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Using the Discourse Domain Hypothesis of Interlanguage to Teach Scientific Concepts: Report On a Case Study in Secondary Education

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Abstract: This paper reports work-to-date on a particular practical context, applying one approach to interlanguage, the discourse domains approach, merged with the rhetorical-grammatical approach, involving both language and content. The context is an MA course for teacher residents placed in urban schools, and their English language learners (ELLs) in math and science classes, providing content area teachers the linguistic support they need to teach the language of their content, and thus the content itself. We were interested in how exactly learners' interlanguage creation interacts with their understanding of scientific concepts. We primarily look at the rhetorical function "definition," with discourse level semantic choices, and attendant grammar, with ELL data gathered by the teacher residents. Correct definitions in expected grammatical form point to an understanding of the scientific concept within the discourse domain, providing evidence that the science or mathematics content has been understood by the student. In our data analysis, we concentrated on the semantics and grammar of this rhetorical function, but other functions kept intruding, especially "classification". Cross-language transfer appears not to be a factor, but cross-domain transfer is. Finally, we discuss how the marriage of this view of interlanguage with safe rule rhetorical/grammatical functions can better support teacher preparation, especially given how challenging teaching ELLs is for content area teachers.

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No one is a native speaker of academic and technical English
Louis Trimble

1 Introduction

The proof of the *importance* of any new theoretical approach is that it permanently changes the discourse of a field. That the "Interlanguage Hypothesis" has done this for Applied Linguistics, shifting from the previous paradigm of extreme contrastive and error analysis, is beyond question. The Interlanguage Hypothesis was primarily developed in two papers, Selinker (1969, 1972) with Selinker, Larry. 1969. Language Transfer. *General Linguistics*. 9(2). 67–92. the first extended summary statement occurring in Selinker (1992). In a more recent updating, Selinker (2011; 2014) spells out issues that have been traditional over the centuries in language learning research, most especially language transfer, vs. issues that could not have been researched without the concept of interlanguage (or something like it), such as variation, stabilization, fossilization, noticing the gap. The history of this paradigm shift is documented in Tarone (2014). How the discourse of this field has been changed is to be found in other papers in this special issue, and is part of considerations of validity, which has a long research tradition. To such considerations of validity, it is always helpful if theory can be united with practice, though given the complexities of empirically studying practice, that is often difficult.

The proof of the *usefulness* of any new theoretical approach is that, not only does it change the discourse of an important and real-life field, but it also changes practical outcomes. The problem in validating this latter is complex. On the one hand, it is difficult to extrapolate from controlled laboratory studies to such real-life and important contexts. That can seem a dead end, most especially to teachers. On the other hand, research done directly in such practical contexts creates a situation where it is notoriously difficult to control variables. We were particularly interested in contributing to the issue of how exactly learners' interlanguage creation interacts with their understanding of scientific concepts.

This paper explores a particular practical context, using one approach to interlanguage, the Discourse Domains approach to interlanguage (Selinker and Douglas 1985), applying that to an area of language teaching, both language and

content. This practical context has not been explored in this fashion to date and we describe the context in some detail below. The case study described here aims at implementing the Discourse Domains Approach in instructional practices in academic language which incorporates the semantics of the rhetorical-grammatical approach laid out below, supporting the development of academic language along with content in a particular well-defined practical context, so, that, hopefully, second language users can become as proficient as native speakers in academic language, an outcome that appears very common in the world today. We report our progress to date.

This case study, which began in January 2017, is part of a larger long-term project whose goal is to prepare secondary content-area teachers to identify, understand and address the needs of English language learners (ELLs) in U.S. schools and develop appropriate instructional practices in educating these students. Ultimately, the project aims at developing pedagogical approaches to be implemented in the classroom so that ELLs can develop academic language alongside native English-speaking students. A background goal is to attempt to contribute on a meta-cognitive level to the repertoire of teacher educators in this, and perhaps, other contexts.

Language socialization in schools, particularly academic language, which is basic to success, needs to be a planned and concerted effort. As stated in the epigraph above, Trimble (1985) repeatedly and profoundly insisted that no one is a native speaker of academic and technical English. Thus, a background theoretical goal would be to contribute, where we can, to the discussion on boundary lines between the language and discourse of native vs. non-native learners of academic and technical language. It is important to try to get evidence as to how these academic contexts affect learner development. We believe that using the work of Trimble (summarized in Trimble 1985) and colleagues (e. g. Lackstrom et al. 1970), and its integration into second language acquisition concerns (Selinker 1986; Selinker and Douglas 1985; Selinker and Douglas 1987; Selinker and Douglas 1988a; and Selinker and Douglas 1988b) can have a profound effect on such achievement. In this paper, we report promising results of the first semester.

2 Background to discourse domains

The idea of context affecting interlanguage production appears in the earliest empirical studies and is highly relevant to academic concerns. Selinker, Larry. 1969. Language Transfer. *General Linguistics*. 9(2). 67–92. , for example, discovered

that when Israeli children talk about subjects studied in school, syntactic word order in their Hebrew-English interlanguage varied from when other topics were discussed. Tarone (1979) in her paper on "Interlanguage as chameleon" highlighted systematic variation in interlanguage, starting an emphasis on research on such, which is still continuing. As a particular take on the variation problem, Selinker (1980) first proposed the discourse domains concept in the second GRAL conference ("Groupe de recherches sur l'acquisition du langage," founded at the University of Paris VIII) where there was much discussion on "the need for a modular approach in which the domain to be investigated is restricted to a manageable size" (Frauenfelder 1982: 156). Even then, the problem of "how and where to reasonably set the limits" (ibid) of such domains was strongly recognized. Selinker and Douglas (1985) attempted to put theory into the discussion with their title "Wrestling with 'context' in interlanguage theory" stating the problem in pithy terms, a problem still with us as Tarone's (2000) "Still wrestling …" title emphasized. Since the learning of serious scientific content is involved in the project, with an attempt through language to validate such learning, we adopt Selinker and Douglas' framework here and note the extensive attempts to create and validate combined methodologies, language and science, through careful use of "subject-specialist informants" (Selinker 1979: 189), another extensive paper published in this journal, where the research methodology is first laid out. Bringing this work together more precisely in research methodology terms with the discourse domains approach to interlanguage was the task of two other extensive papers (Selinker and Douglas 1989; Douglas and Selinker 1994), and that is the approach we adopt here.

Selinker and Douglas (1985) first attempted definition of the concept of "discourse domain" is:

> "a personally and internally created 'slice' of one's life that has importance and over which the learner exercises content-control. Importance is empirically shown by the fact that in interaction one repeatedly talks (or writes) about the area in question. Discourse domains are primarily dynamic and changing, and may become permanent parts of a learner's cognitive system" Selinker and Douglas (1985: 190).

We use this as a working definition. According to Selinker and Douglas (1985; Selinker and Douglas 1989) a discourse domain derives not only from a learner's established understanding about a topic, but also from his or her personal interest in a topic and the degree to which he or she has practiced conversing about it. Therefore, a discourse domain reflects learners' interlanguage creation and performance in specific contexts. When English language learners (ELLs) form a discourse domain, it appears to be based on three fundamental aspects: their personal interest in the topic, the content knowledge,

and the frequent opportunities for rehearsal. According to the hypothesis, when L2 learners are able to construct their own discourse domains, they demonstrate better linguistic ability and communicate more effectively in cross-cultural interactions (Selinker and Douglas 1985; Woken and Swales 1989; Zuengler 1989; Zuengler 1993; Zuengler and Bent 1991).

This case study also aims to identify specific aspects of teacher preparation that can benefit from a deep understanding of the Discourse Domains Hypothesis. We were ultimately concerned with how we could develop instructional strategies to enhance language teaching for ELLs to help and support the development of their academic language as well content knowledge by providing models of language use within relevant domains of science and math, which we think we can define well, as well as opportunities for learners to "rehearse" in the classroom, thus getting their interlanguage more target-like in these domains.

For this paper, we concentrate our focus of analysis on the rhetorical area of "definitions" (well studied by Trimble 1985, and others) – how ELLs express their understanding of scientific concepts through definitions of technical terms used in the classroom, showing the essential scientific components involved which we describe below. Defining terms is particularly important for second language learners who need to ensure that they convey the appropriate meanings within the content area. In science and math, definitions need to be not only precise and accurate, but clear enough so that the words are distinguished from one another and different from the possible everyday meanings of the word. The precision and the complexity of a scientific definition requires ELLs to learn particular language structures, which is why we talk about a rhetorical-grammatical approach. How definitions fit into a larger rhetorical context is beyond the scope of this paper, but some elements are explained in methodology below.

