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ABSTRACT

Anticipated demographic changes in the United States adult population in the decade between the National Adult Literacy Survey (NALS) of 1992 and the National Assessment of Adult Literacy (NAAL), which is scheduled for 2002, were reviewed. Next, the implications of those changes for the NALS and NAAL were analyzed. The analysis focused on births, deaths, and international migration. Next, a demographic model of adult literacy proficiency was described that links changes in literacy proficiency to compositional and maturational changes in the adult population. Composition components were defined as changes over time in membership in the target population, whereas maturational components were defined as changes over time in the literacy proficiencies of given individuals who are in the target population at both time points. The model predicted increases over the decade in the mean literacy proficiency of both the foreign- and native-born adult populations and decreases in the percentages of each that are performing at the lowest level. (Eight implications of the model for the NAAL methodology were discussed, including implications related to the following issues: parallel population coverage in the NALS and NAAL assessments; adequate representation of minority and immigrant groups; and working with populations having limited English proficiency.) (MN)

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Demographic Changes and Literacy Development in a Decade

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Abstract

This paper considers several interrelated topics: (1) anticipated demographic changes in the U.S. adult population age 16 and over in the decade between the National Adult Literacy Survey (NALS) of 1992 and the National Assessment of Adult Literacy (NAAL) scheduled for 2002; (2) implications of these demographic changes for interpreting changes observed over the intervening decade in national and state adult literacy proficiency profiles; and (3) implications of anticipated demographic changes for the NAAL methodology, including the content of the background questionnaire, the sampling design, and other survey and assessment procedures. A demographic model of adult literacy proficiency will be described that links changes in literacy proficiency to compositional and maturational changes in the adult population. The model is used both to project future changes in the adult population's literacy as well as to disaggregate observed past changes in literacy proficiency into compositional and maturational components.

Introduction

It is anticipated that the National Assessment of Adult Literacy (NAAL), like the National Adult Literacy Survey (NALS) before it, will combine methods for cognitive assessment with methods for population surveys. Given the growing interest in improving the literacy proficiencies of the nation's workforce and adult population in general, there will be substantial interest in comparing the proficiencies of adults in 1992 and 2002. Many audiences will naturally try to interpret observed changes in assessed proficiencies as reflecting improvements (or lack thereof) in our school systems, educational standards, and the like.

Given the magnitude of expected demographic change over the intervening decade, such comparisons could be quite misleading. Changes in adult literacy proficiencies are to be expected because of anticipated demographic changes, independently of possible changes in the output of school systems or other factors influencing individual learning. For example, since the nation's elderly population in 1992 had lower educational attainment and lower literacy proficiencies than the younger adult population, we would expect overall population levels of literacy to increase over the subsequent decade as a less educated elderly population gradually dies and is replaced by a more educated population. The interpretation of observed changes in adult literacy between the 1992 and 2002 thus must be made carefully with respect to potential changes in population distributions of age, education, race/ethnicity, nativity, English language proficiency, and so forth.

The first section of the paper describes demographic changes in the U.S. adult population anticipated between 1992 and 2002. The second section considers some issues that will likely arise in interpreting NAAL results as a result of the anticipated demographic changes. In order to focus the results of the NAAL on many of these issues, the third section of the paper constructs a demographic model of adult literacy that will facilitate differentiating changes due to demographic change from those due to other factors of interest. The final section of the paper considers some methodological implications of the anticipated demographic changes for the design of the NAAL.

Anticipated Demographic Changes

The contours of national life in the next decades will depend in no small part on the number and variety of Americans who are alive to shape them. Most of them are already living today, and the arrival and departure of others is reasonably predictable. So demography offers a crystal ball that can draw a fairly reliable portrait of society for years to come. The image that emerges is of an America that is significantly different from that of today. Almost certainly, it will be older, longer-lived, better educated, and more ethnically diverse.

The size and composition of the future population is completely determined by three factors: fertility (the average number of children born per woman), mortality (the average life expectancy at birth), and migration. The Census Bureau and the Social Security Administration make population projections for the United States. The Census Bureau projects higher fertility and a faster improvement in mortality than does the Social Security Administration. As a consequence, going out to 2050, the Census Bureau projects that the present population of 272 million (in 1999) will grow to 394 million by 2050, 34 million more than the Social Security Administration projects. For projections over the next one to two decades, however, the difference in the assumptions matters relatively little.

The population is growing older and will continue to do so in the next half-century. Between 1995 and 2010, the population 65 years and older will slowly grow by about 6 million, from 33.5 million to 39.4 million, as people born in the 1930's and 1940's (when fertility was low) age. After 2010, with the baby boomers aging, the number of elderly will dramatically increase.

Consequently, we can expect America's attention to be increasingly focused on its aging population after about 2010. The Social Security system and Medicare, the two largest federal entitlement programs, operate largely on a pay-as-you-go basis and currently constitute more than half of all federal domestic spending. Between 2010 and 2030, assuming no change in relative contributions and benefits, these two systems will expand substantially and will come under enormous fiscal pressure.

People 65 and older have the highest voting rate of any age group. If current voting patterns continue, 32 percent of voters in 2030 will be 65 and older and 49 percent will be 55 and older. This group will have enormous power to divert resources to itself. Whether these people choose to use that power will

depend upon many factors, including whether they believe that they have been treated fairly. In view of the unappealing major adjustments required for Social Security and Medicare, that may be a hard sell.

Discussions about how to support an aging population may acquire racial and ethnic overtones. By 2050, 53 percent of the population is projected to be whites who do not identify themselves as Hispanics, down from 74 percent today. The white, non-Hispanic population will grow slightly over the period, but will decline as a proportion of the total population. And it will be a very old group. Whites who are not Hispanics will constitute 66 percent of the population over 65 in 2050 but only 44 percent of the population under 30.

