

An Introduction to Researching English Medium Instruction Using Quantitative Research Methods

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Exploring the Complexities of English Medium Instruction

The use of English Medium Instruction (EMI) for teaching content subjects has gained popularity worldwide. There has been a significant interest in exploring different aspects of research in the EMI context, focusing on language and content learning, teaching disciplinary language, evaluating the effectiveness of EMI implementation at various educational levels, and investigating the perspectives of teachers, students, policymakers, and other stakeholders regarding the use of English for instruction. Within this complex landscape, researchers come from diverse backgrounds and orientations. The use of English as a medium of instruction and the exploration of teaching content subjects through English have garnered attention from researchers in various disciplines such as science, technology, mathematics, engineering, medicine, business, history, and sociology. In their recent publication, McKinley and Rose (2019) presented a comprehensive handbook on research methods in applied linguistics, covering the rapid changes in this field. They identify two main types of researchers in applied linguistics: “researcher-practitioners,” who focus on teaching and learning within language classrooms, and “educational psychologists,” who study the cognitive and psychological processes of language learning (2019, p. 1). These classifications are particularly relevant for EMI research, as they underscore the need for an interdisciplinary approach that can address the multifaceted nature of teaching and learning in EMI contexts. The diversity of research orientations represented by these classifications further emphasizes the imperative for a holistic approach to EMI research.

Conducting research on EMI necessitates the integration of multiple disciplinary boundaries, including applied linguistics, education, and language policy. This interdisciplinary approach is crucial for formulating a research agenda that addresses questions about the most effective methods for teaching and learning both language and content. It also involves examining how school-based language policies impact classroom practices, influence teachers’ approaches, and shape students’ coping strategies. Moreover, it considers the

directions set by schools and universities in implementing EMI instruction. To investigate these issues within the EMI context, researchers must possess the ability to conduct scholarly work by employing a wide range of research methodologies that are specifically tailored to address research questions from each discipline. By doing so, the findings can benefit researchers, policy-makers, school administrators, language teachers, and EMI practitioners.

Rationale for This Volume

A recent large-scale systematic review on EMI revealed that methodological issues exist in EMI studies, as few large-scale quantitative studies have been conducted in EMI contexts. There is therefore a lack of concrete quantitative research evidence about whether EMI is beneficial to either language learning, content learning, or both.

Macaro et al. (2018, p. 36) state: “We conclude that the research evidence to date is insufficient to assert that EMI benefits language learning or that it is clearly detrimental to content learning This insufficiency, we argue, is partly due to research methodology problems at both the micro and macro level.”

In Macaro et al.’s (2018) review, twenty-five out of eighty-three studies were quantitative and twenty-seven were mixed methods studies. A high proportion of these studies were classified as “case studies of one institution,” employing mixed methods research with limited sample sizes. Moreover, there is a scarcity of quantitative research, and most studies did not use objective tests to measure the impact of EMI on students’ English language proficiency. Very few studies used standardized tests to measure students’ content knowledge gain. This suggests that the current research methodologies used in EMI studies are somewhat lacking. Therefore, it has been nearly impossible to assess the true costs and benefits of EMI.

Research that focuses solely on one institution as a case study makes it extremely difficult to objectively compare the growth of EMI and evaluate students’ language and content gain in different educational or classroom settings. Such a limitation in research design hinders policymakers or researchers from determining the true impact of EMI. Macaro et al. (2018) also noted that almost no comparative studies between countries and/or institutions have been conducted. The rigor of methodology in EMI research thus does not match that in other fields of study in traditional educational research, particularly that in comparative education (Bray et al., 2014).

Therefore, the lack of rigorous methodology and experimental design in existing EMI literature makes it difficult to address some of the fundamental issues or questions in EMI (Curle et al., 2020; Macaro et al., 2018, p. 69). Consequently, we aim to address two questions in this edited volume: What

issues exist in relation to quantitative research methods of researching EMI? How can these quantitative research methods help researchers and students investigate a specific issue in the field of EMI? Quantitative research methods allow students and researchers to measure the effectiveness of EMI interventions on students' content knowledge and proficiency in English.

In this volume, each chapter focuses on a specific type of quantitative research method in the EMI context. This volume differs from the majority of English as a First Language (EFL), English for Academic Purposes (EAP), and English for Specific Purposes (ESP) books as it not only reports a research study but also explains how the selected research method and instruments were used to generate findings specific to the EMI area. It explores issues central to EMI classrooms, distinct from other contexts such as EFL, EAP, and ESP. As Pecorari and Malmström (2018, p. 499) elaborated in their definitions of EMI, it is different from other classroom contexts: "English is not itself the subject being taught; language development is not a primary intended outcome."

