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Back

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TEACHING GEOGRAPHIC INFORMATION SYSTEMS FOR SOCIAL WORK APPLICATIONS

This article explores the benefits of teaching geographic information systems (GIS) technology as a tool in social work curricula. GIS software makes customized and interactive maps that can help social workers gain a better understanding of multifaceted communities. The authors present four examples of GIS applications developed by social work graduate students demonstrating the potential of GIS in social work, and they outline steps for teaching GIS in social work practice courses. Employment and other opportunities are also discussed.

Geographic Information Systems (GIS) provide a powerful and versatile tool for community development. This computer technology allows people to see and understand communities in new ways by creating pictures of an area that show previously unseen characteristics and relationships (Cox, 1995; Franklin, 1992; Hoefer, Hoefer, & Tobias, 1994; Huxhold, 1991; Martin, 1991).

Social work schools have long taken a variety of approaches to including information technology in their curricula (Cnaan, 1989; Finn, 1990; Kaye, 1991; LaMendola, 1987; Smith, 1984). More recently, GIS has become an integral part of many land planning and development fields and is rapidly expanding into other areas, including business, health care, and education (Bullen, Moon, & Jones, 1996; Ester, 1992; Perlman, 1995; Ventura, 1995; Wilson, 1994). GIS is one of the latest information technology developments, and many other fields, notably geography, have.' incorporated GIS into their education curricula (Brown & Burley, 1996; Kemp, Goodchild, & Dodson, 1992; Scott& Smith, 1995; Walsh, 1992; White & Simms, 1993). Students of community development benefit greatly from having GIS instruction as a component of their learning, particularly for gathering a variety of information about a community and relating each piece of data to other data and to the community's geography. In social work especially, it can be used to assist in community development with planning, program administration, and evaluation.

This article begins by describing the basics of GIS and provides examples of student GIS applications in community development. It then presents a strategy for teaching GIS to social work students and concludes with a discussion of employment possibilities for students knowledgeable in GIS.

What is GIS?

The commonly accepted definition of GIS is provided by the National Center for Geographic Information and Analysis, which was created by the National Science Foundation in 1988: "A geographic information system is a computerized database management system for capture, storage, retrieval, analysis, and display of spatial (locationally defined) data" (Huxhold, 1991). Put simply, GIS software transforms a table of information into a map.

GIS was initially developed in Canada in the 1960s for a land inventory, but not until the 1980s did GIS become more widely used for examining relationships between people and the environment (Goodchild, 1995). Emergency response units (medical, fire, and police) use GIS to quickly identify where a person lives and to find the fastest response route (considering distance, traffic congestion, and one-way streets) ("GIS Combines," 1995). The human services field has also begun to see the advantages GIS can provide, with its technology being employed in social work research projects (Hoefer, Hoefer, & Tobias, 1994).

The saying "a picture is worth a thousand words" begins to explain why GIS has become a popular and effective way to look at information. For example, a standard city street map contains an index of street names with the street coordinates usually given as a letter and a number. One might be able to find out how to get from one point to another by using only these coordinates. However, if the coordinates are shown on a map, the user immediately sees where the two points are in relation to each other.

Figure 1 provides another example of this. The data table on the left shows neighborhoods with crime watch groups and changes in their crime rate, but the map on the right illustrates this information so that a person can see more easily that bordering crime watch neighborhoods have a decrease in crime, whereas isolated crime watch neighborhoods do not have a decrease. This indicates that to effectively reduce crime there might need to be a minimum of two bordering neighborhoods with crime watch groups. This was not apparent from studying only the table. (;IS not only makes information easier to grasp, but provides more dimensions to studying data.

