

A Systematic Framework for Conducting Research Projects in Undergraduate Courses

Yousif Mustafa

Department of Administrative Systems

College of Business

West Liberty State College

West Liberty, WV 26074, USA

y.mustafa@usa.com

ABSTRACT

Research projects are usually given to students in order to broaden their horizons and expose them to experiences and ideas beyond classrooms and textbooks. Research projects also help prepare students to conduct future advanced research work. However, the absence of an easy-to-follow framework for conducting research often results in making this task a burden on students rather than an exciting adventure. Accordingly, most research papers produced by students are not more than copy-and-paste low quality reports. There is a need for such framework, which recognizes research as a process that can be planned, monitored, measured, corrected and improved. In this research paper we present such a framework which, if followed would enable students to produce good quality research projects. It would also help students and instructors to achieve the goals of conducting research projects.

Keywords: Framework, research project, process, template

1. INTRODUCTION

In many upper level classes, especially within the CIS, CS, and MIS curricula, a research component might be part of class requirements. In most cases the outcome of the research project is a research paper developed to explore a concept or idea selected by students from the class materials. Accreditation authorities, such as the AACSB International, insist on such requirement when granting accreditation to schools. In fact, a growing movement, which begun in the 1980's, proposes dual goals: teaching writing within a discipline, as well as, promoting increased learning of a discipline through writing, that is "learning to write while writing to learn" (Rileigh 1993).

Research is defined as a serious, systematic activity, one requiring hard work and perseverance (Walker 1997). Research projects have become an ideal vehicle for the learning process and considered vital in most classes because they:

- Broaden students' knowledge and expose them to ideas and concepts beyond the classroom and textbook.
- Provide students with the skills and know-how they need to conduct research in their future career life.
- Allow students to break away from the fetters imposed by the authority of the instructor in order to

pursue independent study on their own (Burkle-Young 1997).

Under normal circumstances, these projects are not expected to produce any invention or breakthrough. They are rather used to compile a well-organized set of facts and knowledge from existing literature beyond the textbook and classroom boundaries.

2. PROBLEM DESCRIPTION

Traditionally, writing a research paper is not a well-liked idea to most students and is frequently countered by the plaintive cry, "Oh no, not another paper!" (Rileigh 1993). One reason for that, among others, is the long-lived persistence of some instructors to use multiple choice tests in their classes. This practice produced over the years generations of students who can point their fingers to the right answer but cannot describe it, explain it, or write one valid sentence about it. Another reason for students' resistance to research projects is the absence of a guidance, which provides answers to many intuitive questions and issues such as: how do I conduct research? When should I start? How much time do I need? How should I divide my time? How can I put together all the different pieces of facts and knowledge? How much is too much or too little? How do I write 15 pages of good quality research paper? What should the format of that paper be?

Existing literature deals with the research issue from various viewpoints and provides some answers to these questions depending on that viewpoint. Some existing literatures look at the research project issue from the points of view of format, style, and organization of the research paper. Some literature (Berry 1971; Slade 1994; Webster 1998) focuses on the format and style of the research paper, such as titles, captions, and fonts. Others (Li 1999) suggest that a research paper consists of ten components: Title, Abstract, Keywords, Introduction, System Model, Numerical Analysis, Conclusions, References, Appendix, and Figures. In fact (Balian 1994) even proceeds a step further to address the issue of how many references are needed.

Other literature views the research issue differently by providing a list of "how to do" steps to conduct a research project. (Burkle-Young 1997), for example, suggests that research begins with selecting a topic, collecting information, analysis, synthesis, and writing. (Slade 1994), on the other hand, suggests that following steps, such as collecting information, outlining the paper, and writing the paper, is the best approach to research.

(Walker 1997) suggests choosing and narrowing a topic, collecting and studying sources, taking notes, and reporting.