African-Americans will constitute roughly the same percentage of the population in 2050 (15 percent) as they do today (13 percent). The fastest growth will occur between Hispanics and Asian Americans, fueled primarily by immigration. The "replacement" of whites by Hispanics and Asian Americans, however, will probably not cause big ripples in 2050. New immigrants are assimilating along the same dimensions and at roughly the same pace as earlier European immigrants did. For many Hispanics and Asian Americans, ethnic identity itself will be blurred by intermarriage, just as it has been for earlier immigrant groups. Among U.S.-born married women ages 20 to 29 in 1990, 67 percent of Asian American and 38 percent of Hispanic women married outside their ethnic group. Only 3 percent of African-American women currently marry outside their race, a testament to their extreme residential and social isolation.

As noted previously, demographic changes during the next decade will be determined by changes in births, deaths, and international migration.

Births

After the Baby Boom diminished to relatively low fertility levels in the 1970s, the United States experienced a baby bust for almost two decades. By the early 1990s, the Baby Boomers began to have little boomers, with slightly higher fertility rates showing up, compared to early years. Current fertility levels of slightly more than two children per woman have been relatively constant since 1990. Fertility rates vary by nativity and ethnic origin, however, so that relatively unchanging conditions for the national population are comprised by subtle differences in the fertility contributions by different population subgroups. For

population projections, most current demographic scenarios assume that fertility will change little overall for the next decade or so.

Deaths

Mortality has been improving dramatically in the United States over the last century. At current levels of mortality, with a life expectancy at birth of 80 years for women and 73 years for men, more than one-half of all women born will still be alive at age 80, and four out of ten will be alive at age 85. Trivial perhaps, but interesting, is the fact that mortality is currently low enough that more than 10 percent of all babies born in the United States can be expected to have a living great-great-grandmother.

Most demographers expect mortality declines to continue for the next five decades and longer. But all residents do not equally share current low mortality. Differences in mortality by social status are among the most pervasive inequalities in the United States. The connection between health and income, education, and occupation has been obvious for centuries, and whatever characteristics lower social status may increase the risk of dying. As described below, we rely on information about the relationship between education and mortality to assume that there are decreases in survival when education is lower.

International Migration

Annual net immigration in the United States has been at about 820,000 in recent years. This is an estimate of net immigration, calculated on the basis of about 1,040,000 immigrants and 220,000 emigrants per year. Further, the estimate of 1.04 million immigrants includes 225,000 net illegal immigrants annually. Although there are yearly fluctuations in the number of people in the various categories of immigrants (legal immigrants, refugees, and illegal immigrants), the 1.04 million figure is a reasonable level to assume for the next decade.

Relationship of Demographic Changes and Adult Literacy

Existing research and population models enable us to project demographic changes in the U.S. adult population (16 years of age and older) for the decade between the two national literacy assessments conducted in 1992 and 2002.

Demographic changes include births, deaths, and international migration. For the study of sub-national populations, internal migration plays a role. We must consider maturation processes. Because literacy changes over time for an individual, a population model for literacy, therefore, needs to take into account lifetime changes in literacy for population groups.

The kinds of differences found within populations are legion. The array of characteristics for the population modeling of literacy, however, is limited. Along with basic characteristics of age and sex, the key characteristics include educational attainment, nativity, and, if foreign-born, the length of U.S. residence.

Growth from migration exerts various effects on the literacy composition of populations. Because international (and internal) migrants are usually younger adults, they enlarge the population in the younger adult years. The subsequent effects of migration on population composition are transmitted upward in the age scale as a result of the aging of migrants and downward in the age scale through the reproduction of migrants.

An age composition, influenced by heavy immigration, defines the potential, if not actual, population for public programs and services. This is easiest to demonstrate in connection with educational systems because of the rather precise age grading practiced in such institutions. The number of children aged 5 to 17 years determines to a large extent the number of teachers and the amount of plant and equipment needed for local education. An increase in the school-age population, as a result of immigration, may result in either an expansion of the school system or calls for changes in educational procedures. Such changes at the national level need not be reflected at all local levels, because many communities are relatively unaffected by immigration (or by internal migration).

Knowledge of the population composition and the factors changing that composition has two broad uses for the study of literacy proficiency. In the first place, it is useful as evidence of past events in the career of the U.S. population. Composition reflects changes in growth trends, the sources of growth,

and circumstances attending to the changing settlement of the population. Such information informs the discussion about major changes that may be shaping the literacy proficiency of the U.S. population.

Secondly, composition data are useful for assessing the limits of possibility for changes in the literacy proficiency of the population. This utility is difficult to assess, however, without a rudimentary model of the population that includes basic demographic processes as well as maturation estimates for educational change.

A Model of Compositional and Maturational Changes

The model treats adult literacy proficiencies as population characteristics that are influenced by a variety of events, including formal education, births, deaths, maturation, internal migration, immigration and emigration. This demographic model of adult literacy development in the U.S. population includes both *compositional* and *maturational* components. Compositional components involve changes over time in membership in the target population: Some individuals are in the target population at one point in time but not at another point in time. Such compositional change occurs through a variety of events, such as coming-of-age (i.e., individuals were less than 16 at the first point in time but are 16 or older at the second point in time), death, immigration, and emigration. Maturational components involve changes over time in the literacy proficiencies of given individuals who are in the target population at both time points. Maturational change occurs as the result of aging (among the elderly), through English language acquisition and acculturation among recent immigrants, and through participation in formal education, training and other activities associated with literacy acquisition.

The preliminary model will estimate both compositional and maturational components of change in the adult population's literacy proficiencies. The paper details the demographic model and its key parameters that need to be ascertained in order to separate maturational from compositional changes within state and national comparisons of NALS and NAAL data. Best sources of data for estimating key parameters will be identified, and the sensitivity of resulting predictions to various modeling assumptions will be considered. A number of specific projections of NAAL results for 2002 will be worked out in detail as illustrative applications of the model. Projections of literacy will be generated in five-year increments, so

that we will produce illustrative estimates for 1997 (midpoint between the 1992 NALS and 2002 NAAL) and 2002.

The following material identifies some of the key components of our model of changes in adult literacy proficiency between 1992 and 2002. The target population's noninstitutionalized U.S. residents, age 16 and above.