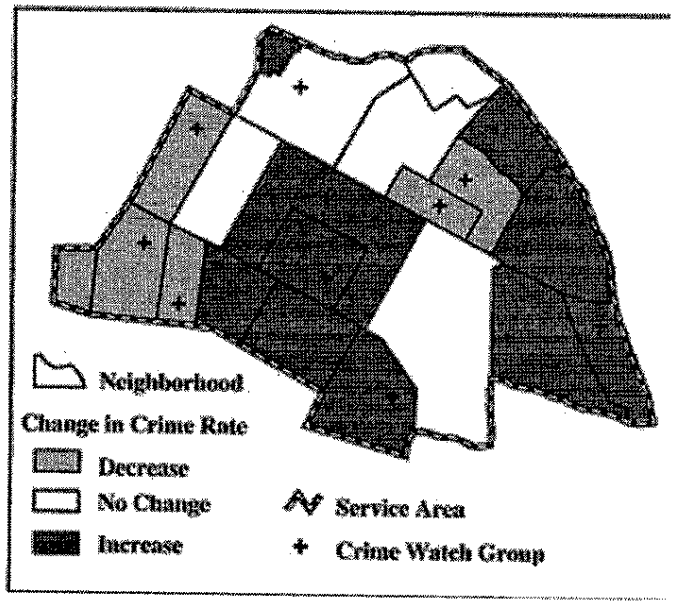

Figure 1. Use of GIS in Program Evaluation: Crime Watch Groups and Crime Rate Changes by Neighborhood: A map makes information easier to understand and can reveal relationships that are not obvious from a table. The map shows that neighborhoods with bordering crime watch groups have a decrease in crime.

Communities have many faces, depending on age, gender, race, or ethnicity of the population, even on the

time of day. A student of community development needs to discover the links and various layers of information and resources that a community holds. This is a challenging and time-consuming task that GIS can help accomplish more easily. For example, young mothers in a neighborhood may have collective knowledge of youth-related resources, but with the help of GIS, community development workers can also uncover other resources in a community (such as those for the elderly) which for residents were not previously known.

Most information relating to community development can be mapped using GIS soft,ware to enable analysis of spatial relationships between different types of information (Franklin, 1992; Huxhold, 1991). The data to be mapped must fit into one of three spatial categories: points, such as a physical building (school) or incident location (birth or crime); areas, such as a zip code, census tract, or service area; or lines, such as a bus route or street.

The power of GIS comes from its versatility. A user works interactively with the software to design maps that supply desired information and answer specific questions. Maps made with GIS can be customized in three ways: adding, deleting, and arranging the layers of a map; mapping organization-specific information; and changing the level of specificity of information.

Maps are created by putting together layers of information. A common street map is made up of a street grid, municipalities (often shaded in different colors), and zip code boundaries. Each of these features is a map layer. With GIS, these layers can be quickly and easily added, updated, and arranged to meet specific needs. For example, a health clinic that provides school physicals might want a map of school locations in its service area. This map would contain four layers: zip codes, streets, schools, and a service area border (such as a county outline), as shown in Figure 2. GIS makes it simpler to add and remove layers, allowing the user to tailor visual information to specialized needs.

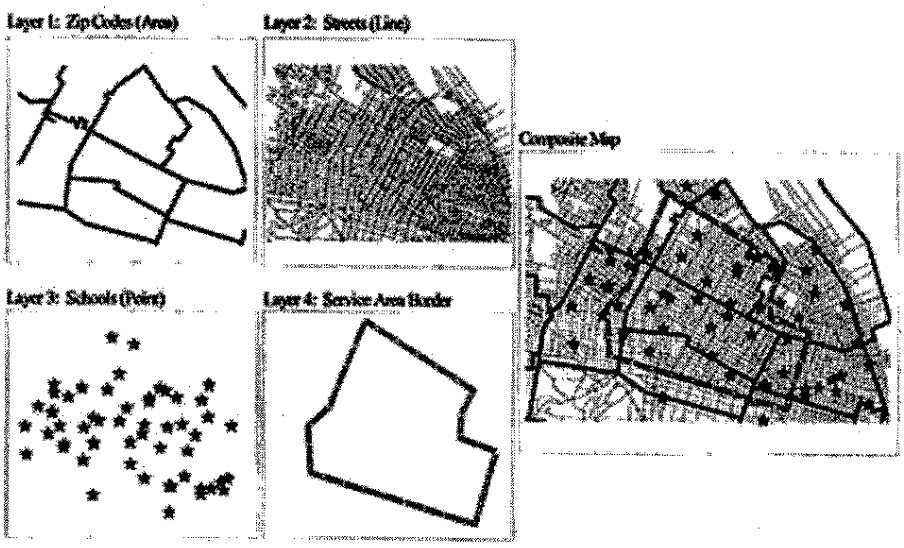

Figure 2. Examples of Map Layers in GIS: Area, Line, Point, Composite

Standard public information (streets, counties, census demographics, etc.) is often readily available on maps, but GIS technology also allows the user to add information to the map that is of interest to specific organizations, such as the locations of clients or referral agencies. Information can be collected and put into a database format that the GIS software can read and automatically map by matching street addresses, for example, with a street layer. A social worker can then create a multitude of maps for a variety of people.

