Supporting statistical, graphic/cartographic, and domain literacy through online learning activities: MapStats for Kids

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Abstract

This paper reports on a Digital Government pilot project, *MapStats for Kids* – a sub-project within the *Quality Graphics for Federal Statistical Summaries* (dgQG) project. *MapStats for Kids* will contribute toward a long-term goal of providing web-based support for statistical, graphic/cartographic, and domain literacy through online learning activities that are fun for young web-site visitors to use.

1 Introduction

MapStats for Kids will consist of web tools that integrate with the information system used to produce current MapStats products (geospatially-referenced, federal statistical summaries) within the FedStats program. The objective for this demonstration project is to create prototype interactive web pages that provide statistical and geographic information in a manner that will engage a young web site visitor's attention and interest (the target users are children in grades 4 through 8). Information will be displayed in a manner that encourages the young users to become active participants on the site as well as to provide them with a better understanding of the impact that numbers can make on daily life (through the use of age-appropriate games, trivia questions, statistical facts, and other methods).

MapStats for Kids activities will be made available through the FedStats web portal. FedStats is a cross-agency Internet portal designed to help all Americans find statistical facts for making personal or business decisions, conduct research on a myriad of topics, or participate in public policy debates. Work on *MapStats for Kids* is being carried out in conjunction with the FedStats Technical team and the FedStats Task Force.

2 Conceptual Approach

A large body of research demonstrates that it is impractical to develop a "one-size-fits-all-ages" computer game or computer learning tool for kids. Web sites for use by young visitors must be sensitive to this issue. We address age appropriateness directly by focusing on a target audience of 4th through 8th graders and developing prototype products that are usable by and of interest to web site visitors across this range. An initial approach we are taking is to develop coordinated web tools that focus on the same problem context and associated statistical-geographical information, but that are designed to appeal to each end of the age range and to take advantage of the respective abilities and interests that span that range. This strategy will provide a solid base for exploring and documenting differences in web-based statistical and geographic information products needed for different age ranges. It will also provide a base for future expansion to different age ranges and kinds of information.

In addition to considering age-appropriateness, the demonstration development team is focusing on development of web products that are matched to current national-level education curricula. Most states have adopted at least a portion of the national math, science, and geography curriculum standards. Map-

based and graphical representations of federally produced statistics offer a range of possibilities for products that are at the intersection of these standards and, thus, that support an integrated approach to education across these subject areas.

Our basic approach to the *MapStats for Kids* demonstration project is built on two fundamental ideas: (1) fostering *an exploratory, flexible, problem-solving approach to the use of statistical data*, and (2) supporting the development of the *sets of knowledge and cognitive skills that underpin the use of statistical data*.

First, we need to foster and develop a positive and effective attitude toward and approach to data and data analysis. Our goal is to create an inquiry-based approach to *MapStats for Kids* that emphasizes question asking and problem solving. Statistical data sets are useful only if they can be converted into information that the young data user can apply to answering a question or solving a problem. Therefore, we need to attract young users to the portal by making it interesting, accessible, challenging, informative, and above all else, useful.

Second, we need to develop young users' knowledge and skills in terms of statistical data analysis. Crucial to this idea is (a) an appreciation of the cognitive skills that underpin successful performance (Liben, 1999), (b) a recognition that the skills develop over age in children (DeLoache, 1989), (c) an awareness that there are individual differences in performance on the same task for children at the same age range (Liben, 2000), and (d) an articulation of the procedural and declarative knowledge that underpins the use of the *MapStats for Kids* site. We can use the *MapStats for Kids* portal to foster knowledge and skills in a way that is informed by cognitive developmental theory and educational best practices (e.g., collaborative learning strategies), and that is supportive of the standards-based approaches to education in relevant domains such as science, mathematics, geography, and civics and government.

There are three sets of skills central to statistical data analysis: (a) logico-mathematical skills, (b) representational skills, and (c) spatial skills. Although these skills are not independent of each other, as a starting point it is useful to think of them as three separate clusters. The initial applications developed will include components that address each skill set. There are also important educational implications of a developmentally-based approach to *MapStats for Kids*. First, the National Educational Standards for knowledge domains such as science, mathematics, and geography emphasize a problem-solving approach and are developmentally based. Therefore, the *MapStats for Kids* portal will support a standards-based approach to school education.

By grounding our approach in a cognitive developmental context, we can provide your web site users with feedback that is based on analyses of tasks in terms of the prerequisite cognitive skills. The feedback can be used to scaffold the young user's developing understanding of key cognitive skills by providing extensions and alternatives that are challenging. Using our Flash-based tools (see below), that feedback can be provided in real-time (as children make an error they are prompted not only to try again but to think about the representational issues that are posed by the problem context). Thus, the tasks and games will not be of a "one size fits all" type. We are building the games/applications so that they are age-appropriate in the sense that they acknowledge the things that children can do at, say, age 9 versus those things that we can expect a 13-year-old to be able to do. The games/applications are being created as modules within a "tutorial" that provides sequences of experience and extensions to those experiences such that they present challenges to a student, offering opportunities to extend their understanding of key concepts. The tools can provide feedback that supports the developing understanding of those same key concepts.