(Smith 1981) presents a scientific method that consists of ten steps starting with selecting a topic and ending with writing the research report. (Balian 1994) presents what he calls the research chain, while (Farrelly 1988) suggests steps such as gather, sort, analyze, synthesize, and distill large quantities of information and communicate what is important to others. Other researchers worked on defining and detailing these steps. In fact (Watson 2001) distinguishes three types of reading: quick, close, and insight reading. (Farrelly 1988), on the other hand, distinguishes between "thinking" and "hard thinking". (Farrelly 1988) implies that "thinking" is characterized by learning from one source within a classroom setup, while "hard thinking" is characterized by:

- Acquiring new knowledge from multiple sources outside a classroom environment
- Synthesizing this knowledge with a previously learned one
- Asking critical questions about facts and ideas
- Resolving any conflicting conclusions
- Presenting a unified coherent outcome

What is lacking in the literature, however, is the recognition that research is a "Process". This process has its own defined input and output. It has distinguishable phases each of which has its own input and output. Only few existing literatures such as (Farrelly 1988; Rileigh 1993; Rabinowitz 2000) point out that research is a "process".

In fact, (Rileigh 1993) identifies research as a project consisting of 5 phases: topic/title selection, reference compilation, outline, rough draft, and final version. She also mentions concepts such as having manageable tasks deadlines, checkpoints, and feedback.

It is evident to us that there is a need to model research as a "process", identify the phases of that process, and its input/output in order to produce high quality papers, as apposed to producing useless papers generated via a mechanical routine and boring copy-and-paste. As will be shown in the next section, students would be able to produce high quality research outcomes and achieve the goals of research projects only after recognizing that research is a "process".

3. THE PROPOSED MODEL

Before introducing our proposed model, it is worthwhile to justify our insistence on identifying the research as a "process". Only if research is viewed as a "process" with very well defined phases then:

1. It can be planned just as any other project, where the various resources and times needed (such as slack time, critical time and crash time) can be exactly identified before execution. In fact a complete PERT chart can be automatically generated using tools such as Microsoft Project to plan a research project.
2. The input and output for each phase of the process can be very accurately identified and quantified.
3. The phases of the project will be executed in the right sequence.
4. The performance and productivity of each phase can be measured separately. Accordingly, the performance of each phase can be maximized and the time scheduled for that phase can be minimized. This is the only way to enable instructors to measure any improvement in productivity and performance for successive projects or when comparing various teams and projects.
5. The process can be monitored and any deviation in performance or schedule can be corrected.
6. It can be improved over time by observing "Lessons Learned" at the end of the process.

According to (Mejabi 1997), the quality of outputs are entirely dependent on the quality with which the process is executed, and excellent outcomes only result from excellent processes. The quest for process excellence using process management is the way to achieve such a goal. Process management involves the design, improvement, monitoring, and maintenance of an organization's most important processes in order to bring them up to the highest level of excellence. This approach is different from BPR in that it analyzes the dynamic interactions between the various processes. In other words, this holistic approach implies that any process should not studied in

isolation because it may have a ripple effect on another process.

The rest of this section will be dedicated to introducing our model. The model, which we have developed at our CIS department, represents a generic framework for conducting research projects. It consists of two components:

- Four-phase iterative process, shown in Figure 1, to describe research.
- Generic template, shown in Table 1, which lays out the structure of the final paper.

Each component will be explained below in detail. Figure 1 shows the four phases of the process, which are: Collect, Read, Digest, and Write. We chose to call these four phases the “CRDW process”. These are iterative sequential phases consisting of other finer processes shown below.

