

# Writing in the Biomedical Engineering Discipline

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## **Abstract**

As the movement of “writing in the disciplines” continues to advance in the university curriculum, anticipation increases for students to publish their own research material. However, there is a stark contrast between the genre of student writing and research journal articles. This project will evaluate the process that is required to construct a published research article. This includes defining the genre and discourse community that the biomedical engineering field uses to transform what is now a Biomedical Engineering Master's thesis into a potential journal article. This project aims to clearly construct this process using a variety of rhetorical strategies and to provide insight into the question: why can't a graduate/undergraduate student just write their own journal article?

## **Acknowledgements**

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## **Introduction**

### **1. Origins of Academic Writing**

In order to understand the current university-wide approaches towards student writing, there must be a review of the historical strategies that universities employed. Before the 1950's, writing-specific classes were not mandatory for American universities and disciplines were expected to

incorporate writing literacy within previously established courses (McLeod & Soven, 2000). A majority of professions immediately required a strong skill set of oral communication and presentation rather than writing, which created a deficit of intensive writing skills among collegiate students. As time passed this, deficit had spread on a massive scale to the point in which it could no longer be ignored by the public nor professional corporations (Bazerman et al., 2005).

Sensing the uneasiness of several prominent organizations, many universities had employed mandatory writing-based enrollment exams in the late 1870's. Unsurprisingly, nearly 50% of students from private secondary institutions had failed these exams, which pushed these schools to begin the incorporation of several English-based courses (literature, grammar, etc). In order to supplement this, universities had also begun to create opportunities to enhance student writing. However, this was often limited to a single introductory course of English Composition & Literature, thus placing the responsibility of student writing within an English-discipline specific course (Bazerman et al., 2005).

Alvin Eurich (President of the University of Minnesota) presented the institution's own investigation on student writing in the National Council of Teachers in English (NCTE). This study found that writing skills did not improve before and after the required freshman composition courses were taken, suggesting that even literature courses did not improve the deficit of student writing. Eurich suggested that English and discipline-specific professors should create specific writing assignments together, encouraging a Writing Across the Curriculum (WAC) approach. However, with the strain of World War II looming over the United States, further movement towards changes in student writing weakened (Bazerman et al., 2005). It was not until James

Britton (Durst & Newell, 1989) promoted the pedagogical notion that writing should be a “tool of self expression”. Students should use writing as an activity to discover and transform their own thoughts so that they become active participants within their own discipline and ‘shape new [literacy] information into familiar [discipline-specific] knowledge’ (McLeod & Soven, 2000).

### 1.1 Writing Across the Curriculum (WAC)

The WAC movement was pioneered by James Britton, however, it would take several decades for reform to be present in over 50% of universities in the United States in 1988 (McLeod & Soven, 2000). Initially, WAC consisted of what Britton identified as “three functional types of writing: *transactional*, for communicating information; *poetic*, for creating beautiful objects; and *expressive*, for exploring and reflecting upon ideas” (Bazerman et al., 2005). A larger emphasis was placed upon the ‘expressiveness’ of student writing and students were encouraged to use informal writing as a form of self-discovery to enhance writing literacy. However, this aspect of WAC alone did not address the issue of students’ inability to write within their professional discipline. Therefore, WAC had transformed into “a comprehensive [and continuum] program that...encourages ‘writing to learn’ and ‘learning to write’ in all disciplines.” (McLeod & Soven, 2000). As a continuum, WAC covers a wide spectrum of pedagogical genres and as the traditional WAC approach (as stated by Britton) lies on one end of the spectrum, a discipline-specific writing lied on the other. McLeod and Soven (2000) argued that this additional rhetorical approach, writing in the disciplines (WID), focused to “understand what writing actually occurs in the different disciplinary areas” and encourages students to transitioning from the informal student writing genre into a professional genre of interest.

## 2. Understanding Genre in Rhetorical Writing

Before WID can be discussed further, there must be a clarification of what is meant by the term ‘genre’ and its role as a “conventional category of discourse” within a specific community (Bazerman et al., 2000). As described earlier, collegiate students were found to lack the writing skills necessary to effectively contribute in the profession of their studies (Bazerman et al., 2000). With the writing strategies that WAC provides, students would better assimilate within their own discipline-specific professional community upon graduation. However, how exactly can their contribution be measured? What defines the professional community they are a part of? How does genre play a role in student writing? Before answering these questions, there must be an analysis of what a “discourse community” is.