Compositional Components of Change

Compositional components of change in the target population include:

A. Members of the target population in 1992 who will not be members of the target population in 2002. Such individuals either:

1. *Died between 1992 and 2002*

   It is important to take education variations in mortality into account. Pioneering mortality work by Philip Hauser and Evelyn Kitagawa[1] (1968), using matched death and census records in 1960, revealed a striking inverse relationship between educational levels and mortality, for males and females and for major race groups. Although education alone does not account for all the variation in mortality, education is probably the single most important variable, having a strong independent relationship with such other factors as diet, smoking, lifestyle, and income.

2. *Emigrated from the United States between 1992 and 2002*

   We lack considerable information about emigration from the United States. The best estimates are that about 150,000 to 200,000 persons emigrate from the United States each year and most emigrants are immigrants. In other words, about one-third of immigrants probably return to their countries of origin. Although we lack information about the demographic characteristics of immigrants, most emigrants were originally from countries characterized by higher levels

of education (e.g., European countries and Canada). If anything, it appears that the emigration may be selective of better-educated immigrants. Selective emigration, other factors being equal, would tend to make the resulting pool of immigrants appear to become less educated over time. This is a potentially important selection to take into account, especially when analysis focuses on selected countries of origin.

We assume that there are about 220,000 emigrants annually from the United States, incorporating the emigration estimate in our model by calculating a rate of net immigration. We describe below how we incorporate net immigration in the model.

B. Members of the target population in 2002 who were not members of the target population in 1992. Such individuals either:

1. *Were under 16 years of age in 1992 (i.e., age 6–15 in 1992)*

   Important shifts are now occurring in the maturation of the population who were youths in 1992. Following the substantial increase in the volume of immigration in the late 1960s, accompanied by a shift in the origin of immigration from European and Canadian sources to Asian and Latin American countries, the nation is now witnessing the initial upswing in sons and daughters of these new American immigrants. In the 1992 survey, the first native-born offspring of the new immigrants were just beginning to leave school. Now, ten years later, there are substantial numbers of second generation persons who have left school, entered the labor force, and begun families.

2. *Immigrated to the U.S. between 1992–2002*

   The volume and characteristics of immigration into the United States are dynamic. Refugee flows continually change in terms of countries of origin and can, at special periods, dramatically increase the volume of U.S. immigration. Legal immigration has been changing

[1] More comprehensive information is available in Kitagawa, E. M., and Hauser, P. M. (1973).

in the 1990s, largely because the U.S. offered amnesty to 3.1 million previously illegal immigrants in 1986; these individuals began to gain legal resident status in the early 1990s and then became eligible for U.S. citizenship after 1996; many are not currently eligible to sponsor immediate relatives for U.S. immigration. Illegal immigration into the United States continues at a level of about 225,000 net arrivals each year. The composition of illegal immigration seems to continue to be primarily from Mexico, although there may be recent increases in illegal immigration from Asian countries.

Taking emigration into account, recent U.S. net immigration has been running at a level of about 800,000 annually. In order to add net immigrants into the U.S. population, we rely on data from the 1997 CPS, calculating the number and educational characteristics of immigrants who reported arriving in the United States in the five years between 1992 and 1997.

Maturational Components of Change

Maturational components of change include members of the target population in 1992 and 2002 characterized by the following:

C. Attain educational degrees between 1992 and 2002

We will use analyses of the relationship between education and proficiency in NALS and other studies to estimate literacy proficiencies associated with completion of high school and various levels of postsecondary education. These functions will be applied to existing future projections of high school and postsecondary completion rates.

D. Recently immigrated as of 1992 (i.e., immigrated in 1987 or later)

Educational maturation is related to age at arrival in the United States and to duration of U.S. residence. The measurement of duration of residence is, in part, dependent upon data sources (the

decennial census groups duration of residence). We will, however, prepare analysis that matches as closely as possible information collected in the 1992 survey. For example, we will examine immigration in the five years, five to ten years, and so on prior to the 1992 survey in order to be able to make projections ahead to the 2002 survey.

The modeling of educational maturation of the foreign-born population requires a different approach than the one described above for the native-born population. The foreign-born population continues to receive new additions who may enter the population with different educational characteristics than the existing foreign-born population. We model educational changes in the foreign-born population by distinguishing five-year periods of duration of residence. Then, for the projection modeling, over a given five-year period, we "mature" each surviving length-of-residence group by five years. For the most recent population subgroup (i.e., with 0–4 years of residency), we assume that it has the same educational distribution as the 0–4 years of residency group in the initial period of observation. This assumption is substantially borne out by studies of recently arrived immigrant populations.

Modeling Framework

In order to model change in the adult literacy of the U.S. population over time, we must distinguish and track changes within the above compositional and maturational components. We developed a modeling framework that combines (1) a dynamic demographic model for the adult population of the U.S., (2) a model linking the aggregate literacy proficiencies of the component sub-populations to other key sub-population characteristics, and (3) a model of how some key characteristics change over time.

Population Model

Our demographic model follows the changing U.S. resident population, age 16 and above, in five-year cycles, starting with the NALS-base year, 1992. Two cycles are projected through the NAAL year of 2002. The five-year cycle matches the five-year age and length-of-residence groupings readily available in NALS

data for the literacy linkage model for the native-born and foreign-born sub-populations, respectively (see below).

Initial population. The initial population is the one studied and sampled in the 1992 NALS. We divide this adult (age 16 and above) population by nativity into its native-born and foreign-born components. The native-born sub-population is disaggregated into combinations of age and educational attainment groupings described above. The foreign-born sub-population is disaggregated by the length-of-U.S.-residence categories distinguished in the NALS dataset.

Survivorship. Mortality was modeled by developing estimates of S_x, the probability of surviving five years for a person at age x, for the five educational levels distinguished in the model (i.e., less than nine years of schooling, nine to eleven years, high school graduate, some college, and college graduates). We started with mortality estimates from Kitagawa and Hauser (1968) and adjusted them to match the overall mortality levels experienced by the U.S. population in 1995. Such an adjustment produced S_x rates for five-year age groups for five educational categories that, when applied to the current U.S. population, produce the observed current number of deaths. Ten-year survivorship rates for 1992–2002 were estimated using the product of the 5-year S_x rates for 1992–1997 and 1997–2002 (est.), respectively.