This book addresses current central themes within EMI research and explores the research methodologies used to investigate those themes. The chapters document the processes EMI researchers underwent to conduct their research, highlight key dilemmas they faced, and particularly focus on the methodological issues they encountered. By exploring these issues, this volume aims to inform the theory (or lack thereof) underlying research into the phenomenon of EMI. This volume is indispensable for EMI tutors, EMI education curriculum officers, EMI researchers, education policymakers, higher education educators, and undergraduate and postgraduate students specializing in fields such as applied linguistics, language education, ESP, ELT, and Teaching English to Speakers of Other Languages.

Volume Structure

This volume aims to serve as a comprehensive resource for students and researchers in the field of EMI education. It offers guidance on adopting quantitative research approaches to study selected topics within EMI. This methodology is particularly useful for exploring the intricacies of language teaching and learning, and content delivery.

The goal of this book is to equip researchers and postgraduate students with accessible, manageable, and practical advice on how to adopt quantitative research methods (specifically, experimental designs) in researching the complex phenomenon of EMI. These methods provide practical tools to measure the effectiveness of EMI implementation, such as measuring actual learning and/or content knowledge growth of students in EMI classrooms, evaluating the effectiveness of an EMI program, and assessing EMI teacher training, to name a few. This book aims to serve as a primary resource for researchers who

wish to expand their knowledge of both EMI topics and quantitative methodological approaches.

The volume is divided into two parts: (1) theoretical chapters and (2) empirical/case study chapters. Each chapter elaborates on a quantitative research approach, either by reviewing studies that have used that method and describing how it can be used in EMI research or by reporting an actual case study that demonstrates the use of a specific quantitative research method. In each chapter, we first introduce the quantitative approach and its rationale and implications for EMI research, then provide readers with specific examples of the discussed research method and illustrate how the method can be applied in the field of EMI. While it is impossible to include all kinds of research methods in one volume, we have chosen to focus specifically on quantitative research methods and experimental designs. To provide empirical evidence on the relationship between EMI and language teaching and learning, quantitative research methods can serve as the main method of study or be embedded within a mixed methods research design. Therefore, we have selected research approaches and methods that have been frequently adopted in the context of EMI in recent years. These research approaches provide examples for EMI researchers who adopt a purely quantitative method design or a mixed methods design. We have selected topics in EMI as examples to illustrate the selected methods that have been frequently researched.

Descriptive Chapter Summaries

To explicate the thematic coherence and methodological diversity of this volume, the following summaries offer an overview of each chapter's focus and contributions to the field of EMI research. Chapters 1–4 are theoretical chapters and Chapters 5–14 are empirical chapters.

Chapter 1 explores the implementation of EMI in diverse settings, highlighting challenges such as teacher proficiency and classroom dynamics. It utilizes international assessments such as the Programme for International Student Assessment and Trends in International Mathematics and Science Study and observes benefits of mother-tongue instruction. It concludes with recommendations for EMI practice and features a Welsh case study on assessment fairness. **Chapter 2** presents the use of the analysis of variance (ANOVA) test in EMI research. It demonstrates ANOVA's application through two case studies, examining students' perceptions and academic performance. The chapter also discusses ANOVA assumptions, potential issues, and alternative methodologies. **Chapter 3** examines the design and development of Likert-type scales and response categories in an online questionnaire for a case study at an EMI university in Hong Kong. The study scrutinizes students' attitudes, challenges, and perceptions. It discusses various rating scale formats and the influence of