### 2.1 Discourse Communities

Upon graduation, a collegiate student is expected to move forward and join a professional community that incorporates the discipline-specific skills they learned. This professional community can be identified as a “discourse community” given that it generally follows six characteristics suggested by Swales (1990). Using the anthropological example of a scientific community introduced from Latour (1979) in *Laboratory Life*, a brief overview of what constitutes a discourse community will be made.

1. *Has a broadly agreed set of common public goals*

When considering a common group of research scientists within a laboratory, its goals can be readily identified either through its mission statement or simply speaking to any member. Generally, professional organizations try to acquire significant results, publish/promote a product,

and establish funds to retain its foundation. In Latour's observations of laboratory researchers, a member had previously found strong evidence for the presence of a new protein and published a widely applauded research article. To retain credibility and funding for the laboratory, a shift of resources was made so that more experiments could be made concerning this protein. Even those involved in different laboratories had changed their research goals, upon agreement of the strong evidence provided.

*2. Has a mechanism of intercommunication among its members*

A key factor is that intercommunication does not necessarily require members of a particular discourse community to directly communicate with one another. For example, Latour had noticed that in order to prepare a research article, there are separate offices and departments that the original raw data will pass through to be edited and refined. Even researchers from separate facilities and different countries will comment (peer review) on the product so that it may be published. While many of these contributors (e.g. scientists and technical writers) do not necessarily meet face to face, channels of communication are established throughout the discourse community.

*3. Uses its participatory mechanisms primarily to provide information and feedback*

This type of mechanism is essential to establish a consistent workflow and evolution of a discourse community. In the case of professional communities, this can often be done through a weekly newsletters, scientific journal issues, and other forms of accessible documents. In the case of Latour, this is done through the research article feedback loop briefly mentioned in the previous section. With peer-reviewed commentary, journal articles can be readily reviewed and published in journal subscriptions for a specific discipline. This laboratory not only focuses on generating

journal articles for publication but also takes a strong lead on providing feedback for any related articles that may be related to their research.

*4. Utilizes and possesses one or more genres*

The definition of genre will be explained in detail later in this report, however, it “is how things get done [in a discourse community], when language is used to accomplish them” (Martin, 1985). Using the Latour example, the main genre that the community possesses is the genre of the research article. Both those in “wet lab and dry lab” (scientists and office workers) utilize this genre to create their own journal articles and in order to move forward in research, journal articles must be continuously produced in a similar fashion to efficiently communicate within a discourse community.

*5. Has acquired some specific lexis*

A common characteristic of a discourse community that can often be identified by “outsiders” is the specialized language that the community uses to accomplish the previous characteristics. This lexical text could range from discipline-specific terminology such as “telomere-binding protein (TRF)” and “spin-column endo-free centrifuge protocol” to specialized abbreviations and acronyms (Swales, 1990, pg. 26). Due to the fact that this range can narrow according to the discourse community, it is often the first obstacle that “outsiders” and newer members would have to face when trying to understand and join the community.

*6. Has a threshold level of members with a suitable degree of relevant content and discorsal expertise*

A discourse community cannot be comprised of only experts, for this would only stale the continuous growth that the community will survive upon as new goals are achieved and proposed. Swales (1990) describes this membership as “individuals enter as apprentices and leave by death



or in other less involuntarily ways.” (pg. 27). Throughout their collegiate career, students begin to acquire the necessary knowledge required to begin their memberships and grow their expertise to become senior members.

However, what can students do to increase their discourse expertise? How does the historical example of a lack of writing affect a student’s development in these organizations? As previously mentioned, a ‘genre’ is a major tool of a community to maintain a stable means of communication, development, and publicity. But how can students utilize a rhetorical concept?

## [2.2 Defining a Genre and its Social Action](#)

Now that a discourse community has been established, there must be a reviewal of the components that comprise a genre and how it can be utilized within a ‘profession’. Commonly, the term ‘genre’ is used to categorize a variety of topics and concepts that have no physical presence. Miller (1984) argued, that the “[previous] taxonomy definition limits the usability of genre for a particular community to claim as its own”. Instead, “genres change, evolve, and decay” (pg. 163) over time within a community that claims conventional use over it. Especially within an evolving scientific research community, the genres associated with this community will evolve alongside it. This presents the obstacle of being able to provide a pathway for students to become a part of the discourse community through an accurate rhetorical analysis of the genre of a Biomedical Engineering research article..

