



Establishing a Niche for Research in Mathematics Articles

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Conference on Writing in the STEAM Fields:
Science, Technology, Engineering, Arts and Math

Theoretical Background

- Genre theory emphasizes link between institutions and genres (Bhatia, 1993 & 2004; Swales 1998; Hyland 2000)
- Inspired by Swales' *Genre Analysis*, RAs in over 30 disciplines have been studied for their rhetorical structure
- 'Niche' has turned into a prominent concept (Lyda and Warchal, 2014) that highlights the significance of the problem and provides a rationale for conducting new research
- Despite widespread similarities, disciplinary-specific variations have been reported
- RAs in Mathematics have received little attention despite this trend

Establishing a Niche is an important concept

- Educational Psychology (Loi, 2010): 66.7 %
- Biochemistry (Kanoksilapatham, 2005): 70 %
- Second Language Writing(Ozturk, 2007): 80 %
- Biology (Samraj, 2002): 91.7 %
- Computer Science (Shehzad, 2008): 94.64%
- Management (Lim, 2012): 100%

In these fields establishing a niche is conventional, if not required

Part of a larger study but today's focus:

- How do mathematicians 'establish a niche' for their research (Move 2 in Swales' 1990 and 2004 CARS models)?
- How does disciplinary culture shape whether and how niches are established for research?
- What are the theoretical implications and practical applications of our work?

Design and Methodology

Corpus: (30 RAs) from

- *Discrete Mathematics (DM)*,
- *Discrete Applied Mathematics (DAM)*,
- *Journal of Combinatorial Optimization (JCO)*,
- *Graphs and Combinatorics (G&C)*
- *SIAM Journal of Discrete Mathematics (SIAM)*

Method:

Triangulated approach (Candlin and Hyland, 1999) that integrates

- **textual data** (description)
- **ethnographic accounts** from disciplinary specialists (interpretation)
- **explanations** of disciplinary writing practices as social institution (exploration)

Some details of the corpus

Number of RAs	Number of sections	Number of authors	Publication date	Number of countries represented
30	43	65	2007-2009	21

Swales' 1990 CARS Model

Move 1: Establish a territory
Step 1: Claim centrality
Step 2: Make topic generalizations
Step 3: Review items of previous research

Move 2: Establish a niche
Step 1A: Counter-claim or
Step 1B: Indicate a gap or
Step 1C: Question-raising or
Step 1D: Continue a tradition

Move 3: Occupy the niche
Step 1A: Outline purposes or
Step 1B: Announce present research
Step 2: Announce principal findings
Step 3: Indicate RA structure

Swales' 2004 CARS Model

Move 1: Establish a territory (citations required)

Move 2: Establish a niche (citations possible) via
Step 1A: Indicate a gap
Step 1B: Add to what is known
Step 2: (optional) Present positive justification

Move 3: Present the present work (citations poss)
Step 1: (obl) Announce present research descriptively
Step 2*: (opt) Present RQs or hypotheses
Step 3: (opt) Definitional clarification
Step 4: (opt) Summarize methods
Step 5: (PISF**) Announce principal outcomes
Step 6: (PISF) State value of present research
Step 7: (PISF) Outline the structure of the paper

(**PSIF: Possible in some fields)

Do mathematicians establish a niche for their research?

66 % of writers establish a niche (Move 2)

Five steps/methods for establishing a niche:

- a. **Retrieve a problem (used in 9 RAs)**
- b. **Indicate absence of or insufficient research (used in 9 RAs)**
- c. **Raise a question (used in 9 RAs)**
- d. **Add to what is known (used in 4 RAs)**
- e. **Counter-claim (used in 3 RAs)**

New method of niche establishment:

Step 1a: Retrieve a problem

Writer highlights an existing unsolved problem or retrieves an existing problem

- **Open problem**
 - Labelled/Named problem (e.g., Fermat's theorem © 1637)
 - Conjecture
- **Existing problem**
 - Usually referred to in general terms “interesting problems . . . still emerge”

“uplifting the whole people”

Swales' "indicate a gap" wrong language for mathematics

- In agriculture, writers present inconsistencies in previous findings to create an existing gap (Del Saz-Rubio, 2011)
- In mathematics, proofs with inconsistencies or existing gaps are proofs with flaws; they would NOT be published
- Mathematics version is "insufficient or absent research" in an area:

"Although it is a very simple problem to describe, **very little is known** in terms of theoretical results." (JCO6: 351) (Emphasis added)

Step 1c. Raise a Question

Writers pose questions to show need for research:

“The fact that every edge in a graph will be traversed raises several questions.
Question 2.4 Over all possible initial weightings and initial locations of the robot for a graph $G = (V, E)$,
1. What is the maximum number of times an edge $e \in E$ can be traversed before every edge has been cleaned? . . .” (JCO6: 353-4)
(Emphasis added)

Directly pose questions

Step 1c. Raise a question

For the string barcoding problem, a **NATURAL QUESTION ARISES** when we consider the number of testing substrings as a parameter k . In particular, we would like to know whether it is possible to develop an algorithm that can decide whether a testing set with k substrings exists . . . (JCO5: 41) (Emphasis added)



Indirectly pose a question

Step 1d. Add to what is known

Options:

- **Overtly acknowledge intention to continue current research tradition (Lim, 2012)**

“In this paper we *continue* the study of restricted dominating sets started by Sanchis (1997) . . . We *prove* a general result which gives sharp bounds for several domination-like parameters.” (JCO3: 353) (Emphasis added)

- **Improve on existing results**

“The initial motivation for the present work was to *improve* on the above lower bound” (SIAM4: 489. Emphasis added).

