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Evolution of a Collaborative Model between Nursing and Computer Science Faculty and a Community Service Organization to Develop an Information System

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Abstract

Nursing and computer science students and faculty worked with the American Red Cross to investigate the potential for information technology to provide Red Cross disaster services nurses with improved access to accurate community resources in times of disaster. Funded by a national three-year grant, this interdisciplinary partnership led to field testing of an information system to support local community disaster preparedness at seven Red Cross chapters across the United States. The field test results demonstrate the benefits of the technology and the value of interdisciplinary research. The work also created a sustainable learning and research model for the future. This paper describes the collaborative model employed in this interdisciplinary research and exemplifies the benefits to faculty and students of well-timed interdisciplinary and community collaboration.

Keywords

Disaster planning; Rescue work; Medical informatics; Cooperative behavior; Information systems

INTRODUCTION

Following the 9/11 disaster two faculty from the Department of Nursing at Miami University in Oxford, Ohio, who are American Red Cross volunteers, identified an emergent need for a disaster information system to support Red Cross disaster services nurses. At that time faculty and students in the Computer Science Department were researching mobile computing applications, the Internet and web-services technologies. Early in 2002 the needs identified by the nursing faculty, and the research interest of the computer science faculty, combined in the form of an interdisciplinary research project to aid the Red Cross disaster services nurses. The project has improved delivery of care to Red Cross disaster victims and created a sustainable learning and research environment for both the nursing and computer science departments.

This paper describes the background that led to the project vision, the evolutionary collaborative model between the Red Cross and Miami University faculty to implement the project, and the benefits of the collaborative model.

BACKGROUND

Annually the Red Cross responds to an average of 67,000 natural and human-made disasters each year by offering health and human service assistance to affected clients.² The majority of these events occur in the local community and are addressed by disaster services nurses, many of whom are volunteers. Examples are house fires and localized storms. The function of these nurses is to assess the health care needs of clients and connect them with needed assistance such as: replacement of medications and medical equipment; temporary shelter and transportation; mental health resources; and mediation of environmental hazards or infectious agents. These nurses may also accept assignments to national disasters, such as the New York World Trade Center terrorist attack, hurricane Katrina, or the California wildfires.

During a disaster nurses need to know where local health and human services and products are found in the impacted community. Many nurses rely on information they have accumulated through personal experience, compiled in a loose-leaf notebook or a file folder and shared informally with other nurses in their localities. This method of data management is inadequate and may result in incomplete information that is not easily searched; information that is not available to others; duplication of effort; and outdated information. These problems are exacerbated in time of a national disaster when the Red Cross mobilizes workers from around the country. These workers arrive in the community affected by the disaster, usually during the recovery phase which occurs a few days following the event. The workers typically are unfamiliar with the local community and its resources.

A critical component for any emergency response system is a local resource database that includes physical, informational and human resources.³ Examples of this information are names, addresses, and phone numbers of local pharmacies and other suppliers of health-care products, hospitals and transportation services. While researchers expect information technology to have an increasingly important role in information-sharing during emergencies and disasters,⁴ a recent study found that 42% of local community web sites have no disaster related content.⁵ It is notable that the 2005 hurricane disasters had little effect on municipal website content.⁵ Recent experiences with the Katrina response cite the need to strengthen information and communication technology capabilities.⁶

Currently, no information system is in place to provide Red Cross disaster nurses with the information documenting the availability of health and human services that they need to serve their clients at the time of local or national disasters. It is recognized widely that nurses need to acknowledge the importance of preparedness to disasters^{7,8,9} and for response to bioterrorism.^{10, 11} A disaster information system would enable Red Cross disaster services nurses to employ innovative technology to prepare for and respond to disasters. The vision of the interdisciplinary team was to develop an information system to significantly improve disaster services nurses' access to comprehensive information of local community health and human resources. This system would result in improved and expeditious service to disaster victims.

Early in 2002 the vision for an information system for documenting and querying community-based health and human services for disaster services nurses was presented to two Red Cross chapters located near the researchers in southwest Ohio. The vision included a collaborative relationship between the Red Cross chapters and the nursing and computer science researchers to evaluate and test the feasibility of the proposed information system. The foundation for this relationship was based upon two key factors: the more than 20 years of combined local and

national Red Cross disaster experience of the two nursing faculty and the expertise of the computer science faculty in information system design. The Red Cross local chapters were very interested and supportive of the concept of an information system that had the potential to aid Red Cross disaster victims and volunteer nurses. The researchers were also aware that an emerging goal of the government's Homeland Security initiative was to improve information sharing through the development of an Information Integration Office.¹²

The vision became the blueprint for development of the project (see Figure 1 for the project objectives and goals). The term Community Disaster Information System (CDIS) was adopted for the information system. To move the vision to reality a collaborative model was developed and is described in the following section.