## **Project overview:**

The aim of this project is to produce an artifact similar to a published research article in the disciplinary field of Biomedical Engineering. This will be done by utilizing various rhetorical strategies. As stated earlier, there are several key differences between student writing and professional writing. By identifying these characteristics, it will not only be possible to establish the genre of a BME research article, but to also equip students with the ability to enhance their own writing. Also, it will be possible to transform a Biomedical Engineering Master's thesis (Makridakis, J. L., 2010) into a proposed research article. Below is the three major points that this project will cover:

1. How student writing differs from professional writing in a BME research article
2. Rhetorical analysis of a reference BME research article
3. Production of a research article for Biomedical Engineering

### **3.1 Genre of the Research Article**

As Fahnestock (1998) mentioned, it is imperative for science communication to be uniform in order for discourse to occur between different discourse communities (e.g. student vs. professional). In the case of the research article, the discourse community is often comprised of highly credentialed members. Therefore, it is evident that the genre of the research article will differ in complexity, as the “research article is anything but simple” (Swales, 1990). Before describing the general characteristics associated with a BME research article, it is imperative to discuss that depending on the scientific community in question (e.g. Tissue Engineering vs.

Molecular Engineering), there will be different characteristics associated with those research articles. Identifying these characteristics will be included in the *Findings* section noted below.

## Methods

### 1. CARS Method (Introduction)

Swales (1990, pg. 141) provided a detailed model to track rhetorical movements in the introduction of a general research article. A table of this model can be seen below alongside descriptions of each step that is used to fulfill the purpose of the moves. The three major moves that comprises this model is 1. Establishing a territory. 2. Establishing a niche. 3. Occupying the niche.

**Table 1: CARS Method Move and subtypes.** Below is a description of each rhetorical move type introduced by Swales.

Move Type	Description
<i>Move 1: Establishing a territory</i>	
1-1 Claiming Centrality	Acknowledgement of well-research concepts/facts (e.g. Type 5 facts)
1-2 Making Topic Generalizations	Generalization of knowledge, practice and phenomena
1-3 Reviewing items of previous research	Reference of others within the discourse community
<i>Move 2: Establishing a niche</i>	
2-1A Counter claiming	Acknowledgement of presented claims within the research community, but directly argues against it
2-1B Indicating a gap	Usage of subtle terms (e.g. ‘however’, ‘is limited to’) in order to indicate a gap in the research
2-1C Questioning raising	Statements that indicate a possible miscalculation (e.g. ‘it seems’)
2-1D Continuing a tradition	Expectations and goals of discourse community not yet met (e.g. ‘it is of interest’)
<i>Move 3: Occupying a niche</i>	

3-1A Outlining purpose	Claims such as “in order to” utilized to describe hypothesis
3-1B Announcing present research	Description of the methodology in the current study
3-2 Announcing principal findings	Description of the results in the current study
3-3 Indicating RA structure	Summary of the sections included within the current study

## 2. Textual Connotation

One rhetorical strategy that Latour (1979) employed during their own analysis of the construction of a fact was to create stages of validity. Type 5 facts are considered taken-for-granted facts (part of the ‘mythology’ that scientists revere) and its rationale is left unexplained as members of the discourse community widely accept it as a belief. Type 4 facts are similar to this, however they do require a brief explanation. Type 3 facts contain modalities (inclusion of a reference) and are more often claims than facts. The strength of this fact relies on the reference used within the published work. Type 2 facts contain modalities which focus on the general availability of evidence (e.g. “However it seems unlikely...”). Type 1 facts are classified as speculations. Using this classification system will be helpful not only in the analysis of the reference research article but also to assist in the transformation of one fact type to another in the final product.

## 3. Referenced BME RA

In order to produce a BME research article, the particular BME-associated characteristics will be derived from a reference article. The article chosen is *Crosslinking of discrete self-assembled collagen threads: Effects on mechanical strength and cell-matrix interactions* (Cornwell et al., 2005). This article was chosen due to the fact that it is an accepted submission from the same

research laboratory of the master's thesis, it utilized similar methodologies and background information, and this enables a “quick and dirty” rhetorical analysis (Swales, 1990).