Our background assumption is that language socialization in schools, particularly academic language, can be taught within specific discourse domains and this paper aims to identify specific aspects of teacher preparation that can benefit from a deep understanding of the Discourse Domains Hypothesis and how to develop instructional strategies to enhance language teaching for English language learners to help and support the development of their academic language as well as content. More importantly, we aim to identify how exactly learners' interlanguage creation interacts with their understanding of scientific and mathematical concepts and/or rhetorical functions (such as definitions). As we identified particular structures, rhetorical devices and linguistic forms by domain, we also aim in this long-term project to discover whether preparing teachers to develop pedagogical strategies based on the discourse domain hypothesis can affect their teaching practices and the ELLs' L2 performance across content areas.

3 Background context

As the American educational system is different from most other international contexts, we start this section with an overview of some basic elements that are necessary to understand the context in which this study was developed. The American educational system is decentralized and it can and does vary by state, and sometimes even by county. There is no integrated national curriculum, but the current climate is one of standardization, which has created a wave of high stakes testing and professional standards for teachers across content areas. There is a growing concern with what students need to know and be able to do at each grade level and an increasing orientation towards college and career readiness. English language learners in American schools today study alongside native English-speaking children in what is referred to as mainstream classes. Students who are identified as ELLs may receive additional support in the form of English as a second language (ESL) classes, which can be done through a "pull-out model" (students leave their homeroom to have class with an ESL teacher) or "push-in model" (the ESL teacher comes into the general education classroom to support ELLs in the content area classes). With the development of national and state standards along with high stakes testing, there is a strong push for mainstreaming ELLs and for bringing them into the general education classes. ELLs are held accountable to the same standards and take the same tests as their native English-speaking peers.

Content area teachers today are expected to also be language teachers of the content they teach and teacher preparation programs are now focusing on providing teachers with the necessary skills and scaffold to enable them to develop classroom instruction that focuses on promoting language along with content (Echevarria et al. 2008; Schleppegrell 2004). The premise is that language and content cannot be separated or taught separately from each other. Language only makes sense when contextualized and academic language needs to be explicitly taught so that students can focus their attention on the specific features of academic discourse. The idea is to prepare teachers to approach language in purposeful and meaningful ways in the classroom and provide them with the necessary tools to make learning content comprehensible while also focusing on the uses of academic language and its functions in their content area discourse.

American schools are now implementing the standards and learning goals of the Common Core State Standards (CCSS). The focus of the CCSS is on preparing students in the K-12 educational system (i. e., from kindergarten to the end of high school) for life as engaged and informed citizens by defining

consistent goals in terms of the knowledge and skills students should gain and develop as they move up within the school system and as they graduate high school to pursue further education, an entry-level career or the workforce. The standards were initially developed for mathematics and English language arts and literacy, but now additional content areas are being included (e. g. Next Generation Science Standards).

As part of the English Language Arts standards, there is an emphasis on developing academic language and preparing students to engage in academic discourse. One of the ways that the CCSS is addressing academic language is through an emphasis on vocabulary teaching and lexical development. This is reflected in the tiered vocabulary instruction that was initially developed by Beck and McKeown (1985) and that has now been widely adopted in the general classrooms as well as in the work done aiming at teaching English language learners to acquire and develop academic competence in English (Beck et al. 2013; Taylor and Ysseldyke 2007). The basis for such approach is that, given that words vary in terms of frequency of use, usage, complexity, and meaning, the attention they should be given in instruction should also vary and reflect their need for a student to understand content and develop academic language.

Beck et al. (2013) describe academic vocabulary using the concept of tiers. Three word-tiers are distinguished:

> Tier 1 words are words a student uses in everyday language as part of the socialization process in the family, with friends and in the community one belongs to. Because these are highly frequently used words in everyday speech outside of school, there is no need for teachers to spend time or attention in classroom instruction. These are words students should be familiar with and that should be part of their lexical repertoire, and will not be considered in this paper.
> Tier 2 words are words that are considered academic and are found across discourse domains. These words are used in academic language to express multiple meanings used in textbooks, instructional materials, and classroom talk. Words such as "analysis", "complexity", "investigation", and "measurement" appear in different content areas and are considered tier 2 words. The word "layer", for example, is considered a tier 2 word as one can talk about layers of meaning (in English language arts), layers of the Earth or the atmosphere (in science), or layers of the skin (in biology).
> Tier 3 words are context-specific. These are words that appear within specific discourse domains and therefore, have very specialized meanings that need to be understood and well defined within the content in which they occur. "Quadrilateral" is a tier 3 word, as it only occurs in mathematics. The same is true of words such as "isotope" (in chemistry), "photosynthesis" (in earth sciences) or "estuary" (in geography).

For them, the emphasis for ELLs should be in the teaching of tier 2 words, as these are words that can help students understand different content areas (http://www.colorincolorado.org/article/selecting-vocabulary-words-teach-eng

lish-language-learners) and the rationale for their instruction lies in the principle of transfer of knowledge, i. e., being able to understand the meaning of a word within one content area should facilitate its understanding when students come across the same word in a different content area. Tier 3 words, on the other hand, need to be taught and understood within specific contexts and contents. In the classroom, these words need to be placed in well defined contexts so their meaning is clear, precise and unequivocal. The proponents of the tiered vocabulary system claim that "the operative principle for vocabulary instruction is that it be robust: vigorous, strong, and powerful in effect. A robust approach to vocabulary involves directly explaining the meanings of words along with thought-provoking, playful, and interactive follow-up." (Beck et al. 2013: 3). We find these distinctions useful, but for us, there is an over-emphasis on individual words, i. e., a concentration on vocabulary acquisition is not enough. We know there is much more involved conceptually, which we try to sketch out here.

4 The study

4.1. Participants

The participants of this study are twofold: teacher residents and their English language learner (ELLs) students. We use the word "course" for the instruction given to teacher residents, and the word "class" for the subject matter/content area classes these teacher residents teach in various high schools.

The teacher residents are novice teachers who are enrolled in a Master of Arts in Teaching (MAT) program at a large public university in the northeast region of the United States. They all have bachelor's degrees in their content area of STEM (science, technology, engineering, and math) education. They are called teacher residents because their teacher education program is a field-based program called "Teacher Residency", which places them in the classroom from the very beginning of their preparation as teachers. They work alongside an experienced teacher who serves as a mentor throughout their first year. During the residency program, we hope to help them develop the knowledge, skills, and dispositions needed to become the "teachers of record", a term used in American schools to refer to a teacher who is assigned to a specific classroom and is responsible for students' learning in a content area and course in that classroom. The teacher residents are being prepared both to their role as teachers in American urban public schools as well as to the academic language and

discourse of their content area. At the end of the MAT program, these teacher residents become certified teachers in secondary mathematics and science education.

The most important point is that, given that all the teacher residents have been placed in urban schools, they all have ELLs in their classes, most often not knowing how to deal with the language problems ELLs have in learning their subject matter and this is the practical problem we need to address. As a matter of interest, the schools used in the study classify ELLs as any student who speaks a language other than English at home.

4. 2. The course

The university course for teacher residents is designed to prepare them to understand and address the needs of their high school students who are English language learners. In the course, teacher residents discuss theories of second language acquisition and approaches to teaching ELLs, such as content-based and sheltered instruction (Krashen 1981; Faltis 1993). During the course, the teacher residents focus on applying the tiered-vocabulary instruction reflecting the Discourse Domain Hypothesis. As we prepared the teacher residents to develop appropriate pedagogy for their ELLs, we focused on understanding the needed Discourse Domains and how to transform them into a sound pedagogical approach to teaching ELLs within the required standards established by the CCSS for American schools.

In our weekly meetings, the teacher residents leaned about the policies affecting the education of English language learners in the United States and discussed ways to address the challenges of teaching ELLs in mainstream classes along with native speakers. Trimble's epigraph was always a reminder of how in fact everyone is a learner of academic and technical English and that, therefore, the instructional strategies and pedagogical approaches to teaching ELLs can ultimately help all learners in the classroom. How ELLs might differ from native speakers is always a question in the background and we try to contribute to this issue.

An interesting initial impression was that the teacher residents themselves had to learn to look at their content, science and math, differently, and had to engage in a metacognitive process which involved analyzing the language used in textbooks and course materials so they themselves could become more proficient in teaching the language of science and math. A large portion of the course was designated to heighten the teacher residents' awareness and sensitivity to issues of the use of language in their respective discourse domain. When

the concept of definitions was introduced and discussed, the teacher residents also practiced and rehearsed in our course their own ability to develop definitions that would reflect the knowledge of the discourse domain and the appropriate rhetorical devices needed to express content precisely and adequately.

Everyone was asked to keep a journal and take copious notes of what was happening in the classes. The use of reflective journals was a way to keep a record of classroom procedure, of student feedback and, more importantly, to explore the impact of introducing language within specific discourse domains on the ELLs' interlanguage development in their classes. Our analysis of the primary data (see below) was guided by the various reports provided by the teacher residents involved in this case study.