1. COLLECT
 - After selecting a well defined subject, determine the beginning and ending calendar years, which your research will cover (e.g. 1995-2002).
 - Use a keyword, phrase (e.g. State Transition Diagram), or author name to search for the relevant material.
 - Collect the relevant material using title or abstract as an indicator for relevancy.
2. READ
 - Quickly skim through the material.
 - Categorize and prioritize the material according to their relevancy to the target subject (irrelevant, relevant, very relevant).
 - Filter out the irrelevant material.
 - Read the relevant material in-depth and with more concentration.
 - Highlight and underline facts and important key issues then write notes.
3. DIGEST
 - Think and internalize all the material.
 - Look at the big picture and visualize all the different opinions, facts, and approaches.
 - Look for similarities and differences between the different approaches in order to group them in categories.
 - Map the material to the items in Table 1.
4. WRITE
 - For each section, shown in Table 1, provide the information indicated by each bullet in order to develop your final paper.
 - Include citations in your write-up.
 - Develop a list of references.

Each phase can be further broken down and refined depending on the very characteristics of the project. Figure 2 below shows a heuristic time distribution that we suggest for each of the four phases relative to the total time planned for the entire project. It suggests, for example, that

35% of the total time should be spent on reading existing literature while spending only 10% of the time on writing.

For our time distribution, we used Rileigh’s figures as a base, where she suggests one month for reference compilation, five weeks for rough draft, and two weeks for the final version (Rileigh 1993). We also used the time distribution for the SDLC phases suggested in (Satzinger 2000) as a guideline.

Again, viewing research as a “Process” would imply that the relative times of each phase of this process should be monitored and met. If they are not, then the whole purpose of research will be defeated. It should be emphasized that monitoring the whole project is different from monitoring its individual phases, because meeting the dead line of the whole project does not necessarily mean that each individual phase was executed within its planned time. If the actual time spent on “COLLECT” for example, exceeded its planned time, then definitely less time will be spent on the rest of the phases, such as “DIGEST” or “READ”, for the project to be completed on time. In other words, the whole project may be completed within the planned time while its individual phases took more or less than their individual planned times. Therefore, monitoring a project as a whole, without monitoring its individual phases, could be misleading.

As shown in Figure 1, the fourth step is the one, which will produce the final report. We suggest a generic template similar to the one shown in Table 1, for an average research project for an undergraduate course. The five sections of the template cover almost all aspects of average research work. In other words, the report will have the structure shown in Table 1, and students have to plug in all the information to obtain a complete final report. The items shown for each section of the report should be weaved in a sequential, logical, and understandable manner. The length of each section depends on the nature and the purpose of the subject. If the purpose of the research, for example, is to present a state-of-the-art of certain technology, then section 3 will be the longest section.

4. IMPLEMENTATION

We did not conduct a formal statistical experiment to evaluate the impact of using this framework. However, the author presented this framework to his students in CIS-3660 (Management Information Systems), CIS-3660 (Systems Analysis and Design) and CIS-4610 (Software Quality) where a research project is an essential component of these classes and asked them to apply it.

The outcome of the assessment was that 74 out of 109 students reported that the framework:

- Enabled them to better manage their research
- Emphasized the concept of a process
- Enforced their understanding of the SDLC.

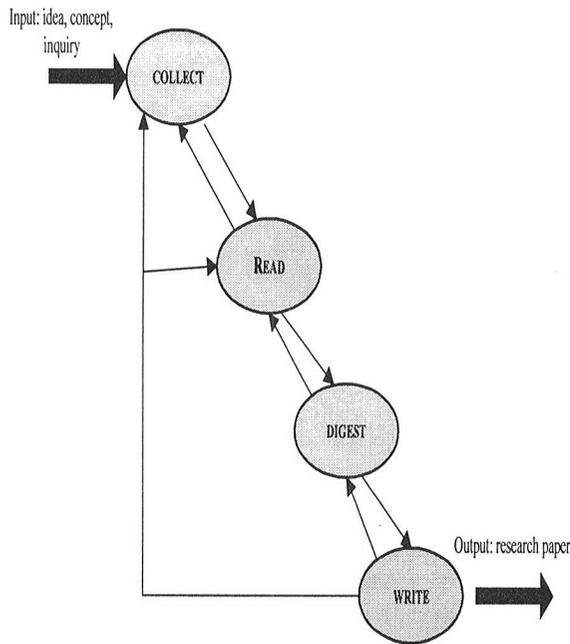


Figure 1: The CRDW Research Process

At least 70 of those 74 students indicated that they would be using the framework in future research work. However, more than 20 of these students complained that they lost some time trying to further understand the framework and implement it.