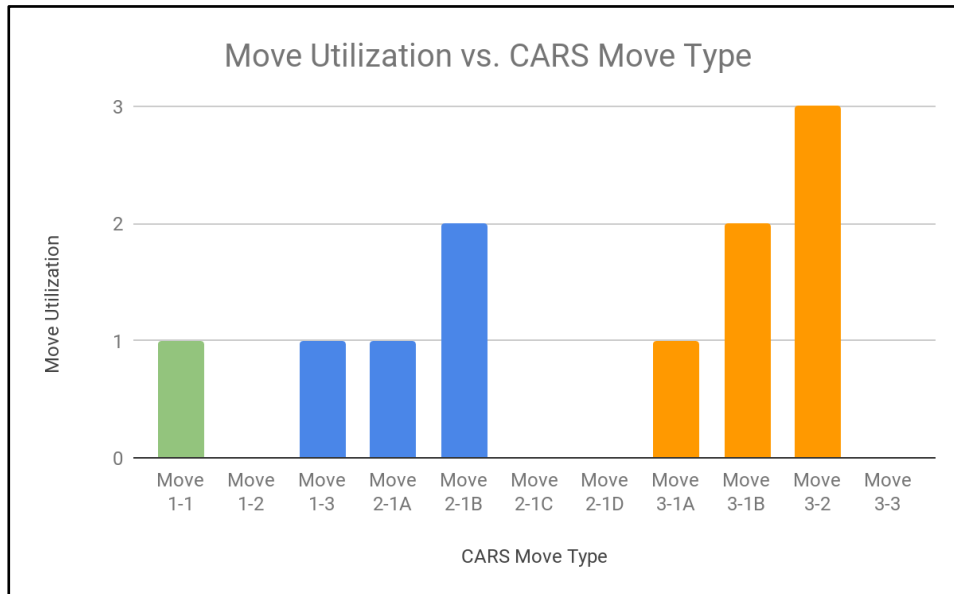
## Findings

### 1. Trends in the BME RA

Within the master's thesis, chapters 2 and 3 ('Background' & Hypothesis and Specific aims) were completely removed from the proposed research article. Chapter 2 reiterated the main claims found within the abstract and introduction. This chapter also reiterated the key points and rationale of the methodology used for the project experiments, which is not common in the BME discourse community. Chapter 3 consists of mainly Type 5 and Type 4 statements (Latour, 1979), which are assumed to be already known by members of the BME discourse community (e.g. introduction to skeletal muscles, growth factors, and clinical large muscle treatments).

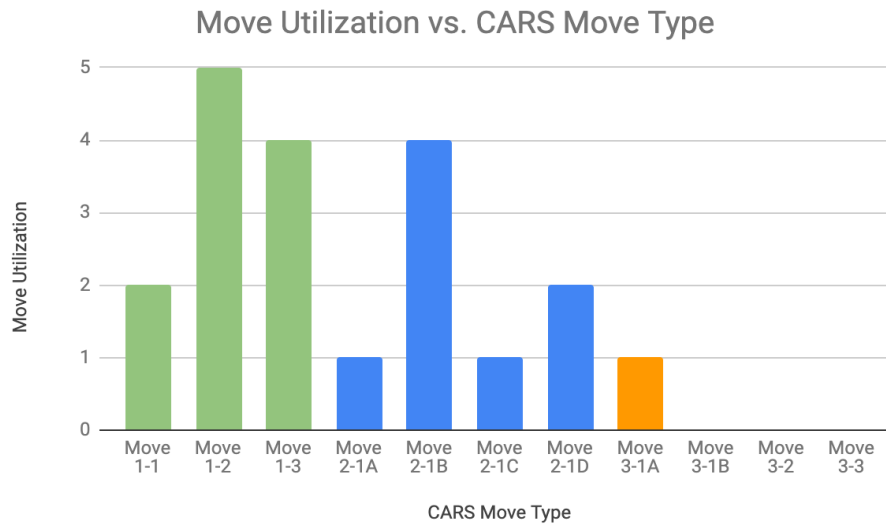
### 2. Introduction

By using the CARS method on both the reference research article and the master's thesis, an introduction was created for the proposed research article. Below in **Figure 1**, the amount of times a rhetorical move was used in the introduction of the reference article is depicted. In this article, it is evident that the authors chose to utilize a majority of their arguments in favor of establishing a niche in biomaterial scaffolding and then using their research to occupy the niche that they created.



