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Book Review on Language, Literacy and Learning in STEM Education

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Abstract

Language, Literacy, and Learning in STEM Education is a comprehensive examination of the role of language and literacy in science, technology, engineering, and mathematics (STEM) education. The book provides an in-depth look at the ways in which language and literacy skills impact student learning and achievement in STEM subjects, and offers practical strategies for addressing the linguistic and literate demands of STEM education. Through a combination of research, case studies, and practical examples, the book offers a valuable resource for educators looking to support the linguistic and literate development of their STEM students.

Keywords: STEM Education, mathematics, language, literacy, learning, interdisciplinary.

1. Introduction

Language, literacy, and learning in STEM Education is a collection of essays on the relationship among applied linguistics and the fields of science, technology, engineering, and mathematics (math). The book is the first in a series that was started "to distribute tasks at the interplay of language education and STEM" (p. xv). The book's seeds are the numerous projects that have been evolved over the period of several years all over linguistic theory and STEM, and the book's plant is the eventually results tree of (interdisciplinary) expertise. Mary Jane Curry and David I. Hanauer (Eds.) wrote the book, which was released in 2014 by John Benjamins Publishing Company, Amsterdam/Philadelphia.

In order to create new multidisciplinary approach, this book series aims to gather combined experts from the domains of language studies and science/engineering education. This book series is based on the idea that science is crucial to the twenty first century and that

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linguistically inspired studies may improve how science and engineering are described, understood, taught, and practiced. Through multidisciplinary collaboration among language scholars, science and engineering education professionals, and scientists, this series aims to improve both professional and educational procedures in the sciences and engineering.

The book is primarily targeted towards STEM and language professionals, although it is equally understandable to readers with a broader range of interests. A source of motivation for everyone interested in the educational process, the book does contain some portions that readers may find a little too technical and tiresome. The authors have compiled research studies from the disciplines of math, engineering, microbiology, and chemistry. Although technology is not included, the term STEM has been utilized for simplicity (p. 2n). The connection between discipline-specific language and literacy and a sociocultural theory of learning—which maintains a balance between theoretical analysis and real-world examples—is the central theme of the entire book. Ten chapters make up the book; the first is an introduction in general, and the remaining nine are separated into four primary categories: science, engineering, mathematics, and future prospects.

2. Summary of content

The collection of books called Language Studies, Science and Engineering includes the book *Language, Literacy, and Learning in STEM Education*. According to the introduction, the main objective of this book series is to offer practical and multidisciplinary information developed through interaction between applied linguists and STEM (science, technology, engineering, and math) specialists (pp. xv-xvi).

There are ten chapters in all in this book. The first chapter offers some underlying theoretical orientations, while the next nine chapters are divided into the following four sections to match to the ideas described in the main objective:

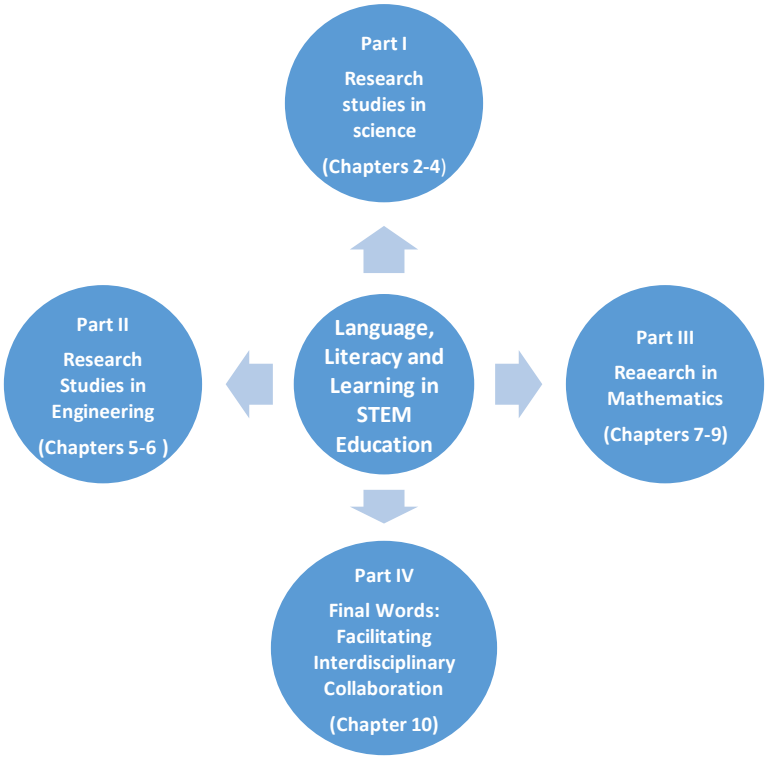

Figure 1. Summary of the book's contents

Because literacy development is frequently overlooked throughout college years, Part One's Chapters 2 and 3 discuss the challenges STEM learners may face in their academic careers, particularly when preparing a dissertation. Enhancing writing abilities (research articles, abstracts, reports, etc., properly investigated with regard to colloquial expressions, verb sentence structures, vocabulary frequency, and more), as well as ESP instruction, are some solutions. The findings are unquestionably intriguing. For instance, "considering the widespread perception that scientific language does not use first-person pronouns (e.g., I, us), we investigated historical changes in the use of the first-person plural 'we' in three chemical journals throughout three time periods" (p. 16).

In in addition to the studies on applied linguistics and chemistry, investigations and multidisciplinary operations are also described. These include a case study on freshmen and how they learn to speak in CI (Communication Intensive) programs, as well as a paper on lab notebooks. David Hanauer's Chapter 3 is particularly helpful since it demonstrates how teachers instruct students to describe their experiments in depth and step by step so that they may be easily repeated by others.

Moreover, there are two chapters (5 and 6) in Part 2 which focus on engineering. The first chapter (5) of part two is research on "the link between interdisciplinary epistemology, ideology, and writing in engineering" which was compiled by Julio Gimenez (p. 68). Analytical hypotheses, data coding, writing as a social activity, and "the key significance that flow sheets and visuals play in describing the outcomes of the study carried out" are all topics covered in this chapter (p. 79). The preceding chapter which is about graphics and invention was also compiled by Mary Jane Curry, and is linked from flow charts and graphics as a reference for scholarly engineering publications. Under this chapter, she describes the interpretative role of graphics "in contrast to possessing just auxiliary and illustrative roles" (p. 102) against the backdrop of ethnographic study.

One of the collection's most entertaining chapters overall is this one. Readers may be reminded of Abbott's Flatland or Swift's island of Laputa, where the people extol the beauty of a woman by using parallelograms, circles, and rhombs since their language lacks vocabulary for imagination and flair.

"Research studies in mathematics" is the title of Part Three, which encompasses Chapters 7, 8, and 9. It is generally about the interaction between students and instructors in the classroom, including how to teach math in a multicultural environment, what it's like to learn about students' reasoning while teaching, and how to get high school girls interested in a subject that many of them find boring. The first chapter provides a variety of materials. For instance, writing about the students' original language and cultural background highlights the need to deal with false friends, which is usually a productive exercise when teaching a second language.

The authors, Moreira and Latas, mention the terms "root" and "operation" (p. 112); I would also add "figure," which a French speaker might mistake for "face, countenance," or "addition," which a Portuguese or French speaker might mistake for a "restaurant bill," although, of course, this is not often the case with math classes. The two authors emphasize the value of relating mathematics to experience while discussing methodology, attempting to "understand 'reality' from the standpoint of research participants" (p. 114). They discuss the results of a study they completed in a coastal community, connecting the investigation of wind data and surfing which is a common hobby among students. Surprisingly, one of the class assignments called for presenting "the aforesaid circumstance in a manner that everybody could comprehend" (p. 117).

When Galileo wrote Il Saggiatore in 1623, he asserted that the book of nature is written in the language of mathematics. What would he say now? The language should definitely be reintroduced. This brings up linguistic features in the classroom that are "related as far as how

teachers listen" (p. 127), "the persistent problem of gender inequalities in students' acquisition of mathematics" (pp. 143-144), and the overall issue of STEM education.

Finally, the book is concluded by a concluding chapter written by Cynthia Bauerle, Graham Hatfull, and David Hanauer that calls for cooperation between the scientific and applied linguistics sectors. It is astonishing the variety of tasks completed by STEM practitioners and displayed in this volume. The quantity of disseminated academic knowledge is also acknowledged but there are undoubtedly other approaches to learning besides a social perspective.