design decisions on data collection and analysis. The chapter also provides insights on choosing the most effective survey design and format, despite a lack of established guidelines. **Chapter 4** highlights systematic literature reviews in EMI research, emphasizing their role in consolidating diverse findings and reducing bias. It provides a step-by-step guide for these reviews, discusses their implications and limitations in the EMI context, and delves into quantitative approaches such as systematic quantitative reviews and meta-analyses. **Chapter 5** focuses on introducing partial least squares structural equation modeling (PLS-SEM), a powerful statistical analysis technique advantageous in many social science research scenarios. It is shown as an alternative to the widely used covariance-based SEM (CB-SEM) for studying latent phenomena such as perceptions, attitudes, and intentions in EMI. Using an EMI-related case study for demonstration, the chapter explores the potential applications of PLS-SEM in various EMI research contexts. **Chapter 6** employs exploratory factor analysis to study grammatical complexity in second language (L2) writing using a corpus of EMI students' scientific reports. It presents a step-by-step guide to utilizing Second Language Speech Communication Anxiety (L2SCA) and Statistical Package for the Social Sciences (SPSS), revealing three dimensions of grammatical complexity. The findings endorse grammatical complexity as a multidimensional construct, offering insights for future EMI research. **Chapter 7** introduces Rasch modeling as a solution to inherent issues with questionnaire data interpretation in educational research. Three case studies applying this model for scale development and validation are discussed. The chapter also outlines a detailed analysis procedure using Rasch Measurement in a study of 102 Chinese undergraduate students' attitudes toward EMI, revealing insights into course design for Chinese EMI institutions. **Chapter 8** applies questionnaire-based research in EMI, utilizing an adapted Attitude/Motivation Test Battery (AMTB). It validates the scale, probes correlations among various motivational factors, and scrutinizes the impact of demographics. It endorses the survey method's effectiveness in EMI, highlighting the potential of mixed methods approaches. **Chapter 9** explores the effects of EMI on language learning through corpus-based analysis. It reviews relevant literature, details the method's application, and showcases a study examining learners' phraseological competences over time within an EMI course. The study demonstrates the value of corpus-based analysis in EMI research, proving that this methodology provides quantitative evidence of language learning progress and the impact of input on learners. **Chapter 10** applies path analysis, a quantitative method, to a study on factors influencing students' academic achievement in EMI science courses. By examining data from eight EMI secondary schools in Hong Kong, the study highlights the interplay between EMI proficiency, language use in the science classroom, perceived English difficulty, and self-concept on science learning. The chapter underlines the value of path analysis

in refining theoretical models within the EMI context. **Chapter 11** details a survey distributed to students in an EMI course who completed a collaborative writing assignment. A combination of descriptive statistics and inferential statistics (paired sample *t*-test) was used for data analysis. Results showed that students saw the assignment as a means of alleviating emergency remote teaching-related stress. Significant improvements were observed in online engagement regarding skills, emotion, and participation. However, no significant correlation was found between online collaborative writing and students' performance in tests and quizzes. **Chapter 12** employs a one-way between-groups multivariate ANOVA to examine gender differences in perceived English language challenges within an EMI university context. The dependent variables were perceived writing and speaking challenges while the independent variable was gender. Results revealed significant gender differences, particularly in perceived speaking challenges, with females finding it more challenging than males. **Chapter 13** discusses a longitudinal quantitative study examining students' perceptions of lecture listening difficulties during their transition into an EMI university in China. The study highlights the importance of considering learner factors, such as English listening proficiency, in understanding these perceptions. Methodological procedures, and handling challenges of attrition and missing data, are also discussed. The chapter concludes with insights for future EMI research and critical reflections on the study's limitations. **Chapter 14** introduces the principles and practices of an additive multidimensional analysis, a corpus-based analytical framework, in the context of EMI studies. The methodology is demonstrated using a case study involving the Singapore EMI corpus. The chapter also shows how to identify text types through cluster analysis, providing further insights into EMI classroom discourse.

These chapter overviews highlight the volume's comprehensive approach to quantitative research in EMI, serving as a roadmap for scholars, practitioners, and policymakers interested in this multifaceted educational context.

Chapter Overviews and Thematic Progression

This volume is structured to provide a comprehensive understanding of the quantitative research methods applicable to EMI. It is divided into two overarching parts: theoretical frameworks and empirical case studies. Within these parts, chapters are grouped by thematic focus, allowing for a nuanced exploration of key topics in EMI research.

Questionnaire Design and Attitudinal Studies

Chapters 3, 7, and 8 delve into the intricacies of questionnaire design and attitudinal studies. Chapter 3 sets the stage by examining the design and

development of Likert-type scales in an EMI context. Building on this foundation, Chapter 7 introduces Rasch modeling as a sophisticated tool for questionnaire data interpretation, while Chapter 8 validates the AMTB for EMI research. Together, these chapters offer a comprehensive guide to designing, implementing, and interpreting questionnaires in EMI settings.