3 An Initial Prototype Implementation

An important consideration in the development of the demonstration project is the need to ensure that the developed applications are portable to a variety of web environments (e.g., Mac as well as Windows, Netscape as well as Internet Explorer), and that they adhere to the requirements of Section 508 usability re-

quirements relating to Federal web sites. Although the particular web tools proposed are targeted to younger visitors, it is anticipated that components of the resulting technology could be used in generating other types of statistical information displays for other website audiences. To facilitate this potential, software is being designed to be as modular as practical. Close coordination is occurring between the team developing the *MapStats for Kids* demonstration project and the broader *dgQG* development team (with its 8 current federal agency partners).

The information representation components of the web pages are being created through the use of Macromedia's Flash software, used effectively in other parts of the *dgQG* project (Steiner et al., in press). Flash allows designers to quickly develop dynamic applications that are visually appealing, highly interactive, and Web-friendly. Because Flash files are vector-based, they download quickly. Furthermore, Flash applications run well on older computers (a concern for classroom use), and the software required to view Flash content is bundled with most Web browsers or is otherwise available for free from Macromedia. Thus, there are few barriers to accessing Flash content online and it has become a *defacto* standard for dynamic Web content. Perhaps most importantly, Flash applications can be data-driven, allowing designers to build applications that can accept data from the multiple Federal agency partners in FedStats. Our tools import data that are formatted as XML, allowing us to use a variety of data sets and change the data sets quickly and easily if necessary. For more information about XML, see http://www.xml.org/xml/resources_focus_beginnerguide.shtml.)

There are two main application development challenges in this project: (1) making geo-statistical data interesting to kids aged 9 to 13 who would not normally be inclined to explore such datasets, and (2) developing ways to teach the underlying concepts and skills required to use abstract representations such as thematic maps and graphs (in ways that do not seem like classroom lessons to the users). Our efforts have, thus, been directed toward building interactive "games" that use geo-statistical data from Federal agencies in map based activities that support underlying learning objectives noted in the previous section.

Figure 1 shows how geospatial statistical data can be incorporated into a Web-based game for kids. The goal of this game is to "paint the map" according to the election results from the last presidential election (any data that can be parsed into two mutually exclusive categories per state can be used). The election results in the prototype are shown as numbers and as a bar graph (lower right). The challenge for the user is to locate the state on the map and paint it with the correct color to show which party won that state (by dragging a color chip from the legend onto the correct state). Like many video games, performance is scored on both success of task completion and time it takes to do the task. The objective for the user is to paint the map as *quickly* as possible and with as *few mistakes* as possible (red for Democrat, blue for Republican). Low scores are best; points are added to the score when mistakes are made (painting the wrong state or picking the wrong party) and as time passes. Users are provided with audiovisual feedback as they play. The feedback distinguishes between geographic errors and data interpretation errors. In the process of playing the game, young users learn locations of states that they do not know and learn to use bar graphs to make quick relative comparisons. Two difficulty levels can be chosen; the "easy" choice displays the map and the names of the states while the "hard" choice displays the map without state names (the later is shown above).

This application allows kids to become active participants because they must construct the maps and graphics themselves. From the perspective of the information depicted, playing this game helps kids learn about the spatial patterns of the last federal election. From a statistical-graphical literacy perspective, kids learn how to transfer information presented as numbers and simple bar graphs (i.e., election results by state) into a choropleth map. We are following a similar active learning strategy in other applications under development (e.g., one of these supports building regions having similar socio-demographic characteristics).

Figure 1. Map-building game, try it at: www.geovista.psu.edu/grants/MapStatsKids/feature_election.html

4 Work in Progress and Potential Extensions

As noted above, our overall plan for the *Mapstats for Kids* web site is to create a tutorial application that supports addition of game-learning modules focusing on specific representational, logical and spatial skills (as well as on sets of skills). One integrative module we are developing uses the metaphor of a quest, either going forward from place to place, or retracing the steps of a previous route (to help teach transitive logic). This quest will initially use states as the spatial unit, and a selection of different federal statistical variables. The goal for the young user is to reach the origin, or destination, by following a set of clues. Clues will emphasize a broad range of logical and inferential skills, by requiring student's to compare numbers, symbols, positions, directions and distances.

To assess modules developed in relation to learning/literacy goals identified, our tools can capture and store user data as XML files. The user data that we can collect are of two types. First is data that helps guide feedback and future module planning, thus user mistakes (both geographic and statistical) and time taken to finish various tasks. Second are overall performance data that allow each user to see how they compare to those of other users.

As initial demonstration products are developed, attention will also be given to exploring the potential of the Scalable Vector Graphics (SVG) protocol for future (extended) implementations. In addition, we will explore the possibility of extending the web-tools for different place collaborative use; i.e. where children, possibly remote from each other, collaborate together via the Internet to solve problems or complete tasks (e.g., collaborative map-based games).

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