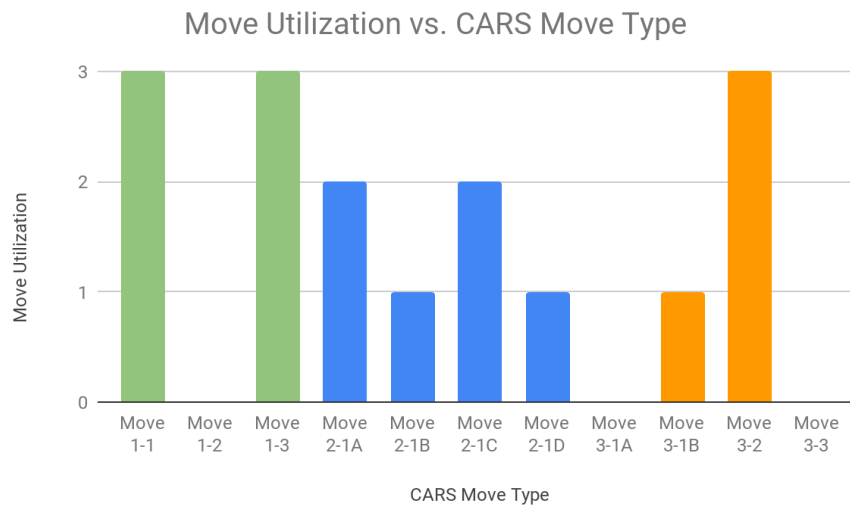
**Figure 1: CARS Method on reference article.** Above is a bar graph depicting the amount of rhetorical moves that the introduction of the reference article utilized: Move 1 (green), Move 2 (blue) and Move 3 (orange). Note the larger amount of Move 3's.

However, as depicted in **Figure 2**, the rhetorical moves used in the master's thesis heavily rely on 'establishing a territory' and 'establishing a niche', rather than occupying that niche. It should be noted that a separate chapter 'Hypotheses & Specific Aims' followed the introduction which satisfied this occupation. A master's thesis is often used as a way for students transitioning from student writing to professional writing, therefore the goal of this piece is not only to display their research project and findings but to also show the in-depth knowledge they have of the field. This could be considered similar to an initiation into a discourse community and would allow the student to fully become a member of this community.



**Figure 2: CARS method on Master’s thesis.** Above is a bar graph depicting the amount of rhetorical moves that the introduction of the thesis utilized: Move 1 (green), Move 2 (blue) and Move 3 (orange). Note the lack of Move 3’s in the graph.

In order to mimic the style of the reference article, the proposed article was edited in order to remove any Type 5 statements that did not directly contribute to the findings of the master’s thesis. The overall changes can be seen in **Figure 3** below. The key differences between these revisions was that moves 1-1, 1-2, and 2-1C shifted and incorporated more Move 3 strategies. Swales (1990) himself stated that Move 1-1 and 1-2 are often interchangeable, and his purpose of creating the second move was to incorporate larger introductions as opposed to short ones. This allowed for Type 5 or 4 statements to be utilized in the master’s thesis.



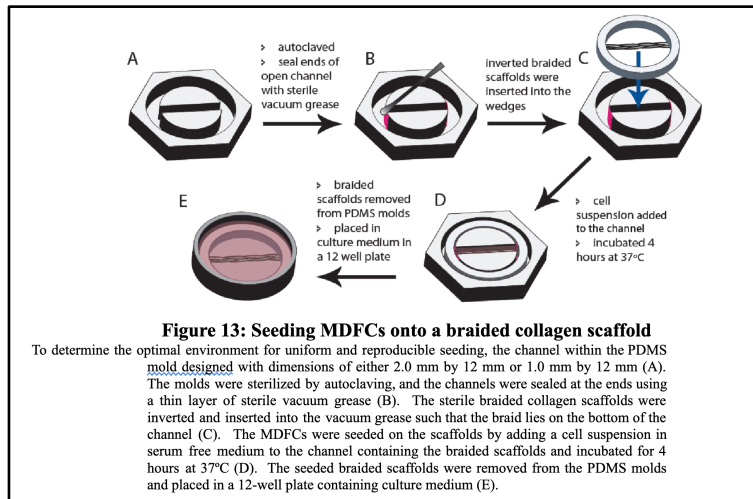
**Figure 3: CARS method on Proposed Article.** Above is a bar graph depicting the amount of rhetorical moves that the introduction of the proposed article utilized: Move 1 (green), Move 2 (blue) and Move 3 (orange). Note the increased amount of Move 3's, similar to the reference article.