GIS-created maps can also be changed to display information at different levels of specificity. If an organization is interested in nonmarital birth rates for a zip code, it would make sense to view births by

address, as in the lefthand map in Figure 3. However, if the organization is observing the entire state, births mapped by address would create too many details to be meaningful. In this instance, it would be better to view births by county, with different colors or shadings to represent different quantities of births (see Figure 3, right; also see Figure 4). GIS allows the user greater flexibility to change the level according to the information being mapped.

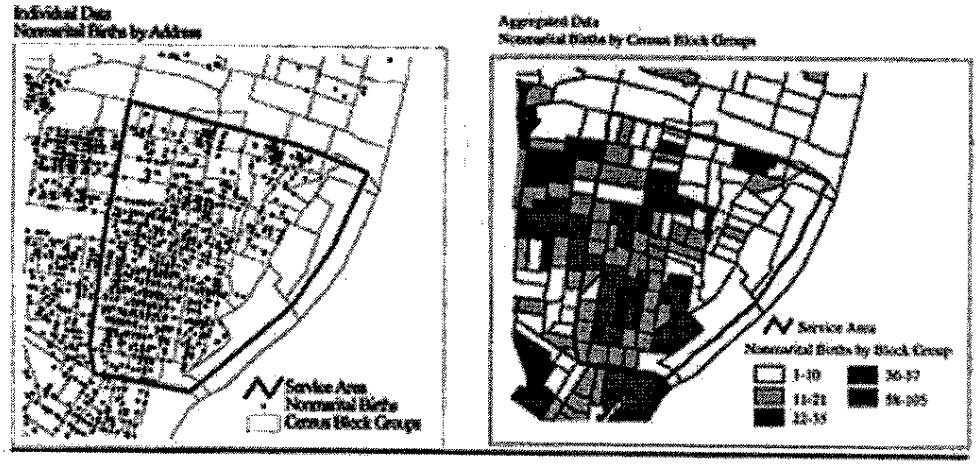

Figure 3. Map Information at Different Levels of Specificity

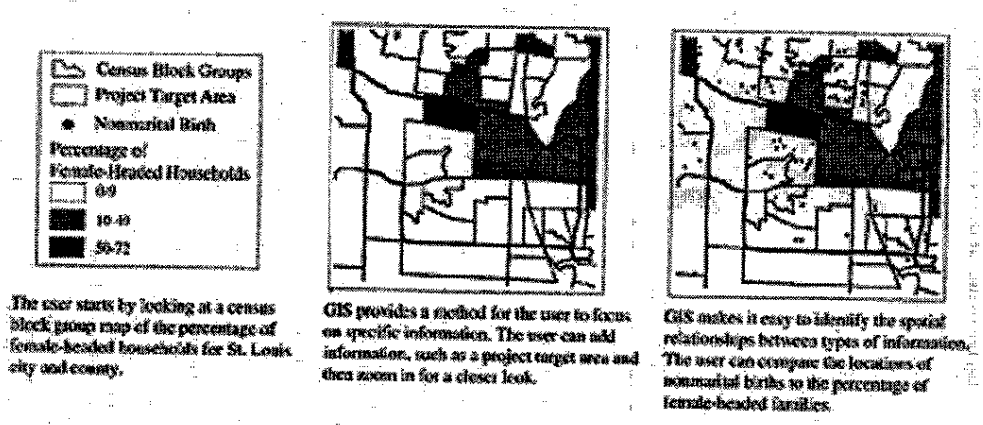

Figure 4. GIS Maps Showing Explorative Process

The ability to map information by addr.ess is especially useful to community development efforts. Without GIS, this task would be too arduous to be practical. This level of specificity allows small areas, such as a single community, to be mapped showing locations of various resources and other valuable information that residents and professionals can use.

It is true that, when examining community information for patterns, the more general the data displayed, the more likely the information can be misleading. An unpublished study by one of the authors with the Missouri Division of Family Services showed that although an entire zip code initially appeared to have a high number of abuse and neglect cases, mapping the data by address revealed that the majority of hotline calls were concentrated in a five-block area. Discovering such a pattern affects how services should be targeted to this area. GIS makes it practical to view information by address, which provides a more accurate method for examining relatively small geographic areas.

