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Behrooz Seyed-Abbassi

University of North Florida
Jacksonville, FL 32224 USA

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Practical Aspects of Promoting Research in a Graduate Course

Behrooz Seyed-Abbassi

abbassi@unf.edu

Department of Computer and Information Sciences

University of North Florida

Jacksonville, Florida 32224 USA

Abstract

The introduction and reinforcement of skills related to communication and research are vital components that need to be incorporated into the course structure of undergraduate and graduate programs related to computer technology. Practical utilization of these skills is essential for students to develop their critical thinking proficiency, to understand how to assess a particular domain, to enhance decision making expertise, and to share their work through written documentation and verbal communication. However, this incorporation often presents a challenge since the emphasis in many computer and information systems/science courses is frequently focused on implementation proficiency. An approach that provides an opportunity for students within a topic-oriented class setting to learn the basics of research, while at the same time develop oral and written communication skills through presentations and documentation of a research project is presented. The overall methodology has the potentiality for adaptation in other undergraduate and graduate courses.

Keywords: graduate students, research, pedagogy, project, communication skills, database

1. INTRODUCTION

Various approaches have been used to embed techniques associated with research, as well as to provide communication opportunities into computer and information systems programs. Some programs have had success in establishing a course or seminar set in a conference structure where students complete tasks that may include researching, implementing, writing, reviewing, and presenting projects (Norris 1999; Silvilotti 2004; Borstler 1998). Other approaches are to offer a research course that varies in length and coverage depending on the program (Ward 2004; Witten 1993), or to encourage participation in research groups (Bernat 2000). Each of these methods demonstrates significant benefits for preparing students with the skills needed for professional careers and/ or for advanced studies leading to thesis or dissertation work.

Within the current programs at the Department of Computer and Information Sciences (CIS), there is not a separate learning ex-

perience that focuses on research methodology available for students. This is in part due to the limitations on instructor time and issues with total credit hours required for graduation. Each instructor is responsible for the integration of written and oral communication skills, and research experiences as appropriate for different courses. Particular courses that require project presentations have been designated for the oral presentation requirements needed for graduation from the undergraduate programs.

This paper describes an approach, which is the culmination of experiences over the past six years to integrate effective communication and research practice into a graduate course, Developments in Database Structures (DDS), in the Masters degree program for computer and information systems/science students. The course focuses on recent advancements in database systems technology and prevalent areas that are beginning to influence today's industries. In addition, students undertake the devel-

opment of a team research project in a specialized database area that results in both conceptual and implementation components, with their findings documented throughout the semester in write-ups, a poster display, and oral presentations.

In the next section, general information about the course is described. A more specific description is given in section 3 about the association of the students' topic presentations to their research area. In section 4 and section 5, the topic presentation and research project are discussed in more detail respectively, with the final project deliverables presented in section 6. Section 7 provides feedback and comments from students regarding their experiences. The final section considers the outcomes from utilizing the methodology in the advanced database course.

2. MECHANICS OF THE DDS COURSE

The following descriptions are an overview of the general ingredients that constitute the framework of the DDS course.

Topics

As with many computer technology areas, database systems and closely associated fields are in a state of expeditious growth. Over the past six years, the sheer number of possible topics has necessitated the limitation to a feasible selection of rotating topics that takes into consideration the prevalent technology. The instructor predetermines the topics that will be treated as traditional lectures, and the topics that will be presented by the students. In an advanced course, it is particularly important to offer a selection of topics that will entice students to learn more about the areas. Making a list of topics requires some deliberation by the instructor using sources such as topic listings in call for papers, advanced technology areas of newly published books, and a variety of related websites and professional journals.

Questionnaire

Although a basic database course is required as a prerequisite, students enter the course with a great deal of diversity as to their actual experience with database. In the first week of the course, students are given a questionnaire, which helps to clarify the

background and knowledge level of each student. The information is helpful in identifying the types of individual database-related assignments needed at the beginning of the semester to ensure that all the students have the necessary database foundations, design and programming skills, and are familiar with the available hardware and software. The questionnaire also includes the list of database topics that could be covered in the course. Students are requested to rank their top three areas of interest in order of priority.

Team Determination

Using the background and ranking information from the questionnaires, the instructor matches the students into teams. The number of teams and the number of students in each team are determined by the size of the class. Based on experiences with this type of research grouping, two-member teams seem to have better communication and distribution of tasks than larger teams. Students also have the option of completing the work individually after conferring with the Instructor. For class stability, grouping is announced after the drop/add week.