### 3. Methodology

The methodology section of this paper was found to be very similar in structure and length to the reference article. Aside from minor textual changes, the major changes that were made were figure interpretation and the removal of an experiment with no significant findings. To ease the interpretation of figures, different stylistic changes were made in order to preserve the content of the figure but also remove any reiteration/Type 5-4 statements from the methodology of the proposed article. For example, in one section of the methodology in the master's thesis, a detailed step by step description of the process of how collagen fibers were prepared for scaffolding was placed both in the methodology and in a figure description. This can be seen in **Figure 4** (which is Figure 13 in the master's thesis) below. While the text below the figure seems to belong in the

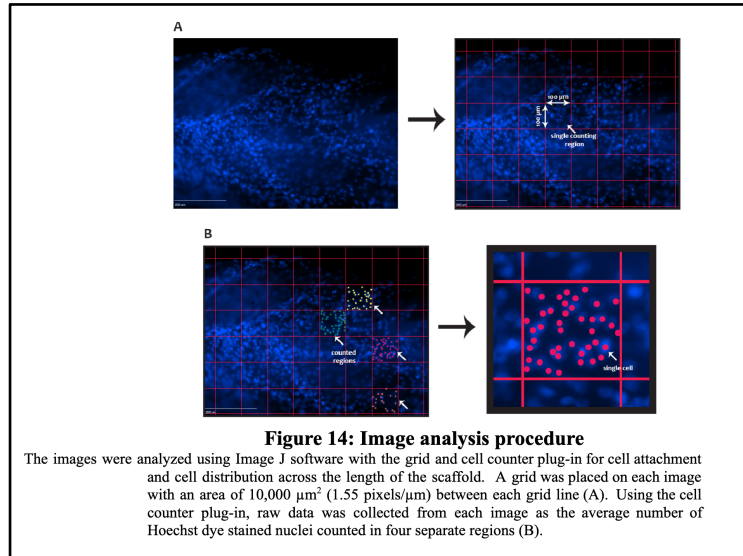


methodology, it is imperative that this information can be easily accessible and accompany the figure in order to explain the methodology more clearly than a descriptive paragraph text would.



**Figure 4: Thesis Example 1.** The image above shows the description of seeding cells onto a scaffold and a figure to show the actual process.

Another example of figure interpretation is how the master's thesis incorporates a diagram in order to describe a common method. One example is in **Figure 5** below, which describes the image analysis procedure to measure the cell adherence and distribution. This method of image analysis is often used by a variety of different groups of discourse communities. Due to the fact that this method did not result in any novel findings nor is significant in itself, it was replaced with a short description.



**Figure 5: Thesis Example 2.** Above is an image showing the image analysis procedure.

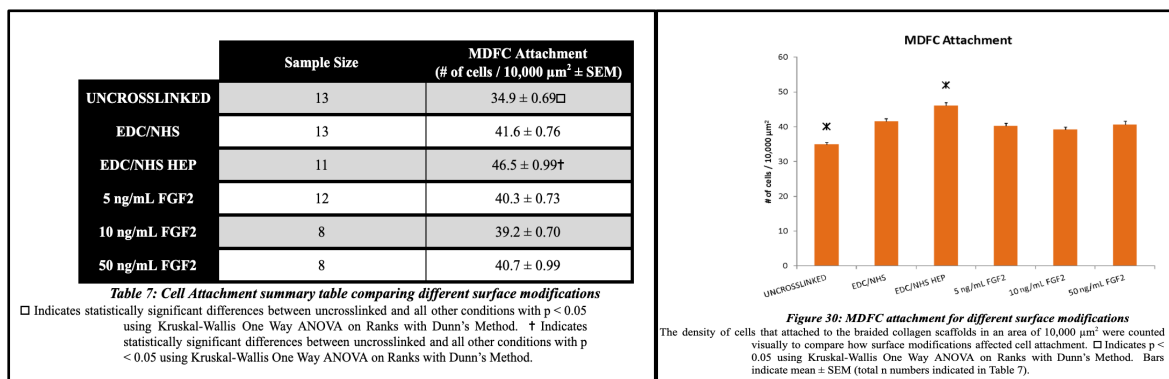
The master's thesis also included a methods section on an initial design of a seeding cell method. From the insignificant findings of this method, the author was able to identify and optimize a new method (in the thesis section of "Optimized Seeding cell method"). The reference research article contained no indication of using insignificant methods and the optimized section contained nearly a mirror image description of the initial method section. Due to this, the initial seeding method was removed in order to ensure less confusion for the audience. This section was also referenced in the Results section of the master's thesis, so the insignificant results were removed as well.