Using the map on a computer is also more valuable than having a booklet of printed maps. GIS allows the

user to interact with the data and to answer emerging questions by continuously customizing the map. A social worker can quickly and easily design a new map containing different combinations of information, which takes the computer only a few seconds to draw. This capability makes it feasible to examine a variety of information that previously would be very time-consuming or too difficult to accomplish. With GIS, individual maps can be easily generated for reports once.' the different layers are prepared. Information on a computerbased system can also be updated and maintained more frequently, making the information more accurate and valuable.

Using GIS for Community Development

Community development has been defined as "taking planned action to address the common concerns of people who share a geographic locality, cultural anti philosophical solidarity, or essential social and economic relations" (Harrison, 1995). GIS naturally fits with community development efforts because it readily draws links between the physical community and its social, economic, and political components.

Several U.S. cities have started using GIS to gain a better understanding of trends and community changes (Barndt & Craig, 1994; "GIS Helps," 1995; "GIS Improves," 1996; "Small City," 1994; Thrall, 1993). Providing local public officials and residents with more knowledge about their communities gives them the insight to proactively address community concerns. The visual dimension of GIS is especially useful in helping residents and other nontechnical people to understand the issues and problems facing their community.

The following four examples show student applications of GIS to community development projects. These studies were developed in 1996 by students in a master's-level community development practice course. All students in the course engaged with a community organization alone or in groups to design plans for advancing the agency's work; several plans involved GIS components that relate to improving child welfare services and hotline services, establishing community gardens, and assessing community services.

Delivering Child Welfare Services

One group helped the Sigel Community Education Center (CEC) in St. Louis identify community assets and weaknesses (Kretzman & McKnight, 1993) by identifying all services provided in the center's two-zip code area, gathering their hours of operation and intake requirements, and making maps of this information to improve services to clients. Therapists, child welfare workers, a police officer, a community outreach worker, and others work out of the center, located in an area of south St. Louis that is becoming poorer and less stable. The students' project grew out of a child welfare pilot project that provides a focused approach to preventing child abuse and neglect.

At the time, Missouri state legislature was exploring an alternative response to abuse and neglect calls. Under the program, a Division of Family Services (DFS) hotline worker would screen each call for imminent danger, which, if present, would be dealt with in the traditional manner with the police (though not via 911). Nonemergency calls from the service area would be referred to DFS staff located at the center. These professionals would then refer families to services in the local neighborhood for additional support.

Students were particularly concerned about gathering information needed to respond to the abuse hotline calls referred to the CEC. The first step was to create basic area maps, including streets, neighborhood boundaries, the CEC service area, and other identifying characteristics. Next, the students met with CEC staff and created a list of information that they felt were high mapping priorities. Staff were most interested in knowing resource locations, such as day care centers, mental health providers, and youth programs. Much of the CEC workers' time was spent finding appropriate resources, and they often relied on the limited resources with which they had personal knowledge.

The students collected the desired information on community social service agencies, child abuse hotline calls, crime statistics, churches, and schools. This involved negotiating with several organizations. Although many people were happy to help students, it was sometimes challenging for students to find and execute the right steps to receive information in a usable format. The students then entered the resource data into a spreadsheet (Microsoft Excel, in this case) and loaded it into the GIS software, which automatically maps the data by comparing street addresses to an existing street layer. These maps were made available to the CEC

workers for use in developing services for clients referred from hotline calls (see Figure 5). The students also created a customized version of the GIS program that made it much easier for CEC workers, many of whom had limited computer skills, to use the program and access the information.

Figure 5. Map of Sigel Community Education Center Service Area

Improving a Crisis Hotline

Another group of students collected and mapped resource information for a suicide hotline organization in St. Louis's College Hill neighborhood. The purpose of the pilot project was to give those answering the phones a better understanding of the caller's community, including which resources were needed by the caller. Students collected information from various sources, including the United Way, phone books, and local directories, to compile a list of neighborhood resources. The resources were then mapped in the same manner as described in the previous project, with the resultant map identifying local social service agencies and other community institutions, as well as information on incidents of crime in the neighborhood (see Figure 6). The hotline operator was able to access information more quickly and to find specific types of resources because of the GIS technology.