Replenishment. The above sections described how the model moves the population ahead through five years of time. This population advancing over five years requires "replenishment" of two groups: (1) the native-born population aged 16–20 years and (2) the foreign-born population with 0–4 years of residence in the United States. We create the replenished native-born population by assuming it is equivalent in educational characteristics to the similar observed populations in the initial year of the projection. Our model assumes that the native-born population in 2002, aged 16–20 years, has the same educational distribution as the 1997 population, aged 16–20 years. We calculate the number of 16–20 year olds in 2002, however, by surviving the native-born population aged 11–15 from 1997 to 2002. We use data from the 1997 CPS (March Supplement) to estimate the size of the foreign-born population in 1997 with 0–4 years of residency. We use this same size as the estimate of foreign-born population with 0–4 years of residency in 2002.

Literacy Linkage Model

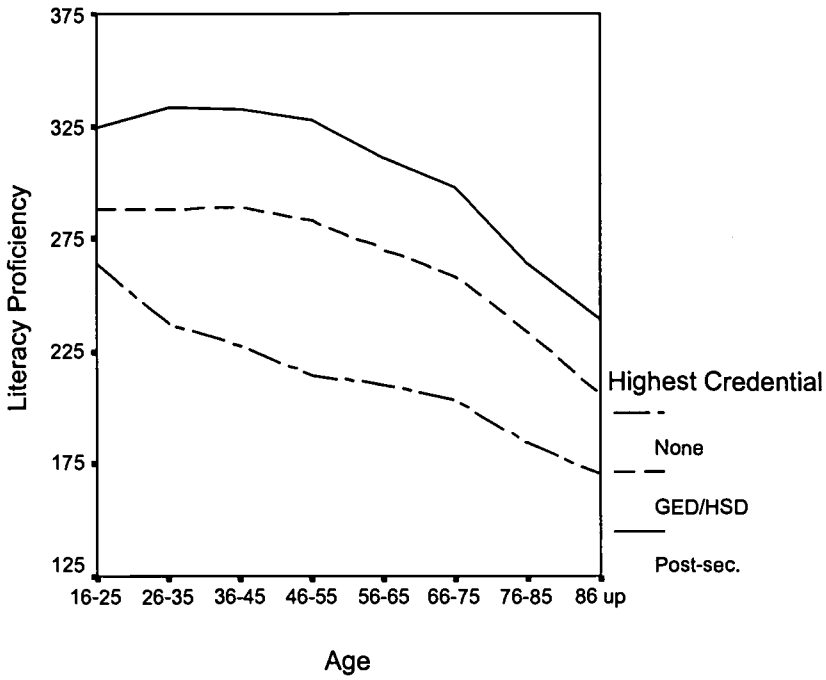
The literacy linkage model assumes that the literacy characteristics of native-born U.S. adults in given age by education groups are stationary over the time period 1992–2002. This assumption appears to be empirically confirmed for the youngest age group (16–20) where comparable data are available in 1986 in the Young Adult Literacy Survey (YALS) and seven years later in the 1992 NALS. The validity of the assumption can be more broadly examined, of course, once the NAAL data are available, by comparing the literacy characteristics of comparable subgroups in the NAAL and NALS.

The linkage model also assumes, for the foreign-born adult population, that the literacy characteristics of length-of-residence sub-populations are stationary between 1992–2002. Although the educational and national origin characteristics of successive cohorts of recent immigrants are known to vary widely over broader historical periods, current immigration policies are expected to produce successive cohorts of new immigrants having roughly comparable characteristics over this period.

To explore the appropriateness of these linkage assumptions within the NALS data, let us consider several figures shown below. Figure 1 displays the mean composite literacy proficiency[2] for selected age and educational attainment groups of native-born adults. The pronounced variation of proficiency with respect to both educational attainment and age is evident in the figure. Our linkage model assumes that as the native-born population matures over time with respect to age and educational attainment, longitudinal increases in age and educational attainment are accompanied by the corresponding cross-sectional differences in literacy present in the NALS data.

[2] For purposes of brevity, literacy data and projections presented in this paper are for a composite literacy proficiency scale (which averages proficiencies across the NALS Prose, Document and Quantitative scales). Though we have modeled each of the three scales separately, the operation of our model is readily illustrated by results for this composite scale.

Figure 1.— Mean literacy proficiency (composite) for U.S. born age and education groups.



SOURCE: National Adult Literacy Survey, authors' calculations.

There are two important assumptions being made here, one about age-related literacy changes and another about education-related literacy changes. Looking at Figure 1, we see an apparently steady and dramatic drop in literacy proficiency over the later years of adult life. But these age-graded differences are cross-sectional, and could be interpreted as either maturational differences within individuals' lifetimes or as cohort differences varying over historical time. Both maturational change and cohort effects could underlie these data. Although modern cognitive theory and measurement indicates that some components of intellectual activities are relatively stable over biographical time, other components may decline in older age. At the same time, considerable evidence has been adduced for substantial intercohort changes in some cognitive abilities.[3]

[3] This is a complex and still unresolved topic in the research literature. A range of conclusions is evident in works such as: Alwin, D. F. (1991); Cattell, R. B. (1971); Neisser, U. (1998); Schaie, K.W. (Ed.) (1983); and Wilson, J. A. and Gove, W. R. (1999).