This, in turn, would not account for neuroscience and its relationship to linguistics, STEM practice, and literacy, that would also explain, among other things, why finger counting differs across the globe and why every individual being is born with grammatical and syntactic understanding. However, David Hanauer believes that *Language, Literacy, and Learning in STEM Education* will be the first in a series that includes more works by "applied linguists and STEM professionals, multidisciplinary collaborations, and research projects" (p. xvi). Because of this, we might also be able to perceive "the force that through the green fuse powers the flower," to continue with the horticulture metaphor.

3. Analysis and evaluation of the book

This book exemplifies attempts to highlight the importance of applied linguistics in the quest to enhance interdisciplinary education. Our students will gain from being knowledgeable of the interdisciplinary interactions among linguistic scholars, science and engineering educators, and scientists since they will be better able to meet the requirements of their courses, institutional policies, as well as the discourse community. In order to improve their learning, applied linguistics and STEM fields should be combined. Reading *Language, Literacy, and Learning in STEM Education* would be beneficial for any language instructor or scientist who wants to involve their pupils in the learning process.

A deeper analysis and evaluation of the book was centered on the part III which discusses mathematical scientific studies. Three chapters (7, 8 & 9) make up this part. The authors of Chapter 7 are Darlinda Moreira and Joana Latas, which is titled "Mathematics Education, Cultural Practices, and Communication." Chapter 8 of Part III, written by Jeffrey Choppin, is titled "Learning while Teaching: How Classroom Discourse Practices Mediate Mathematics Teachers' Learning about Student Thinking." The final chapter of this part is titled "Improving Girls' Interest in Mathematics via Writing: Findings from a Mixed-Methods Study" is Edel M. Reilly's third chapter, which corresponds to Chapter 9 of this part. In order to enhance better understanding of the component of this part, the figure below summarizes the various chapters of the third part of this book.

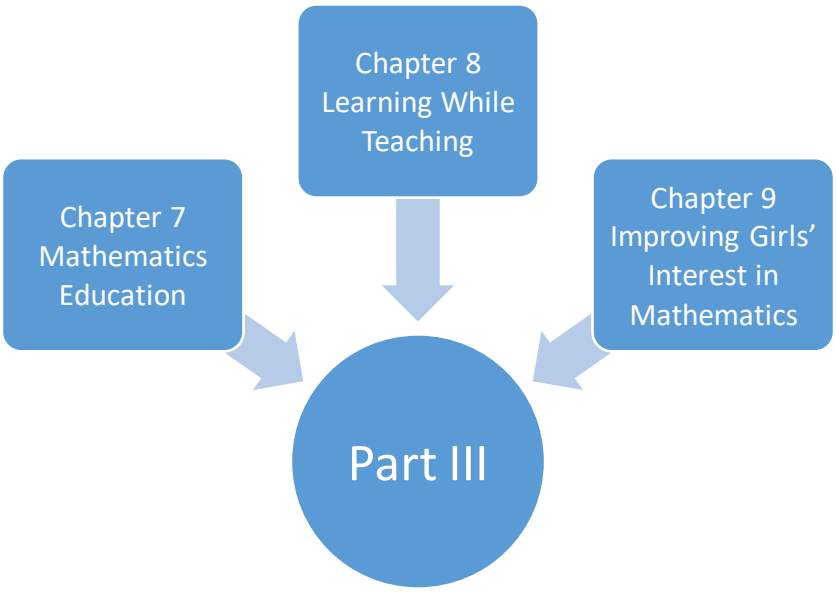

Figure 2. Summary of the chapters in part III of this book

In order to improve conversation and communication in multicultural classes, The authors explored various ways of improving learning of mathematics and making it more real than abstract. The Chapter 7 discusses the role of students' cultural practices in mathematical problems. It begins by outlining the characteristics of mathematical discourse and demonstrating how they relate to the students' home languages and cultures. Mathematics teachers must create strategies to help all students' mathematical learning, irrespective of their cultural, language, and social backgrounds, in light of the multicultural realities of today's classrooms. The idea of cultural practices is then spoken about and framed in relation to mathematical instruction. Barton (2008: 125) made a profound statement that "Mathematics is not a world of triangles, symbols, and rules of reasoning; it is a world of networks of people conversing about ideas." This emphasize on the fact that the construction of mathematical knowledge through the exchange of ideas, using both students' native languages and progressive discipline narratives, or modalities of linguistic is essential in students' learning of mathematics.

