

**A Case Study: Using Geographic Information Systems for  
Education Policy Analysis**

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*Effective exploration of spatially referenced educational achievement data can help educational researchers and policy analysts accelerate interpretation of datasets to gain valuable insights. This paper illustrates the use of Geographic Information Systems (GIS) to analyze educational achievement gaps in Arkansas. The Geographic Academic Policy Series (GAPS), developed in the National Office for Research on Measurement and Evaluation Systems, provides a visual "snapshot" of achievement relative to important policy issues. The GAPS series displays maps in conjunction with state-wide summaries of educational statistics, but does not require complicated understanding of statistics or methodology by the user. Currently, the GAPS series examines the relationships between school district academic performance and other district level variables including percent of students participating in Free and Reduced Lunch Programs (a proxy measure for poverty), school district size, and per pupil spending. In addition, district performance on the ACT exam, which is completed by students intending to attend college, is presented and examined in relation to district size. The GAPS series also includes state maps identifying the academic performance status of all districts and schools in Arkansas relative to NCLB. Policy makers have been particularly interested in the GAPS series, noting that it provides them with an effective method for examining academic achievement statewide.*

**Introduction**

Since the implementation of the "No Child Left Behind" Act in 2001, educational assessment has become increasingly

important to educators, administrators, and policy makers. Analysis of educational achievement gaps is, however, a complex and rapidly developing field.

In the last few years, through the National Office for Research on Measurement and Evaluation Systems (NORMES), we have been asked to provide information on numerous education related policy issues. Our immediate reaction was to organize and develop formal academic studies. However, we have also learned that in most cases what was requested was not a comprehensive research study, but an overview of data addressing the question being asked. For education policy analysis, while school and district academic performance data are useful for obtaining specific achievement results, it does not facilitate broader examination of performance trends within a state, region or district. In this time of school accountability, it is vital that the policy analysts have access to data that can inform their decision making. Educators and policy makers require information that will enable them to determine which programs and policies are effective, and which might need to be revised.

“A picture is worth a thousand words.” Graphical representation has always been a vital tool for education policy analysts, because it shows patterns in the data rather than detail, accelerating the interpretation of datasets to gain valuable insights (Tukey, J. W. 1977; Wegman 2000). Many people involved in education policy are often not comfortable with ‘numbers’ or ‘statistics’ but color-coded graphical representations of the information. As Cobb (2003) noted “Considering that it has been estimated that 80% of all local government decisions are made with geography in mind (Garson & Biggs, 1992), it seems reasonable for education researchers and policy analysts to study the world in a geographic context.” Given the importance and the need for analyzing and understanding of geographic influences in support of decision making, Geographic Information Systems (GIS) and associated tools provide a strong foundation for dealing with these problems. A GIS is a computer-based tool for mapping and

analyzing data and events. GIS technology integrates database operations with the visualization and geographic analysis benefits offered by maps. Digital maps created using GIS can directly access the power of human vision and reveal patterns that are often more difficult to discern in numerical summaries of data.

In research-based work with Toronto School Board, Brown et al. (1999) used GIS as a communication tool in the development of school profiles; and GIS also was used by them to identify high-performing and low-performing schools. They concluded that GIS “is an effective way to present complex relationships within a spatial context. It can do this in a way that graphs and tables cannot. GIS representations make it easier for educators to remember data patterns and to use these in their decision-making activities.” The authors determined that “GIS representations are particularly helpful in relating educational outcomes to socio-demographic factors, in part because many of these factors are closely related to geographic distributions.” Reeves et al. (2000) used GIS as a spatial analytical tool to study the effects of poverty and rural-metro differences on educational accountability scores in Kentucky. Lee (1998) used GIS to analyze factors influencing school performance differences in Maine. Cobb et al. (1999) used GIS technology for studying ethnic segregation in Arizona charter schools, and the authors also noted that “Social science researchers, education researchers, and education policy analysts are beginning to recognize the unique descriptive and analytical capabilities of GIS.” In addition to the use of GIS in educational research, GIS technology is also used by many school districts to plan bus routes and bus schedules. As Cobb (2003) concluded “the utility of GIS in education research is limited only by our imagination,” GIS will allow educational stakeholders to become more knowledgeable about academic achievement trends.

GIS and educational information for Arkansas have already been merged successfully through GAPS, and now our research results are available on the website <http://normes.uark.edu/gaps>. The goal of GAPS is to provide

education policy analysis through geographical representations by using educational information and colors to represent the results for the analyses. This paper will introduce GAPS and present one example of GAPS as a case study of using GIS in the education policy analysis.