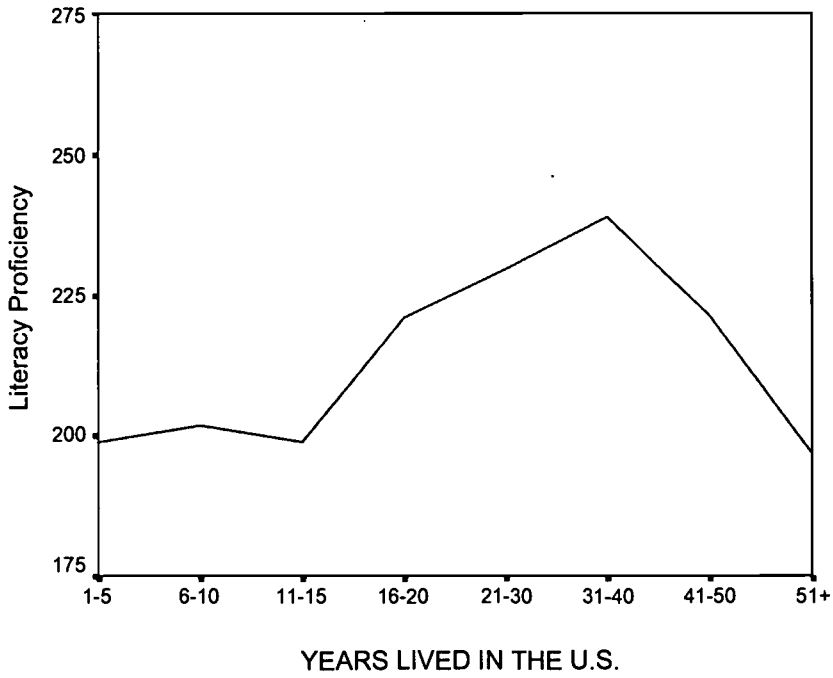
Our modeling framework assumes as a default that such age-graded change reflects a maturational effect rather than a cohort effect. We will term this the *maturational vs. cohort assumption*. Despite this assumption, we have designed the modeling framework so that it may be possible, if the NAAL assessment is appropriately conducted, to distinguish maturational from cohort-based effects of age within the observed NALS-NAAL trend data that will become available. Our modeling framework permits us to moderate or even eliminate the assumed effects of aging *per se* on literacy within models of literacy development between 1992–2002. We will demonstrate how this may be done when we consider our 2002 projections of adult literacy presented below.

The second assumption concerns the extent to which educational maturation over time in the native-born population is accompanied by longitudinal increases in literacy proficiency corresponding to the cross-sectional increases in literacy by educational attainment. We know that many adults in our population acquire additional education and degrees over their lifetime, and this educational maturation is explicitly modeled in our framework. The strong positive correlation between educational attainment and literacy proficiency evident cross-sectionally in NALS, however, does not necessarily imply that longitudinal gains in adults' educational attainment will produce corresponding longitudinal gains in their literacy proficiency. Reder (1998) has distinguished two processes that may underlie such cross-sectional correspondences between literacy and educational attainment. In one process, termed *literacy development*, the more schooling individuals receive, the more their literacy develops and the higher their proficiencies become. At the same time, literacy proficiency itself often limits access to educational opportunities, with increasingly higher levels of education becoming increasingly selective in terms of their literacy requirements. This selective filtering of literacy proficiencies through the educational system, termed a *literacy selection* process, often serves as a gatekeeper for access to postsecondary education, training and various career ladders.

It is clear that literacy development and literacy selection processes can be simultaneously active. As noted above, our modeling framework assumes that educational advancement over time will produce increases in literacy corresponding to observed cross-sectional differences in literacy among those same educational levels. This is what we term the *literacy development assumption*. Our modeling framework again allows us to moderate or even eliminate the assumed effects of literacy development on projected

literacy growth.[4] We will illustrate this possibility in discussing our projected literacy results in a subsequent section.

Figure 2.—Mean literacy proficiency (composite) for foreign born population by years of residence in the United States.



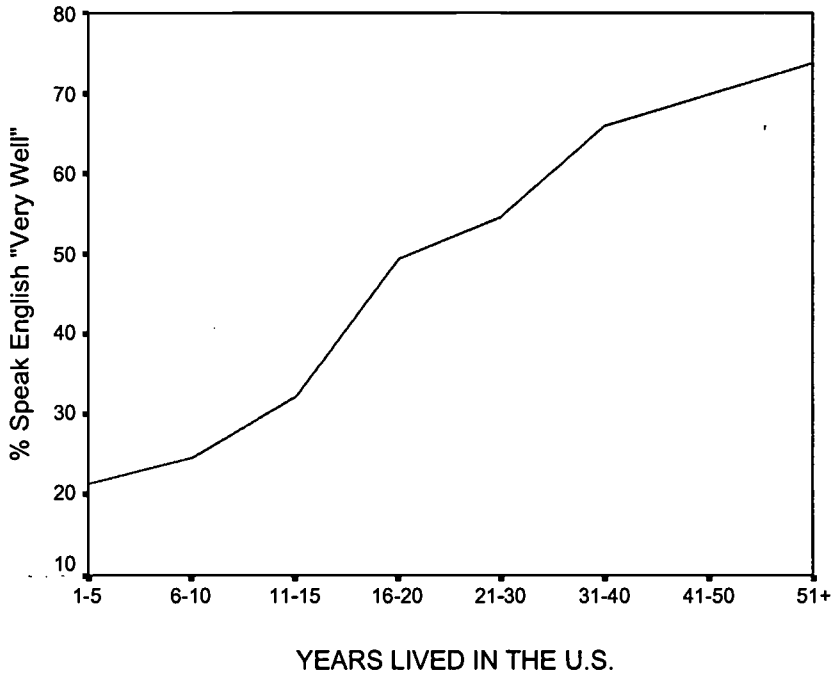
SOURCE: National Adult Literacy Survey, Author's calculations.

Figure 2 displays the relationship between length of residence in the U.S. and literacy proficiency for the foreign-born population. The inverted "U" shape curve in the figure reflects the summation of two processes that vary with time in country. One process, which increases with time in the U.S., is the development of English language and U.S. cultural knowledge, whereas the other process is the age-related

[4] It is generally very difficult to distinguish the relative effects of the literacy development and literacy selection processes underlying observed correlations between schooling and literacy. The two processes can be statistically isolated by analytical techniques that utilize other variables as well. By applying structural equation models to the NALS data from the United States, Reder was able to estimate the relative strengths of the literacy development and literacy selection components underlying the positive correlation observed between years of schooling and literacy proficiency. In the models considered, there were reciprocal positive effects of literacy and education on one other, with the estimated magnitude of literacy development (i.e., the direct effect of schooling on literacy) being roughly three times as strong as the magnitude of literacy selection (i.e., the direct effect of literacy proficiency on schooling). See Reder, S. (1998).

decline in literacy proficiency (just as seen for the native-born) that accompanies increasing time in the country. Evidence for the latter process was shown above for the native-born population, whereas evidence for the former process can be seen in Figure 3.

