Work in Progress: The Use of Scaffolding and Peer Reviews to Improve Effective Writing Skills in Biomedical Engineers

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Dr. Simpson received her B.S. in Biochemistry from Clemson University. Her doctoral research focused on developing cell therapy treatments for vascular calcification. Her research interests were in targeted therapies and she strengthened her polymer expertise during her postdoctoral training at Rice University. Her postdoctoral work focused on injectable gene therapy for bone grafting. As an independent researcher, her work is focused on vascular calcification and related co-morbidities including end stage renal disease. She is developing therapies to maintain serum mineral balance in kidney disease patients and to prevent vascular calcification. She is also focused on understanding the phenomenon of phenotypic switching of native smooth muscle cells into osteoblast-like cells in calcified arteries and developing intervention therapies to prevent this switch. She began her faculty position at Mississippi State University in 2013. Dr. Simpson is dedicated to enhancing the educational experience of her students. She strives to provide the most holistic classroom environment. Dr. Simpson is beginning to develop her education research endeavors.

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The Use of Scaffolding and Peer-Reviews to Improve Effective Writing Skills in Biomedical Engineers
**Introduction:** Technical knowledge among engineering graduates is at an all time high, however those same graduates lack interpersonal and social skills that would be required in present-day job settings [1]. Some of the skills that these graduates lack are effective communication and teamwork, both skills being of high value and importance in a job setting for engineers that have to work closely and collaboratively with fellow co-workers [1]. While technical expertise and knowledge have profound impacts on the skills employers look for when hiring graduates, recently employers have started emphasizing the importance of skills such as integrity, communication, and flexibility. The emergence of these skills is a result of the economic shift from an industrial to an information society [2]. This means that there is a need to further emphasize these kinds of skills early in higher education curricula so that students can grasp the importance of these skills in the beginning of their academic career and long before starting their professional career [2]. In an effort to train senior biomedical engineering students to be more effective writers we adopted a two-stage approach that began with first training the professors to effectively teach students to be better writers (Maroon Institute for Writing Excellence) then employing two strategies: Writing-to-Learn and “Scaffolding” Writing in the course to develop our students into effective writers (Figure 1).

![Figure 1. Flowchart of Intervention to Improve Effective Writing Skills](image)

**Maroon Institute for Writing Excellence:** Strong written communication skills are essential for college graduates, regardless of their discipline. Mississippi State University (MSU) has highlighted the importance of written communication in both its primary student learning outcomes and its Maroon & Write Quality Enhancement Program (QEP). This five-year long QEP was designed in accordance with Southern Association of Colleges and Schools Commission on Colleges (SACSCOC) accreditation standards and focuses on improving writing across the curriculum. One major initiative of the QEP is faculty training through a professional development program called the Maroon Institute for Writing Excellence (MIWE), which is a three-week long course that faculty members apply to and attend at the end of the spring semester. The course provides faculty with pedagogy and theory in teaching writing and guidance in revising a specific course to include effective writing assignments. During the
following academic year, faculty teach their revised course, which includes at least one formal writing assignment that uses a scaffolding approach.

Faculty members in MIWE get a primer on various teaching pedagogies and spend time writing, responding to, and discussing writing in the course. By engaging with literature ranging from Paulo Freire to John Bean to Kathleen Yancey, faculty are encouraged to think about innovative ways writing can be implemented in their courses. The writing exercises faculty participate in after reading articles follow the same strategies they can use in their own courses; so faculty members experience first-hand the types of writing they implement in their courses. Also, several of the readings offer practical guidance for incorporating and assessing student writing assignments. The second half of the MIWE course is largely focused on allowing faculty members to revise the class they intend to teach MIWE-style. They revise the syllabus and design at least one formal writing assignment that will be added to the course work.

Throughout the MIWE course, faculty are encouraged to view writing as process rather than product; this places more emphasis on the learning that happens during and as a result of writing rather than on the grade that a given writing assignment receives. When students approach writing this way, they focus more on the content than the correctness of the writing—and so does the teacher.