4.3. Methodology

Summarizing to date, as part of their course assignment, the teacher residents were assigned to engage their ELLs in defining a specific number of tier 2 and tier 3 words related to the content being taught to their students. The activity was also consciously used by the teacher residents as a pedagogical strategy to socialize ELLs into the various Discourse Domains of science and math, and the language needed to understand and express meanings scientifically and mathematically. As a metric, defining terms with the proper technical information is then used by the teacher residents to infer that ELLs understand the meaning, uses and significance of a technical term within the content area in which it is being used, and thus mastery of the scientific or mathematical content was indicated to the teacher resident. Thus, through their definitions, ELLs created statements which demonstrate their understanding of the meaning of the technical terms to the satisfaction of the teacher residents, i. e., an explanation and examples of the scientific and technical phenomena being described.

Part of the course content to the teacher residents involved explaining the relevant rhetoric of Trimble (1985), which describes the kinds of language tasks students need to engage in as they develop their understanding of the discourse domain. These tasks reflect the many significant features of the discourse domain, such as types of classification, definition, and instruction, among others. In developing a pedagogical approach using Discourse Domains with definitions at the start, we hope to help ELLs get to an 'individualizing process' where they will bring their own specialized material into the discourse domain. This step is extremely important, as it reflects the way students display their understanding of the discourse domain by bringing elements of their own lived

experiences and how they relate to the content being studied. In a way, this step described by Trimble is what critical pedagogy refers to as ownership of knowledge (Naiditch 2017), the stage in learning where students personalize and make the content their own; this individual differentiation fits in with interlanguage variation, the heart of the discourse domains idea. It also reflects one of the aspects necessary for ELLs to form discourse domains, more of which we will discuss in the final section.

The Trimble approach is summarized in his (1985) book *English for Science and Technology: A Discourse Approach*. The rhetorical-grammatical approach is essentially hierarchical in nature (see Appendix 1), the main concerns being to understand how sentences are combined in academic discourse to semantically produce meaning through rhetorical organizational choices, and the linguistic means by which these choices are signaled. Interlanguage learning is directly connected here since ELLs in particular can then see gaps which exist between the language they produce and the model they are aiming to achieve, both informational and grammatical, and is essentially an updating of Schmidt's (Schmidt and Frota 1986; Schmidt 2012) "noticing hypothesis" within specified contexts.

Important to this process, there is involvement of grammatical choice by ELLs. A summary of which rhetorical choices on which levels control which grammatical choices is summarized in Appendix 2. For detail, interested readers are referred to the extensive set of studies appearing in the references below. Here we focus on the rhetorical-grammatical area of definitions, but definitions do not stand alone in a technical piece. They fit into an overall rhetorical structure, summarized in Trimble (1985), but were originally presented in terms of a "Rhetorical Process Chart" (Appendix 1) in Lackstrom et al. (1970), involving discourse level semantic choices.

Here, although we concentrate on formal definition, we emphasized to teacher residents that this rhetorical function fits into a much larger framework which this project will more fully exemplify in the educational context sketched out here. In Appendix 1, we have a summary statement of the research showing the rhetorical-grammatical process chart containing four hierarchical rhetorical levels:

1. LEVEL A: Objectives of the total discourse (e. g. detailing an experiment, making a recommendation, presenting new theory);
2. LEVEL B: General rhetorical functions (e. g. reporting past research, stating the problem);
3. LEVEL C: Specific rhetorical functions (e. g. definition, classification, physical/functional description), and
4. LEVEL D: Rhetorical techniques (e. g. time order, space order, causality).

In this framework, each lower level provides options to elaborate the objectives of the choice made on the level above. Definition, which we are concentrating on here is just one of many specific rhetorical functions needed, and it is important to emphasize that when students get all of the elements of the formal definition, they are showing knowledge of the content area, and we relied on the interviews with the teacher residents to provide this secondary data which, in turn, guided the analysis that follows.

A detailed example of the rhetoric and grammar of formal definitions was taught in the course to the teacher residents. Trimble (1985) describes what he refers to as a formal definition by using an equation:

$$T = C + D$$

where T stands for the term being defined, C for the class to which the term is a member, and D to the differences, the differentiae, that distinguish that term from other possible members that constitute a set within a category that relates to classification. In sum, and crucial to making this manageable for teacher residents, a formal definition provides these three pieces of information about a term: the nature of the term being defined, the class to which the term belongs, and the differences between the term and other members of the class. Trimble (1985) uses the following example:

> An arachnid is an invertebrate animal having eight legs extending at equal intervals from a central body (p. 80).

In this definition, T refers to the term arachnid, C refers to the class of invertebrate animal, and D refers to the specific features that distinguish arachnids from other members of the invertebrate class (having eight legs extending at equal intervals from a central body).

Note that in a rhetorical-grammatical sense, there is a syntax-semantic interface here where these three pieces of definitional information are projected onto the following prototypical surface syntax:

$$\text{Noun Phrase (Term)} = \text{Noun Phrase (Class)} + \text{Relative Clause (Differences)}$$

One of our main points is that content and grammar in language can be closely related and taught to great effectiveness for certain types of students working in certain domains This sort of prototypical syntactic construction for this and other rhetorical functions are initially described in Lackstrom et al. (1970; 1973), and Bley-Vroman et al. (1973). There is a summary of determining factors for the difficult area of article and tense choice in academic and technical English in Appendix 2.

Definitions, however, can also be semi-formal but contextually appropriate, providing fewer details, such as the name of the term being defined and only the differences between the term and other members of the class, without necessarily identifying the class. Trimble (1985) uses the following example:

> An arachnid has eight legs extending at equal intervals from a central body (p. 80).

In this definition, the taxonomic class of animals is not included. One may argue that this is an incomplete definition. However, this is a very common situation involving ELLs during their learning process. When learning within a complex discourse domain which requires specific and precise language, ELLs may still find it hard to identify classes, especially when there are many new terms to learn, use and apply; but they may still be able to display their understanding of specific terms by identifying and describing features that distinguish it from other terms that may have similar meanings. Defining by distinguishing or by identifying what a term is not only a learning strategy, it is also a way of demonstrating knowledge and understanding by highlighting differences between terms.

Our course focused on formal definitions trying to isolate the semantics, rhetoric, and grammar of this specific rhetorical function. The teacher residents practiced defining terms using the equation that Trimble created for formal definitions. Significantly, by infusing the course with theoretical aspects of second language acquisition, the teacher residents had the understanding that, even though formal definitions were an aim to be achieved, in order to get there, they needed to let ELLs display their knowledge of the technical terms by accepting semi-formal definitions as long as they were based on the linguistic content appropriate to the relevant Discourse Domain.

For example, one of our teacher residents reported that, when discussing astronomy in class, students inevitably brought up the term astrology and some were confused between the two terms. As an exercise, the teacher gave the students a short text about the two which contained the following definitions:

- Astronomy (term) is a branch of scientific study (class) primarily concerned with celestial objects outside of the earth's atmosphere (differentiating characteristics).
- Astrology (term) is a branch of scientific study (class) primarily concerned with how the positioning of celestial objects affects people and events on Earth (differentiating characteristics).

It is important to note that the teacher residents used templates of formal definitions as part of their classes. They presented and described Trimble's

equation to students and rehearsed it in class both as a group activity (as part of whole class instruction) and an individual task (exit tickets, explained below).

In the case of astronomy versus astrology, some of the ELLs came up with:

- Astronomy (term) is a part of science (class) that studies objects outside the Earth's atmosphere (differentiating characteristics).
- Astrology (term) is how we are affected by the stars and the planets (differentiating characteristics).
- Astronomy (term) is a subject that scientists study (class) to learn about the planets and the stars (differentiating characteristics).
- Astrology (term) is the technique of studying (class) people's behavior according to the moon (differentiating characteristics).

These examples demonstrate how simple to complex a definition can be, but more importantly, how writing definitions within specific discourse domains can indeed affect ELLs' understanding of that discourse domain and their evolving interlanguage. As shown above, astrology and astronomy, for example, can be described by ELLs as a part of science, a subject or even a technique. All these words reflect nuances in meaning that display the different levels of precision and understanding that an ELL is getting to by defining a technical term. This interlanguage variation, which can be seen in the form, structure and content of the definitions, points to a developmental process of language acquisition.

5 Data, data analysis, and emergent findings

The data for this study come from two sources, teacher residents and their students. Recall that in order to avoid confusion, we have stipulated and reserved the term 'course' for the MA level teaching, and 'class', for the high school math and science which the ELLs are part of. Since we are focusing here on the rhetorical function of definition (Appendix 1, Trimble's Rhetorical Process Level C 1985: 11), *the primary data* consist of technical definitions of words used in the science and mathematics high-school classroom created by the students (interlanguage with parallel native speaker data as baseline). We have also used *secondary data* which helped guide our analysis in procedures described in detail in Selinker and Douglas (1987), 1988a, 1988b, and 1994). These secondary data come from interviews with the teacher residents whose comments about implementing discourse domain hypothesis as a pedagogical tool in their content-area classes are used in choosing exemplars in the analysis of the sentences produced by the ELLs. Our analysis is also informed by course notes, journals,

and discussions the teacher residents were instructed to create. These teacher resident field notes contributed with additional classroom information which includes procedural aspects of their teaching as well as interpretations of the specific language produced by the students and the students' use of technical definitions in the exercise used for this analysis (i. e., in the exit ticket). These data reflect a sample of our initial and emerging findings and the analysis that follows is part of input to the ongoing study that we continue to develop with new teacher residents.