EVOLUTIONARY MODEL

The faculty developed an evolutionary collaborative model to guide their work, progressing from an informal conceptual stage to a formal, operational partnership. This is similar to a collaborative model used by Schermer, Geisler and Vang¹ in their nursing thesis database project involving a nursing faculty member, a computer laboratory administrator, and a programmer. This section discusses investigative, operational, and expansion phases of the model whereas Schermer¹ et al organized their model into concept, planning and implementation phases.

Investigative Phase

The goal of the *investigative phase* was to identify the requirements for the information system, to produce an operational prototype, and use this prototype to assess the potential to further develop and field test the project with the Red Cross. The initial investigative team consisted of the three authors (two from nursing and one from computer science), two nursing students enrolled in the Registered Nurse baccalaureate completion program and two undergraduate computer science students. The investigative phase was a one year commitment funded by intramural and extramural grants to support the work. The nursing students participated in the requirements gathering and computer science students developed the prototype software. These activities are described below.

Nursing Independent Study Course: Requirements Identification—The primary role of the nursing students was to determine the user-level requirements for the information system and its associated database. Requirements included queries needed to search for information, types of stored information and needed information fields. To facilitate this work, the nursing faculty designed an independent study course the outcomes of which were to produce the requirements.

The students received tuition reimbursement to participate in course. Faculty selected the nursing students based upon their interest in informatics, motivation, and desire to enroll in a summer course.

The course focused on identification and categorization of the wide variety of local and national community resources available to aid individuals and families during physical and or emotional crisis. This required identification of local and national agencies and businesses offering the resources and the specific information to be stored in the information system's database. Near the end of the course the computer science and nursing students worked together to translate the user requirements to design requirements for the information system database and user interface.

Computer Science Summer Internship: Implementing the Prototype—The primary role of the computer science students was to design and implement the prototype information system to meet the requirements produced by the nursing group. This involved implementation of the database, developing user interfaces for data entry, and developing the search engine for searching. Software for both the web and for personal digital assistants (PDAs) was developed (See figure 3 for the computer science project requirements). This phase lasted about 15 weeks, overlapping with the nursing independent study phase and took the form of a paid summer internship.

Investigative Phase Accomplishments—Over the summer term, the combined team of students and faculty produced an operational prototype system. They entered a small but representative set of information into a database and tested the prototype information system.

At the end of the summer term, the entire team presented the completed prototype project to the two local Red Cross chapters who enthusiastically endorsed the prototype. The chapter representatives were particularly impressed with the user friendly interface, the database design, and the comprehensiveness of the system. They immediately validated the applicability for such a system during both local and national disaster responses. We feel that the involvement of nursing students, who represented the end users, and the close collaboration with the computer science students, was a key factor in the success of this phase.

Operational Phase

The *operational phase* was a multiyear commitment, supported with external funding, to take the project from proof-of-concept to field testing. This required a more formal collaborative relationship between the interdisciplinary faculty and the Red Cross (See figure 2 for the organizational and reporting structure).

The two local Red Cross chapters were instrumental in fostering a positive relationship with executives at the national Red Cross headquarters. The project team met with key decision makers at the headquarters in Washington, D.C. This meeting led to the plan to expand the project to seven test site Red Cross chapters in different regions of the country. Additionally Red Cross pledged support through participation on a project advisory board, to contribute in the development of system standards, and to explore organizational structures to support the project.

Following the endorsement from Red Cross headquarters and the results of the investigative phase, a three year National Institutes of Health/National Library of Medicine Information Systems grant was secured to support field. The objectives and goals for the project were developed in collaboration with the Red Cross (see figure 1 for the objectives and goals). A Project Advisory Board was established to identify field test sites, implement field testing, and to provide continuous project evaluation and refinement based upon lessons learned during field testing. The Project Advisory Board membership includes Red Cross representatives. The Board plays a key role in assessing the results of the field tests and in formulating an organizational and funding plan that supports the expansion and ongoing operation of the CDIS information system after the field testing phase.