Figure 3.—Self-rated oral English language ability for foreign-born population by years of residence in the United States.



SOURCE: National Adult Literacy Survey, authors' calculations.

It might well be desirable in future work to add age and/or educational attainment to our linkage model for the foreign-born population, but the limited sample size of the foreign-born population in the NALS effectively precludes such detailed disaggregation. Nevertheless, years of residence in the U.S. appears to function reasonably well as a proxy for both age and educational attainment within the foreign-born population as a whole; both certainly increase smoothly with increasing length of residence ("cultural age") in the United States.

Changes in Key Characteristics over Time

As the population survives and moves through each five-year time cycle in our modeling framework, several key characteristics change. Of course, survivors' age increases by five years. Foreign-born survivors' length of residence in the U.S. also increases by five years over the period. These changing characteristics are straightforward. Though it is equally clear that some individuals' educational attainment also increases across such intervals as they continue their schooling and acquire degrees, the description and estimation of this process of educational maturation is considerably more complex.

Educational Maturation. In order to move the population five years in time, by age and educational level, we needed to estimate values for educational improvement. Further, because the initial population experiences mortality over time, we needed to make estimates that are independent of mortality. We developed the following procedures for modeling educational improvements.

- We used 1990 decennial census and 1995 Current Population Survey (CPS) data to estimate changes in educational attainment over a five-year period. We selected these two datasets because they include comparable survey questionnaires, are both conducted by the U.S. Bureau of the Census, and distinguish the population by nativity. Because we want to estimate educational improvements for the native-born population separately, we need to use surveys that ask the respondent about their nativity. The CPS introduced a nativity question in 1994, and has continued asking nativity to present. Unfortunately, the CPS has only four years of nativity information available, so we were not able to rely solely on the CPS for our estimates. Combining census and CPS change has one potential limitation: the coverage of the U.S. population is much higher in the census (about 1.8 percent net undercount) than in the CPS (probably about 10 percent undercoverage). The CPS is adjusted for its undercoverage, although there are potential differences in undercoverage by age and educational level that still persist.
- We selected the native-born population from the 1990 census and the 1995 CPS data. We defined five-year age groups for the census, using 16–20, 21–25, ..., 86 years and greater. We defined similar age groups from the CPS. We tabulated the 1990 and 1995 data for five educational

attainment categories: less than high school, some high school, high school graduate or equivalent, some college, and a baccalaureate degree or higher.

- We compared age groups for the 1990 census with age groups five years older for the 1995 CPS. In all cases, we calculated the percentage point increase (or decrease) for each of the five educational categories. For example, if there were 26 percent of the 16–20 age group in 1990 in the less than 9 years of schooling category and 10 percent of the 21–25 age group in 1995 in the same educational category, we calculated that there was a 16 percentage point decrease in the category over a five year period. We made similar calculations for each initial five-year age group for each of the five educational categories. It should be noted that the percentage point changes sum to zero because the origin and destination percentages are 100 by definition.

Preliminary Findings

The modeling framework was utilized to move the base 1992 NALS population through 2 five-year periods, 1992–1997 and 1997–2002. We still consider the model and its projected estimates as "preliminary," since many of the model details are in need of further refinement and evaluation. Nevertheless we believe the model to be a valuable and productive intellectual framework in which to consider the interplay between population change and literacy development. Many of the uncertainties associated with the model in its current form will be effectively resolved when applied to disaggregated components of change within the NALS-NAAL trend data, *if the requisite data are collected by the NAAL in 2002*. Recommendations for the NAAL design necessary for accomplishing this are presented in the final sections of this paper.

Initial Projections

Table 1 displays, for 1992, 1997, and 2002, the estimated size, mean literacy proficiency and percentage performing in the lowest of the five NALS proficiency ranges. Projections are tabled separately for the total U.S. population age 16 and above and its native- and foreign-born sub-populations. Both the foreign-born and native-born adult populations are expected to grow substantially in size over the decade

between 1992 and 2002, with more pronounced growth among the foreign born than the native born groups because of continuing net immigration. This increase in the relative size of the foreign born population would itself (in the absence of other changes) be expected to lower the overall literacy proficiency of the U.S. population, given the dramatic difference in proficiency between the foreign and native-born populations in English language literacy.

Our model, however, predicts increases over the decade in the mean literacy proficiency of both the foreign- and native-born adult populations and decreases in the percentage of each that is performing at the lowest level. Among the foreign born adults, these improvements are estimated to be relatively modest, with a two point increase in mean proficiency and a one percentage point decrease in the percent performing at the lowest level. Among the native born adults, the projected changes are in the same direction but larger in magnitude. A five point increase in mean proficiency is projected, accompanied by a 2 point decrease in the percentage of the population performing at Level 1.

Table 1.—Estimated Literacy Proficiency in United States, 1992–2002.

Population	Size	Mean Proficiency	% Level 1
United States, age 16+			
2002	212,802,130	273	19%
1997	202,774,468	272	20%
1992	191,226,039	270	21%
U.S. born, age 16+			
2002	185,731,663	282	14%
1997	179,202,790	280	16%
1992	171,038,996	277	17%
Foreign born, age 16+			
2002	27,070,467	214	49%
1997	23,571,678	213	50%
1992	20,187,043	212	50%

Notes: 1992 estimates from National Adult Literacy Survey (NALS).
1997 and 2002 estimates synthesized from NALS, 1990 Census and 1997 CPS.
Literacy proficiency shown is average of NALS Prose, Document and Quantitative scales.

Discussion

In the native born population, several factors are combining to produce the projected changes. First of all, the educational and literacy proficiency levels of the surviving population are projected to be higher in 2002 than in 1992. This occurs in our model both because of lower mortality among the more educated individuals in each age cohort as well as because of the generally higher levels of education in the younger age groups that are replacing the older age groups as they die out. A counteracting influence, one that serves to decrease the overall population literacy proficiency, is the overall aging of the population. As we noted above, everything else equal, the aging of the population results in declining literacy proficiency as elder individuals mature. We will examine below the contribution of this assumed maturational effect. Finally, the ongoing educational maturation of the surviving population generates increased literacy development within our model. We will evaluate below the contribution of this assumed literacy development.

