Applied Mathematics & Information Sciences
An International Journal

http://dx.doi.org/10.18576/amis/180303

Bridging Languages and Numbers: Exploring the Intersection of Translation Studies and Mathematics

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Received: 21 Dec. 2023, Revised: 11 Feb. 2024, Accepted: . 2024
Published online: 1 May 2024

Abstract: The primary focus of this research is to explore the relationship between translation studies and mathematics, specifically examining the challenges, approaches, and consequences of translating mathematical ideas from one language to another. Employing a qualitative and descriptive methodology, this study addresses the issue of accurately conveying mathematical concepts without introducing any "foreign" implications, while also investigating the influence of culture on the translation process. The objective of this study is to provide a qualitative description of the various difficulties that translators encounter when dealing with both linguistic diversity and their own cultural backgrounds. Through this qualitative analysis, the study reveals how translators navigate language obstacles by utilizing intricate details that may otherwise go unnoticed. Mathematical language is highly specialized, and its meaning is contingent upon the specific context in which it is employed. As a result, the findings of this research underscore the significance of adopting an interdisciplinary approach that incorporates the analysis of mathematical language, the utilization of terminological databases, and the contextualization of mathematical concepts. These elements are crucial for achieving a more precise and accurate translation of mathematical ideas. The global implications for education, collaboration, and the democratization of mathematical knowledge are illuminated by the qualitative nature of this research, in addition to the abundance of linguistic diversity. By fostering interactive relationships among various languages, this would not only promote inclusivity within the global mathematics community but also facilitate a more comprehensive and interconnected approach.

Keywords: Translation Studies, Mathematics, Language and Numbers, Interdisciplinary Collaboration, Global Education, Multilingual Collaboration, Terminological Databases, Contextualization.

1 Introduction

Traditionally, multidisciplinary "translation research" focuses on the interlingual transfer of meaning, on the psycholinguistic (and therefore often invisible) dynamics of linguistic and cultural exchange [1]. However, the intersection of translation studies and mathematics is a new and unexplored area that may open new horizons in language transfer research. The aim of this article is to explore the still largely unmapped regions where languages and numbers overlap, and to observe what happens between translation processes and mathematical principles.

Central to this is the view that translation involves conversion from one linguistic system to another and therefore implies an exceptionally sophisticated understanding of linguistic complexity, cultural contexts and semiotic systems [2]. The concept of this process - sometimes even referred to as art - until recently remained largely confined to the humanities. Computational linguistics and the increasing use of artificial intelligence in translation can be seen as new opportunities for translation to explore transdisciplinary approaches.

The connection to mathematics in translation comes when we think about the algorithms and mathematical models that underlie machine translation [3]. These systems use statistical and neural network methods, based on mathematical calculations of linguistic patterns and translation probabilities, to generate understandable results. As translation technologies advance, understanding the mathematical principles used in their systems is becoming a key requirement for both researchers and practitioners.

Moreover, the connections between translation studies and mathematics go beyond machine translation. Quantitative analysis of translation results, corpus research and the use

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of mathematical models to assess translation quality open up prospects for rigorous research [4]. A quantitative lens only brings precision to research objects that could otherwise be explored through qualitative methods, providing a complementary approach to translation that, in the long run, can lead to a more three-dimensional understanding of a phenomenon.

This study examined the relationship between translation studies and mathematics from various aspects. We will look at the mathematical nature of machine translation, examining language transfer algorithms in artificial intelligence [3]. At the same time, we will consider how the use of mathematical methods can extend traditional research methodologies to translation, providing a much more accurate picture of the dynamics of intercultural communication.

We hope that this foray into the intersection of languages and numbers will ultimately expand understanding of translation processes, combining knowledge from the humanities and mathematics and discovering synergies that will enrich translation studies as well as make mathematics more comprehensive in language learning.

1.1 Translation and Mathematical Concepts: Navigating Linguistic Challenges and Cultural Nuances

Translation, as a complex process of conveying meaning across languages, encounters unique challenges when dealing with mathematical terms. The distinctive nature of mathematical language, characterized by precision and universality, poses intricate linguistic hurdles for translators [5]. When translating examples of mathematical discourse, linguistic competence is, of course, only part of the picture - an experienced mathematics translator also needs a thorough understanding of the cultural contexts in which these discourses are embedded [6]. This section explores the linguistic challenges in translating mathematical terms and analyzes the impact of cultural nuances on the language of mathematics.

Linguistic Challenges in Translating Mathematical Terms

Many mathematical writings are filled with symbols and notations, as well as specialized vocabulary, and one of the biggest problems in translation is maintaining the precision and clarity of the expressions used [7]. The ambiguity that may arise from linguistic variations can lead to misunderstandings, particularly in mathematical texts where accuracy is paramount.