Test Site Structure—Seven test sites were selected by Red Cross national headquarters based on a broad geographic representation, balance between urban and rural settings, diverse racial/ethnic populations served, and interest in the project and the ability to serve as a test site. Within each test site key personnel were identified to manage and use the information system within each community. These personnel are called Chapter Facilitators, Community Managers, and Disaster Services nurses. Each of these roles is described below.

The Chapter Facilitators oversee the day-to-day project activities of their test site; advocate the importance of the project within their test site; and participate on the Project Advisory Board that meets at least semi annually. The Community Managers serve as gatekeepers for their chapter's data. Their responsibilities include oversight of data collection and entry of their local community resources into the CDIS; implementation of software upgrades; assessment of progress and providing ongoing feedback to their own Community Managers and the Miami University investigators. The roles of the Disaster Services nurses are to develop a comprehensive disaster services resource list; enter the disaster services resource information into the database; field test the system during local disaster responses; and provide ongoing feedback to the project team and their own Community Manager.

Operational Phase Accomplishments—To assist in populating the database, associate and baccalaureate nursing students and graduate students in pharmacy and public health were used in both service learning and in courses. For example, the nursing faculty developed an independent study nursing elective course to introduce the students to disaster informatics, disaster nursing, and healthcare databases. In three separate offerings of the course eight associate degree and baccalaureate students collaborated with other disciplines and community organizations in assisting the test sites with their database development. With this support in assisting with database development, the Red Cross disaster nurses concentrated their expertise on field testing the information system.

This work resulted in early operational testing of the system during the Hurricane Katrina response at two of the test sites. A test site participant stated: “DHS (Disaster Health Services) volunteers used CDIS to track health professionals volunteering their services to assist with everything from eyeglasses, to hearing aids, to prosthetics.”¹³ The seven test sites continue to populate their chapter's database which contains approximately 8,300 community resources in over 170 different categories such as pharmacies, diabetes clinics, pediatric dentistry, ostomy supplies, and special needs shelters.

The Computer Science faculty worked with three computer science students to refine the database design, user interface, and searching approaches based on project evaluations and recommendations by the test sites and the Project Advisory Board. This resulted in three system upgrades including: improved search functions, printable pages, help boxes, Google Maps, and the adoption of AIRS/INFO LINE Taxonomy of Human Services^{14, 15}. The AIRS taxonomy is a conceptual framework with standardized terminology and definitions that provide a comprehensive and standardized classification and indexing system.

Expansion Phase

An administrative unit, called the Resource Data Center (RDC), was formed within Miami University to formally house the project and to manage the *expansion phase* of the project. The goal of the expansion phase is to build on the operational phase and expand the information system beyond the field test sites to ultimately lead to national deployment. The RDC also is the administrative hub for future research on other related projects.

Specific objectives of the expansion phase are to: provide for management and operation of the information system as a public service to the American Red Cross; foster research opportunities for Miami faculty and students in nursing informatics, computer science, and disciplines related to disaster services; provide a mechanism for strategic planning with the guidance of an external advisory board; support national homeland security initiatives for disaster preparedness; and identify and procure financial and other resources for the center's operation.

Expansion Phase Accomplishments—Since inception of the project students and community organizations have participated in CDIS. Key personnel at the test site chapters have been so enthusiastic about the project that they have been instrumental in the expansion to agencies that share information with Red Cross chapters. Currently CDIS serves a regional Emergency Operations Center (EOC) and a local United Way information and referral agency in addition to the Red Cross test sites.

Results of the expansion phase have also led to the study of the application of information technology to support community based disaster preparedness (CBDP). CBDP¹⁶ refers to a specific form of local-level capacity building and represents increasingly important elements of vulnerability reduction and disaster management strategies. CBDP strategies leverage the knowledge and capabilities of local community resources. This is a new research area for the investigative team.

Benefits of The Collaborative Model

Schermer, Geisler, and Vang's¹ cooperative venture with nursing faculty and computer science professionals resulted in similar benefits to the collaborative model presented in this paper. Schermer et.al. found that the combined efforts resulted in closer interdisciplinary relationships and sharing of nursing research information within the university.¹ Collaboration with faculty from nursing, other disciplines, and community agencies in the CDIS project opened new and exciting learning and research opportunities, especially as they address current issues. Linkages developed by faculty engaged in community service can evolve into meaningful, real-life projects for students, faculty, and society.