Team matching has been done in a variety of ways (drawings, topic matching, selection by students, instructor matching) over the semesters. The matching done based on the ranking of topic priority by the instructor worked well, in that students with a common interest were grouped together and fewer compatibility problems were noted.

Participating as a member of a team has several advantages over individual work. Students learn from each other by sharing knowledge and exploring alternatives from different viewpoints. They gain valuable experience in the necessity to divide responsibilities and tasks for the completion of specific goals similar to a work environment. If more than two members are in a team, additional evaluation forms are used to assess each member's participation level.

Course Schedule

Instructor lectures and guidance in research techniques occur during the first five weeks of the 16-week semester. The dates for the topic presentations from the 6th to 13th weeks are determined by a two-phase drawing process (order of drawing and drawing

for dates). Four to five team research meetings with the instructor are scheduled during the semester with the final research projects presented at the end of the course.

Individual Assignments

At the beginning of the semester, students are given 4-5 assignments on logical/physical database design and implementation. The assignments are usually interrelated, and give the students an opportunity to renew their understanding of the essential concepts and practice with the available systems.

Reference Material

Finding textbooks that incorporate the selected topics is difficult in that these areas are undergoing continual changes with the focus of different authors varying in quality and quantity, which would require the purchase of multiple books. As an alternative to this expensive proposition, a combination of literature from different sources is used as required reading for the entire class. The materials are chosen from e-books available through the netLibrary collection at the University of North Florida library, books placed in the reserved area of the library for limited checkout, and selected research papers on the web.

Course Management System

Blackboard, an on-line course management system, is utilized to provide course information, assignments, assignment turn-ins, and shared notes. Class announcements and schedules are posted on the system. Each team is also provided with a group account for topic and research documentation.

Grading Considerations

Grades are determined by a weighting of 25% for examination 1, 25% for examination 2, and 50% for assignments and the research project. The examinations are scheduled for the 9th and 14th weeks over the material covered by the instructor lectures and student topic presentations, including notes provided on Blackboard and assigned reading material. The 50% component includes individual assignments, topic development, presentations, evaluations, and research parts (I, II, III, IV, final).

3. CORRELATING TOPIC PRESENTATIONS WITH RESEARCH AREAS

Once the topics have been assigned, students begin the initial study of the background and conceptual foundations of their areas through reading the assigned materials, and the search for additional research material found on the web and in the library. The information studied provides the underpinning for their research project and provides a significant amount of assurance about the subjects prior to venturing into their own research ideas. In preparing a topic presentation for their peers in the class, students work more diligently to understand and master their subject than if it had been given as a reading assignment. The topic presentation provides a very relevant experience as the initiation into same area as their final research project and presentation.

Dividing the research project into 4 parts prior to the final turn-in enables the instructor to discuss different aspects of research and format guidelines at applicable times during the project. It also provides students with a somewhat structured time frame for successful completion of the project that is less overwhelming than receiving the entire project at once.

A variety of subjects that affect research development are intermixed with the traditional lectures in various areas of advanced database. Initially, the focus is on utilization of resources to locate previous work done by other researchers, the differences between sources, and critical perusal of research papers. Other areas of discussion include selecting an area of interest within the general topic, narrowing down the focus to a practicable size, considering conceptual and implementation phases of the project, extending a personal vision into the area, and applying the methodology to future research work. Ethical issues of research and plagiarism are discussed, as well as the importance using their own words in their written documentation with appropriate citations to the references used as support for their research work.

After the turn-in of each part, a meeting is scheduled to review the instructor's evaluation of the submission, areas that need more focus, and specific questions/concerns. Stu-

dents are also encouraged to see the instructor as needed during office hours or by appointment for additional guidance in their research projects. For meaningful understanding and accomplishments to occur, consistent guidance and mentoring by the instructor is essential for the students during this type of course.

4. TEAM TOPIC PRESENTATIONS

Each team gathers information from the assigned materials, determines the essential facts, prepares presentation materials, and conducts a presentation to the class about their area. The goal of the presentation is to inform the class about the topic, and to increase the understanding and appreciation of the area as a special part of database technology. As previously mentioned, this topic study provides part of the general background information for the development of their research project. The other students in the class are responsible for reading the assigned materials to be more knowledgeable during the presentations, and their comprehension of the material is tested in the exams.