Evaluating the Effect of the Maturational vs. Cohort Assumption

The model framework enables you to pose and answer the question, "What if there were no maturational effects of aging on literacy?" The projections shown above in Table 1 for the native-born population change dramatically if we eliminate the linkage of age to literacy proficiency. By eliminating this linkage in our model, there would be no age-variation in literacy given constant levels of mortality and educational maturation.

When the model is recalculated under this modified assumption, the mean proficiency of the native-born increases from the 1992 baseline level of 277 to 300 in 2002. Thus the effects of selective mortality and educational maturation within the native-born population, if unchecked by effects of aging, produce a huge projected increase in literacy proficiency. Between these extremes of no aging and full aging effects is a range of possible moderated effects, a likely value of which could be estimated by our model for the NALS-NAAL trend data when they become available.

Evaluating the Effect of the Literacy Development Assumption

Let us now put the effects of aging on literacy back into the model and ask, "What if there were no effects of educational maturation on individuals literacy development?" When the model re-estimates projected changes in mean literacy proficiency under these assumptions, it predicts that mean literacy proficiency in the native-born population will rise from the 1992 level of 277 to a marginally different value of 278 in 2002. Thus the considerable effects of educational maturation present above are largely offset by the strong overall effects of aging in our model.

Once again, a range of intermediate assumptions about the potency of literacy development processes could be implemented and explored within this modeling framework. If the NAAL collects appropriate background information in 2002, it should be feasible to identify the best fitting combinations of aging and literacy development processes for the NALS-NAAL trend data.

Implications for Interpreting Literacy Changes

The modeling framework for population and literacy change described in the previous sections indicates some of the challenges to be anticipated in trying to separate compositional from maturational components of observed changes in the adult population's literacy proficiencies.

- *Identify key background variables needed for analytic decomposition of NALS-NAAL trend data into compositional versus maturational components of change.*

Based on preliminary work with our modeling framework, it will be essential, at a minimum, to have comparably defined information in 1992 and 2002 about individuals' educational attainment, age, nativity and length of residence in the U.S. These variables need to be carefully aligned between the two assessments. This was not the case when we tried to model relationships among the NALS, the decennial census and the Current Population Survey.

- *Identifying comparable sub-populations in NALS (1992) and NAAL (2002) for estimating maturational changes related to education, training, aging, etc.*

When the NAAL 2002 results are released, there will be considerable interest in assessing the extent to which particular kinds of adult experiences are associated with gains in literacy abilities observed within various sub-populations. For example, policymakers and researchers interested in the impact of ongoing changes in K–12 education on adult literacy may compare the literacy abilities of young adults coming out of high school in the years immediately prior to 2002 with their counterparts in the years prior to 1992. Those interested in the impact of changing skill requirements within particular industries and occupations, on the other hand, may wish to compare the literacy proficiency distributions in 1992 and 2002 of specific groups of incumbent workers.

- *Examining proficiency trends among key populations comprising compositional changes (e.g., immigrants, elderly)*

Other important questions are likely to arise about the literacy proficiencies of key sub-populations comprising the compositional changes in the adult population between 1992 and 2002. Changes between 1992 and 2002 in the literacy profiles of recent immigrants, for example, have implications for the public schools, for adult education and training programs, and for the provision of support services that facilitate adjustment and acculturation. Similar attention will likely be focused on the literacy needs and abilities of the nation's elderly population, which will grow rapidly between 1992 and 2002.

- *The role of interstate migration on changes in state adult literacy proficiencies*

Other work in progress is analyzing patterns of state-to-state migration between 1985–1990 (reported in the decennial 1990 Census). Preliminary findings indicate that state differences in literacy proficiencies are substantially influenced by domestic migration within the United States. The population

of movers is more highly educated and very likely more literate than the population of stayers within the states. It will be possible to apply the modeling framework to changes in state-level assessments of adult literacy only if the pertinent patterns of interstate migration are taken into account.

Implications for the NAAL Methodology

The above comparisons and trends, of course, have implications for (sub)sampling requirements and procedures as well as for the content of some background questions needed to isolate key subgroups and their relevant experiences. This final section of the paper briefly discusses some of the specific issues that need to be addressed in making such comparisons given other demographic changes anticipated between 1992 and 2002.

Some of these considerations should have significant implications for improving the design of the NAAL methodology and instrumentation. In particular, we will mention some sampling issues and topics for background questionnaires that could increase the power of the assessment to separate compositional and maturational components of changes in the nation's adult literacy proficiencies.

- *Parallel population coverage in the NALS and NAAL assessments.*

The valid application of our modeling framework requires that the adult population coverage of the NALS and NAAL surveys be comparable. Although this sounds trivial, lack of parallel coverage often proves to be a major issue in modeling relationships between datasets. We experienced this problem repeatedly in applying our model to analytic comparisons among NALS, Census and CPS data sets. There are several points of concern here. First, NALS treated "group quarters" residents (e.g., the institutionalized, the incarcerated, college students living in dormitories) differently than Census or CPS. It is *essential* that key groups such as the incarcerated and college students living away from home be sampled and classified comparably in NALS and NAAL. Other groups such as the homeless or seasonal and migrant workers need to be treated comparably as well, even if they are not purposely sampled.

- *Adequate representation of minority and immigrant groups*

Given the anticipated major increases in minority and immigrant populations in 2002 (compared to 1992), it will become increasingly important for the NAAL to portray the literacy abilities of key minority and immigrant populations. This will likely require oversampling of selected key populations as well as the inclusion of critical background questionnaire items to help identify members of important sub-populations. With respect to ethnic and race groups, it is important that the NAAL follow new conventions and procedures for self-identification being adopted by the Census 2000, as well as working out the ways in which such changes should be reflected in the imputation procedures for literacy proficiency (assuming such proficiency estimation procedures are again utilized in the NAAL). With regard to immigrant populations, it is highly desirable to include additional background questions to distinguish generations of descent from immigrants (e.g., first generation, second generation, and so forth). Conventions for self-report of such distinctions are available in the research literature.