We selected five teacher residents to participate in this study: three science and two math teachers. We chose them based on the concepts that they asked their students to learn – evolution, conversion, structure, energy, and dilation – words which can fit into both tier 2 and tier 3 categories described above.

Because one aim is to try to determine whether learning academic vocabulary within rhetorical-grammatical formulas and within specific discourse domains affects ELL's understanding of scientific and mathematic concepts, our analysis focuses on the definitions of the terms produced by ELLs within the tier 3 category, which reflects a specific usage of that particular word within the scientific or mathematical discourse domain. According to our teacher residents, if there is correct use of words in Tier 3, they believe the scientific or mathematical content has been learned by their students. More data in subsequent semesters will show whether this is a reliable metric.

During the high-school science and math classes, students were taught the lexical items in the specific discourse domain as part of the content of the lesson and were also taught the structure of a definition as described by Trimble. At the end of the unit, the teacher residents asked students to define the terms we analyze below as "exit tickets". Exit tickets are a common instructional strategy used in American classrooms. At the end of a class, a week or a unit, teachers ask students to answer a question, to solve a problem, to summarize or list the main points of a topic or, as in our case, to write definitions of specific terms used during that unit. It is called an exit ticket because it is done just before students leave the classroom and it is usually written on a small piece of paper or index card. Exit tickets serve as formative assessment which provide the teacher with feedback about what students have learned and what needs to be adjusted for future lessons (For more information on this instructional technique, see https://www.edutopia.org/practice/exit-tickets-checking-understanding)

For the analysis, we use samples of actual definitions provided by the students. As mentioned, we focus on definitions that were deemed appropriate and accurate by the teacher residents. We also include some that were not considered accurate by the teacher residents for comparison purposes.

Table 1 below summarizes the number of participants in each class and the words defined in each content area class:

Table 1: Number of participants and words defined in each content area class.

Class and Term Number of Participants	Teacher Resident 1 – Science: Evolution	Teacher Resident 2 – Math: Conversion	Teacher Resident 3 – Science: Structure	Teacher Resident 4 – Math Potential Energy	Teacher Resident 5 – Science: Dilation
ELLs	17	10	7	8	12
Native Speakers	9	5	6	6	9

Each of these five teacher residents in the course teaches in a different high school, giving us a widely placed sample so that there is no particular school bias. The larger number of ELLs in our sample is due to the way the schools we work with classify ELLs – any student who speaks a language other than English at home. Because the schools are located in urban areas that welcome large waves of immigrants, there are a number of first languages and cultures represented in the ELL student population; the main ones being Spanish, Portuguese, Arabic and Haitian Creole.

From the teacher residents' perspective, correct definitions point to an understanding of the term within the discourse domain, which provides evidence to them that the science or mathematics content has been understood by the student. As will be seen in the analysis, there were very few instances where the definitions were considered incorrect or inaccurate, which has to do with students not demonstrating mastery of the content or the structure of a definition given that the expectation was that the definition would fit into the academic discourse expected for the discourse domain in question (math or science).

The terms analyzed below were chosen by the teacher residents and were used as part of our course discussion. The teacher residents rehearsed the technical terms in the course before presenting them to their students and developed their pedagogical approach used to teach content and the rhetorical function of definition with us and their colleagues. Given that the problem that science and mathematics are discourse domains that encompass a large body of knowledge with varied and multiple contents, when the teacher residents chose a term, they were inevitably forced to choose a sub-domain of science or math. For example, one of the teacher residents was teaching a unit in geometry, which, for our purposes, is analyzed as a sub-domain of mathematics.

5.1. Teaching the technical concept "evolution"

The term evolution was presented to students by the teacher residents in a science class, and class discussion focused on biological changes that different species experience over time across generations, and the factors that contribute for such changes. Table 2 below presents sample definitions chosen by the teacher resident.

Table 2: SAMPLE Students' Definition of "Evolution".

COLUMN A	COLUMN B	COLUMN C
ELL Definitions showing mastery of content	**ELL Definitions showing less than total mastery of content**	**Native Speaker Definitions showing mastery of content**
– Evolution is growth and development of something over time – Evolution is the growth and development of living organisms over time – Evolution is growth from a previous period of time to present. For example, Darwin's evolution – Evolution is the development of organisms over time – Evolution is change over a period of time – Evolution is the change over time of an organism. It is how an organism changes and develops over time – Evolution is a long-term change over time of a living thing – Evolution is the way that humans (organisms) develop over a long period of time – Evolution is the change in a species over time like how humans evolved from apes to the way they are now – Evolution is exponential growth and change over time – Evolution is something developing or growing controllably	– Change over time – Things that change over time. Example: humans – the development of a species to become a greater one	– Evolution is different kinds of living organisms that are thought to have developed during the history of earth – The improvement of something past the generation – Growth over time – The development of organisms over time – the gradual development of mankind as it was formed throughout history to become complex human beings over a long period of time – a species development over a long period of time – evolution is the way any living organism develops/changes over a certain amount of time – evolution is basically a process of changing over time, which species adapt over a long period of time to fit in a specific environment – the change of a species over time growing or development of that species (a living organism) over time

In Column A, the first thing that we notice is how closely ELLs seem to adhere to the formula of formal definition that they were taught in class. Not only did they write complete grammatical sentences, they also used qualifiers to describe the kinds of growth, development, and change associated with evolution, as in:

- Evolution is a *long-term* change over time of a living thing
- Evolution is the way that humans (organisms) develop *over a long period of time*
- Evolution is *exponential* growth and change over time
- Evolution is something developing or growing *controllably*

One may argue that these qualifiers may not be as important or even essential in defining the term, but if academic language is to be precise, refined, and semantically appropriate, it is the exact presence of these qualifiers that in fact can make a difference in the larger academic discourse of these students. Moreover, these ELLs are also demonstrating their ability to use specific linguistic devices to modify their definitions by adding an element of precision to their intended meaning. There is clearly a difference between growth alone and growth that is controllable or exponential, and if a learner chooses to use these words to qualify the kind of growth that is being referred to, this means that there is an underlying meaning in the interlanguage that is being formed and that the learner is trying to use the linguistic resources they have to demonstrate nuances in meaning.

The definitions that were not deemed appropriate, and thus did not demonstrate knowledge of the scientific content, by the teacher resident were those that were either incomplete or incoherent, as in:

- evolution is one thing to another
- the progress of something
- growing up

These definitions were written by ELLs. Even though some of the meaning of the concept may be gleaned by the reader, the definitions still lack in scientific content and expression. There were very few instances where a definition was totally rejected by the teacher residents, and when they were not sure, at least in some cases, these teacher residents brought the definitions to our course meetings to engage in a discussion and have the group of teacher residents help decide whether or not the definitions reflected understanding of the scientific concept, which, though not controlled for this study, presented a type of informal reliability. For example, the definition of evolution as “the development of a species to become a greater one” in Column B. Teacher residents as the experts considered that “evolution” does not always mean better and that,

therefore, the term greater was not used within the context of the class. These course discussions served as an additional pedagogical tool that helped our teacher residents develop their own understanding of the rhetorical devices and academic discourse of their domains.

The definitions written by native speakers in Column C were not very different from the definitions written by ELLs in Column A and this may be a reflection of the approach used by the teacher resident to introduce the word evolution and to contextualize it within a specific discourse domain. The words development, growth and change were also used by native speakers and, like the ELLs, they also identified a period of time as an essential component of the definition, as in:

- the development of organisms over time
- a species development over a long period of time
- evolution is the way any living organism develops/changes over a certain amount of time

5.2. Teaching the technical concept "conversion/convert"

The term conversion (and its verbal form convert) was presented to students in a different school by a different teacher resident in a mathematics class as part of a larger project students engaged in while comparing the Metric System, used in most countries, to the American system of measuring units, which is many times referred to as Standard, Customary, or even Imperial. The idea of comparing different ways of measuring units was particularly relevant in a class with students from many cultural backgrounds and the main teaching point here was that, irrespective of the unit of measurement being used, the size or the amount of the object being measured remains the same.

From the teacher resident's perspective, teaching the concept conversion within the particular discourse domain of converting one unit of measurement to another was a useful pedagogical strategy given the polysemous nature of the term, since the word can be found in many different contents and contexts with multiple meanings and connotations. For example, conversion is also used in the discourse domain of science where a material or a state can go through a physical transformation (from a solid to a liquid to a gas). Table 3 below presents sample definitions chosen by the teacher resident.