Each team is evaluated by the class and by the instructor for factors involved in the presentation. The factors are discussed and agreed upon by the class prior to the presentations. The topic presentation is 45 minutes with 15 minutes for questions and answers. Preparing a presentation requires that students have a good understanding of their topic. The questions from the class often help to stimulate additional illumination into the area. The students gain practical experience in the preparation of presentation materials, oral presentation skills, and interaction with an audience.

Required materials to be submitted by each team before their presentation:

1. Cover page with topic name, presentation date, and student names
2. List of chapters used for presentation material and any additional information about the development of the topic presentation
3. Description about importance of the area to database technology
4. Presentation materials in hard copy, and a soft copy submitted through digital

drop box in Blackboard for the class to access

5. COMPONENTS OF THE RESEARCH PROJECT

Each part is assigned points that increase as the project develops. Points are also given for the meetings with the instructor. By assigning points to each task, it provides a measurable way to evaluate the students' effectiveness in each component, and accentuates their responsibility to complete the assigned work and to attend meetings. The following summarizes the basic requirements for each turn-in with the flow of the project components summarized in Table 1.

Table 1: Flow of Project Components

<p>Part I</p> <p>A. Review research publications related to assigned topic area.</p> <p>B. Determine projects with reasonable scopes for successful completion.</p> <p>C. Submit 1-2 pages containing 2-3 potential projects - each with a brief, clearly defined description and 3-4 initial references.</p>
<p>Part II</p> <p>A. Submit 3-4 pages of introduction and background information.</p> <p>B. Cite references within paper and provide list of references.</p> <p>C. Include personal ideas and possible implementation plans.</p>
<p>Part III</p> <p>A. Continue paper development based on further research.</p> <p>B. Submit 6-10 pages with abstract, introduction, background, planned methodology, and implementation with software requirements.</p>
<p>Part IV</p> <p>A. Submit modified conceptual work addressing instructor comments/concerns.</p> <p>B. Include progress report about implementation phase of project.</p>
<p>Final</p> <p>Submit completed project including re-search paper and software.</p>

Part I (3rd week): Students review recent research publications related to the assigned topic area to determine possible research projects with reasonable scopes for successful conceptual and implementation completion during the semester. Each team submits 1-2 pages containing 2-3 potential research projects clearly defined with a brief description and a list of 3-4 initial references (journals, proceedings, web sites,...). The instructor determines the approved project.

Part II (5th week): Students prepare 3-4 pages of introduction and background information about the project (citing references within the paper and listing references as a bibliography) including their own ideas and possible implementation plans.

Part III (8th week): Students continue the paper development based on their research to include 6-10 pages with an abstract, introduction, background information, planned methodology and implementation with anticipated software requirements.

Part IV (10th week): Students submit a modified conceptual research work addressing the instructor's comments and concerns, and a progress report about the implementation phase of the project.

Final Project (15th week): Students submit the final completed project including the research paper and the software. Described in more detail in section 6.

6. FINAL PROJECT DELIVERABLES

Each team is responsible for three exhibition methods for their research project. Each method gives the students experience similar to a conference type of setting for sharing the fruition of their research.

Poster Demonstration

Each team develops a poster presentation about the description and facts of their project, using information from a class discussion about research posters, and guidance from an article on the ACM student chapter website (Cranor 1996). The posters are displayed at the College of Computing, Engineering, and Construction (CCEC) Annual Symposium in the 15th week of the course. Designing and presenting a poster display helps to clarify the essential highlights of their research project. In addition, comments from attendees help to identify im-

provements and additional areas to contemplate prior to the final project turn-in.

The students are responsible for registering the posters, providing the appropriate project information, identifying the imperative aspects of their research for a cohesive display, and following the poster procedures at the CCEC Symposium. CIS faculty members, who rank a variety of qualities for awards, judge the posters. Although these posters were presented in a college-sponsored event, the poster presentation could also be utilized in a class setting with the other students critiquing the displays.

Research Project Write-up

The expectations for the final project documentation focus on being clearly descriptive and grammatically correct, with appropriate citations to references. The submission guidelines follow the basic format of research papers, including an abstract, introduction, body (i.e., background, comparisons, algorithms or pseudocode, methodologies, results, ...), conclusion, references, and appendix.

Each team submits the final completed project in a folder containing the research paper with supporting materials (i.e., appendix, software, how to run the program, ...), as well as soft copies on CD or Blackboard. The teams are encouraged to be sure that their software will work properly when the instructor uses the provided instructions to test the implementation part of the research work during the project evaluation.