For example, translating the English word "derivative" poses an interesting challenge because there are different (semantic) linguistic concepts associated with this term in another language. In response to this cultural dimension of translation, translators must work with semantic subtleties so that native words in the source language (such as the English derivative or the French dérivé) do not encode mathematical meanings in the same way as the English originals. In many situations, creating equivalent words or phrases must be creative to ensure that the translation conveys the intended mathematical meaning [8].

The cultural specificity of mathematical notation can also create problems for translators; symbols denoting mathematical operations and variables are not always easily transliterated. There can be a fine line between adopting the mathematical traditions of the target language and distorting mathematics itself [9].

Analyzing the Impact of Cultural Nuances on Mathematical Language

Mathematicians possess the ability to discern the impact of cultural disparities on the language of mathematics. The progressive evolution of mathematical principles across diverse societies and the manifold methods by which these principles have been assimilated into distinctive cultural frameworks have resulted in the current kaleidoscope of mathematical vocabulary. To ensure an accurate portrayal of mathematical concepts, it becomes imperative to comprehend and integrate the cultural complexities inherent in a particular language while translating mathematical texts [10].

The true essence of mathematical concepts holds the power to bestow diverse cultural interpretations upon them. These cultural interpretations, in turn, can impose limitations by steering the understanding in a particular direction or even result in distinct terminologies within different mathematical traditions. Consider the concept of infinity, which has been approached divergently in Eastern and Western mathematical and philosophical traditions. Therefore, translators must possess an acute awareness of these factors to effectively communicate precise mathematical meanings through various forms of expression [11].

Moreover, the curricula in these countries are not identical and the terms referring to mathematical concepts vary depending on the culture. Moreover, when translating mathematical and scientific texts, translators must use terminology that is understandable to readers and appropriate to the educational level of the reader's target group, and they use appropriate mathematical conventions in the cultural environment in which they work [10].

To sum up, the translation process encounters language problems related to the precision and recording of mathematical concepts and the impact of cultural conditions on the language of mathematics. Solving these problems improves intercultural communication in the field of mathematics.

1.2 Research Problem

Simply put, the core of the research problem is the question of mathematical translatability or transferability across linguistic/cultural boundaries. Mathematics is a precision-oriented field of science and research, as well as a highly universalistic discipline. These two features of mathematical language - precision and universality - can be a nightmare for translators who have great difficulty in precisely translating mathematical terms, often not knowing the meaning behind the symbols, i.e. not knowing the justification for the original statement. Therefore, the study examined the difficulties that different languages and cultures encounter in translating mathematics and how translators deal with them. Therefore, the question arises how translators solve the difficulties related to the above-mentioned problems. The research problem of mathematics-specific translation difficulties may spur an emerging interdisciplinarity, Translation Studies/Mathematics, which focuses on phenomena related to mathematics translation.

1.3 Research Objectives

The main research goals of this project are to systematically describe the specifics of mathematical translations into different languages.

First, it aims to identify and describe the linguistic challenges that this type of translation poses and how to overcome them. In particular, the study aims to understand how translators can cope and what specific difficulties they encounter with the variety of mathematical terms and symbols used in mathematics. Secondly, it aims to search for and describe the influence of cultural factors on mathematical translation. By "cultural factors" I mean people's general cultural background (e.g., people's habits of thinking and acting in certain ways as a result of their lifestyle), as well as other forms of cultural factors, such as the graphical aspects of the mathematics of texts (e.g., the way evidence is presented, in including the choice of markings). Third, it aims to propose solutions to the problem of mathematical translation. In this respect, it aims to build on previous research carried out by researchers in mathematical terminology, on terminology databases (the analysis and creation of such databases) and on contextualization. In addition, it aims to describe some important case studies (i.e. examples that highlight some of the challenges translators face, in addition to the solutions they provide). Finally, it aims to assess the broad impact that improved mathematical translation (for example, improved intercultural learning based on improved translation of mathematical texts, more multilingual cooperation, the dissemination and democratization of mathematics, etc.) could have on education..