The first thing we notice in the definition of convert/conversion is that, even though the teacher resident gave students the noun and the verb in the exit ticket, most students chose to define the verb and only four students wrote definitions using the noun:

Table 3: Students' Definition of Convert/Conversion.

COLUMN A	COLUMN B	COLUMN C
ELL Definitions showing mastery of content	**ELL Definitions showing less than total mastery of content**	**Native Speaker Definitions showing mastery of content**
– To change something into something close of the same value	– Conversion is changing one thing to another	– Change of form or a character or function
– To change from one measurement to another	– Using steps to change from one thing to another	– Convert is a change in function. You are going from one product to another.
– to change out units	– To change or switch	– Convert means change into a different state or unit
– to change from one unit to another	– to change from the original form	– A process where something is being changed, to turn something into something else
	– cause to change a form	– to change an amount of one measurement to another
	– convert is turning bigger a measurement to another measurement	

- Conversion is changing one thing to another
- Using steps to change from one thing to another
- Change of form or a character or function
- A process where something is being changed, to turn something into something else

In defining convert/conversion, students did not strictly adhere to Trimble's formula, but this may be due to the fact that conversion is not a category in itself; the unit of a conversion is a category. Students do follow a similar structure in their definitions and whether they use unit, measurement or amount, they certainly identify categories in their definitions (more about categorical classification below).

In fact, what distinguishes Columns A and B is that this teacher resident considered that the definitions in Column A were more explicit in identifying categories of conversion. ELLs used words such as value, measurement, and unit. In Column B, the focus of the definitions was on the change promoted by converting one thing to another. Column C is particularly interesting because native speakers seem to expand their definitions to include function, product,

and state, apart from also identifying measurement and unit. This may reflect a deeper understanding of conversion within a larger discourse domain that implicitly refers to broader categories (function, product), not just units. This is what Trimble (1985: 81–85) calls 'complex definition' and in that it is inherently more complex, both rhetorically and grammatically, its explicit teaching is for a later stage.

When discussing columns A and B, the teacher resident commented on the fact that ELL students' definitions of convert/conversion in science was an illustrative example of how these students seem to be learning domain-specific language and holding on to the teacher definition, as in:

- to change from one measurement to another
- to change from one unit to another

Even the variations, still demonstrate an understanding of the content, as in:

- to change something into something close of the same value
- using steps to change from one thing to another

The teacher resident considered these accurate definitions, but noted that the use of the word 'close' may lead us to question whether the student understands the idea that the value remains the same when units change and the fact that referring to how they actually convert (by using steps) may be considered an extended part of the definition of conversion.

According to the teacher resident, in class, all students provided specific examples and, in many cases, ELLs were even more precise in identifying units of measurement, which may be due to the personal experience of growing up with the metric system. For example, ELLs identified more promptly units of measurement in converting temperature (Celsius to Fahrenheit), in measuring distance (kilometers to miles), in weighing themselves (kilos to pounds), and in changing currency (pesos to dollars).

5.3. Teaching the technical concept "structure"

The data obtained from students' definition of structure is particularly interesting to the discussion on the effectiveness of using the Discourse Domain Hypothesis of Interlanguage as a pedagogical tool in teaching academic technical words. The third teacher resident asked students to define DNA structure after finishing a science unit on this topic. Table 4 below presents their sample definitions.

Table 4: Students' Definition of DNA Structure.

COLUMN A	COLUMN B	COLUMN C
ELL Definitions showing mastery of content	**ELL Definitions showing less than total mastery of content**	**Native Speaker Definitions showing mastery of content**
– DNA structure is genetic information about us	– DNA is a structure in the cells of all human beings	– The structure of the DNA is a molecule that carries the genetic code
– The DNA structure is the genes we have	– DNA structure is where all our information is kept	– The DNA structure is genetic material unique to every living organism
– The DNA structure is made of genetic information		– The DNA structure contains all the genetic information that is inherited
– DNA structure is genetic material people have		– DNA structure has information about our physical characteristics like the color of the eyes and hair

According to the teacher resident, the definitions in general do not necessarily reflect full understanding of the content, except for its most basic meaning: DNA does contain genetic information that is passed along in living organisms. The teacher resident, however, accepted the definitions above because they reflect the students' initial understanding of the unit. Genetic information and genetic material were two ways of describing DNA structure used in class by the teacher resident and both were used as part of the definitions both by native speakers and ELLs.

The definitions that were not considered appropriate were the ones that were descriptive in nature and did not truly express the expected meaning, i. e., any indication that the content was learned. For example, one native speaker defined DNA structure by saying that "The DNA structure is double helix." Even though the information is correct, it does not demonstrate that the student understood the content. The same is true of another native speaker's definition which also describes DNA structure without defining it: "The structure of the DNA molecule is made of two DNA strands". One ELL also wrote a definition that was not considered appropriate for the same reason: "Each person has a DNA structure that is not the same to everyone."

In Column A, the teacher selected definitions that, although simple in language and meaning, follow the structure of a definition discussed in class. Students' examples in Column B also reflect understanding, but to a lesser

degree. The teacher resident argued that simply saying that DNA is a structure in the cells of all human beings or that it is where all our information is kept does not necessarily reflect full understanding of the content, as it does not qualify what kind of information is stored in the DNA.

According to the teacher resident, the definitions written by the native speakers in Column C more closely resemble the language and examples presented in the textbook. The native speakers used what the teacher resident referred to as 'difficult science vocabulary' (molecule, genetic code, living organism, information that is inherited) in their definitions and displayed a larger repertoire of words when describing DNA.

This particular teacher resident was not sure whether or not the task or the teaching itself had affected the results obtained. The idea of task or washback effect came up in the interview as the teacher resident believed that the way she approached definitions in class may have affected student responses. This is in fact one of the areas we were interested in while developing this approach to teaching academic language through rhetorical functions, i. e., whether or not teaching those functions explicitly would affect the development of the ELLs' interlanguage. The teacher resident argued she was not sure whether students had been given ample opportunities to practice the class (C) and the distinguishing differences (D), as described in Trimble's equation.

The teacher resident then decided to create another exit ticket. This time, the exit ticket asked students to define structure alone. The aim was to compare the use of the word as a Tier 3 word within the discourse domain of science as opposed to its Tier 2 meaning, as a technical academic word used in different content areas, such as the structure of a poem, a society or a building.

The teacher resident reported that students needed much more support in defining structure by itself. Most students ended up associating a definition to simply listing terms that are considered synonyms of structure. The native speakers did associate structure with words like shape and form, as in:

- Structure is the shape of something
- Structure is a construction
- Structure is form
- Structure is the different parts that make something

Many ELLs did not respond to the task and those who did associated structure with form or even transferred it from their first language, as in:

- Structure is a form
- Structure is *estructura*

From the teacher resident's perspective, these students had developed an initial understanding of the meaning of DNA structure, but did not seem to be able to dissociate the two terms and define *structure* in isolation. The same students that described DNA structure had difficulty defining structure by itself. It seems as if they understood the term DNA structure as a chunk, but were not able to demonstrate their understanding of the components of this chunk separately from the discourse domain in which it was learned.

The teacher resident informed the students that this was just an exercise to help her prepare the lessons more focused on their needs. Time was spent talking about the word *structure*, both in isolation and within the discourse domain of science. The teacher resident reported that most students eventually understood structure as referring to the elements that make up a system or an object, but it seems to her that it makes better sense for students if the word structure is attached to a specific element so that they can visualize and then define it more precisely. Structure by itself did not seem to convey any particular meaning to these students. DNA structure, on the other hand, places the word *structure* in a specific and well-defined discourse domain, and this seems to be helping students develop a more complete and contextual understanding of the term.

5.4. Teaching the technical concept "potential energy"

Our fourth teacher resident chose to have his students define the term potential energy (PE), which, as we saw with the term 'structure' importantly involves a collocational issue, a real learning problem for many ELLs, and thus an interlanguage issue. It was argued before that energy in itself could be considered a Tier 2 word (or even tier 1 for some students), as it is a relatively common word used when talking about electricity, weather, and even physical activity and emotional state. The teacher resident thought it would be a good example of a word that does have a specific meaning within the overall discourse domain of science, especially because it refers to position or condition rather than motion. Students in this class had also been studying kinetic energy, which is the energy of motion. Therefore, there was an added interest in checking if the contrast between the two types of energy and the two technical terms (kinetic and potential) and the fact that they were both taught within the same unit in a well-defined context would affect students' definitions. The results can be seen in Table 5.

The definitions the students wrote on potential energy were very much in tandem with the rhetorical function of definition they had been introduced to in

Table 5: Students' Definition of Potential Energy.