The rest of the students (35) did not like nor did they implement the framework under various claims. Some claimed that there is a long learning process involved; others did not believe that a sophisticated research tool is needed at this stage of their study.

We emphasize that no statistical experiment was conducted to measure the degree of learning, performance, and the efficiency. However, a careful examination of the papers of those students who reported using the framework shows that about 60 papers share the following four distinctive characteristics:

- Very well structured and there were no overlapping materials throughout the paper.
- No unnecessary repetition was observed.
- The materials were very well woven together and put in a reasonable logical flow.
- Quotes were cited and used very efficiently within the context of discussion, where no imposed “copy-and-paste” could be sensed.

We believe that we can claim a reasonable degree of success in our initial implementation trial. We also believe

CRDW Time Distribution

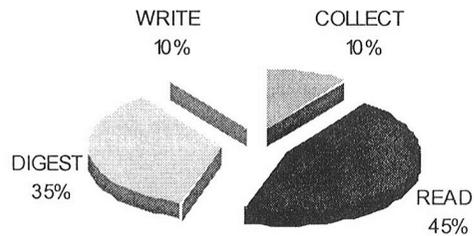


Figure 2: The CRDW relative Time Distribution

that a scientific statistical experiment is needed to benchmark the framework and address issues such as measuring the degree of learning, performance, and time efficiency in full details.

5. CONCLUSION

We believe that we have presented an adequate framework to help our students achieve the goals set for conducting research projects. It will also guide them in a systematic fashion to produce high quality worthy research papers. The framework will provide a tool to enable researchers to

1. Breakdown any research undertaking into smaller manageable phases, then develop a well-defined plan for the project and schedule its phase, where the input and deliverables or each phase are also identified.
2. Measure the productivity of each phase of the project by measuring the time spent on that phase versus its expected deliverables.
3. Monitor and correct any deviation in any phase of the project instead of carrying the problem over to the end of the process.
4. Verify that most of the total project time is spent on the "READ" and "DIGEST" phases. This will ensure that the purpose of conducting the research is accomplished.
5. Implement incremental improvement approach to maximize time efficiency and learning, which can then be used as a benchmark for similar future research projects.

Generic Template for a Research Paper	
1. Introduction	<ul style="list-style-type: none"> ▪ Define in some details the problem or the subject under consideration. ▪ Explain why this problem or subject is important to Explore or write about. ▪ List the benefits of solving or exploring the subject.
2. Historical Background	<ul style="list-style-type: none"> ▪ Write in separate paragraphs and in chronological order all the different phases of how the problem/subject evolved.
3. Current Approaches	<ul style="list-style-type: none"> ▪ List the different current approaches to the subject/problem. ▪ Write a separate paragraph for each approach containing: <ol style="list-style-type: none"> I. Its full detailed description (with figures and tables) including tools used, if any II. Domain of application III. Advantages IV. Disadvantages and shortcomings ▪ Develop a matrix, whenever possible, to summarize the differences and similarities among the various approaches to the problem/subject.
4. Conclusion	<ul style="list-style-type: none"> ▪ Is the subject/problem worth the attention? Why? ▪ Is the subject given enough attention? Why? ▪ Are the different approaches adequate? Why? ▪ Is more research necessary? Why?
5. References	<ul style="list-style-type: none"> ▪ List all the references which you have cited in your write-up following certain citation style such as the APA or MLA.

Table 1: A Generic Template for a Research Project

In fact, we think that it is very intuitive and beneficial to CIS/CS/MIS students to view research as a process for the reasons mentioned earlier. Drawing analogy between the SDLC and the CRDW is also beneficial because it will:

- Deepen the concept of a process by showing that both research and software development can be viewed as a process
- Enforce the discipline of decomposing any problem/system into finer processes in order to gain insight and detailed understanding.