### **Background of NORMES and Related Efforts on Data Analysis**

NORMES has been creating and maintaining educational achievement data for the Arkansas Department of Education (ADE) for six years. NORMES staff has worked with the ADE in developing an accountability plan that fulfills the requirements of NCLB. Adequate Yearly Progress (AYP) calculations are completed at NORMES, and school status reports are provided to school and district administrators through NORMES system. In response to a need articulated by many educators for electronic student-level assessment information, NORMES created a password protected system that utilizes SAS Enterprise Guide (E-Guide) software. E-Guide provides Arkansas superintendents and principals with access to their student-level data and easy to use analysis tools. E-Guide provides point-and-click analysis capabilities, which NORMES has enhanced through custom “add in buttons”. These “buttons” are SAS programs that can be downloaded from the website and used to perform analyses needed by Arkansas educators. Custom programs include trend analyses of overall performance in reading and math as well as strand and item level analyses for all subgroups assessed in AYP calculations. Since these analyses can be completed with a single click of the mouse, and the majority of the results are presented in color-coded graphical formats that are familiar to educators, such as pie and bar charts, they have become favorites of Arkansas educators. The staffs at NORMES have provided E-Guide training and technical support for educators throughout the state. Based on positive feedback from educators, the analyses available through E-Guide seem to be impacting curriculum and policy decisions in schools

throughout Arkansas.

While school and district academic performance data are useful for obtaining specific achievement results, it does not facilitate broader examination of performance trends within a state, region or district. The educators and policy makers require effective methods that will enable them to do the comparison of student performance based on groups, or to determine what programs and policies are effective, and which might need to be revised. In an effort to meet the above requirements by educational stakeholders, NORMES has successfully developed GAPS.

The development of GAPS was also indirectly related to a November 2002 superior court ruling in Arkansas favoring the plaintiff in the Lakeview v. Governor Huckabee suit regarding the funding formula for Arkansas public schools. The ruling stipulated the funding system was not equitable and needed to be modified. This stimulated a series of investigations including adequacy and efficiency studies by interested parties to create a new educational funding formula in Arkansas. As a research organization at the University of Arkansas, NORMES was inundated with requests for data, analysis, and interpretations to support any number of theories and approaches to obtaining an adequate equitable funding formula.

Attempting to maintain an *apolitical* role in this issue, NORMES developed GAPS to provide information for decision-making. This process began by obtaining and analyzing statewide academic performance data. District or school performance data from the Arkansas Benchmark, End-of-Course and/or ACT exams were analyzed for literacy and mathematics. Next, GIS data layers were joined with the achievement data to create thematic map. The use of thematic maps enables NORMES to provide educational data based on various levels of aggregation and overlay these values on a geographical map of Arkansas. In essence, the data requested from the various parties investigating equity and funding formulae were requesting similar data. GAPS series provided this data while helping NORMES maintain an *apolitical* role. Finally, in lieu of globally

naming the graphs, the graphs in GAPS were identified by selecting the research question associated with the graph. For each map generated, a narrative of the methodology and a brief interpretation from the author's perspective were provided. Effectively, much of the data available in the E-Guide system is now being modeled using GAPS.

### **Methodology**

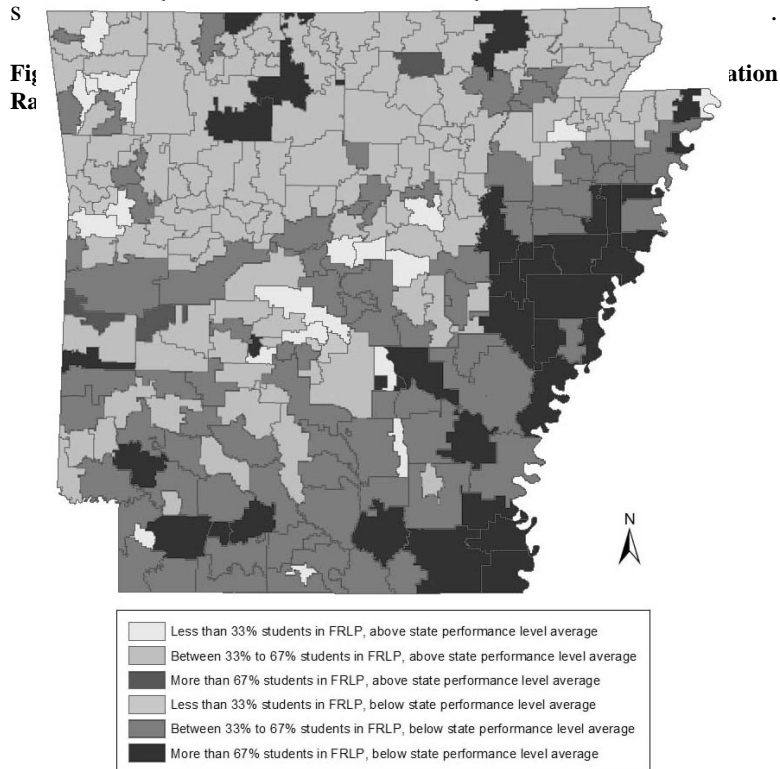
The Arkansas Department of Education provided NORMES with electronic data files containing student-level assessment information. The data were then compiled at the school and district level, with regard to percent of students scoring proficient on the exams. Percent of students proficient calculations were also completed for all subgroup populations reported in the state (African-American, Hispanic, Caucasian, Economically Disadvantaged, Limited English Proficient, and Students with Disabilities). Based on the percent of students identified as proficient, districts and schools were assigned an AYP status. The data were compiled into a SAS dataset including district and school-level proficiency percentages and AYP status information for all groups. The school and district performance data were exported from SAS to EXCEL and were converted into DBF (database) files. The DBF file was joined to our GIS database, and the geographically based attributes were mapped using ArcMap of ESRI (Environmental Systems Research Institute).