Class Presentation

The research project presentations, scheduled for the last days of the course, provide an opportunity for each team to demonstrate their research project as well as to exchange information and ideas about areas of current database technology. A hard copy of the presentation outline and any other presentation information are turned in the day of the presentation and added to the folder.

Each team is allotted 25-30 minutes for the presentation and 5-10 minutes for questions/answers, with the understanding that the time slot will not be shifted forward if the project presentation or software did not work properly and that they should be prepared to continue the presentation if difficul-

ties should occur. A two-phase drawing process determines the order of drawing and the time slots.

An evaluation form for the presentations is reviewed and modified by the students according to class discussions of what they believe will be important to a professional presentation. Each area is ranked on a scale from 1-10 with 10 = excellent and 1 = poor. Points are given to the classmates for completing the evaluation forms if all are turned in at the end of each presentation day. If all the forms are not turned, no points are given. This encourages attendance to all presentations.

7. FEEDBACK FROM STUDENTS

When asked to write observations about what they found to be the most important aspects involved in the initiation and development of a research area based on the experiences encountered with the project, the majority of students responded with insightful replies about their experiences indicating that they developed a better understanding of research concepts and applications. A more measurable questionnaire is in the process of being developed to quantify student experiences. The following samplings of written observations made by students reflect their increased comprehension of the importance of topic selection, previous research work, problem analysis, the conceptual model, and the substantiation through implementation.

Topic Selection

1. Analyze what subject would be of interest and which particular area of the subject could potentially benefit from research work.
2. Does the researcher feel it makes a contribution, is it exploring new ground, is it within the abilities of the researcher.
3. Find an interesting problem that is still unsolved-this can be challenging and requires imagination, critical thinking, and the ability to realistically estimate what is doable.

Supporting Research Material

1. Gather the necessary research material.
2. Research must rely on peer-reviewed publications.

3. Find good and current information about the topic of choice.

Problem Analysis

1. Learn the fundamentals of the topic, and become familiar with the problem domain and the applicable literature.
2. Read a lot of research papers, understand their ideas and find small flaws or areas of improvement in these papers on which to build own research paper.
3. Find different, more efficient solution to a particular problem identified in various research papers.

Conceptual Model

1. Study the background of the problem to come up with conceptual design of the solution.
2. Develop the conceptual method first and then work on the implementation.
3. The conceptual model can change a great deal as you think it through.

Implementation Procedure

1. My implementation has definitely helped me gain a better understanding of the topic.
2. Implementing the research is relatively easy once the basic ideas are worked out.
3. Only after conceptual design is completed, come up with implementation strategy and methodologies.

Overall Experience

1. Set realistic goals for yourself.
2. Development of the research paper should be an ongoing part of the project.
3. Enjoyed hearing other students discuss their topics - many of the discussions sparked my interest in specialized areas of database research.

8. CONCLUSIONS

The end results of using a combination of learning experiences for introducing students to the various aspects of the research process within a course setting have been similar to that of other educators who have utilized methodologies that involve independent re-

search seminars, courses, and groups. The students are provided an opportunity to practice a variety of essential skills, including practical analysis, critical thinking, decision-making, and communication in the preparation of their conceptual and implementation documentation. Instead of jumping directly to the implementation, they learn the importance of foundation information to support their ideas. Alternatively, they understand the foundations better after working on an implementation.

In programs where a separate learning experience for research methodology is not feasible, the presented approach provides a strategy for integrating research information and practice into a topic-oriented course. By assigning students to study a topic in which they are interested for a presentation to the class, the students initiate the foundations to pursue further research work and to determine a self-motivated selection of a specific research topic. Timely interjections about research techniques, as well as segmented project assignments avoid overwhelming the students with too many requirements to sort out and help to provide a time frame for successful completion of the project.

There are factors that can effect the success of incorporating a research project into a course, such as the number of enrolled students, instructor time to review and critique each part, and instructor familiarity with the topics. However, in courses where appropriate, the integration of a research experience can provide students with a motivating and valuable opportunity to learn about a particular topic and to share their findings through written and verbal communication.

The sharing of information benefits the entire class in raising their awareness in a way that is different from more traditional lectures - it is more interactive and requires the students to accept more responsibility for their learning process. This approach has resulted in more confident students who have improved written and oral communication skills, and consequential research experience prior to the initiation of their thesis work.

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