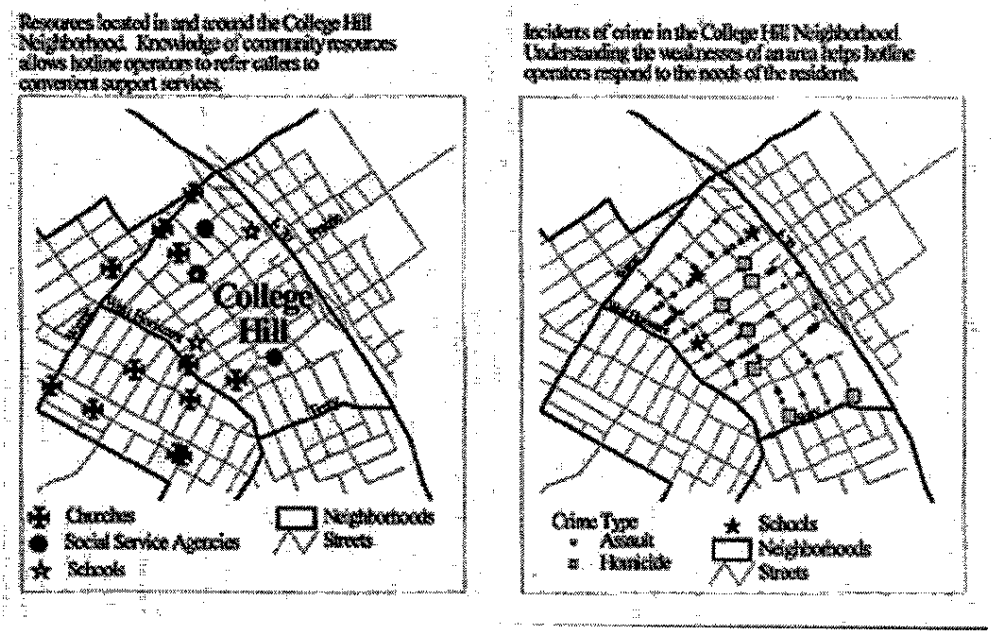

Figure 6. Maps of College Hill Neighborhood Produced for Crisis Hotline

Gauging the Effects of Community Gardens

Gateway to Gardening is a St. Louis organization that assists low-income communities in building and maintaining public gardens. After several years of operation, this organization was interested in examining long-term revitalizing effects of the gardens on the surrounding communities. In response, one student created a map of the gardens and overlaid it with census information showing average housing value, percent of abandoned buildings, and average household income. By working with the student to create a series of maps for each of the preceding years, Gateway to Gardening was able to assess what neighborhood changes occurred around the gardens and to target where new gardens should be placed. Figure 7 shows how one of the variables was mapped.

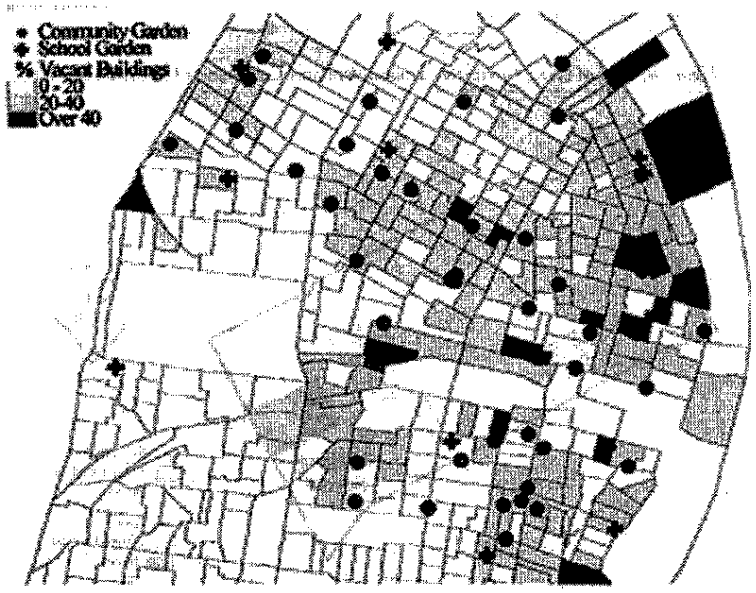

Figure 7. Detail of Map for Gateway to Gardening

Understanding Accessibility to Community Programs

The fourth GIS project involved efforts to ascertain why many neighborhood children were not participating in the Willirons Community Education Center's after-school programs and services for neighborhood families. Students first identified the service area and its major geographic characteristics, including streets, neighborhoods, and other schools and social service agencies. They also included census information to assist in understanding the area's age, race, family, and income characteristics. Students then interviewed former gang members, neighborhood residents, and a law enforcement official to understand gang activity and discover gang territorial boundaries.