I strongly support the authors' assertion that language and culture play a significance role in students learning of mathematics. For instance, in the *Handbook of Test Development* by Dr Jamal el Abedi (2015) titled Language Issues and Item Development, the researcher investigated the linguistic elements that might make it more difficult for students to grasp test items, or language that interferes with the assessment of content. His recommendations were taken by Mrs. Weiss, who made language simplification adjustments in her class. Additionally, she discovered a piece on translanguaging techniques, and she made the decision to use them in her math lesson. Mrs. Weiss noticed an improvement in math test results, self-esteem, curiosity, and motivation after putting the linguistic test item adjustments and translanguaging assessment procedures into practice (Mahoney, 2017: 117). According the Mahoney (2017), "Translanguaging assessment techniques give teachers a means to work with multilingual students to access and evaluate challenging subject." The aforementioned practical example makes it quite evident how important language is to all forms of learning, including mathematics.

Moreover, Chapter 7 depicts an ethnographic investigation done in Portugal that concentrated on math students from low-income families. The use of activities created from the pupils' local surfing culture gives frameworks for resolving mathematical issues. Under this, the author made it very obvious that choosing and using a specific context for a mathematical assignment is essential to establishing a productive learning environment and making the activity

relevant and important for all students. We must therefore stress on how crucial it is for teachers to decide on the type and diversity of contexts to utilize in classroom activities and how pertinent these activities are to students' backgrounds (Alrø et al., 2009; Skovsmose, 2002; Vithal & Skovsmose, 1997).

The authors did an excellent job of supporting their claim that Learning mathematics can be done well by making it more practical to the daily life activities of learners. They supported this claim with an illustration where students considered their favorite sports which is surfing and being assigned to the task of measuring the direction of the wind in page 116. This example demonstrates how students understand how mathematics plays a part in the world around them, even though they are aware that they are not familiar with the mathematical concepts that were used to develop the information about how mathematics can be applied to how surfers perform. This is because the mathematical concepts act at the level of the students' cultural foregrounds. Students' comment that "in meteorological stations they use a lot of math". This confirms that they are aware that mathematics is used in relevant advanced technology, but they were unable to demonstrate how to use this knowledge in practice, i.e., by learning to identify the wind direction, a skill required in a sport like surfing.

In order for students to communicate mathematically and subsequently understand mathematics, the author suggests that sharing cultural experiences in the classroom, creating a common vocabulary for the explanation of mathematical ideas, and creating linkages with mathematical themes all play a role.

The authors did a good job of addressing all the relevant angles and providing relevant, reliable information to back up their claims. I am convinced that if math teachers follow this advice, teaching students how to communicate in mathematics and how it applies to everyday activities, students would gain a deeper comprehension of the subject and develop a greater enthusiasm in learning it. The author draws the conclusion that mathematical activities that link mathematics to the students' real-world experiences help them to grasp and communicate mathematics better.

"Learning while Teaching: How Classroom Discourse Practices Mediate Mathematics Teachers' Learning about Student Thinking" is the title of Chapter 8, the second chapter of Part III, and it was written by Jeffrey Choppin. In order to investigate the relevant claims that teachers' opportunities for listening are related to the linguistic features they use in their classrooms and that what educators learn in the perspective of their teaching is connected to their listening styles, the author focused on building this chapter on Davis's (1997) description of listening practices.

After that, the author used instances from classroom conversations to highlight diverse listening and language patterns and how they affect teacher learning. From evaluative listening and teacher-centric linguistic features to more interpretive listening and interactive discourse practices, the episodes of classroom discourse show a continuum of instructors' listening techniques and accompanying linguistic features. The author also emphasized how the social settings in which these activities are placed affect the objectives and reasons of education and, as a result, how individuals communicate and represent their expertise (Gee, 1999). These viewpoints cast doubt on the idea that information is transmitted, in part because they emphasize the importance of language in education and the idea that knowledge is contextually dependent. For instance, Sfard (2007: 565) claims that participating in discourse activities is equivalent to learning something new and expanding individual's communication.