Writers use this step following a reference to past research without criticising, questioning or counter-claiming that reviewed literature

Step 1e. Counter-claiming

Counter-claiming is rarely used to create Move 2 (3 RAs/10 %)

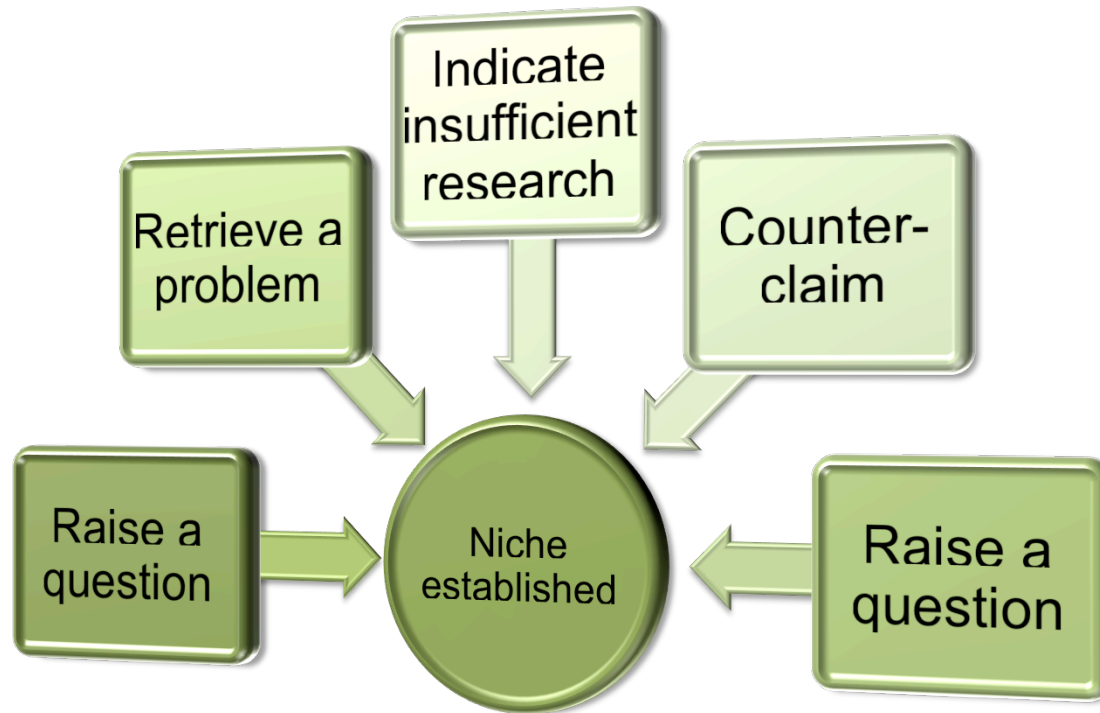
Counter-claiming suggests error in previous work: if it was erroneous, it would not be published, esp. in pure math

- **Used once (applied math RA) to judge existing knowledge inadequate**

“This, along with the fact that there have been **no improvements** on Fredman’s and Khachiyan’s quasi polynomial algorithm [13], suggests that . . .” (SIAM2: 937. Emphasis added).

- **Used twice to address a conjecture (unproven hypothesis)**

Use of multiple steps to establish a niche



In 9 RAs the writers used multiple steps to establish a niche:

- One step used multiple times (2 RAs)
- 1 – 4 steps used (7 RAs)

Niche: “The Sequential Method is inefficient no matter how . . .

The question whether $TR(H)$ can be listed in time polynomial in the input and output size

. . . whether $TR(H)$ can be listed in time polynomial in the input and output size . . . is a **longstanding open problem** for enumeration algorithms.

While the approach . . . is well known and appears often . . . there is **little theoretical knowledge** about its behavior.

This, along with the fact that there have been **no improvements** . . .

Answering a question posed by Hirsch [21] . . .

We show . . . that the **Sequential Method is inefficient** no matter . . .

