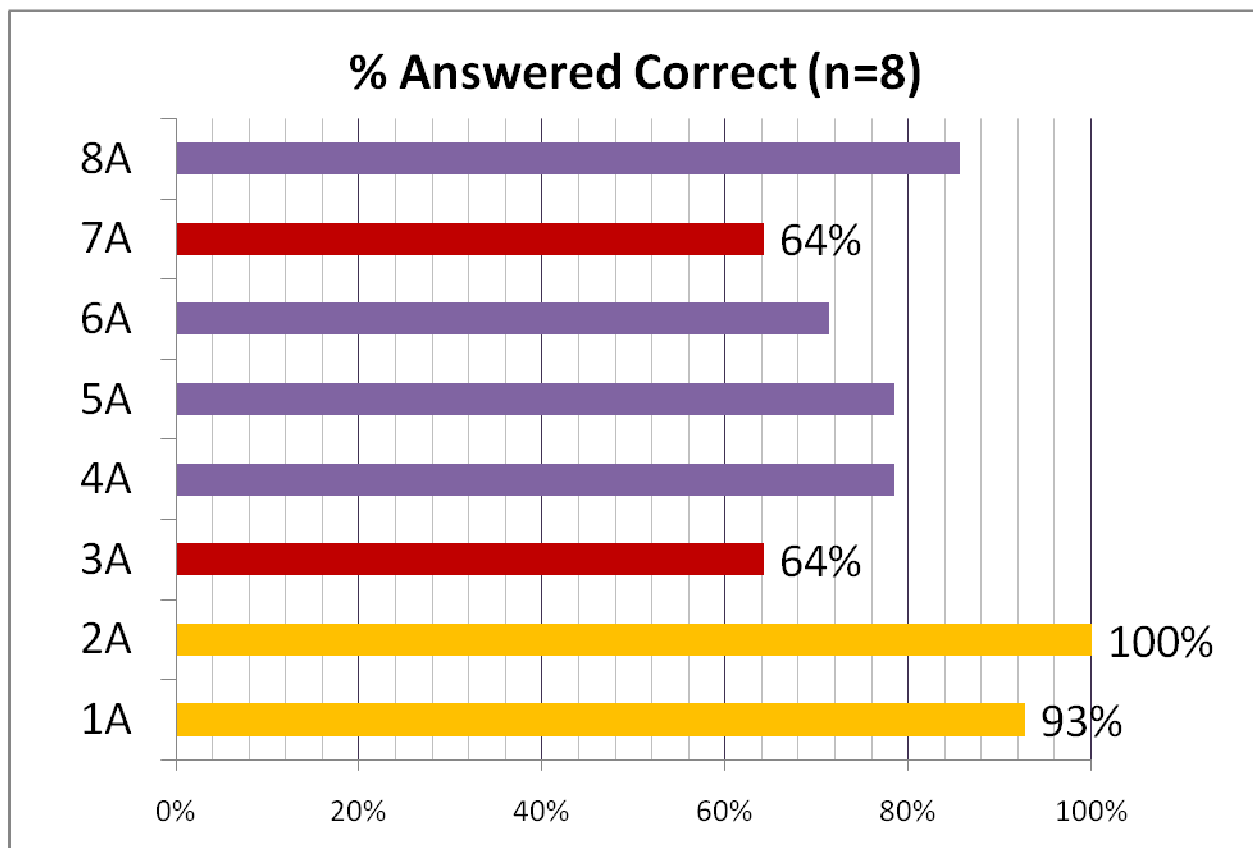


Table 1: Results from students with highest correct and most incorrect responses.

Quest. #	Question text	1	2	3	7
1	Grade	3	5	5	3
2	Age	8	10	11	8
3	Gender (G/B)	G	B	B	B
4	1st Arch class	3	5	4	3
	#years since 1st Arch class	0	0	1	0
5	Mode of transp.	Walk	Car	Car	Car
6	Zip code	Squirrel Hill	15012, Belle Vernon	15012, Belle Vernon	15367
7 Total	Attended classes outside of school	2 (Arch)	2	1	1
		93%	100%	64%	64%

Table 2: Results from students with highest correct and most incorrect responses.

The yellow highlights in the table below identify the six (6) questions all students answered correct. The orange highlights identify the four (4) questions that received the least incorrect responses.....

From the table we learned that.....

Ceiling effect.....

--

Question #	Question text	% Answered correct
8	Type of drawing	50%
9	# Bedrooms	100%
10	Identify stair	100%
11	Identify bathroom	75%
12	Identify hallway	100%
13	Identify door	100%
14	Identify teacher's desk	100%
15	Identify blackboard	100%
16	Identify window	50%
17	# Windows	50%
18	Measure 1.5"	75%
19	Measure 3.25"	75%
20	Measure 9.5 mm	88%
21	Identify correct section	63%

Table 3: Results from questions

REVISED QUESTIONNAIRE

The questionnaire was revised to..... increase our ability to identify what the children do not know.....

- *Include more questions*
- *Additional identify the image questions*
- *Images require additional thought*
- *Include a question about what an Architect does.*

)

POST SURVEY PROCESSING

We will conduct post survey processing after completing the two surveys



CARMALT ACADEMY

Processing for Carmalt will be in this section.

LINCOLN ACADEMY

Processing for Lincoln will be in this section.



RESULTS

General results will be in this section.

ANALYSIS OF POPULATION

Brief synopsis of census results.

CARMALT ACADEMY

Analysis for Carmalt will be in this section.

LINCOLN ACADEMY

Analysis for Lincoln will be in this section.

ANALYSIS BASED ON RANDOM SAMPLES

We will randomly select XX questionnaires from the population and compare the results with those of the census.

.

SAMPLE SELECTION

Include formulas utilized to identify the number to sample.

!

Identify methods to select samples.

- *Randomly select completed questionnaires*
- *Stratify completes questionnaires by grade and randomly select based on grade per school.*

CARMALT ACADEMY

Sample population descriptive statics from Carmalt will be in this section.

LINCOLN ACADEMY

Sample population descriptive statics from Lincoln will be in this section.

RANDOM SAMPLE RESULTS

Results of sample population and comparisons to census results.

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CARMALT ACADEMY

Analysis for Carmalt sample population will be in this section.

/

LINCOLN

Analysis for Lincoln sample population will be in this section.

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BIBLIOGRAPHY

National Assessment Governing Board. (2010, May 20). *Several Urban Districts Post Gains But Most Score Below Nation in Nation's Report Card for Reading*. Retrieved January 2011, from National Assessment Governing Board: <http://www.nagb.org/newsroom/release/release-052010.htm>

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Quellmalz, E., Davenport, J., Timms, M., & Buckley, B., & WestEd. (2009). *Quality Science Simulations for Formative and Summative Assessment*. Retrieved January 2011, from SimScientists Publications: http://www.simsScientists.org/downloads/Quellmalz_NCNE4-09.pdf

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**...plus the other references
interspersed above**

APPENDICES

Include Pilot and final questionnaires.