## 4. Results

In order to ensure that the findings are clearly displayed and concise, it was necessary to remove a few figures and tables from the master's thesis. This section originally contained 30 pages, however, this is not the standard characteristic as seen in many BME research articles. While the reference article is on the shorter end, it dedicated only 3 pages to its findings. The removal of

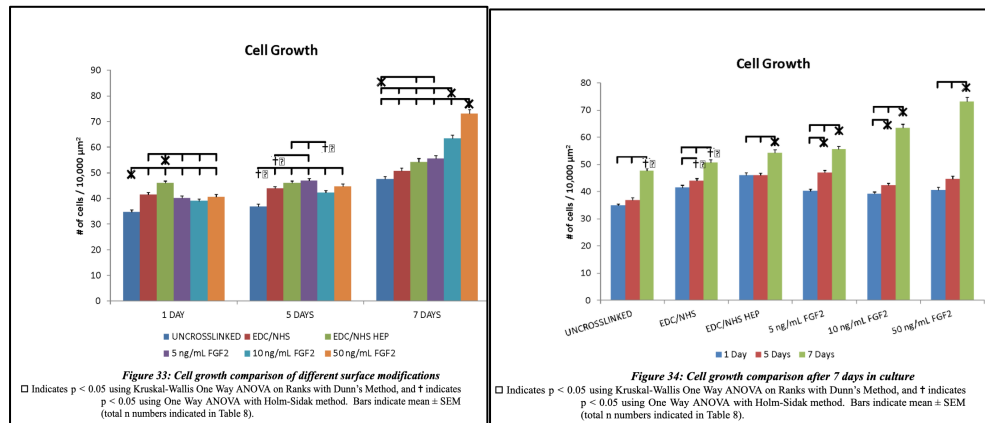
certain findings was due to the following reasons: figures/tables that did not contribute significant findings (as noted in the previous section) and repeated data displayed in a different format.

An example of similar data being displayed in different formatting can be taken from **Figure 6** below. Both of these figures contain the same information, however, one is displayed as a table and the other as a graph. The aim of these figures is to highlight the evidence that the samples coated with “EDC/NHS and heparin” show a significant increase in cell attachment. The graph is able to allow the audience to visualize this finding more clearly than the table, therefore the table was removed in order to restrict data repetition.



**Figure 6: Thesis Example 3, Cell attachment Table (left) vs. Figure (right).** Above shows two images that display the same information (table and bar graph).

Another example can be seen in **Figure 7** below, which compares two different graphs that changed the group of the data type (e.g. by day vs. by sample type). The graph on the left separates the data by days, but groups the samples being tested together. While this allows the audience to view the general increase in cell attachment as the number of days increase, it weakens the comparison being made between each type. The graph on the right, however, separates the data by sample type, allowing the audience to realize that the increase is seen across every sample type, a notion that may not have been clear beforehand.

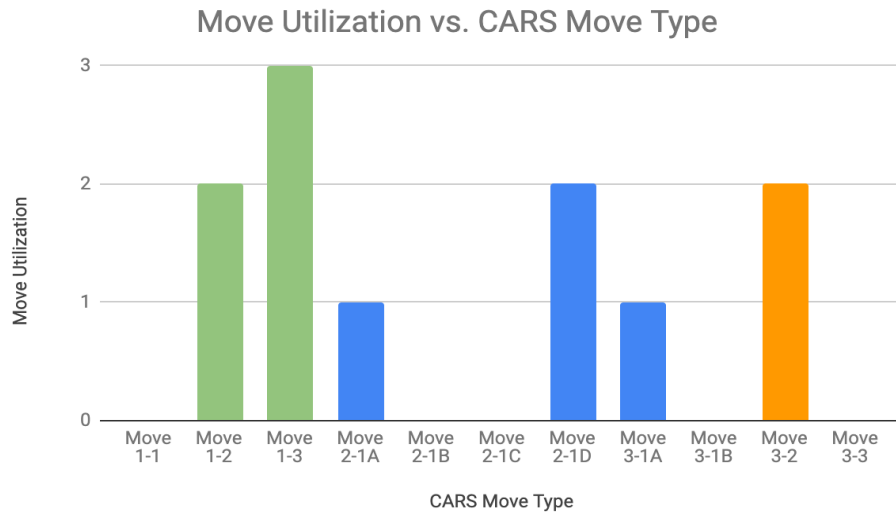


**Figure 7: Thesis Example 4, Cell Growth Days (left) vs. Sample Type (right).** Above shows two images of a graph that display similar information but group in different ways. Note that the trends in significant growth are clearly seen in the image on the right.