1.4 Methodology

The aim of this research is to apply a qualitative approach to the complex intersection of translation studies and mathematics. Because this is a qualitative study, it is based on a qualitative paradigm that draws on descriptive methodologies to understand complex phenomena. In the specific focus of this intervention, a qualitative research approach based on a descriptive methodology is particularly suited to addressing the linguistic, cultural, and translational complexities that arise when mathematical concepts are translated from one language to another. A qualitative approach allows for in-depth exploration of phenomena of interest, allowing researchers to discover linguistic challenges, cultural layers, and translation strategies. The descriptive approach also allows for the presentation of a detailed view of the area of interest, which contributes to building a representation of the phenomenon from which subsequent analytical exploration can be used. Analytical tools are judiciously applied to collected data to provide description and representation of complex intersectional issues, providing valuable insights that can contribute to scholarly discussion about the intersection of languages and numbers.

2 Mathematical Communication across Languages: Exploring Expressions and Preserving Precision through Translation

Communication is mathematical, not just linguistic. Mathematical concepts are often transferred between languages. This section focuses on how precisely concepts are expressed in different languages, the different shades of meaning they can conceal and reveal, and the role of translation in maintaining mathematical precision by ensuring the constancy of meaning.

2.1 Expressions of Mathematical Concepts in Different Languages

Mathematical concepts are the same all over the world, but cultural diversity affects the way mathematicians can describe them locally: proof words and phrases in English, for example, are English expressions, while in other languages different words may be used to describe different steps in proving a mathematical theorem. In Chinese, for instance, the term "证明" (zhèngmíng) is used to describe the act of proving. The word seemed to provide proof and explanation, in keeping with the importance that Chinese mathematical discourse attached to the rigor of mathematical proofs [12]. It is precisely such linguistic

details that need to be examined to better understand how mathematical ideas can be expressed in different cultural and linguistic contexts.

2.2 The Role of Translation in Maintaining Mathematical Precision

In mathematics, translation plays a fundamental role, being the most important interface between mathematics and languages. In this way, precise mathematical concepts can move from one linguistic system to another. When translating mathematical texts, accuracy is crucial so that the mathematical ideas contained in the original remain intact. Consider the translation of the mathematical term "limit." In French, the term "limite" is used, while in German, it is referred to as "Grenzwert." None of these terms can be translated by simply providing a linguistic equivalent; each requires careful preservation of the mathematical meaning of the boundaries [7]. Mathematical precision hinges on accurate translations that capture the essence of concepts, allowing for consistent understanding across languages.

Moreover, even the choice of symbols and notation is ultimately linguistic; and mathematical communication is not free from difficulties that translators must cope with. Symbols sometimes need to be transposed to match symbols used in the target language, but they must not lose their mathematical precision in the process. Translating mathematical symbols involves a different sensitivity to the boundaries of meaning [13].

In summary, interlingual mathematical communication is a complex problem that concerns different expressions of the same mathematical concepts and the possible role of translation in preserving the mathematical nature of the language. The analysis of linguistic details and the possible analysis of the problems created by cultural and linguistic diversity allow researchers to contribute to a better understanding of the mathematical nature of language.

3 Case Studies: Navigating Challenges in Mathematical Translations

This section is devoted to specific case studies that aim to illustrate some aspects of mathematical translation, shedding light on the difficulties this process entails and how to overcome them. These case studies offer paradigmatic situations for understanding translation studies and mathematics.

3.1 Case Studies

Case Study 1: Translating Topological Concepts from English to Japanese

In the translation of topological concepts, the English term "open set" poses a challenge when rendered into Japanese. The direct translation, "開いた集合" (hiraita shuugou), may not fully capture the mathematical essence. However, Japanese mathematicians have difficulty conveying the concept of openness in a topological sense due to subtle differences in linguistic interpretation. One used both a literal translation and two additional explanatory terms: one expressing the openness of the set and the other more in line with the definition of the Japanese mathematician community [14].

Case Study 2: Challenges in Translating Algebraic Notations from French to English

Translating French alphabetic symbols into English using algebraic notation is difficult. For example, the French term "polynôme irréductible" involves an algebraic concept denoting an irreducible polynomial. Translating this term requires careful consideration of the specific algebraic structure, as the English equivalent "irreducible polynomial" might not encapsulate the same mathematical properties. To circumvent these difficulties, translators must provide additional context or explanations that help explain the many shades of meaning of a French algebraic term [15].

Case Study 3: Cultural Nuances in Translating Mathematical Proofs from Russian to English

It is necessary to find a cultural environment that contributes to the way of thinking about the style of presenting mathematical proofs and in which one can see a tradition of motivation and explanation rooted in the very material of the proof itself: this is a long-standing practice in Russian mathematical discourse, which contrasts with the typically much shorter writing style in English. And while the translator must respect the way the building works and the rigor of the evidence, in most cases this goes against the style expected of the recipient. The task of balancing these issues can be solved in various ways, depending on the specificity of the target text, always bearing in mind the need to preserve the richness of the original style and to meet the standards of conciseness of English mathematical discourse [16].