The resulting GIS-generated map made the problem more understandable (see Figure 8). Students found that a series of gang territories surrounded the Williams School,. and that to get to the school from some streets in the neighborhood, it was necessary to cross a gang territory. Most neighborhood residents were unwilling to cross these boundaries; as a result, the school was blocked off from a significant part of its service area.

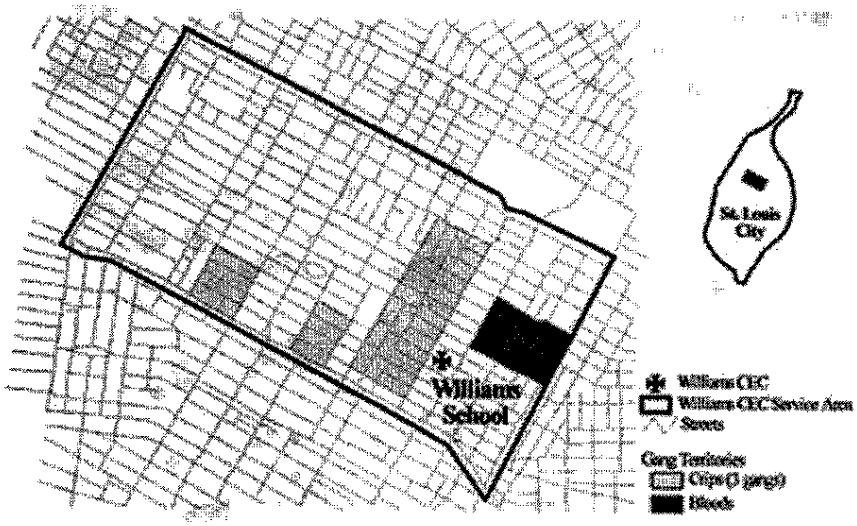

Figure 8. Map of Gang Territories around Williams Community Education Center

Teaching GIS to Community Development Students

GIS software might seem sophisticated at first to students with minimal computer skills. Users need to be familiar with the basics of either Windows or Macintosh operating systems, such as opening a program; using a mouse; resizing application windows; operating pull-down menus, buttons, and tool bars; and working with file management programs, such as File Manager for Windows 3.1 or Explorer for Windows 95. Some GIS programs offer a basic tutorial demonstrating the necessary skills for software use.

Students with ,experience using spreadsheet or database programs will be comfortable preparing data for GIS mapping. Since GIS is a graphics program, experience with layout or graphics programs, such as PowerPoint, proves valuable as well.

Before working with a computer, it is advantageous to review with students how the software will be applied. Without this understanding, a student can easily get lost in the details and lose track of the goal. An introduction should include not only what GIS is, but how it can and is being used in the social services sector. If possible, computer demonstrations of GIS applications will establish a practical context for students before they jump into the technology. If the instructor has no "real world" applications to demonstrate to

students, most GIS packages can illustrate the software's different uses.

Group dynamics play a crucial role in learning GIS software. Students reduce frustration and reinforce one another's learning as their group solves problems together. Students can also divide up tasks when they gather data. Community development and public planning projects almost always involve group work, which reinforces the need for students to learn development skills in a group context. The challenges and benefits of group work can be increased when employing a computer technology, which is designed for independent use (Armstrong, 1994).

Online tutorials provide a structured and pre-existing medium for students to begin work with the software. They introduce terminology and demonstrate various functions of the program. After completing the 15-20 hours of tutorials available with some software packages, students will become familiar with the program, but they may not necessarily feel confident in knowing how to use it. Even computer-literate students are sometimes struck with computer phobia when exploring GIS software. The teacher can assist the learning process by giving students encouragement and creating practice exercises and deadlines to motivate students to push beyond their initial uneasiness. Some students will find that a tutorial is all they need to start a project, while others will need more structure and support. These students should go through at least part of the tutorial as a structured in-class assignment. In the end, however, each student must work independently with the software to master it. Students who rely less on instructor support are likely to learn more quickly, because they are engaging with the software earlier. By combining online tutorials with in-class instruction, a medium can be found for both types of learners to ensure that students successfully learn how to use the program.