Complexity in EMI Research

Chapters 6 and 14 focus on the theme of complexity in EMI research. Chapter 6 employs exploratory factor analysis to study grammatical complexity in second language writing, revealing it as a multidimensional construct. Chapter 14, on the other hand, introduces additive multidimensional analysis, a corpus-based analytical framework, to explore complexity in EMI classroom discourse. These chapters collectively contribute to our understanding of the multifaceted nature of language and content in EMI.

Statistical Methods and Their Applications

Chapters 2, 5, and 10 explore various statistical methods and their applications in EMI research. Chapter 2 introduces the use of ANOVA, Chapter 5 discusses PLS-SEM, and Chapter 10 employs path analysis. These chapters not only provide a toolkit of statistical methods but also demonstrate their applicability in addressing diverse research questions in EMI.

Additional Themes

The remaining chapters cover a range of additional themes, from the implementation challenges discussed in Chapter 1 to the methodological considerations in longitudinal studies highlighted in Chapter 13. These chapters serve to round out the volume, providing a broad spectrum of methodologies and research concerns in EMI.

Conclusion

In conclusion, this volume serves as a pivotal resource by focusing on the quantitative approach to EMI research. Its contributions are highly relevant to a broad spectrum of scholars in educational linguistics, including those engaged in English language teaching, content-based instruction, and content and language integrated learning. By offering a rich array of insights and methodologies, the volume has the potential to be a catalyst for future developments in these educational domains. As a comprehensive guide, it is positioned to be an indispensable resource not only for academic researchers but

also for education policymakers, schoolteachers, and students majoring in English and education. The volume offers clear, actionable guidance on the application of quantitative research methods in EMI, thereby enhancing the reader's ability to navigate this complex, compelling field.

Each chapter in this volume illustrates a different quantitative approach, providing robust examples to showcase how each mentioned method can be applied in EMI research. The illustrations serve as an important guide for those looking to explore EMI, as they highlight real-world applications of these methodologies, thereby making the information more tangible and accessible. The significance of this volume goes beyond its immediate audience. The exploration of various quantitative approaches in EMI research contributes significantly to the broader academic discourse. It enriches the repository of knowledge and methodologies used in educational linguistics, paving the way for more rigorous, nuanced, and insightful studies in the future. It challenges and encourages EMI researchers to employ more sophisticated methodologies, which can capture the complexity of EMI more accurately. This, in turn, will enhance our understanding of EMI's potential and challenges, ultimately leading to more effective instructional practices and better learning outcomes for students.

In essence, this volume is poised to make a profound impact on the field of EMI. It is set to redefine the landscape of EMI research by contributing to the development of quantitative research methods and by influencing the choices and practices of a diverse range of stakeholders involved in EMI education.

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Part I

Theoretical Chapters

1 Mathematics and Science Learning in Primary and Secondary School EMI Classrooms

Evidence from PISA and TIMSS

Sibel Kaya

Mathematics Learning in EMI Classrooms

Traditionally, mathematics is believed to be a subject that does not require strong language skills. However, researchers highlight the importance of a good command of language to be successful in mathematical reasoning and problem-solving (Bernardo, 2005). Especially, word problems in mathematics require students to read and understand the problem to solve them. In English Medium Instruction (EMI) classrooms, if students have not yet mastered English, they might struggle to understand and solve word problems even though they do not have mathematical difficulties.

In some countries such as the Philippines, EMI in mathematics used to start as early as prekindergarten. In a quasi-experimental study, Ricablanca (2014) compared the mathematics achievement of first-grade students in EMI and mother tongue instruction classrooms. The participants were sixty-three first-grade students (thirty-one mother tongue, thirty-two EMI) from the same school in the Philippines. During this period, the students were taught the same lessons by the same teacher and exposed to the same activities and homework in two different media of instruction. Students took the same achievement test as the pretest, posttest, and retention test, but the mother tongue classroom took the test in their mother tongue whereas the EMI classroom took it in English. Paired samples *t*-test and analysis of covariance (ANCOVA) were used to analyze the data. Students in the mother tongue classroom received significantly higher scores on the mathematics achievement test compared to their peers in the EMI classroom both in the posttest and in the retention test. The researcher recommends that the school systems should consider using the mother tongue for mathematics instruction in the early years since important mathematical concepts are easier to grasp in the mother tongue. When students try to learn a subject such as mathematics in a language they have not yet mastered, they take on a cognitive load alongside learning the concepts, which affects their academic performance negatively. In 2013, the Philippines government institutionalized the use of the mother tongue in all subjects from preschool to third grade as part of a new