The geographic data files were downloaded from GeoStor, which is an on-line data delivery system that allows the user seamless access to digital map data of any area in Arkansas. The Geodata, provided by GeoStor, were obtained from Federal and State agencies.

### **Example of GAPS**

Figure 1 is an example of GAPS. The research question is "Does the percentage of students participating in the free and reduced lunch program impact the percentage of students'

proficient?” The Literacy map represents district-level classifications based on the percentage of students enrolled in the Federal Free and Reduced Lunch Program (FRLP) and their performance on the Benchmark and End-of-Course Exams. Districts with a percentage of students’ proficient at or above the state average are colored green. In contrast, red represents districts that have a percentage of students proficient in literacy that is below the Arkansas average. The shade of the color represents percent of students participating in FRLP in the district: the lighter the shade, the smaller the number of students participating in FRLP. For example, if a school district had less than 33% of students participating in FRLP, it was assigned a light shade. If a school district contained between 33% and 67% students participating in FRLP, it was assigned a moderate



Finally, if a school district had more than 67% of students participating in FRLP it was assigned a dark shade.

To help facilitate interpretation of these graphical plots, a brief summary is provided, but only as a brief narrative to represent a global interpretation. A statement is provided that encourages more comprehensive studies to specifically identify the meaning of differences in performance. However, the goal of GAPS was to provide information for the practitioner or policymaker where they could obtain the essence of what the data “looks” like without completing a formal study. In the case of Figure 1, it is readily obvious that the southeast section of Arkansas lags academically relative to the rest of Arkansas, and a few specific trends exist in the map. Districts with more than 67% of students participating in FRLP are more likely to have student performance below the state average. The likelihood increases if the district is in southeast Arkansas. Districts with 33% to 67% of students participating in FRLP also exhibit student performance below the state average and the increased probability for low performance in southeast Arkansas. An important conclusion from the map is that poverty, as measured by participation in FRLP, is not isolated to the Delta region of Arkansas, but a greater systemic problem in performance is associated with this region.

### **Results and Discussion**

Currently, GAPS series examines the relationships between district academic performance and size, percent of students participating in Free and Reduced Lunch Programs



(a proxy measure for poverty), and per pupil spending. In addition, district performance on the ACT exam, which is completed by students intending to attend college, is presented and examined in relation to district size. GAPS series also includes state maps identifying the AYP status of all districts and schools in Arkansas. All of our research results are now available on the website <http://normes.uark.edu/gaps>.

GAPS series displays maps that have been created using GIS, but does not require complicated understanding of statistics or methodology by the user. Effectively reducing background information needed to understand the analysis, using variables that the public is familiar with (i.e., percent proficient) and symbolically color-coding areas on the map (ie green for good achievement performance, red for poor achievement), the GIS maps become a tool most stakeholders can use. Finally, given the depth of the educational database at NORMES, virtually any conceived statistical analysis can be intersected with GIS.

The educational impact of GAPS is to increase the knowledge and use of educational analyses. Primarily, it is anticipated stakeholders of the Arkansas K-12 school systems will have an enhanced understanding of what is occurring in their schools. The results will be greater educational and administrative opportunities to develop and implement programs to improve student achievement, with the information utilized by policy makers to create more accurate and effective policy decisions in Arkansas. Further, parents, the business communities, and other interested parties can complete visually based assessments using the results information generated via GAPS. Parents of students attending schools not meeting Adequate Yearly Progress standards will also have access to the information

needed to locate a school near their residence that is experiencing greater achievement-related success.

GAPS must be based upon academic achievement databases that represent the most current educational assessment information available. The development of these databases is completed as part of NORMES for the Arkansas Department of Education, and thus, is a readily available resource for use in our research. The assessment data could be subset by demographic characteristics as well, such as has been modeled with the district Free and Reduced Lunch Participant (FRLP) population. In addition, for the data to be meaningful and the analyses relevant, the current analyses must be continually updated as districts consolidate, annex and add new school sites. All elements completed within NORMES for AYP models.

The implementation of “No Child Left Behind” (NCLB) legislation has resulted in an exponential increase in the amount of educational data. This has increased the number of questions or analyses than can now be more fully investigated. However, from a policy perspective, most individuals are not interested in comprehensive research studies, but quick information that conveys the essence of what may be identified if a more formal study was completed. GAPS offers “data driven graphics” within websites, and it represents an innovative approach to providing educational data that adheres to an integrity we demand of educational statisticians (accuracy, meaningfulness etc.), while providing useful information for the practitioner and policymaker. Policy makers have been particularly interested in GAPS series, noting that it provides them with an effective method for examining academic achievement statewide.

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## **News and Notes**

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