Multiple steps build a strong argument for significance

- **Emphasize the longevity of the open problem (its importance)**
- **Frame open problem as question raised in the field (advance knowledge in this area)**
- **Refute previous researchers' assumption that when the graph edges are ordered correctly efficiency will result (reinforce significance of contribution)**

Multiple steps demonstrate the strength of these writers' knowledge contribution on several levels

Some mathematicians do not establish a niche

1/3 (33 %) of writers did not establish a niche

Two options:

- Imply the niche (5 RAs)
- Assume readers will infer the niche from information in Move 1 (review literature) and Move 3 (announce current research) (5 RAs)

Imply the niche

Writers summarize problems from literature then announce their own work:

“A number of variants of the following basic problems have been considered. **EXT_H**, called the extension problem for H, is the restriction of LHOMH to inputs with lists $L.g/; g \in V.G/$, which are either singletons ($|L.g/j| \leq 1$), or the entire set $L.g/ \subseteq V.H/$. Thus the extension problem for H asks whether or not a partial mapping of $V.G/$ to $V.H/$ can be extended to a homomorphism of G to H. Δ **CLHOMH**, the connected list homomorphism problem to H, is the restriction of LHOMH to inputs where each list $L.g/; g \in V.G/$, induces a connected subgraph of H. ...

In this paper we will focus on **the problems EXT_H and CLHOM_H.**” (DAM5: 1592-3) (Emphasis added)

They do not address the ‘significance’ of their work

Assume readers will infer the niche

“In 2006, Kotani [7] investigated how many non-separating vertices a tournament with minimum degree greater or equal two has at the least.

Move 1: Review previous research

Inspired by this article, Meierling and Volkmann [9] generalized her results in considering the class of local tournaments. ...

Move 3: Outline paper structure

In Section 3 **we characterize** all strongly connected local tournaments with exactly two non-separating vertices

In Section 4 we further investigate **the following problem**.

Move 3: Announce present research

Problem 1.7. Given a strong local tournament D How many cycles of length r exist in D ?” (DM4: 2043) (Emphasis added)

How does disciplinary culture shape whether and how niches are established for research?

- Brevity & conciseness are important values in mathematics
- It is an art to decide when to include and when to omit details in proofs
- Readers derive pleasure from working out the undemonstrated calculations for themselves
- Hardy (1940) states that mathematics resides closer to the arts side of the continuum than the sciences
- Aristotle (1984) states that readers' commitment to the argument increases when they must supply key elements themselves to construct the argument

How does disciplinary culture shape when/ how niches are established?

- **Few mathematicians order Moves chronologically (2 RAs/ 30 in our corpus)**
- **Most of writers use the Moves multiple times/recursively**
- **All mathematicians use a Move not included in Swales' models (Move P, "Establishing Presumptions")**
- **Swales' CARS models are useful for writers in mathematics but modifications are necessary to reflect how these writers actually construct their arguments**

Limitations of this study

Findings limited by the size of our corpus (30 articles)

Our corpus lacks range of sub-disciplines, diversity of problems in mathematics that might alter these conclusions

Additional study of sub-disciplines of pure & applied mathematics are needed to substantiate or generalize these results

What are the theoretical implications of our work?

- **Swales' CARS models accurately reflect practices in many disciplines, but not mathematics**
- **Numbered Moves imply a chronology that may mislead novice writers in disciplines like mathematics**
- **Novice writers may benefit from learning a model that emphasizes flexibility of Move structure in math**
- **We propose letters rather than numbers to identify moves, at least in relation to mathematics**

Swales' 1990 CARS Model

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CARS Model for Mathematics

Move ET*: (obligatory [obl])
Establish a territory (citations required)

Move P: (obl) **Establish presumptions**
Step 1: Present assumptions
Step 2: Introduce notations
Step 3. Define objects/terms
Step 4. (optional [opt]) Refer to previous research

Move PPW: (obl) **Present the present work**
(citations possible)
Step 1: (obl) Announce present research
Step 2: (opt) Present RQs or hypotheses
Step 5: (opt) Announce principal outcomes
Step 6: (opt) State the value of the present research
Step 7: (opt) Outline the structure of the paper

Move EN: (opt) **Establish a niche**
Step 1a: Retrieve a problem (and/or)
Step 1b: Indicate absence of or insufficient research
Step 1c: Instigate a problem (and/or)
Step 1d: Add to what is known (and/or)
Step 1e: Counter-claim

What are the practical applications of this work?

- **Grad writing instruction for mathematicians should present a realistic model to learners of how arguments for a researcher's work are structured**
- **Few grad writing courses (or workshops) may cater exclusively to math students, but multi-disciplinary classes should examine multiple models**
- **Students can observe the potential for difference and become sensitized to possible variations in the models of discourse in their disciplines**

Justification from Writing Studies:

Generic writing instruction for grad students provides lower exigence-based writing assignments and limited genre knowledge-building opportunities for students (Tardy, 2009)

Courses should expose students to a wide range of documents “to broaden learner’s exposure to and engagement in genres” (Tardy, 2009: 281)

Mono- and multi-lingual writers alike benefit from “seeing how a single genre may be approached by different writers in unique rhetorical contexts” (Tardy, 2009: 284)

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Thank you for attending this talk

Any Questions?

Comments?

Suggestions?