There are several forms of writing that reinforce the idea of writing as process, including journaling, free-writing, and drafts. Implementation can occur in class or out of class, and this flexibility makes it possible to integrate writing in classes that may not seem like obvious fits (e.g., math courses). During MIWE, faculty members get experience using many of these strategies, which gives them a clear idea of what strategies can be used most effectively in their own courses.

In addition to getting guidance during the MIWE course, each MIWE faculty member works with a QEP writing coordinator who acts as a consultant during MIWE and while the designated course is being taught. The writing coordinators offer guidance in assignment design and implementation, rubric design, general writing instruction, and assessment. They can also assist in the classroom, by giving lectures on writing and facilitating in-class writing exercises.

**Writing-to-Learn:** Traditional writing has become associated with grammatical correctness and style and isolated from critical thinking. According to Bean, when writing is looked at in this way it becomes just a learned skill through repeated grammar drills [3]. The cost of this type of perception is that writing gets disconnected from the writer’s actual thoughts resulting in a curriculum lacking critical thinking. Therefore, it is important for teachers to understand that writing should be taught as a process of critical thinking.

Writing and critical thinking are connected in ways that mutually reinforce each other. According to the Framework for Success in Postsecondary Writing, “[w]riters use critical writing and reading to develop and represent the processes and products of their critical thinking” [5]. Not only is critical thinking measurable through writing assignments, but writing forces students to consider ideas, problems, texts, and their assumptions in ways that allow them to “move past obvious or surface-level interpretations” [5]. If students are able to think critically
as they write, their written communication will be more likely to be clear and of substantive nature.

“Scaffolding” Writing: Typically in the classroom setting, a course is oriented around one major writing assignment, either a research paper or something similar. These assignments often require the student to perform some type of preliminary research to aid in developing a succinct and sound argument for the reader to follow. Often, this research can be aided by what Bean describes as “scaffolding” writing assignments [3]. The term refers to the creation of a foundation or baseline to begin building on, and similarly to scaffolding on a building, these types of writing assignments create a baseline for the student to form their argument around.

Scaffolding engages the student with the topic early enough so that a more cohesive thesis can be formulated. Often with undergraduates, and many writers in general, the most difficult and debilitating part of a writing assignment can be taking a persuasive stance and building a paper or piece with the power to change the reader’s mind. Scaffolding can be categorized as pre-writing, the first stage of the three stage writing process, which is then followed by writing and rewriting. According to Murray, the prewriting stage can commonly take up to 85% of the total time spent on the assignment [4]. In addition to strengthening students’ writing, the emphasis on writing as process also has positive impacts on content learning [4]. Using this scaffolding skill in engineering classes would provide an effective mechanism to train students to become better writers, but also better communicators in general. It stimulates more contact between student and instructor, allowing feedback and revisions to strengthen their skills.

Assignment Redesign: In addition to doing the kinds of writing they will require of their students, faculty members spend time in MIWE developing fully-formed writing assignments or revising existing assignments. Redesign of this course assignment was largely based on Vygotsky’s Zone of Proximal Development theory [6]. A once month-long timeframe to complete a group research proposal is now broken into two individual assignments prior to peer review and a compiled group research proposal. The timeline for redesigned assignment shown in Figure 2. Scaffolding of the assignment and requiring independent work before the peer review and group assignment allows for individual accountability within the framework of Vygotsky’s theory. This allows for students to develop within his or her own unique zone of proximal development [6]. The peer review and final group research proposal affirms the fourth basic element of Vygotsky’s theory small-group and interpersonal skills. This allows for students to achieve upper limit cognitive growth based on the zone of proximal development theory [6]. The scaffolding approach to the Biomedical Materials (ABE 4523) course was to include drafts and peer review sessions leading up to the final research proposal.