In the chapter the author employs a mixed-methods approach to analyze and understand how discourse practices influence what teachers are aware of regarding how students learn mathematics in classroom settings. The author did a fantastic job by adopting one of the modern research approaches for the study. According to Creswell and Guetterman (2021), graduate students employ mixed method approach since they want to master the most recent

research approach in research (p. 545). Using a mixed methods approach gives researchers a better understanding of a study topic than either quantitative or qualitative data alone. Mixed methods designs are ways for collecting, investigating, and integrating (i.e., mixing) both quantitative and qualitative data when performing a single study or a multistage series of researches (Creswell & Plano Clark, 2018). According to Miles et al. (2014), "we have a really powerful combination" when one mixes quantitative and qualitative data.

In order to enhance better understanding of the mixed methodology used by the author in the study, I present a notational scheme and visual representations for the design. Visualizing processes and using a Morse-designed notation system has been essential to this way of thinking about various models or designs Morse (1991).

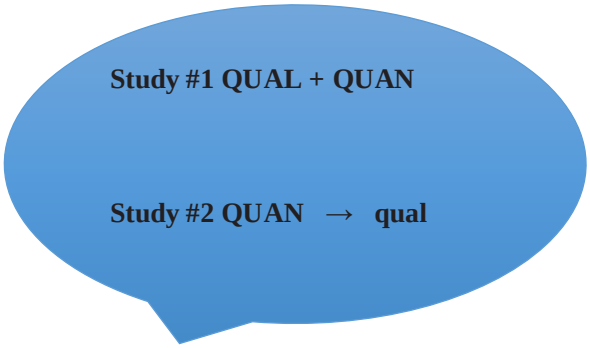

Figure 3. Notation system for a mixed methods study

Notation used:

+ indicates the simultaneous or concurrent collection of quantitative and qualitative data.

→ shows the sequential collection of quantitative and qualitative data.

- Uppercase letters indicate a priority or increased weight for either the quantitative or qualitative data.
- Lowercase letters indicate a lower priority or weight for either the quantitative or qualitative data.

The notation system illustrated above explains the powerful combination of qualitative and quantitative data collection used in the mixed method. It depicts two examples of designs. Researchers can emphasize on both quantitative and qualitative data and integrates or combines the data in the study, as demonstrated in Study #1. In Investigation #2, the researcher places a greater emphasis on quantitative data in the first stage of the study, and a smaller emphasis on qualitative data in the second stage.

The chapter emphasizes the importance of discourse analysis in understanding the practices used in mathematics classrooms for both teaching and learning. The author provided proof for his assertion using three episodes that showed a range of listening techniques and related linguistic trends, ranging evaluative and direct to more interpretative and collaborative forms. Depending on her educational objectives and what she may have intended to learn about her students, the teacher in each situation can be considered to be "productive" in some way.