Case Study 4: Translating Geometry Terminology from English to Arabic

The translation of geometric terms, such as "congruent triangles" from English to Arabic, introduces challenges related to the linguistic structure of Arabic. Arabic often relies on root words and derivations, and finding precise equivalents for certain geometric concepts can be intricate. For example, translating "congruent" as "متطابق" (mutatabiq) captures the essence, but subtle geometric

distinctions may be lost. In this case, a strategy involves providing additional context and descriptions to clarify the specific characteristics of congruent triangles [17].

Case Study 5: Mathematical Notations in Chinese to English Translation

The translation of mathematical notations from Chinese to English, especially involving characters and symbols unique to Chinese, requires careful consideration. For instance, the Chinese character "方" (fāng) can represent both "square" and "method." Context can help the translator choose the appropriate English equivalent. In such situations, when translating mathematics into English is involved, the translator must select the most appropriate English equivalent, guided by context and adding additional terminology to convey the mathematical meaning, or by using a translation that is a hybrid of English terms [18].

Case Study 6: Arabic Algebraic Terminology in English Translation

The challenges of translating algebraic terms from Arabic to English are primarily context-related and related to the linguistic structure and specific nuances of Arabic mathematical discourse. For example, translating " معادلة تربيعية" (mu'adala turbii'a) to "quadratic equation" requires consideration of both linguistic and mathematical precision. The solution is often to combine the text in the original language with additional explanations [19].

3.2 Solutions and Strategies

Addressing issues related to mathematical translation as a whole is, in my opinion, the key to engagement and I believe this should be done coherently, using the mutual and synergistic use of linguistic knowledge, mathematical competence and cultural awareness. The first requires combining mathematicians, linguists and translators into interdisciplinary teams. In any case, it is important to ensure that translation teams - in addition to the need to maintain mathematical accuracy in each area of specialization - check the overall translation for any linguistic nuances in order to obtain more accurate translations. Similarly, compiling glossaries and terminology databases for mathematical translations is indeed a sound strategy for retaining the nuances of mathematical terms across languages; they are indeed a valuable repository of data for translators and readers of mathematical text. When direct translation is not possible, it is also useful to be able to clarify, add a footnote or additional terminology. This is not an extreme case, but an ongoing practice among writers. The reason for explanation is to explain what or exactly what this mathematical expression is, in order for it to convey specific mathematical meaning that would otherwise be lost. It is important to recognize cultural nuances in mathematical discourse, so it is important for the translator to be aware of how mathematical concepts are embedded in cultural contexts. In short, feedback provided by mathematicians or readers can also help improve translations, as is the case with iterative review and proofreading processes aimed at achieving greater linguistic precision and, overall, more accurate mathematical translation. Specialists could possibly collaborate on the creation of terminology databases and glossaries. This is done by creating terminology databases and glossaries specific to mathematical translations. These are valuable resources that capture the nature of mathematical terms in different languages and help translators make consistent translation decisions throughout the book [20]. However, context and culture can help improve clarity by using footnotes, endnotes, or more vocabulary to provide necessary context to mathematical terms, since a direct translation may not give the reader the mathematical meaning of the word [21]. Finally, recognize and account for cultural nuances in mathematical discourse. Translators should be attuned to how mathematical concepts are embedded in cultural contexts to ensure translations resonate with diverse audiences [22]. With these solutions and strategies, researchers and practitioners will be better equipped to deal with the translation problems, puzzles, and pitfalls that may arise when moving between different languages and forms of mathematical communication, and will help to more refine the intersection of translation studies and mathematics.

Implications for Education and Global Collaboration

The ability to effectively translate mathematical concepts has a profound impact on education and collaboration around the world, contributing to the development of mathematical knowledge worldwide. This section discusses implications for education and collaboration within the global mathematics community.

Enhanced Cross-Cultural Learning

The more sophisticated mathematics translation strategies become, the greater the opportunity to improve intercultural learning in mathematics education and offer greater opportunities for students from different linguistic backgrounds. This will ensure more transparent and effective mathematics education, ensuring its content is understandable to a wider audience [23].

Promotion of Multilingual Collaboration

The emphasis on accurate mathematical translation promotes and facilitates multilingual collaboration between mathematicians, educators and researchers. The closer the global mathematics community becomes, the more important it becomes to be able to communicate mathematical ideas in different languages. The strategies presented are beneficial not only for communication, but also for collaborative research projects, curriculum development and educational programs, which in turn help to further strengthen bonds in the global mathematics community and make it a place for sharing and collaboration [24].