Nursing students were challenged to apply their community health knowledge as they learned the process of developing a disaster information system. Nursing students experienced an application of informatics in their discipline. Computer science students worked with innovative mobile computing, web-services and the Internet as they learned about disaster nursing response. The students and faculty learned about the disciplines of nursing and computer science. They discovered that their vocabularies and critical thinking patterns were very diverse and this proved to be a challenge in communicating their ideas. They learned how to understand each other and respect the expertise that each brought to the project. These skills will enhance the students' ability to work with interdisciplinary teams.

Motivated by the obvious need for the system, the students and faculty dedicated themselves to producing a significant and impressive informatics application. Through interdisciplinary collaboration nursing and computer science students learned to apply informatics to solve a community need. Both groups frequently commented about their personal satisfaction of working on a project that would actually be implemented in the community and increased their interest and dedication to the project. The students learned how to work together to accomplish a mutual goal from very different perspectives.

Nursing and computer science faculty found a new energy that came from expanding their horizons beyond their comfort zone. This synergy has evolved into an empowered team that together has received departmental, divisional, university, local and national recognition.

The Red Cross and ultimately their communities benefit from an information system that can be used for local and national disasters. With the expertise and funding sources available from academia, faculty and students capitalized on an educational and research opportunity to collaborate with a service organization to produce a much needed community resource. All parties benefit by producing products and services that neither would have produced individually.

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Biographies

Jean Vanderbeek is an Associate Professor with the Department of Nursing of Miami University. She has published articles and presented at various conferences on topics related to nursing informatics and health care and received the Miami University Middletown Campus technological achievement award. She is the co-principal investigator working with the other two authors on a National Institutes of Health/National Library of Medicine Grant to develop a Community Disaster Information System (CDIS) for the Red Cross.

Anne Carson is a pediatric nurse practitioner and an Associate Professor in the Department of Nursing at Miami University. She is the co-principal investigator working with the other two authors on a National Institutes of Health/National Library of Medicine Grant to develop a Community Disaster Information System (CDIS) for the Red Cross. She is working with a local Emergency Operations Center and a local 211 HelpLink United Way organization to share data developed through CDIS.

Dr. Douglas Troy is a professor and department chair at the Computer Science and Systems Analysis Department, Miami University, Oxford, Ohio. He holds a PhD from the University of Waikato, New Zealand, a Master of Science in Computer Science from Ohio State University, and a Bachelor of Science from Miami University. He has been at Miami University since 1983. Prior to joining Miami, Prof. Troy worked in industry at Bell Labs and CompuServe Network. Doug Troy's current research project is the design and implementation of the Community Disaster Information System (CDIS). CDIS is an information system used by Red Cross and other emergency responders to store and locate information about community resources in times of disaster.

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Objective 1: CDIS will significantly improve American Red Cross disaster nurses' access to comprehensive information of local community health resources.

Goals:

- a. Collaborate with Red Cross local chapters and national headquarters in identifying the requirements for CDIS and consultants throughout project development and implementation
- b. Provide accurate and complete disaster resource information, stored in a central database, maintained at the local level, interactively searched on the Internet and accessed on a handheld personal digital assistant (PDA)
- c. Provide an information system that is indexed and easily searchable in ways familiar to nurses, so that minimal training would be required
- d. Access information in disasters where power and communication infrastructure may be unavailable

Objective 2: CDIS will provide a learning and research experience in nursing informatics and computer science for faculty and students.

Goals:

- a. Offer an elective informatics course for nursing students designed to educate, generate ideas, and contribute to the development of the user interface and requirements for CDIS
- b. Offer undergraduate and graduate computer science students work opportunities in mobile computing
- c. Develop the Resource Data Center (RDC) to foster research opportunities for Miami faculty and students in nursing informatics, computer science, and other possible disciplines related to disaster services

Figure 1.
Project Goals and Objectives for the Community Disaster Information system (CDIS)

Figure 2.
Collaborative Organizational Chart

- Identify a workable organization for the data
- Specify data elements ^{17,18}
- Design the interactive user interface for the PDA
- Design and populate the server database
- Learn the software tools needed for the project
- Develop the software and web service infrastructure
- Test the system
- Identify the suitable performance measures to evaluate the effectiveness of the CDIS
- Test the effectiveness of the prototype
- Present the prototype system to the local Red Cross Chapters

Figure 3.
Computer Science Students Project Requirements