Applying Software Skills to a Project

Teaching students a professional skill such as GIS should be done in the context of practical applications; otherwise, it is training and not educating (Kemp, Goodchild, & Dodson, 1992). Working with an organization or agency will help students, understand the software's potential and realize its implications for community development. Students' motivation will be raised, and they will be able to apply their knowledge in other contexts. Another advantage to a partnership with an agency is that it provides access to data needed to complete an application of the GIS software.

The first step in developing a GIS project for an organization is to define the project goal. The definition should include the population, the geographic area, and the strategy used in addressing the problem. The project must be planned so it can address a particular problem during the length of the course term. While students are completing the tutorial, they can begin to work with their community agency to define the scope of the problem to be addressed. After this is completed, students need to identify the geographical area of interest, often the organization's service area or a specific program's target area.

After gathering basic information for the project, a set of maps providing information for the organization can be developed. Many public types of information are already available in GIS format, including streets, zip codes, city boundaries, neighborhoods, census tracts, and block groups. These can be found already with GIS software and from universities; a city's community development, streets, or planning department; government census bureaus; and the Internet. Students begin by isolating parts of these large information 'layers' that address the initial scope of the project.

The next step is to map new information. Students should identify and collect information, a task that can be a challenging learning experience in itself. Students usually must approach community leaders such as police departments, welfare departments, or United Way agencies to gather the necessary data; written agreements could be required in some cases.

Because the amount of potential information is nearly boundless, students can become overwhelmed with the possibilities that GIS technology has to offer. They must learn to establish priorities for which information is to be collected and mapped. Some information (e.g., census information at local libraries) is easier to gather. This might not be sufficient to address the problem being considered, however, and other information might be both more enlightening and harder to get. Students must know how to juggle information availability and desirability with course time constraints. They will quickly learn that information gathering skills are

valuable for community development work.

Some data is confidential, too, thus requiring decisions about how it will be protected when entered into the GIS software. One way to protect data is by the use of passwords. Another is to put the data only on a diskette, keeping it in the hand of the authorized user. A third way is to round all addresses to block level and remove any unnecessarily specific information, such as people's names; this makes it impossible to identify individual data.

Once the necessary information is obtained, it must be transferred into a usable format. Some data will have to be entered directly into the computer, while some will be available in electronic form. To transfer electronic data into a GIScompatible format, the student might need to consult with someone more knowledgeable about database files. Many GIS programs read basic dbase files, which most spreadsheet and database programs can easily create by exporting the data or by specifying the dbase file type when saving the file.

Data entry involves more than just technical issues, too,. Students must choose the categories into which data is entered. For instance, wilt1 they want to be able to know which schools are elementary schools? Which have more than 500 children? Which provide English as a Second Language classes? Such questions determine the different categories that must be created in the database. In many cases, not until the data has been mapped will students discover which information is required to answer different questions. The trial-and-error process may require them to return to the data entry and coding process.

After the basic data is loaded, students must "geocode" it. This is the process of matching new data with an already mapped layer of information, usually an area, such as a range of addresses, zip codes, or counties. For example, if the original data is a list of the city's zip codes and their crime rates, the software searches for matches between the zip code in the list and the zip code layer of the initial map. When a match is found, the crime data is linked to that zip code. Many of these primary GIS functions are explained in detail in the program tutorial.

The next step for students, once they have collected and mapped information, is to understand its meaning. GIS requires that people learn to think spatially, and students must do this to interpret what the data they have developed and mapped tells them about their original problem. As they experiment with different layers during this explorative process (see Figure 4), students can begin to apply the data to the problem from different perspectives. Because GIS technology can map information by address, for example, students can explore whether-and why–community services face particular challenges, as did students working with the Williams Community Education Center (see Figure 8). They can confirm the accuracy of data analyses that did not include a geographic component, as when one study discovered that the majority of hotline calls in a particular zip code came from a five-block area. Students might also discover the need for additional information, requiring them, if time allows, to include or gather more data.

Students at this stage are also using their creativity and intellect to apply their newly found skills to the problem (Audet & Abegg, 1996; White & Simms, 1993). A good follow-up assignment is a final paper integrating the students' defined problem, how it was addressed, and the results found. This creates a cohesive and independent piece of work that adds complementary practice skills to the technical ones the students have learned. Students must learn how to communicate what they have done and how it benefits the organization. If they have worked carefully, this final paper will be of significant value to the partner organization, as well, further reinforcing how GIS can be incorporated into community development practice.

