Improving Technical Writing through Professional Expression Exercises in a Computer Science Graduate Program

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Abstract—Building quality programs based on workforce skills, such as technical writing, is considered an effective means for recruitment and retention in higher education, especially in the areas of science, technology, engineering and math. In computer science, technical writing can be especially challenging due to the complexity of technical documents. This work incorporated the use of professional expression activities in the computer science graduate curriculum at Nova Southeastern University. Additionally, the results support continual building of the quality of the Master of Science in Computer Science and technical writing in the discipline.

Keywords: Computer Science, Technical Writing, and Professional Expression

I. INTRODUCTION

Writing is the most common form of scientific communication, yet many professors complain that graduate students are too often poor writers. Scientific writing is assumed and not really taught, however, stronger writing skills benefit educational pursuits and science careers. Therefore, the ability to write good scientific articles is a skill necessary to disseminate ideas to the scientific community. Kroll, Schulze & Kern (2014) discuss the importance of reinforcing discourse analysis, which in scientific writing is important because it is taking language beyond the level of a sentence [1]. The value of discourse analysis is that it takes into account context, information extraction, claims and hypotheses, and the identification of methods and protocols.

Professional expression that incorporates technical writing and critical thinking is a necessary skill for STEM careers, particularly in computer science. The literature effectively supports this concept:

“In the STEM fields, the single most important thing we do to teach our students better communication skills is to teach them how to write a lab report. The reason a lab report is so important is not just because it is the end product of a research project, but because each section of a lab report has particular function that often correlates with different types of communication that a STEM professional needs to use” [2].

Many employers share that new employees often require remediation. According to the survey, Are They Really Ready to Work? Employers’ Perspectives on the Basic Knowledge and Applied Skills of New Entrants to the 21st Century U.S. Workforce, only 23.9 percent report that new entrants with four-year college degrees have “excellent” basic knowledge and applied skills [3]. Additionally, employers noted new hires exhibited significant deficiencies in written and oral communication skills.

Computer science is a challenging area of study in many respects but the difficulty is often due to poor writing skills, not the concepts in the assignments. This work found that scientific writing infusion into a computer science course improved the comprehension of the concepts as well as the writing. For sustainable success in both industry and research, scientific writing, that we term “professional expression” is equally important to technical knowledge.

The implications for computer science educators are to create graduates who are more agile graduates. Higher education must be connected to research and industry and realize that professional expression, defined as the ability to take technical knowledge and articulate it to a particular audience, is the main ingredient in graduate
education. Professional expression combines scientific writing and critical thinking with computer science content. This further prepares future graduates in a workforce where they will move across different jobs and sectors. Workforce agility supported through professional expression in the curriculum provides an added benefit to graduate education in computer science. The diagram below indicates the necessary relationship among higher education, research, and industry to provide a workforce ready curriculum.

Diagram 1

II. PROFESSIONAL EXPRESSION INFUSION

Working with data collected for the M.S. in Computer Science, the faculty measured the impact of professional expression exercises on improvement in final course products. The standard for measure was the quality of writing (grammar, word selection, clarity, organization, and smoothly flowing discussion), and understanding of the content (accuracy, analysis, and synthesis) related to a chosen focus within the assigned topic area. The intent was to develop a deeper understanding of the content by being able to explain and defend their thoughts and solutions.

The Computer Science faculty evaluated the work through three to four short professional expression exercises. This paper reports on the outcomes and includes a discussion of the rationale for incorporating short feedback intensive exercises early in a course. The findings clearly show the linkages between the improvement in final student products and performances. These professional expression exercises complemented multiple design/coding assignments along with a major research project. The professional expression work was evaluated per individual then discussed as a group in a classroom setting and in asynchronous online discussions. Research supports that teaching experiences have a positive impact on the participants’ ability to generate testable hypotheses, create valuable research designs, and write research proposals. [4][5].

The writing assignments were designed to provide early feedback, get writing sample baselines, and build a focus on writing for the content area to better express understanding of the material. The emphasis is on both problem-solving and expression of the solution. Examples of the exercises are found in the table below.

Table 1

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<th>Example 1</th>
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<td>Answer the following:</td>
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<td>Two computer science (CS) professionals are having a heated debate. CS professional A believes that all systems and applications must provide for an abstraction from the details of the implementation and CS professional B is an advocate of exposing the details. Provide a detailed account (support your claims) of your view.</td>
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<th>Example 2</th>
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<td>Address the following and be prepared to extend the discussion into a larger group.</td>
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<tr>
<td>As a developer in a research and development department of a startup company that provides web hosted applications, you are asked to support the advantages and disadvantages of using an open-source operating system in your production environment. Provide a brief and supported explanation of your thoughts.</td>
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<th>Example 3</th>
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<td>You work for an IT department that supports a company that manufactures, markets, and sells toys. Additionally, the company’s website provides web applications including games and shopping. While having a conversation with a fellow IT professional, it was mentioned you should read the following:</td>
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<tr>
<td>The next day you are asked by your manager to give a brief but informative paper on the value of DevOps in your IT department.</td>
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III. PROFESSIONAL EXPRESSION RESULTS

The overall results of infusion of professional expression in the M.S. in Computer Science led to an
improvement in the written quality of coursework as well as the ability to better articulate solutions and outcomes. In organized design documents, it was noted that students were better able to connect each part of the document to the entire product while showing how each section stands on its own merit. In our experience, the feedback early in the course translated into a decreased repeat of errors from each assignment. Overall there was a decrease in cases of just pointing to literature rather than synthesizing and relating it to the topic at hand. Additionally, the professional expression exercises heightened the learning experience by engaging students in using feedback in a meaningful manner and increased student engagement. The feedback served two important purposes. First, the instructor gains early insight on the student content base and writing ability. Second, the student is provided with feedback to take ownership in their learning and continual improvement. To this end, faculty should be discussing ways to add flexibility to their computer science curriculum to better address the needs of the workforce. By designing a curriculum that promotes critical skills for success we can produce greater researchers and industry leaders in the field of computer science.

IV. ACTIONS FOR IMPROVING PROFESSIONAL EXPRESSION

Proficiency in a topic area does not necessarily imply that knowledge can be clearly articulated in written or verbal communication. At the graduate level, just giving an example of what is good and bad is not adequate to support quality work. Professional expression exercises with feedback early on and in short turnaround timelines is necessary to provide a continual improvement model throughout the course. Going through these early agile professional expression experiences provide a clearer understanding of expectations and identification of common errors. Additionally, this iterative approach provided a mechanism for improvement within content areas, reinforcing that it is not just what is presented in a communication but how it is composed. This type of articulation in a scientific communication addresses current professional employment requirements by incorporating real-life skills into the classroom.

V. IMPLICATIONS OF THE FINDINGS

There is a lack of literature that provides a conceptual framework for increasing the writing skills for graduate students in computer science and related fields. Additional research on professional expression in the curriculum and preparation for graduate level coursework may lead to practices for graduate-level preparation and may be useful in upper-level undergraduate coursework. Research on scientific writing conducted in the computer science classroom has been limited and not been given enough attention. Thus to improve research and workforce preparation an emphasis on purposeful studies in graduate programs are needed to further emphasize and document effective scientific writing practices across technology disciplines.

REFERENCES