- *Avoiding "ecological fallacy" in oversampling minority and immigrant groups*

Since oversampling is likely to be necessary for accurate portrayal of minority and immigrant populations within the NAAL, care must be taken about how to implement such oversampling. One approach common in national education surveys is to utilize multistage sampling designs in which primary sampling units (PSUs) with relatively high concentrations of key sub-populations are more likely to be sampled. Such approaches could have the unintended result of biasing certain parameter estimates for the key sub-populations. Among immigrants, for example, such clustered sampling schemes could easily over-represent immigrants living in immigrant enclaves (i.e., spatial areas having relatively high concentrations of immigrants). Even though most immigrants in fact live outside of such areas, most immigrants sampled under such clustered designs could well come from enclave areas. Similarly, a clustered approach to oversampling a particular minority group could well result in including primarily members of that minority group living in areas with high concentrations of the group, even though most minority members might well live outside such areas. Although appropriate sample weighting adjustments can reduce some potential

bias inherent in such sampling designs, it is far from clear that all problems have been resolved in what has sometimes been termed the "ecological fallacy" of such oversampling approaches. We urge the NAAL to explore such issues carefully, especially given the magnitude of literacy differences expected among the various sub-populations of interest.

- *Working with populations having limited English proficiency*

Since we anticipate large numbers of adults in NAAL's target population will not be proficient speakers of English, other descriptive information about them will facilitate interpreting their assessed literacy abilities in English. If, as we assume is likely, resources will not permit the direct assessment of their literacy abilities in languages/scripts other than English, it will be important to gather self-reports of their literacy abilities and uses of other languages and scripts, much as the NALS did in 1992. In addition, we would suggest that additional background questions be developed regarding the *linguistic isolation* of adults who are not proficient speakers of English. Questions NALS asked about language choice and usage in surveyed households could be extended into items asking about the interaction of limited English proficient adults in the survey with proficient English speakers in their household, neighborhoods and communities. Other language surveys provide usable frameworks for such questions.

- *Collecting richer information about internal migration*

As noted above, the mobility and internal migration of the nation's adult population is increasing, and affects (and is affected by) the interstate distribution of educational attainment and literacy proficiencies. To help develop better information about this, information that will be useful at both the state and national levels, it is essential to collect additional (but still quite limited) information about individuals' residential and migration history. It would be extremely useful to know how long individuals have lived at their current residences, in their current counties, in their current states, as well as in the United States. It is also important to know the states (and perhaps counties) they lived in one year, five years and ten years

preceding the NAAL interview. There are efficient and reliable reporting schemes developed by Census and other surveys for collecting such information.

- *Collecting information about history of incarceration*

The changing size and composition of the nation's incarcerated population is of particular importance in understanding overall population changes in literacy between 1992 and 2002. Hopefully it will be possible to survey the incarcerated population in the NAAL as was done in the NALS. Regardless, it is essential to ask NAAL respondents about whether they were incarcerated 10 years ago (in 1992, i.e.). If the incarcerated are included in the NAAL, then it will be essential to determine whether incarcerated respondents were incarcerated 10 years ago. Such information can be used for postsurvey adjustment of sampling weights for trend analysis.

- *Collecting better information about histories of educational attainment*

Research linking adults' educational attainment and literacy proficiencies—and the design of better education and training programs—would be considerably advanced by including additional background questions about both whether adults received GEDs, high school diplomas, college degrees, and so forth, and also the years in which such credentials were received. It would also be very helpful (with regard to the internal migration questions noted above) to have some information about the state in which various credentials were obtained. The systematic collection of such retrospective information will enable much more precise and consistent estimation of educational maturation processes for the modeling framework.

- *Indirect assessment (via self-report) of changes in literacy proficiency*

To cross-validate inferences about maturational changes in literacy between 1992 and 2002, it would be useful for the NAAL to include carefully developed background questions about self-reported

changes in literacy abilities over the preceding decade. Assuming that reliable questions can be developed, the following could be usefully explored:

- Do you spend less/same/more overall time each month *reading* now compared to 10 years ago?
- Do you spend less/same/more overall time each month *using math* now compared to 10 years ago?
- Do you spend less/same/more overall time each month *writing* now compared to 10 years ago?
- Do you spend less/same/more overall time each month *using computers* now compared to 10 years ago?
- Are you a less/same/more accomplished *reader* than 10 years ago?
- Are you less/same/more accomplished *in math* than 10 years ago?
- Are you a less/same/more accomplished *writer* than 10 years ago?
- Are you less/same/more accomplished *with computers* than 10 years ago?

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97-09	Status of Data on Crime and Violence in Schools: Final Report	Lee Hoffman
97-10	Report of Cognitive Research on the Public and Private School Teacher Questionnaires for the Schools and Staffing Survey 1993-94 School Year	Dan Kasprzyk
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1999-12	1993-94 Schools and Staffing Survey: Data File User's Manual, Volume III: Public-Use Codebook	Kerry Gruber
1999-13	1993-94 Schools and Staffing Survey: Data File User's Manual, Volume IV: Bureau of Indian Affairs (BIA) Restricted-Use Codebook	Kerry Gruber
1999-14	1994-95 Teacher Followup Survey: Data File User's Manual, Restricted-Use Codebook	Kerry Gruber
1999-17	Secondary Use of the Schools and Staffing Survey Data	Susan Wiley

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96-22	1995 National Household Education Survey (NHES:95) Questionnaires: Screener, Early Childhood Program Participation, and Adult Education	Kathryn Chandler
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98-10	Adult Education Participation Decisions and Barriers: Review of Conceptual Frameworks and Empirical Studies	Peter Stowe
1999-11	Data Sources on Lifelong Learning Available from the National Center for Education Statistics	Lisa Hudson
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97-29	Can State Assessment Data be Used to Reduce State NAEP Sample Sizes?	Larry Ogle
97-30	ACT's NAEP Redesign Project: Assessment Design is the Key to Useful and Stable Assessment Results	Larry Ogle
97-31	NAEP Reconfigured: An Integrated Redesign of the National Assessment of Educational Progress	Larry Ogle
97-32	Innovative Solutions to Intractable Large Scale Assessment (Problem 2: Background Questions)	Larry Ogle
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