We consider that this framework can also be used for graduate research with a little or no modification. However, in order to enjoy the full extent of success of the framework we suggest:

- Promoting and fostering, across the curriculum, a comprehensive culture of essay type of tests and in-class discussion. This will, over time, reduce the accumulated defects done to students' skills caused by the practice of multiple-choice culture. Our framework alone does not guarantee good writing skills.
- Fully exploring and teaching the framework as part of a generic "Critical Thinking" course.

We re-iterate what was mentioned in the previous section that our work needs a formal detailed empirical work to further support our current findings. This may be the subject of future research.

6. REFERENCES

- Balian, Edward (1994), *The Graduate Research Guidebook, A Practical Approach to Doctoral/Masters Research Papers*, University Press of America, Lanham.
- Berry, Dorothea and Martin, Gordon (1971), *A Guide to Writing Research Papers*, McGraw-Hill Company, New York.
- Burkle-Young, Francis and Maley, Sandra (1997), *The Research Guide for the Digital Age, A New Handbook to Research and Writing for the Serious Student*, University Press of America, Lanham.
- Farrelly, James and Murphy, Lorraine (1988), *A Practical Guide to Research Papers*, Harcourt Brace Jovanovich Publishers, San Diego.
- Li, Victor (1999), "Hints on Writing Technical papers and Making Presentations", *IEEE Transaction on Education*, Vol. 42, No. 2, pp. 134-137.
- Mejabi, O., and Black, John [1997], *Process Management: the new frontier for Continuous Improvement and Total Quality*, Simplex systems, Inc. White Paper, Retrieved January 4, 2003, from <http://www.simplexsystems.com/ProcessMgt.htm>.
- Rabinowitz, Celia (2000), "Working in Vacuum, A Study of the Literature of Student Research and Writing", *Research Strategies*, Vol. 17, No. 1, pp. 337-346.
- Rileigh, Kathryn (1993), "Towards a Palatable Research paper Experience", *Innovative Higher Education*, Vol. 18, No. 2, pp. 123-131.
- Slade, Carole, Campbell, William and Ballou, Stephen (1994), *Form and Style, Research*

- Papers, Reports, Theses, Houghton Mifflin Company, Boston.
- Smith, Charles (1981), *A Guide to Business Research, Developing, Conducting, and Writing Research Projects*, Nelson-Hall, Chicago.
- Satzinger, John, Jackson, Robert and Burd, Stephen (2000), *Systems Analysis and Design in a Changing World*, Course Technology, Cambridge.
- Walker, Melissa (1997), *Writing Research Papers, A Norton Guide*, Norton & Company, New York.
- Watson, Jinx (2001), "Making Sense of the Stories of Experience, Methodology for Research and Teaching", *Journal of Education for Library and Information Science*, Vol. 42, No. 2, pp. 137-148.
- Webster, William (1998), *21 Models for Developing and Writing Theses, Dissertations and Projects*, Academic Scholarwrite, San Ramon.

7. ABBREVIATION LIST

- AACSB: Association to Advance Collegiate Schools of Business
- APA: American Psychological Association
- BPR: Business Process Reengineering
- CIS: Computer Information Systems
- CS: Computer Science
- MIS: Management Information Systems
- MLA: Modern Language Association
- PERT: Program Evaluation and Review Techniques
- SDLC: System Development Life Cycle

AUTHOR BIOGRAPHY

Yousif Mustafa received a Ph. D. in Industrial and Manufacturing Engineering in 1998, and a M.S. in Industrial and Manufacturing Engineering in 1993 from Wayne State University, Detroit, MI. Dr. Mustafa is currently an associate professor of Computer Information Systems at the School of Business of West Liberty State College, West Liberty, West Virginia, USA.