Support for Multilingual Educational Resources

Multilingual math education resources, developed in conjunction with accurate translations, have the potential to transform math education around the world. Producing mathematics teaching materials in multiple languages ensures that students around the world can receive high-quality materials in their native languages and in their own linguistic and cultural environment. Democratizing mathematical knowledge reduces inequalities in access to education and supports the development of a universal education system that will be more equitable around the world. It allows teachers to better accommodate diverse language audiences in their teaching practices and helps create inclusive learning environments.

Facilitating Global Research Collaborations

Good mathematical translation plays a key role in enabling international research collaboration. Through accurate mathematical translation, mathematicians from different parts of the world can also collaborate with each other, work on joint research projects, share ideas, and learn from each other in their research areas. In turn, it is easier to disseminate research findings and results in a timely and cost-effective manner. This, in turn, accelerates global research collaboration. Such cooperation is necessary to solve difficult mathematical problems that require combining the knowledge, views and experience of as many mathematicians from different parts of the world as possible [24].

Strengthening International Mathematical Competitions

International math competitions are only fair when participants have the opportunity to demonstrate their best math skills. With the proper use of translation strategies, organizations can minimize language bias and allow participants to demonstrate their mathematical abilities without having to face additional obstacles due to language. This is important to encourage global and diverse participation, maximizing the creation of a rich international cohort of mathematicians [23].

Overall, we hope that the above discussion has convinced the reader that high-quality mathematical translation is both possible and desirable, and that it will have a key impact on global mathematics education, research, and collaboration. Overcoming language barriers will help unite an increasingly diverse global mathematics community.

4 Conclusions

In the exploration of conveying mathematical concepts, this investigation reveals intricate discoveries where the fields of translation studies and mathematics intersect. By examining various techniques, analyzing specific instances, and exploring the resulting implications, a cohesive understanding emerges, highlighting the importance of bridging languages and numbers. This inquiry has provided valuable insights that have enriched scholarly discussions in both translation and mathematics. The methods for achieving accurate mathematical translations undoubtedly emphasize the need for a comprehensive approach that combines mathematical expertise with linguistic skills. This interdisciplinary aspect is essential to maintain the rigor of mathematics while preserving the nuances of language and culture. The case studies exemplify the challenges faced when translating mathematical texts between languages, encompassing a wide range of difficulties, from translating French mathematical proofs into English to accurately conveying the concise notations of Chinese mathematics.

The need to develop strategies for effective translation is evident in every situation, particularly when considering the specific context. Recognizing and valuing cultural variations is crucial in deciphering the complex essence of mathematical ideas. Despite the abstract nature of mathematics, translators are confronted with the challenge of navigating the linguistic structure and distinctive language features of different mathematical systems.

The dynamic relationship between translation studies and mathematics is not a mere intersection within academia, but rather a constantly evolving space that explores the connection between languages and numbers. This intersection holds immense significance and resonates across the academic realm, as well as in international collaboration beyond educational boundaries. Within academia, the audio translation of mathematical concepts enhances cross-cultural learning and fosters a more inclusive and accessible approach to mathematics. These proposed methodologies facilitate the creation of multilingual educational materials, thus promoting fairness and impartiality in the realm of education. Embracing more intercultural approaches to learning allows students to engage with mathematics in their native languages, resulting in a deeper understanding of the subject matter. This inclusive learning environment benefits students from diverse backgrounds. Furthermore, translation plays a crucial role in empowering the global mathematical community by facilitating seamless collaboration among mathematicians from different linguistic backgrounds. This accelerates the overall research process and advances the development of mathematical theories. The invaluable connections facilitated by translation are essential in democratizing mathematics, breaking down barriers, and fostering collaborative inquiry and exploration.

Throughout this journey, it will become evident that there is a need for further exploration and research in the field where translation studies and mathematics intersect. The strategies and insights we have presented serve as a solid foundation, with the hope of inspiring researchers, educators, and practitioners to delve deeper into the intricacies of mathematical translation. In the years to come, we anticipate uncovering more linguistic

complexities, proposing innovative solutions, and elucidating the far-reaching consequences for education and collaboration. The discourse initiated here aims to forge ahead, paving the way for the convergence of languages and numbers. This blending of languages and numbers enhances our comprehension of mathematics and establishes the groundwork for a more inclusive and interconnected mathematical community. The significance of this connection extends beyond scientific discourse; it resonates in classrooms, research institutions, and international interactions. The fusion of languages and numbers is not solely a scientific pursuit; it is a transformative endeavor that reshapes our perception, dialogue, and engagement with mathematics.

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