## 5. Discussion

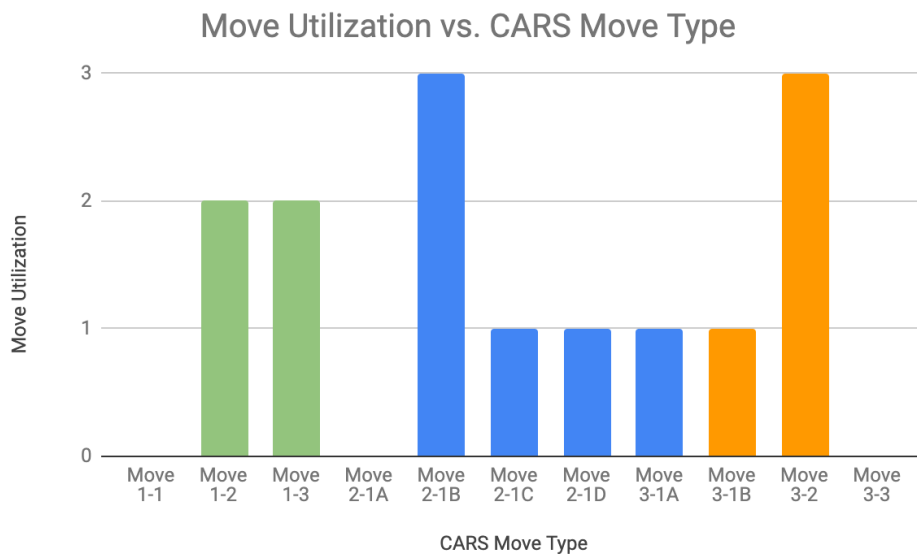
Swales (1990) noted that the discussion of a research article often mirrored the introduction, but instead of writing from ‘general information to particular information’ it does it in the opposite. Noting this, the aim of the revision of this section was to attempt to reverse the CARS model. The master’s thesis contained a discussion section of over 20 pages (information was often reiterated from the methodology/results) and so this method was only applied to the proposed research article and reference article discussion.

**Figure 8** shows the move utilization in the discussion of the reference article. While not shown, the discussion did reflect the “backward” format that Swales (1990) suggested. Also, there appears to be a greater amount of “establishing territory & niche” moves than occupying the niche. This is expected, as the discussion is placed towards the end, after the authors have stated their methodology and results, which would reflect their “occupation of the niche”.



**Figure 8: Discussion CARS Model, Reference Article.** Above is a bar graph depicting the amount of rhetorical moves that the discussion of the reference article utilized: Move 1 (green), Move 2 (blue) and Move 3 (orange). Note the larger amount of moves 1 and 2.

In the proposed research article, similar results are seen in **Figure 9**. However, there was a greater amount of moves that “occupy the niche” of BME. This is also expected, as the thesis is focused on displaying the author’s knowledge and commitment to become an established member of the niche set forth by the discourse community.



**Figure 9: Discussion CARS Model, Proposed Article.** Above is a bar graph depicting the amount of rhetorical moves that the discussion of the proposed article utilized: Move 1 (green), Move 2 (blue) and Move 3 (orange). Note the larger amount of moves 1 and 2.

## Discussion

After reviewal of the changes made to transform a master's thesis into a proposed research article, it is imperative to go over the key observations made as student writing was translated into professional writing. As seen in the *Findings: Introduction*, student writers often include more statements to reflect their knowledge of the territory (e.g. Background chapter) and the niche (e.g. tissue regeneration), rather than provide their own findings immediately. Another key observation that was made is how often information was repeated between different types of figures/tables, paragraph text, etc. This could be an indication of a student trying to display different forms of data interpretation in order to display their acknowledgement of different types of data that the BME discourse community utilizes as well. Often times, students are unsure of their status of membership in a community and employ less counter-claiming and criticism of professional works such as this reference article. However, with rhetorical analysis of the discourse community, the proposed article was able to follow the format of the reference article. This suggests that if students were able to utilize similar rhetorical strategies, they would be able to strengthen their own writing in their disciplinary field.

However, it should be noted that the proposed article did not reach the point of a complete submersion to reflect the artifacts that belong to the BME discourse community. Even in its final format, there was difficulty discerning significant vs. insignificant results. In order to strengthen

this rhetorical analysis, using specialists (as seen in the Latour, 1979, analysis) would not only ensure the correctness of the BME proposed article but to even be used as a part of the rhetorical analysis. The specialists would be members of the discourse community, which would allow potential collection of data such as which characteristics of the research article are preferred, insight into the publication of an article, and a deeper lexical analysis. With this support, it may be possible for students to not only understand the genre of student writing, but to also be able to follow the path of membership into their own professional community.

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