COLUMN A	COLUMN B	COLUMN C
ELL Definitions showing mastery of content	**ELL Definitions showing less than total mastery of content**	**Native Speaker Definitions showing mastery of content**
PE is the energy that is storedin an object that is not moving. PE is the energy that is stored in an object PE is energy that is stored in unused objects PE is the energy that makes an object to move with the source intact PE is the energy that is being stored to be used later PE is the energy that is in an object that isn't moving or is still PE is energy in an object that isn't moving	PE is stored energy	Stored up energy PE is stored up energy within an object Energy stored up in an object to be used at a later time PE is stored energy which builds up transferring to kinetic energy PE is energy that can be released if the object's state or placement changes PE is the energy gained from position

class. Column A is an example of how ELLs seem to have internalized Trimble's formula. Once again, they wrote complete grammatical sentences and used appropriate words (stored, object, moving) in their definitions.

One aspect of the definitions created by the ELLs in this class is of particular interest: the way they reiterate their intended meaning by creating tautological definitions, as in:

- PE is energy that is stored in unused objects
- PE is the energy that is being stored to be used later
- PE is the energy that is stored in an object that is not moving.

According to the teacher resident, the use of the words unused, to be used later, or object that is not moving along with the participle stored represents a tautology, as students are combining terms that have similar meanings. These definitions contrast with:

- PE is the energy that is in an object that isn't moving or is still
- PE is energy in an object that isn't moving

In the definitions above, the ELLs do not use the participle stored and choose to express the intended meaning by using the verb moving instead. A more appropriate definition, according to the teacher resident, would be the one from the ELL who wrote "potential energy is the energy that is stored in an object", which is a clear and concise way of expressing the idea of an object having energy when it is not moving.

This aspect of the ELLs definition could be interpreted as either a need to make sure they convey the right meaning, but indicates to the teacher resident that these students may still not understand fully that stored or stored up already carries the meaning of something that is being stocked, accumulated and put away for future use, which is expressed through the words unused, to be used later, or object that is not moving in their definitions.

From this perspective, then, the definition in Column B (PE is stored energy) is considered appropriate as far as meaning is concerned, but it was categorized by the teacher resident as showing less than total mastery of content because it does not identify where the energy is being stored (an object). The issue here relates also to the rhetorical function 'classification,' which we discuss briefly below. In our overall project, we had not reached the stage of introducing this rhetorical information to the teacher residents as yet, so the attempt on the part of the teacher resident to explain the lack of mastery to students was incomplete. We will report on this integration of content at a later date.

In Column C, native speakers did display a wider repertoire in their definitions – energy is built up, it is transferred, can be released, and is gained. With one exception (Energy stored up in an object to be used at a later time), the students who used the participle stored, did so accurately, as in:

- PE is stored up energy within an object
- PE is stored energy which builds up transferring to kinetic energy

Note that one native speaker wrote a similar definition (stored up energy) and, even though it reflects content, it does not reflect academic language use.

The teacher resident reported that he had stressed the difference between potential and kinetic energy by focusing on two terms: position and motion. In fact, the unit highlighted the contrast between these two types of energy within the discourse domain. Two native speakers did use the terms expected by the resident teacher:

- PE is energy that can be released if the object's state or placement changes
- PE is the energy gained from position

The words placement and position indicate that content has been learned, but more importantly, reflect a deeper understanding of the content based on what

was focused on during the class. When this teacher resident brought these definitions to our course, most of the other teacher residents agreed that all students displayed the right content in their definitions, but they also understood that the argument had less to do with content here. The fact that the teacher resident brought up the idea of definitions being tautological is a demonstration that he himself is thinking about language and looking at it differently, which is exactly what he reported in the interview. In another situation or course, the teacher resident admitted he would never have even considered or noticed the meaning carried by the verb store (stored), especially because if the focus was exclusively on content, all students defined the technical term accurately and showed mastery of content.

What makes this particular definition interesting is that it brings to surface the need for precision and accuracy in the rhetorical function of definition. ELLs did follow the structure of definition they had learned in class, but may have chosen to play it safe by using vocabulary that is familiar to them. 'Safe rules' thus become essential to the teaching and much of the rhetoric of this, along with copious written interlanguage examples, are spelled out in Selinker et al. (1985). In this case, the teacher resident admitted to having used the word store/stored in class to refer to potential energy, but also recognized that its meaning and use was not explained or clarified in class. It did show up in the ELL's output through their definitions and it draws attention to the fact that the input received in class, not only through textbooks, but particularly through classroom talk may be affecting ELLs in a deeper way than the teacher resident had realized. This example demonstrates that teaching academic language is particularly challenging for teacher's perspective, as many teachers (like our own teacher residents) still believe that academic language is restricted to the writing medium and that the textbook or classroom materials may be enough to expose students to academic and technical language. The teacher resident realized that the language used orally in class in helping the students get to a safe place is often as important as what students read in the textbook and also needs to reflect academic use within the discourse domain, and that teacher talk also needs to be technical and academic.

5.5. Teaching the technical concept "dilation"

The fifth teacher resident chose to deal with an academic term that is particularly challenging for students to learn: dilation. The reason is that dilation, as a Tier 1 or 2 word, is commonly associated with the physiological action or condition of becoming larger, wider and bigger. When the teacher resident

first introduced the term in class, students immediately resorted to their personal experiences of having had their pupils dilated at the ophthalmologist (or the eye doctor, as most of them referred to). They understood dilation as an expansion. The teacher resident discussed further examples, such as dilation of the cervix during labor or dilation of blood vessels. The discussion inevitably led to the fact that dilation is a commonly used technical term in the sciences. Considering science as an overall discourse domain, dilation is mostly used the same way most people associate it with, as an enlargement.

When the term dilation is used in the particular discourse domain of mathematics, however, it can either be used to refer to an expansion or, surprisingly, a reduction, i. e., it can refer to an increase or decrease in size. This term used this way is most definitely a Tier 3 technical term that needs to be learned within the specific sub-domain of geometry. A geometrical dilation is a type of transformation that changes to size of an image. The teacher resident understood how challenging it would be to introduce an additional meaning to a term that students understood in its Tier 1 and 2 meaning, but decided that this would also provide an opportunity to develop the concept of definition within a very well defined and specific discourse domain.

In geometry, as described in the given textbook (Larson et al. 2004), dilation is a transformation that produces an image that is the same shape as the original, but is a different size. There were other terms that were introduced as part of the unit and that supported the teaching and learning of dilation. For example, enlargement (a dilation that creates a larger image) and reduction (a dilation that creates a smaller image). The use of a scale factor also helped support the teaching of the technical term, as the scale factor (or ratio) measures how much larger or smaller the image is.

This teacher resident used a variety of well-known pedagogical strategies to help students understand and learn the concept and meaning of the term within the discourse domain. There was a model sentence displayed on the classroom wall: “A dilation is a transformation that reduces or enlarges a figure using the same scale factor in all directions” and students had plenty of visuals that supported their learning.

One week before the teacher resident asked students to complete this particular exit ticket with the definition of dilation in mathematics, he took off the sentence and all the vocabulary associated with dilation from the classroom walls so that no copying would occur. Table 6 presents student sample definitions.

The samples presented above reflect a clear distinction between the definitions created by native speakers and ELLs. All native speakers in this class identified and described dilation as an increase or decrease in size. The native

Table 6: Students' Definition of Dilation.

COLUMN A	COLUMN B	COLUMN C
ELL Definitions showing mastery of content	**ELL Definitions showing less than total mastery of content**	**Native Speaker Definitions showing mastery of content**
– Dilation means a transformation in which you either increase or decrease the size of a shape. – Dilation is when two of the same shapes have different measurements using a scale factor. – Dilation is when something is larger or smaller than the original. – Same image, different size	– To become larger. – The same figure but larger – A dilation would be a transformation where the size of a shape is increased based on a scale factor. – Dilation is when something gets bigger than what they were the first time like the heart and the cats – an increase in the overall shape and size of the original shape – Dilation means to me is a transformation in which the shape or figure grows larger.	– Dilation is when an object increases or decreases by a scale factor – The original picture or shape could become bigger or smaller but keeps the same shape and keeps is measurements on a scale factor – Dilation is when you increase or decrease ONLY the size of the shape by a scale factor, for example if you had a scale of 2 a side with the length of 2 would turn into a length of 4. – A Dilation is a transformation where the original figure enlarges or decreases based on a scale factor. – Dilation is a transformation in which you either make the original shape smaller or larger based on the number you multiply or divide the original shape by. – transformation in which an object is enlarged or reduced based on the scale factor given – Dilation is two visually similar images scaled up or down by a certain value. – Dilation: is the decrease or increase of a shape, changing the position and size – however not changing the actual shape.The increase or decrease in size of a shape while the shape is not distorted.

speaker definitions were not only more complete in terms of reflecting a deeper understanding of domain content, but they also used other terms presented in class and qualified their definitions appropriately, as in:

- The original picture or shape could become bigger or smaller but keeps the same shape and keeps is measurements on a scale factor
- A Dilation is a transformation where the original figure enlarges or decreases based on a scale factor.
- Dilation is a transformation in which you either make the original shape smaller or larger based on the number you multiply or divide the original shape by.

Some ELLs did get the meaning right and wrote definitions that were grammatically and rhetorically appropriate. Their definitions did focus on the specific meaning of dilation in the domain of geometry and they displayed this knowledge by using larger/smaller and increase/decrease, as in:

- Dilation is when something is larger or smaller than the original
- Dilation means a transformation in which you either increase or decrease the size of a shape.

When the ELL did not explicitly state the change in size in terms of increase or decrease, but was still able to identify different measurements, the teacher resident believed that content was learned, and the ELL resorted to terms like 'two of the same shapes' and 'scale factor' to demonstrate the understanding:

- Dilation is when two of the same shapes have different measurements using a scale factor.

One definition was particularly challenging to categorize: same image, different size. The teacher resident admitted that the definition did not follow the rhetorical-grammatical structure discussed in class and that the ELL did not even write a complete sentence. However, given the large number of ELLs that did not recognize the possibility of decrease in size (see definitions in Column B), the teacher resident decided to focus on content only. He believed that, even though the ELL did not write a definition, the content was learned by the choice that the ELL made in using the terms same and different, which, from the teacher residents' perspective, reflects the underlying knowledge of two sizes.

This view was not shared by all course participants. This teacher resident brought the definitions to our course and also shared his notes of the process of teaching the term during our sessions. Dilation was the term that created most discussion and disagreement among the teacher residents. Some course participants did not know that the term could be used to express decrease in size and

thought that the choice was not a good one to be used as part of the teaching and assessment of the rhetorical function of definitions. Their reasons are listed in the definitions provided in Column B where we have most ELLs still associating dilation with an increase in size.

The reason why the teacher resident decided to accept the definitions in Column B, but categorized them as showing less than total mastery of content is because from his point of view, ELLs did understand the meaning partially, i. e., they identified one element of dilation (increase) and not the other (decrease). Moreover, he pointed out that some definitions were written appropriately and demonstrated that most of the content was there, not just through the increase-decrease dyad, but also through the use of scale factor and transformation, as in:

- A dilation would be a transformation where the size of a shape is increased based on a scale factor.
- Dilation means to me is a transformation in which the shape or figure grows larger.

Most ELLs, though, still associated the meaning of dilation to increase. Except for the definition "to become larger," the other two ELLs did mention 'same figure', and 'overall shape and size of the original shape', which do tell the teacher resident that, once again, there is an underlying meaning of change of size that may still be developing:

- To become larger.
- The same figure but larger
- an increase in the overall shape and size of the original shape

In one definition, the ELL used one of the examples that was used in the beginning of the unit (the dilation of the heart) when the students were comparing the use of dilation across discourse domains:

- Dilation is when something gets bigger than what they were the first time like the heart and the cats

A closer look at the definitions written by ELLs allow us to develop a number of assumptions. ELLs may be simply relying on the meaning that they know and are familiar with when writing the definitions, a form of learning transfer. The purpose of dilation may have not been clear to the ELLs, either. They could also just be still not sure of how to express the meaning of decrease because this is new information that is still being processed, and they demonstrate this developing understanding by using terms like figure, shape, size, transformation and scale factor. What is particularly interesting in these definitions is it may be one key to the way interlanguage evolves in specifically learner-created discourse

domains. These ELLs seem to be working through language and content simultaneously and may be able to display a more coherent and comprehensive understanding of the term in this particular discourse domain when provided additional input, feedback and further opportunities to rehearse and practice,

Ultimately, we could infer that the ELL definitions of dilation provides another example of how ELLs resort to the safe spaces when unsure or when still developing their language and understanding of the content. Most ELLs simply held on to their safe space, just like they had done when defining potential energy and this may cause a barrier in some cases to further learning.

6. Discussion and conclusions

The case study described in this paper reports on an initial attempt at providing content area teachers the linguistic support they need to teach the language of their content, and thus the content itself, especially to ELLs. When we started teaching this MA course, we noticed that these content area teachers without exception did not have an understanding of language as an object of study. They are language users of course, but are now expected to become language experts within their respective science discourse domain. The problem is that content area teachers, novice and experienced, do not generally see themselves as language teachers. The teacher residents were not convinced initially that their role also included being a language teacher and hesitated at first. However, once they learned about the policies and the new standards for their professions as well as the expectations for academic achievement, high-stakes testing, and the factors that contribute to student success, they became convinced of the need to develop a deeper and more solid understanding of language – language as content, as we called it, especially as they saw success on the part of the ELLs, as described in the data section.

In this paper, we have described an approach that unites the discourse domain hypothesis of interlanguage with the work developed over a lifetime by Louis Trimble, who clearly and precisely described and identified specific rhetorical functions that enable students to understand language within the discourse domains with relevant grammatical exponents added to by various linguists. We have tried to show that there was impressive success within the rhetorical function of technical definition with students in five different high schools and that practical outcomes were effected by applying this discourse domains view in an area where no one is a native speaker of the language use being learned. We have contributed here to the issue of how exactly learners'

interlanguage creation interacts with their understanding of scientific concepts. By gaining precision in using the safe rhetorical-grammatical template of expressing definition, they have demonstrated to the teacher residents that they are on the way to mastering content. We think this then becomes an interesting unattested type of grammaticalization (cf. e. g. Kuteva 2001), and linking up with that literature remains an interesting background possibility.

In using these templates, something surprising happened when ELL data was compared with native speaker data. In terms of precision of definition and structure of definition, there were times when the ELLs were more precise than native speakers (e. g. evolution, potential energy). This may reflect the need of the ELL to work on the *process* of conveying meaning, especially in an assessment context. The need to make relevant meaning on the part of interlanguage speakers is well known, and here in this context, they are forced into explicitness by having to show that the technical subject matter content has been mastered through following the grammatical order of definition as described by Trimble and colleagues filtered through the teacher residents. At this point, we can safely say that being forced into explicitness in domains of knowledge important to learners, adds to our understanding of interlanguage development by context. Whether this type of precision becomes possible in more complex rhetorical functions showing content mastery remains for us to be testing in the coming semesters.

In our data analysis, we concentrated on the semantics and grammar of the rhetorical function of definition, but other functions kept intruding, especially classification. Though definition is basic to scientific and technical language and subject matter knowledge, we kept emphasizing to the teacher residents that this definition function does not occur in isolation and that this function is not the only rhetorical function with grammatical consequences. We saw above that categories, and thus, classification, is often essentially involved in understanding and producing definition and that classification is itself a complex rhetorical function. It is linguistically interesting to contemplate distinctions between definition and classification, which can be subtle. Definition deals with one member of a class, and the related rhetorical function of classification deals with all members of that class, though the class can be, in principle, open. Classification, to be complete, also has three sets of information, parallel to definition but with key differences (Trimble 1985: 86):

1. the name of the rhetorical class
2. the members of that rhetorical class
3. the basis of classification

One crucial difference between definition and classification is that in the *differentiae* of definition, the information isolates the focused-on member from other

members of that class, whereas in classification, there is emphasis on the basis of features that are shared by all the members of that class. Interestingly, there is another difference between definition and classification, where classification can be a two-way process, either, top/down, from the class to its members or, bottom/up, from one member of a class to the class itself. There is more grammatical variation with classification than with definition, but a safe way to produce formal classification involves the prototypical surface syntax of existential sentences; we have created an example derived from *Wikipedia* entries:

> "There are three subclasses of mammals: monotremes, marsupials, and placental mammals, all possessing "a neocortex (a region of the brain), hair, three middle ear bones and mammary glands. Females of all mammal species nurse their young with milk, secreted from the mammary glands." (https://en.wikipedia.org/wiki/mammal),

Then each subclass can be defined in a safe manner, as shown above.

In the cases presented here, we have tried to show that over-emphasis on acquiring individual words, i. e. a concentration on acquiring vocabulary, on lexical semantics solely, is deeply deficient. With necessary discourse level semantic choices, we have hinted that underlying semantic primes such as truth conditions, presupposition, entailment, construals and the like appear to us basic to the rhetoric briefly outlined here. This is one area where second language learners, even at the most advanced level of proficiency have issues with divergent deep semantic concepts (see Selinker 2014 for interlanguage analysis of several examples), a clear difference between native and other speakers of English. If this is true on a wide basis, there must then be confluence pushing scientific and technical rhetoric to considerations of semantic and grammatical concerns of descriptive and theoretical linguistics. Early on, there was one attempt to specify the connection between theoretical linguistics and the semantic concept of presupposition with factive/nonfactive verbs, analyzed in their relationships to rhetorical-grammatical principles (Bley-Vroman et al. 1973). Non-native speakers can get lost in trying to understand or produce information that distinguishes what is asserted vs. what is presupposed, which seems to be part of native speaker competence, and is often not understood in textbook explanations. Information of this type is needed by teachers of ELLs to clearly describe what is happening in relevant discourse and to provide safe ways of expressing desired semantic content.

In general, what is missing here is an interlanguage semantics beyond the lexical level. Selinker (2014) details some of these relationships in interlanguage studies in a suggested semantic computational frame and provides an initial attempt at spelling out how one would build an interlanguage semantics, something deeply lacking in current applied linguistics and second language

acquisition. This is one background area of research important to the development of teaching for our program. Language transfer is an interesting factor here with its long history in applied linguistics going back at least to the early 1800's (Odlin 2014). In general, in studying second language learning, we expect transfer to occur, but in this case, given the Trimble epigraph printed above, that no one is a native speaker of academic and technical English, we would expect transfer not to be a serious factor in learning to control technical content and the grammar that can go along with it. It would be interesting to study various native language groups to see if language transfer is a factor at this level of language learning, which, we predict, should not be the case, or at the most, a minimal factor.

However, there is another type of transfer that may indeed be relevant, viz. cross-domain transfer: students here learned the terms in context and it appears that they could not always transfer that knowledge to other content areas or contexts (e. g. structure). We could argue that they learned the use of certain terms in their Tier 3, but not Tier 2 use. For example, in producing definitions, many times the ELLs followed Trimble's rhetorical structure of a definition, and its attendant grammar, more precisely than native speakers. There is much to test here in the important area of native speaker vs. ELLs, including the question of whether learning a technical term within its discourse domain facilitate its understanding and use across technical domains for both ELLs and native speakers.

Verb tense was simple here with formal definitions in the data where equation-type sentences mostly involve present tense choice. However, we predict that issues with tense are sure to arise when more complex grammar is involved, such as when definition is combined with classification, and subordination is involved, or when such functions as description (of an apparatus, say, Trimble 1985: 123). In many of these cases, there will be issues with tense choice and/or tense sequencing. Especially in the formal writing in these domains, non-temporal choice of tense can be dominant. Numerous studies of rhetorical-grammatical analysis have shown that there are non-temporal semantic factors governing tense choice and tense sequencing (e. g. Lackstrom et al. 1970; Lackstrom et al. 1973; Bley-Vroman et al. 1973; Selinker et al. 1976; Wingard 1981; Oster 1981). Some of these are summarized in Trimble (1985: Ch. 8). Even at the very highest most advanced level of proficiency (including one of the authors of this paper), non-temporal choice of tense and subsequent tense sequencing are difficult areas for ELLs. Observing our teacher residents, we see that native speakers have an advantage over ELLs, one reason being that for ELLs, there appear to be "transfer-of-training" effects (Selinker 1972) wherein the teaching of tense, and textbooks that support such, tense choice is almost entirely linked to time. If the time governs tense rule is transferred to the

domains of academic and technical discourse, it often causes errors in both tense choice and, even with the most advanced interlanguage speakers, tense sequencing (Lackstrom et al. 1970; 1973; again provide numerous examples of this and of related article use). We predict that some native speakers at least, will have less of this problem and they will immediately recognize other governing factors in tense choice and tense sequence. These claims are testable and we are planning to introduce some of this material in this coming semester.

An interesting related researchable issue that arose even for native speakers is that our teacher residents reported that, as a result of our approach, they themselves were practicing language (in and outside our course and their classrooms) and that they also implemented a similar approach from our course in their classes, and in their own writing. From our experience, this tiered approach to language and content teaching promotes linguistic awareness and develops inquiry-based learning among teacher residents. They report that they found themselves observing language use around them among friends, family members, and when out on the streets. They started holding discussions in their classes about different uses of language and the importance of understanding language contextually within the various discourse domains. One of the premises of using the rhetorical function of definition, as in all rhetorical functions, is that they must be rehearsed. We have noticed that engaging teacher residents in talking about language as an object affected their understanding of academic discourse in general, and of their respective content domains in particular. It seems that the more they rehearsed these forms, the better prepared to take these and integrate them into their teaching they became.

The findings of our case study thus call for infusing teacher preparation programs with language as content. At the beginning of the course, the teacher residents commented on how language had never really been a part of their preparation and that academic language and discourse were theoretical concepts that were never made palpable and relatable in their previous experiences. They had certainly been exposed to the academic language of their discourse domains, but had never used it as content in their previous university courses. We noticed that, as the semester progressed, so did the teacher residents' ability to use the technical terms they were teaching more confidently and to talk about their content in technically and academically meaningful and appropriate ways. Engaging teachers in academic discourse had an almost immediate application to their teaching, as the discourse of their domains becomes more visible and concrete.

When the teacher residents collected the exit tickets and found that the definitions did not correspond to the expected content and form, they needed to create more opportunities for rehearsal. In this case study, the exit ticket thus served its purpose as formative assessment, as the teacher residents decided to create

additional opportunities for students to practice the technical terms and talk about them in class. This result solved a problem of what to teach when. We have found that the marriage of the discourse domain hypothesis of interlanguage with specific rhetorical functions can thus better support teacher preparation, especially given how challenging it is for content area teachers to translate the relationship of language and content in the classroom without relying solely on instructional strategies and techniques that are merely pedagogical facilitators.

There are of course limitations to such a practical case study. As is well known, research done directly in practical contexts creates a situation where it is extremely difficult to control potentially vitiating variables, significantly in this case those related to transfer of various types and native speaker learning vs. learning by ELLs. We did our best to try to control what we could, and to carefully keep track of what we couldn't. Our sample is small and may not be representative of a larger ELL student population. We do not claim to be able to confidently make any broad generalizations since our analysis is restricted to our sample and case study. However, based on our emergent findings and the rich qualitative data provided by the interviews, class observations and field notes, we can attest to the role that instruction played in socializing these students in academic language used across content areas, even after one semester, and that such pedagogical input helped to meet the needs of these teacher residents and their students.

The concept of "domain", though so practically useful, continues to be problematic. First, there is the question of so-called external domains vs. cognitive internal domains and how to link them, a problem not unique to us, but one that we must eventually face. Also, it is clear that we at times are talking about domains on various levels, a problem of categories and classification, and one that we tried to be consistent on using sub-domains when an incipient inclusiveness appeared. Obviously, a theory of the hierarchy of discourse domains would be useful, but still needs to be worked out. It is beyond the scope of this paper to attempt to do so.

But, in sum, given the promising results above, our next applied step at least, is clear. Definitions most often involve categories and thus, the rhetorical function of classification and a safe way to teach classification using existential sentences is what we are developing with basic semantic primes in mind. We have decided to move next to presentation to teacher residents, and a study of such, of the rhetorical function of classification, integrating that into what we have discovered so far with definitions. Based on what we have done and seen so far, we propose consideration of the approach described in this paper both as a protocol to be used in teacher education programs and as an area of inquiry where language and interlanguage as conceived of here, take center stage in content area teaching, mediating teaching and learning.

APPENDIX 1: "EST RHETORICAL PROCESS CHART" (UPDATED, Trimble 1985, 11)

CHART 3.1 EST RHETORICAL PROCESS CHART

Level	*Description of level*
A.	*The objectives of the total discourse* EXAMPLES: 1. Detailing an experiment 2. Making a recommendation 3. Presenting new hypotheses or theory 4. Presenting other types of EST information
B.	*The general rhetorical functions that develop the objectives of Level A* EXAMPLES: 1. Stating purpose 2. Reporting past research 3. Stating the problem 4. Presenting information on apparatus used in an experiment – a) Description b) Operation 5. Presenting information on experimental procedures
C.	*The specific rhetorical functions that develop the general rhetorical functions of Level B* EXAMPLES: 1. Description: physical, function, and process 2. Definition 3. Classification 4. Instructions 5. Visual–verbal relationships
D.	*The rhetorical techniques that provide relationships within and between the rhetorical units of Level C* EXAMPLES: I. Orders 1. Time order 2. Space order 3. Causality and result II. Patterns 1. Causality and result 2. Order of importance 3. Comparison and contrast 4. Analogy 5. Exemplification 6. Illustration

APPENDIX 2: "RHETORICAL-GRAMMATICAL PROCESS CHART" (Lackstrom et al. 1970, 2)

LEVEL	DESCRIPTION OF LEVEL	GRAMMATICAL CHOICE
A	The Purpose of the Total Discourse **Examples:** Presenting information Recommending Providing a total record Presenting a proposal Detailing an experiment	Article
B	The Functions of the Units That Develop the Purposes of Level A **Examples:** Reporting past research Discussing theory Stating purpose Describing apparatus Explaining an illustration Stating the problem	Most tenses in EST Article
C	The Rhetorical Devices Employed to Develop the Functions of Level B **Examples:** Definition Classification Explanation Description (physical, function and/or process) Argument	Article
D	The Relational Rhetorical Principles That Provide Cohesion Within the Units of Level C **Examples:** Natural principles: Time order Space order Causality (sometimes) Logical principles: Comparison and contrast Analogy Examplification Causality (sometimes)	Article

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