Employment and Other Opportunities

Computers are changing social work practice., and social work education must prepare students to practice in a computer-based environment (Mutschler & Hasenfeld, 1986; Mutschler & Hoefer, 1990; Nurius, Hooyman, & Nicoll, 1988; Schwab, Bruce, & McRoy, 1986). Along with other computer applications, such as word processors, spreadsheets, databases, statistical packages, and Internet communication, GIS is becoming a valuable tool for social workers, particularly those involved in planning, managing, and evaluating social work practice.

Currently, employment opportunities exist for social workers with GIS skills in state and federal agencies and

in regional and local planning authorities. A recent survey of trends in technology conducted by American City and County magazine showed that 19% of public officials planned on purchasing GIS for their city in the next 18 months, with cities having between 250,000 and 500,000 residents reporting a 50% likelihood of buying GIS (Wise, 1994). Most GIS work currently involves planning and evaluating services (Petzold, 1994; Steffenson, 1996; Wise, 1994), but child welfare departments in various :regions of the country are also developing GIS components. A federal mandate has been issued to begin to map all federal dollars spent in service delivery (Peirce, 1995), which will accelerate the demand for social workers with GIS skills.

It is a mistake, however, to think of this tool as useful only to large public and quasi-governmental agencies. GIS has significant potential for direct client service, most obviously for matching clients with services. GIS can catalogue and retrieve enormous amounts of data about service characteristics, such as location, time of day, client population service, transportation routes, and payment type. This technology allows social workers to quickly find resources that are specific to clients' needs. These potential benefits are leading social service agencies to develop systems to collect and update electronic service directories on a monthly basis and to make them available to member agencies in a GIS-compatible form.

Social service organizations as diverse as child welfare agencies; public schools; family service agencies; health care providers; and agencies serving the elderly, immigrants, refugees, and troubled youth all need information about services to which to refer their clients. Until now the Rolodex and the service directory have been the most commonly used 'technologies.' The problem with these is that social workers tend to rely only on services already in their experience, and that information--especially about social service agencies--can change frequently, whereas most directories are produced only annually. In addition, such directories can only cross-index a limited number of characteristics. As the current drive for service integration develops, social workers are being required to become more systematic in referring clients to services. With GIS, these social workers can expand the scope of service delivery.

GIS also has potential for those actively involved in direct community development activities. Community organizers can build phone lists by using GIS to identify organizations or contacts, such as the membership of block associations, churches, or PTAs of a particular area. Social trends in a neighborhood can also be analyzed, such as those related to crime, youth activities, and housing sales. Finally, building resource directories also creates cooperative agreements between agencies that can further support joint actions.

While it is unlikely that a large number of social work employment opportunities will appear that list GIS as a primary responsibility, GIS knowledge will give social workers a competitive edge when seeking employment in planning and evaluation agencies, service integration, and, increasingly, community development.

Conclusion

GIS can be taught to students at either the baccalaureate or master's level. These skills will assist students in conceptualizing neighborhood iss ues, focusing on spatial variables, understanding service integration, and[reflecting critically on program design. GIS is most effectively taught in groups, offering the opportunity for students, to develop group problem-solving s kills. Using an actual community problem as the core of students' learning provides a practical context for learning and us ing GIS. The student working with the application has the added advantage of engaging in community development, as well. Thus, just as knowledge of word processing and database programs is currently integral to many social work programs, it is likely that GIS will soon join them as an important tool in a social worker's tool kit.

Figure 1
Use of GIS in Program Evaluation:
Crime Watch Groups and Crime Rate
Changes by Neighborhood

Neighborhood Name	Watch Group	Change
Penrose Park	No	Increase
Penrose	Yes	No Change
O'Fallon Park	No	No Change

O'Fallon	No	No Change
College Hill	No	Increase
Kingsway West	Yes	Decrease
Kingsway East	No	No Change
Fairground Neighborhood	Yes	Decrease
Fountain Park	Yes	Decrease
The Ville	Yes	Increase
O'Fallon Park	No	No Change
College Hill	No	Increase
The Greater Ville	No	Increase
Kinsgway East	No	No Change
O'Fallon	No	No Change

A table provides details, but patterns are hard to see.
(Crime data is fictitious, for demonstration purposes only.)

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