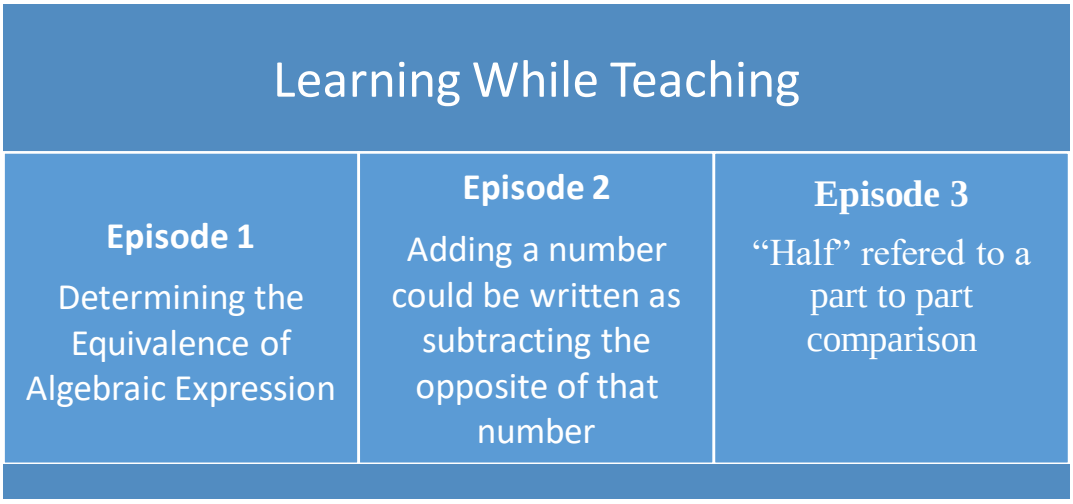

Figure 4. Episodes of learning while teaching

Rudin established a method for figuring out how algebraic expressions are equivalent in the first episode; Browne established that subtracting one number from another can be written as adding that number; and Andrews established that the "half" referred to a part-to-part comparison of cups of concentrate to cups of water in the third episode. The author explained that the finding for the study indicate that the chances for students to justify their decisions, and subsequently for educators to comprehend how students were understanding the mathematics, varied depending on the situation.

The chapter accomplish its purpose on the topic by emphasizing how important discourse analysis is for comprehending how mathematics is taught and learned in classrooms. One of the most important lessons in this chapter is that educators must actually care about students' opinions in order to encourage greater active engagement from them. If STEM educators merely want to get preset answers to their questions, emphasizing interactions and encouraging student thought is a useless exercise. The examples given above demonstrate how the teachers' intellectual involvement with the ideas of the students was reflected in the linguistic elements of the classroom discourse, which acted as cues to encourage more active and significant students' engagement.

It deals with the topic of using writing exercises to help middle school children especially girls to understand mathematics. The author argued that data shows the issue of female low performance in mathematics is still not fully resolved (Beecher & Sweeney, 2008; Hyde et al., 2008; Neuville & Croizet, 2007). In contrast to the CEP findings, Van de gaer et al. (2008) indicate that female students were unable to perform better on standardized tests as their male colleagues. The author therefore conducted a mixed method study with three teachers and their students from Pennsylvania Council of Teachers of Mathematics (PCTM) conference and used evidence from studies conducted by Ntenza (2006) in South African schools, and 22 teachers from schools in Maryland.

The results of the survey used in this research indicated that there is a positive gender difference in attitudes about writing in mathematics classes, with females responding more positively than males. In general, considerably larger proportions of female students perceived writing in their mathematics classrooms as useful to their learning when compared to the male responses to the open-ended questionnaires. The author made the following claim: "Teachers must bridge disciplinary barriers in order to link writing and mathematics." Despite NCTM's demand for work in this field, as Wilcox and Monroe (2011) point out, there is still little study on the integration of writing and mathematics.

The author made a significant declaration at the end of the chapter that "This chapter makes the case that one answer math teachers have been looking for in regards to the issue of assisting female students in succeeding in mathematics classes is writing. Or, to put it more succinctly: Learning + Writing + Mathematics."

4. Conclusion

The authors of the book accomplished the task of making learning of mathematics more practical and drawing math teachers' attention of bringing the daily activities of students to the classroom of which I perfectly agree to that in the sense that we do mathematics every day in our lives, from calculating the distance to travel in driving or walking to shopping at the supermarkets. The illustration of teachers in Portugal teaching students whose favorite sports is surfing to calculate the speed of the wind and waves adds great value to the book since it will remind STEM teachers to make the lessons more practical and link it to the students' daily life activities.

When it comes to ways of improving female students' interest in mathematics made an argument and provided evidence that writing can be utilized to motivate female students to study mathematics. This finding is crucial because finding measures to raise female students' academic performance has historically been a preoccupation of math professors. Even though there has been some improvement in the gender achievement gap, more has to be done to encourage female students to enroll in advanced mathematics courses and seek careers in the field.

This book also offers in-depth knowledge and insight into how applied linguistics and STEM fields interact. The book is also effective at demonstrating the strength and possibility of applying language methods to STEM problems. The publication of cooperative projects as described in this book is beneficial for STEM education, applied linguists, and other language experts. STEM Educators and other language educators can benefit a lot from reading this book and improve on their teaching skills in the classroom.

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