<table>
<thead>
<tr>
<th>Problem Statement Given</th>
<th>Individual Draft Idea Due</th>
<th>Individual Mini-Proposal Due</th>
<th>Peer Review</th>
<th>Group Research Proposal Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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Figure 2. Timeline of Scaffolded Writing Assignments.
Methods: This study includes 45 undergraduate students enrolled in two sections of Biomedical Materials (ABE 4523). Each section of the course included primarily senior undergraduate students. Student data were collected from individual writing assignments and the final group assignments. The students’ proposals were evaluated using rubrics that measured the background and introduction, presentation of the proposal solution or hypothesis, use of evident, evaluation of the solution, organization, and articulation of ideas.

At the end of the semester, the writing coordinator held focus groups in each section during the regular class time. At the beginning of the group, students were given 10 minutes to briefly write about (1) the writing they completed in the course and (2) what they would change about the writing process. After the 10 minute writing period, the writing coordinator asked them questions about the implementation of writing in the course while a graduate student took note of the student responses. Audio recordings were made of the discussion, and all students were made aware of the study and were allowed to leave if they did not wish to participate.

Qualitative assessments of the student work and the implementation of the writing components were collected from graders in the QEP. The QEP graders are instructors and lecturers from the English department who work part-time evaluating QEP writing samples. They hold Masters degree in English and teach composition and other writing classes Validated scores for the students’ individual writing assignments are not available at this time. This work has been reviewed and approved by Mississippi State University Institutional Review Board.

Findings: Student data from the writing assignments are still being processed and evaluated. However, the QEP graders have provided us with some qualitative assessments of the student work in general. Overall, the explanations of the proposed solutions were often clear and detailed; although, the connection between the solution and need for the solution was often not defined sufficiently. One grader explained that it seemed as though “students missed the key linkage of ideas that is important to fully understanding what a document is trying to say. The lack of a clear conclusion to the proposals was also a common issue. The graders reported finding that many of the proposals either lacked a clear conclusion or had a perfunctory conclusion attached to the end of the assignment.

The focus groups were conducted in both sections of the ABE 4523 course to determine what student thought was effective and what could be improved about how writing was implemented in the course. Two main themes consistently emerged in the focus groups. First, students felt like the schedule of deliverables could allow for more time between iterations, and second, the scaffold structure for the writing assignments was helpful in allowing them to fully form their ideas and create effective proposals. The written responses from the focus groups were based on two questions: (1) describe the writing you did in the course and (2) what would you change about the writing process for this course? The responses were coded thematically by those related to the scaffold structure of the assignments and those related to the writing process.

Based on the 45 students’ written responses at the beginning of the focus groups, almost a third (29%; n=13) of the students felt that they either needed more time between drafts to be able to
develop quality writing or the writing process needed to start earlier in the course. Students said the turn around times for different iterations of the scaffolded project were too quick to make meaningful changes. Another common response was that the scaffold structure (aside from the timing) was a good way for them to come up with ideas and revise their writing (16%; n=7).

Figure 3. While some students (29%) felt they needed more time between drafts, 16% found the draft process to be helpful.

29% (13) - More time needed between drafts/start writing process earlier in semester
16% (7) - Draft process was helpful
8% (4) - Combining separate mini-proposals was difficult
2% (1) - More class time to work on proposals/guidance on research

The three most common issues that came up in the focus group discussions were (1) scaffolding the writing assignments made the process easier, (2) peer review was not helpful, and (3) more feedback on drafts would be helpful.

**Future Work**: Based on the feedback we received, we are considering changes to the course to try to ensure the students have a clear understanding of the assignment requirements. Since the conclusion aspect of the proposals was a common issue, changes may be made to add more explicit details in the assignment description so students have written instructions that indicate conclusions are necessary. Devoting some class time to a discussion of the structure of the proposal could also be beneficial. While all the students in the course clearly understood the importance of the proposals they wrote, it could be helpful to discuss communicating that importance to the audience so it is relevant to an audience that may not be peers or colleagues.
References: