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Conceptual Evolution in Scientific and Technical Translation: A Systematic Review

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Abstract
The interconnection between concept and translation has long been recognised. However, conceptual evolution poses great challenges in scientific and technical translation. While conceptual research is central to terminology standardisation, it is less clear how conceptual evolution influences scientific and technical translation, particularly in rapidly evolving fields. This study reviews existing literature over the past five years, analysing the research trends and challenges and strategies in scientific and technical translation. Based on two databases, it retrieved 22 articles from a broader sample of 518 publications. The analysis identified the growing importance of interdisciplinary collaboration and the integration of advanced technologies like artificial intelligence (AI) and machine learning in scientific and technical translation. The findings indicate four main challenges: technological advancements, cultural and contextual differences, complexity of technical language, and regulatory challenges. The five main strategies for these challenges are: interdisciplinary collaboration, terminology standardisation and management, technological integration, ethical and cultural adaptation, and professional training and methodological innovation. However, it reveals the need for more systematic research into concepts for terminology standardisation in technical fields. These results bring practical implications for improving effective standardisation of terminology and enhancing translator training in specialised fields.
Keywords: Conceptual evolution, Scientific and technical translation, Systematic literature review, Terminology standardisation

Introduction

Concepts have long been widely explored and are still a popular area of research today. They have been researched in many fields, including cognitive science (Cross & Ramsey, 2021; Blasi et al., 2022), neuroscience (Bennett & Hacker, 2022), philosophy (Bhat et al., 2023), and cognitive linguistics (Littlemore, 2023). Concepts are units of thought that are used to organise our knowledge and perception of the world (Wright, 2001). In a rapidly changing global landscape, concepts themselves are undergoing constant evolution.

Conceptual evolution is a dynamic process by which ideas and terms change in meaning, scope, or usage over time, mostly under the influence of new discoveries, innovations, and interdisciplinary interactions (Biondi, 2011). These shifts have occurred in biotechnology, in which today genome editing and CRISPR have different meanings (Huang et al., 2023). Similarly, in AI, a great number of terms have come to apply to "machine learning", with new methods and applications evolving because of advances made continuously in the field (Cross & Ramsey, 2021). Such evolution is not limited to niche areas, but frequently occurs in scientific and technical fields, which requires continuous updates in terminology and understanding.

In translation, especially in scientific and technical fields, conceptual evolution is a key consideration. Scientific and technical translation accounts for over 90% of the world total output (Alonso & Vieira, 2020). According to Plofker (2022), translation is more than language transfer but also involves the conceptual transfer of ideas. Therefore, it contributes to the global dissemination of scientific knowledge while accurately conveying evolving concepts across cultures.

However, this evolution brings great challenges for terminology standardisation. Terms are the linguistic designation of concepts and terminology is a collection of terms used in specialised domains (Olohan, 2016). Terminology standardisation is the process of developing and implementing standards for the consistent use of terms within a particular domain (ISO 704, 2009). As it stands, clarity and precision in communication is highlighted in scientific and technical fields. In the case of medical translation, it is efficiently used when standardised terminologies enhance the efficiency of clinical decision-making (Fennelly et al., 2021; Czaplewski & Smitka, 2024).

Conceptual evolution affects the way in which knowledge is spread and communicated throughout the world in scientific and technical fields (Coccia, 2020). This action is underpinned by two major facts, according to the author: (1) the re-definition of some common ideas owing to the scientific revolution, and (2) the re-interpretation of one and the same conception across disciplines. For example, one might see in genetics that tools such as CRISPR-Cas9 have given rise to new terms, such as "guide RNA", and "gene drive". Similarly, the term “algorithm “differs in meaning in Information technology (IT) and medicine. The former refers to a specific, step-by-step procedure for performing a task, while the latter means decision-making protocols for diagnosis. This interdisciplinary nature of modern research has made conceptual evolution in scientific and technical translation more complicated.

Nonetheless, conceptual evolution poses severe challenges in scientific and technical translation. It is displayed mainly in three areas. First, the need for semantic precision (Villani et al., 2024). According to Berg et al. (2020), the evolving concepts lead to semantic derivation that requires contextual adaptation, especially in medical field where the terminology is often context dependent. Semantic precision in such fields is critical to avoid misunderstanding that may cause improper diagnosis or treatment. Second, the rapid development of new terms. This is within regular happens in the digital age, as already discussed (Sierra, 2022). Finally, the potential for inter- and multi-disciplinary collaboration. As scientific research becomes cross-disciplinary, it should be envisaged that terms may acquire different meanings across the varying fields owing to the increasing complexity of interpreting the terms.

Despite these challenges, addressing conceptual evolution is necessary in this ever-changing world. As science and technology drives our modern society, it can be inferred that conceptual evolution is frequent and inevitable. The accuracy and clarity of communication across cultures is the prerequisite for preserving the integrity of scientific knowledge, innovation and global collaboration (Beck et al., 2022). In fields like artificial intelligence (AI) or gene editing, where new advancements occur, researchers, policymakers and practitioners may encounter difficulties in exchanging ideas without accurate translation of novel concepts and terms. Consequently, the need for precise translation in technical fields is a fundamental aspect of bridging linguistic and disciplinary gaps for more effective knowledge transfer.

While the importance of conceptual evolution is clear, few research has focused on its challenges in scientific and technical fields. Previous studies have primarily addressed the translation of terms rather than underlying themselves, although the study of concepts is central to terminology standardisation (Olahan, 2016; Mills et al., 2020). Moreover, many studies failed to address the unique challenges in scientific and technical translation, with the focus on literary texts (Kardiansyah & Salam, 2020). The lack of research on conceptual evolution in technical fields such as AI, biotechnology and MedTech remains a notable gap.

To address this research gap, this study conducts a systematic literature review (SLR) to examine conceptual evolution in scientific and technical translation. SLR is effective in synthesizing the existing research, evaluate the consistency of findings of the research among each other, and identify potential directions for further research (Snyder, 2019). This review seeks to answer the following questions: (1) What are the current trends of conceptual evolution in scientific and technical translation? (2) What are the main challenges and strategies in the conceptual evolution in scientific and technical translation? Towards this end, the present study would provide practical suggestions concerning terminology standardization, and more broadly, give some insights on interdisciplinary studies of conceptual studies in scientific and technical translation.

Literature review

Concepts serve as fundamental cognitive units that represent abstract or concrete entities, which form the basis of thought and communication. They are designated by terms, which are the linguistic labels assigned to these cognitive constructs in specialised fields (Olohan, 2016). Sager (1990) further emphasised the importance of terms in conveying meanings across specific domains. As discussed earlier, precision in conceptual transfer is a must for maintaining accuracy and effective communication especially in scientific and technical fields. The cognitive approach to translation assumes that concepts are cultural constructs that can be transmitted across cultural boundaries (Hong & Rossi, 2021).

Conceptual challenges are especially relevant in specialised fields, due to the presence of highly specialised terminology and rapid evolving concepts (Coccia, 2020). Precision and consistency are required in scientific fields such as healthcare, engineering and IT, when rendering concepts. Otherwise, any misalignment between the ST and TT can impede international collaboration or scientific knowledge dissemination (Villani et al., 2024). Moreover, the new concepts such as gene editing and AI derived from these disciplines also need accurate translation from their source languages to be better employed in the real world (Berg et al., 2020; Lan et al., 2021).

In specialised domains, translation influences conceptual evolution to a great extent. It allows for the transfer of knowledge and being involved with reshaping concepts, which likely lead to the emergence of evolved concepts (Liqiu et al., 2024). With rapid technological advancements, concepts constantly evolve in fields like healthcare, IT and engineering. For example, machine learning, a term that originally referred to a subfield of computer science, is now being applied in predictive diagnostics in healthcare (Panesar 2019), as well as in engineering for the autonomous system domain (Hawkins et al., 2021).

Moreover, translation certainly adapt concepts to the TL (target language) context in cultural and linguistic ways. It sometimes means contextual adaptation so that the TL conceptual system is in tune with the source-language (SL). These contexts are most common in interdisciplinary fields such as biotechnology or IT, as rapid innovation usually creates new terminology. Undoubtedly, a very delicate issue of different significance emanating from cloud computing for various environments like environmental science, economics, and IT. Cloud computing may mean different things in different areas, for example, environmental science, economics, and IT. In IT, it refers to the supply of computer services like databases; in economics, it translates to how cloud computing would help to bring down the infrastructure cost of SMEs (Skafi et al., 2020). Further onto education, it becomes cloud-based e-learning which personalises the available educational resources (Alam, 2022). These differences do show the influence of translation in formulating a view based on the specific domains and cultural contexts.

This brings implications for translators mainly in two aspects. One is to account for these semantic variations so that the concept is accurately conveyed and understood while also

maintaining its evolving technical meaning (Lan et al., 2021). The other is to navigate varied interpretations of concepts in a way that concept evolves consistently in global discourse (Baygi et al., 2021). Since terminology standardisation is highlighted in specialised fields (Tur et al., 2023), translation continues to play a pivotal role in shaping and evolving scientific concepts across disciplines and cultures.

Recent studies on conceptual evolution in scientific and technical translation were conducted mainly in three areas (see Table 1). The first is related to standardised terminology (see Alonso & Vieira, 2020; Fennelly et al., 2021; Czaplewski & Smitka; 2024). Medical terminology needs adaptation to guarantee the conceptual integrity in the medical domain (Alonso & Vieira, 2020). This was echoed by Fennelly et al. (2021) who argued that using standardised terminologies can lead to quality clinical practice for patient wellbeing and safety. Additionally, Czaplewski & Smitka (2024) analysed the importance of standardized product terminology in product development and clinical practice.

Table 1. Existing reviews on conceptual evolution in scientific and technical translation

Author (year)	Objective	Methodology	Main Findings	Limitations
Panesar (2019)	To explore AI's role in healthcare	SLR	AI-powered systems facilitate translation processes in healthcare	Not analyse how AI impacts conceptual accuracy in scientific fields
Alonso & Vieira (2020)	To explore the terminology adaptation in medical fields	Case study	Emphasized the need for adapting medical terminologies	Limited focus on fast-evolving fields such as IT or biotechnology
Coccia (2020)	To investigate interdisciplinary communication in applied sciences	SLR	Interdisciplinary communication helps expand conceptual scope and innovation	limited focus on the role of translation in other rapidly evolving fields
Klein (2020)	To explore cross-sector collaborations	Case study	interdisciplinary collaborations address complex scientific challenges	Ignore other influencing factors such as power dynamics
Hawkins et al. (2021)	To investigate AI in autonomous systems	Case study	AI facilitates translation process in autonomous technologies	not explore the concepts of AI tools in specialised domains
Fennelly et al. (2021)	To assess the role of standardised terminologies in clinical practice	Case study	Standardised terminologies are crucial for effective patient care	Limited applicability to fast-evolving technical fields

Huang et al. (2023)	To examine challenges in translating new concepts in medical field	Case study	Translating CRISPR-Cas technique is difficult due to a lack of established terminology	not explore solutions to these challenges
Czaplewski & Smitka (2024)	To analyse the importance of standardized terminology in biotechnology	Case study	standardised terminology improves product development and medical practice	not address terminology issues in emerging fields

The second area involves the practical application of new concepts and its challenges (Alam, 2022; Fang, 2023; Huang et al., 2023; Czaplewski & Smitka, 2024). Alam (2022) presented various solutions to the translation of new concepts, including cloud-based system and cyber-physical system i.e., to have an in-depth study concerning both ST and TT, and with certain technical texts concerning. In addition, Fang (2023) illustrated how the big data concept had closed the gap between the tools they used before to this time corpus-based tools augmenting the translating of forestry terminology. Huang et al. (2023) and Czaplewski & Smitka (2024) explored the specific challenges associated with new concepts like CRISPR-Cas and pathogen detection in medical field that include factors like the absence of established terminology and corresponding terms in TL.

The last area pertains to interdisciplinary collaboration (Coccia, 2020; Klein, 2020). In this regard, Coccia (2020) pointed out the contribution of interdisciplinary communications in widening the space of concepts governing applied sciences, particularly in experimental physics. He also indicated that cross-disciplinary communication carried out via translation contributed to knowledge sharing and innovation. Klein (2020) mentioned that cross-sector interactions have the potential to systematically address complex scientific problems; they allow for multifaceted understanding among different fields. Equally, Sierra (2022) explored the notions of sociolects within audiovisual texts and explains how interdisciplinary insights would benefit the transfer of cultural expressions.

While Fennelly et al. (2021) and Czaplewski & Smitka (2024) represent such studies, being mere tentative research into standardized terminology, they did not mention the dynamic nature of linguistic and cultural contexts that could influence contemporary practices in the industry. Besides, it could not credibly validate in Alam (2022) that the use of translation strategies has been limited in real-world contexts, more particularly relevant in evolving fields. There is a need for more refined empirical testing of translation tools and techniques in future studies to answer the ever-evolving needs of interdisciplinary fields. Finally, even though studies like Klein (2020) recognised the issue of interdisciplinary collaboration, they did not address issues of power dynamics and communication barriers that could impede meaningful collaboration across scientific and technical fields. Similarly, Sierra (2022) did not really show how concepts could be integrated into interdisciplinary translation practice in technical fields.

Existing studies on conceptual evolution in scientific and technical translation reveal three notable research gaps. First, few studies have focused on translating concepts in fast-evolving fields such as IT, biotechnology and engineering. While studies by Alonso & Vieira (2020) and Fennelly et al. (2021) have largely focused on medical terms, there remain unexplored ventures in the realm of cross-cultural communication in rising concepts like blockchain, quantum computing, and AI. These fields require careful translation so as to select sufficiently proper knowledge that can be universally transferred.

Moreover, limited research explores the role of machine translation (MT) and AI-powered tools in the conceptual evolution of scientific and technical terms. While more research is being done to assess AI's role in healthcare and autonomic systems (Panesar, 2019; Hawkins et al., 2021), scant studies have been undertaken to see how AI-driven translation systems processed intellectual integrity in the rapidly shifting parameters of fields such as robotics and genomics, where technical translation is progressively being automated (Vieira, 2020). Therefore, addressing this knowledge gap is vital to the ongoing evolution of scientific knowledge in the worldwide context.

Last, little research exists on terminology management tools in technical fields except medicine. Although Fennelly et al. (2021) presented these tools in a healthcare perspective, none of the studies addressed its application within fields such as cloud computing or genetic engineering, where a standardised terminology is essential for accuracy in cross-border collaboration.

To bridge these gaps, a systematic literature review (SLR) serves to assess the conceptual evolution of scientific and technical translation. In particular, it will investigate the contemporary trends in translation practices. Following the identification of challenges and strategies associated with rapidly evolving concepts, the review aims to improve accurate and consistent knowledge transfer, contributing to the standardisation of terminology in technical fields which has further implications for researchers and practitioners in navigating the complexities of conceptual issues.

Methodology

This study follows the PRISMA guidelines. PRISMA stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses, which makes for a very well organized and replicable method, covering all aspects in a systematic manner to guarantee that the study is performed and presented in an orderly manner (Page et al., 2021). These include the methodology of the search strategy, selection process, data extraction and analysis, and limitations.

Search strategy

According to Bramer et al. (2017) and Ewald et al. (2022), at least two databases should be used. The literature search for this review was conducted using two databases: Scopus (a general database) and WOS（a leading citation database）. Scopus and WOS were selected due to their comprehensive coverage of high-quality, peer-reviewed journals, particularly in the fields of linguistics, translation studies, and technical disciplines (Yubo et al., 2023). While databases like JSTOR and PubMed also contain relevant studies, they tend to focus more on humanities and medical fields, respectively, which may not provide targeted analysis of conceptual evolution in technical translation.

The search strings consisted of two parts. The first focused on *conceptual evolution* and its most common synonyms (“conceptual change”, “concept evolution”, “concept change”*)*. These search strings cover various perspectives on how concepts evolve. The second part targeted keywords linked to *scientific and technical translation*. The combined search strings helped identify the most relevant literature. The formulation is: *TITLE-ABS-KEY (concept OR conceptual AND evolution OR change AND scientific AND translation OR technical AND translation) AND (LIMIT-TO (DOCTYPE, “ar”)*

The search was conducted in October 2024. It was limited to peer-reviewed journal articles published in English published between 2020-2024. The results thus included the most recent studies from these two databases until October 2024. In total, 518 records were identified and exported to a reference management software that identified 87 duplicates. These duplicates were manually removed, which left 431 unique records (see Fig. 1).

Selection process

Titles and abstracts were scanned based on the following criteria: (1) published in English in a scientific peer-reviewed journal; (2) published between 2020 and 2024; (3) conducted in scientific and technical fields, and (4) specifically investigated the translation practice of conceptual evolution in technical fields.

The first criterion aimed to exclude studies that lack scientific rigor for acceptance through the peer-review process. Peer-reviewed journals were chosen to ensure that only high-quality, validated research was included. However, by limiting to English-language publications, there is a potential bias towards research conducted in Western contexts. Future research should expand the linguistic scope to include non-English studies, particularly those from rapidly developing fields in Asia and Latin America, where unique challenges in conceptual evolution might emerge.

The second criterion eliminated any article published prior to 2020. This intention ensures that the review captured the most recent advancements and discussions in this field. Since the rapid evolution of technical fields and translation practices, studies before 2020 may fail to reflect current trends, emerging technologies, or new translation strategies in conceptual evolution.

The third criterion restricted the selection to studies within scientific and technical fields, since they are most relevant to the research focus on conceptual evolution. Fields like literary studies, which might approach translation from a more interpretive or creative perspective, were excluded. This helps the review focus on the specific challenges and strategies relevant on technical translation.

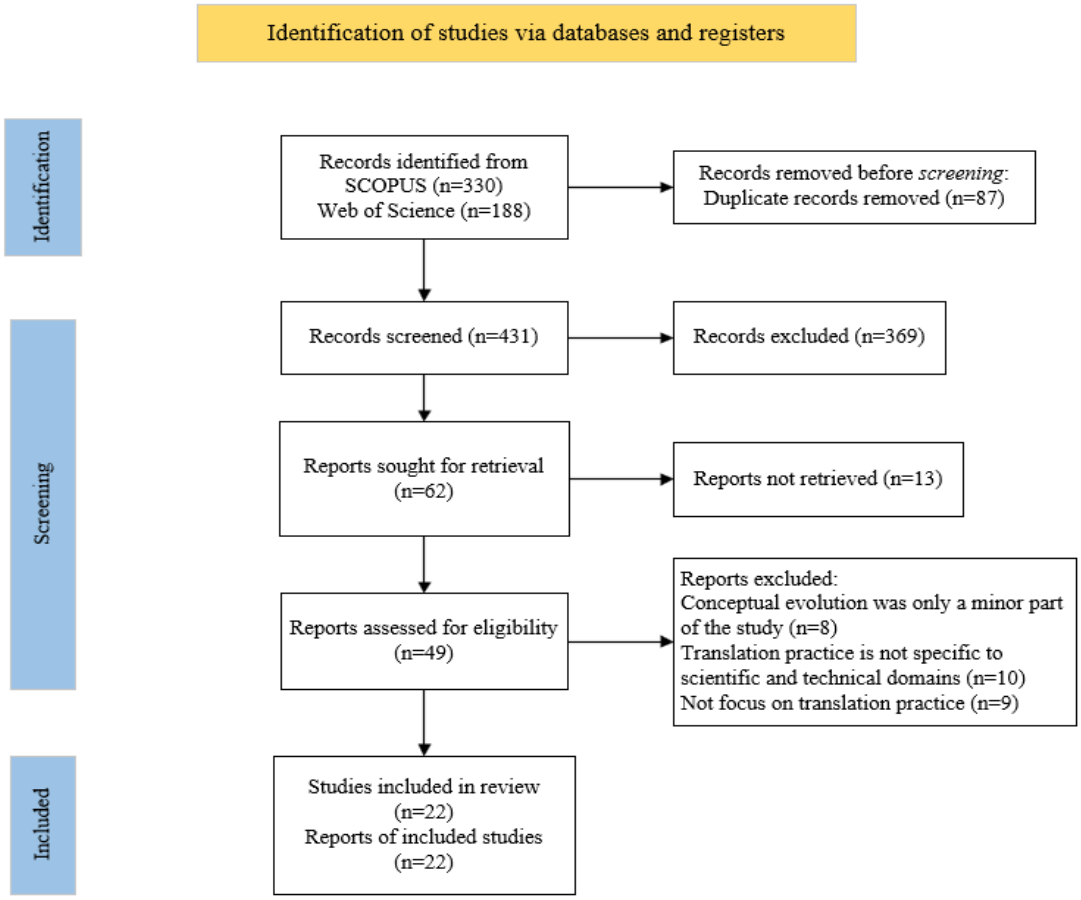

Figure 1. Flow diagram of selecting relevant publications. Note From: Page et al. (2021).

The fourth criterion focused on studies that specifically addressed the translation practice of conceptual evolution. Studies focusing solely on general translation issues without delving into conceptual evolution were excluded, as they are irrelevant to the research questions.

Following the title and abstract screening, 369 records were excluded. Full-text versions of the remaining publications were retrieved, except for 13 articles that could not be accessed, even after personal requests to the authors. The full texts of the remaining 49 references were then carefully screened, with 27 publications excluded based on the eligibility criteria (the specific reasons for exclusion were detailed in Fig. 1). Ultimately, 22 articles were included in the final review and subsequently analysed.

To ensure the reliability of the screening process, the automatic screening tool Rayyan was used. This decision was driven by two factors: First, there has been a growing trend in recent years towards the use of automation in SLRs (Marshall & Wallace, 2019; Chai et al., 2021). Second, Rayyan has been recognised for its high performance in weighted feature analysis, achieving the highest score among other screening tools (Valizadeh et al., 2022). With an exclusion threshold set at <2.5, Rayyan showed a sensitivity rate of 99%, which indicates minimal risk of omitting eligible literature.

Data extraction and data analysis

Following the guidelines of Petticrew & Roberts (2008), a narrative synthesis approach was used in the wide range of study subjects in the review. This narrative synthesis consisted of three steps.

Step 1 involved data extraction. The relevant information for each article was systematically recorded using a data extraction form, including the following sections:

• General information (title, abstract, author names and affiliations, publication date, journal, and research subjects)

• Study aims (research question, the specific aspect of conceptual evolution explored in scientific and technical translation)

Results and conclusions

The characteristics of each study were descriptively analysed to answer the first research question (i.e., What are the current trends in conceptual evolution in scientific and technical translation).

Step 1 focused on carefully reading each study and examining the results in details.

Step 3 deals with cross-study analysis. The results were organised based on (1) the primary challenges identified and (2) translation strategies used to address conceptual evolution in scientific and technical translation to answer RQ2: What are the primary challenges and strategies in the conceptual evolution in scientific and technical translation?

During the final step, three checklists proposed by Efron & Ravid (2019) were used for assessing the quality of each study. The purpose of the quality appraisal was not to exclude any study, but to identify the strengths and weaknesses of each study to (1) consider them when synthesising the results and (2) have an idea of the overall quality of research in the field to identify the limitations and future research opportunities. Indeed, even studies with important limitations such as by Gathogo (2023) and Liqiu et al. (2024) can provide valuable information to explore challenges in conceptual evolution, it's still necessary to consider the overall quality. The critical appraisal of all 22 qualitative studies is presented below.

Table 2. Critical appraisal for qualitative studies

Article	Methodology	Relevance	Strengths	Limitations	Contribution

El Qasem (2023)	2	2	2	1	2
Gogalniceanu et al. (2021)	1	2	2	1	1
Samphel et al. (2021)	1	1	1	2	2
Mascagni et al. (2024)	2	2	2	1	2
Seibold et al. (2023)	2	2	2	1	2
O'Brien (2024)	2	2	2	1	2
Jian (2022)	2	2	1	1	2
Hartmann et al. (2023)	2	2	2	1	2
Letourneur et al. (2021)	2	2	2	1	2
Lee et al. (2022)	2	1	1	1	2
Cameron et al. (2022)	1	2	2	1	1
Barreto et al. (2021)	2	2	2	1	2
Colldén & Hellström (2022)	2	1	2	1	2
Henke (2024)	2	2	1	1	2
Wong et al. (2023)	2	2	2	1	2
Di Roberto et al. (2023)	1	2	1	2	2
Diep et al. (2023)	2	2	2	1	2
Felzmann et al. (2020)	2	2	2	1	2
Barry (2024)	1	2	1	1	1
Collier & Stewart (2022)	2	1	2	1	1
Mikelionienė & Motiejūnienė (2021)	1	2	2	1	2
Turner et al. (2023)	2	2	2	1	2

Limitations of the methodology

This research attempted to make an in-depth synthesis of the conceptual developments in scientific and technical translation. However, there are some methodological limitations.

As far as influence over choices of databases for selection is concerned, there might be biases that cause this research to bend in one particular direction. The selection covered only two databases: Scopus and WOS. Even though Scopus and WOS are known for their representation of high-quality peer-reviewed research, there is a potential risk, i.e., the exclusion of some contributions that are widely considered as the most relevant from key alternative databases such as JSTOR, or PubMed. This might limit the diversity of extreme ideas that are potentially applicable in this review (Mongeon & Paul-Hus, 2016).

Second, the exclusion of non-English studies presents another limitation. While English is the dominant language for academic publishing, insights into conceptual evolution and scientific and technical translation might not be obtained. Non-English studies bring critical perspectives in that view (Caputo & Kargina, 2022). Therefore, this selection for this study may reduce generalisability and comprehensiveness.

Future studies may therefore benefit from expanding the search to include non-English studies in consideration for more extensive analysis.

Results and Discussion

Conceptual evolution in scientific and technical translation saw expansion across various sectors, bringing about both opportunities and challenges. Analysing the research trends from

2020 to 2024 will help identify existing research gaps and future research directions in this field. This review synthesises research trends by examining the annual distribution of publication, geographical origins of authors, journal allocation, and research subjects.

Research trends of conceptual evolution in scientific and technical translation

Annual Distribution of Publication

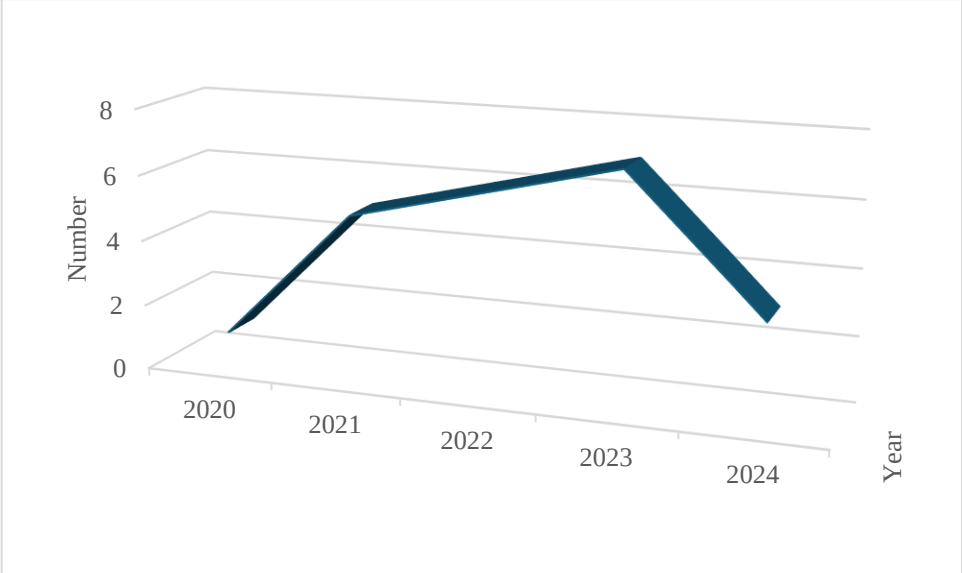

Figure 2. Annual distribution of publication from 2020-2024

The annual distribution of publications from 2020 to 2024 (see Figure 2) demonstrates a consistent increase over the years, with the highest number of studies published in 2023. In 2020, there was only one publication, but it grew to five in 2021, reflecting a growing scholarly interest in the field. The momentum continued in 2022 with six publications, followed by the peak in 2023, where seven studies were published. However, in 2024, the number of publications decreased to three.

It is likely that future research in this area will move toward more specialised and advanced topics. The decrease in the number of publications in 2024 may signal the saturation of broader research themes, enabling researchers to explore niche areas or more interdisciplinary approaches. This shift could result in fewer studies overall but with a more concentrated focus on high-impact, and cutting-edge research.

Geographical Origins of Authors

The geographical layout of the authors is shown in the Figure 2. It demonstrates that the research in this field is being done in ten countries. UK led with four publications, followed by France, Germany, Ireland, and China, each with three publications. Next came the USA with two publications, while Italy, Brazil, Sweden, and Lithuania each have one. While the geographic spread is wide, demonstrating an interest in this area globally, there is still greater emphasis on Europe and developed countries.

The continuing trend of geographic diversity is expected to continue; the emergence of the latter markets and developing regions may provide a progressive means towards advanced research technologies and resources. Countries like China and Brazil, which already bear representation, are likely to increase their contributions as their academic background and research capabilities grow. As research becomes increasingly globalized, the geographic diversity of contributions will reflect a wider and a more balanced representation of the international community.

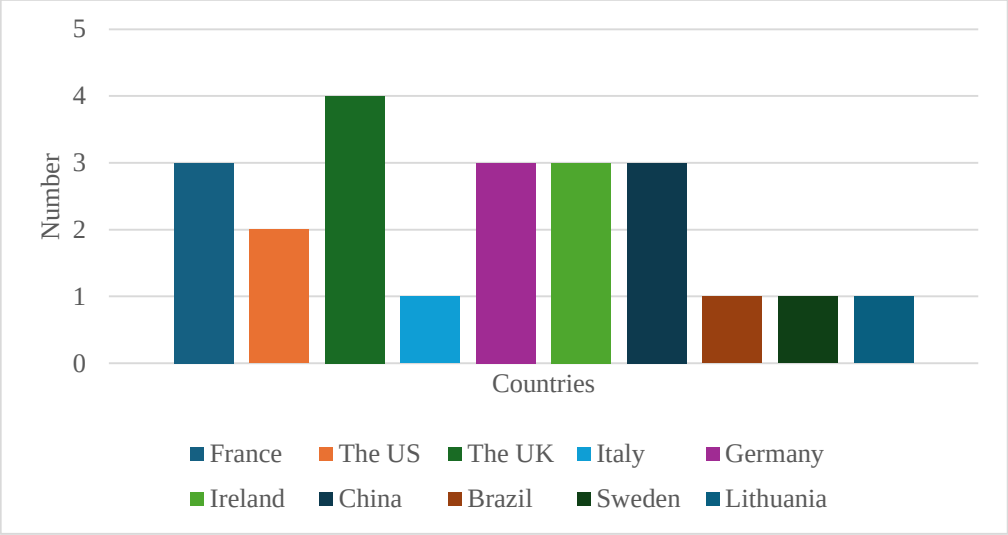

Figure 3. Geographical origins of authors

Journal Allocation

The analysis of journal allocation reveals the distribution of publications in the subject category of linguistics and related fields. It also offers practical suggestions for researchers seeking suitable publication venues. Table 3 shows the journal names, the number of published papers, and the countries where these journals are based. In addition, the SJR quartile, impact factor, and H-index are shown to highlight the reputation and influence of each journal in the academic community.

The table shows that publications are disseminated over quite many journals. Majority of them segue into Q1, which marks them up for high scientific stature and energetic influence within their respective fields. Notable journals are *Advanced Healthcare Materials* (Q1), whose impact factor is 10, *Academic Medicine* (Q1), whose impact factor is 8.03, and *Neural Computing and Applications* (Q2), whose impact factor is 4.5, showing significant emphasis given to technology, healthcare and applied sciences. The journal *Meta* appears, too, as Q1 with an impact factor of 1.1. It enjoys a conspicuous place of recognition in translation studies, representing one of the influential niches for research on translation. The US is particularly well represented, with more than 30% of the high-impact journals listed on this list.

Table 3. Journal allocation of conceptual evolution in scientific and technical translation (2020-2024)

No.	Journal name	No.	SJR quartile	IF	H-Index	Country
1	Meta	1	Q1	1.1	32	Canada
2	Journal of Surgical Education	1	Q1	2.6	72	the US
3	Frontiers in Communication	1	Q2	1.5	31	Switzerland
4	Cirugía Española	1	Q3	1.3	29	Spain
5	Journal of imaging	1	Q3	2.7	43	Switzerland
6	Perspectives	1	Q2	1	34	the UK
7	Computational Intelligence and Neuroscience	1	Q2	3.12	78	the US
8	Medicine, Health Care and	1	Q1	2.3	51	Netherlands

	Philosophy					
9	Advanced Healthcare Materials	1	Q1	10	140	the US
10	Neural computing and applications	1	Q2	4.5	130	the UK
11	Applied spectroscopy	1	Q1	2.2	67	Netherlands
12	Learning Health Systems	1	Q2	2.6	19	the US
13	Journal of Science Communication	1	Q1	1.93	32	the US
14	Asia-Pacific Journal of Regional Science	1	Q2	1.9	14	Netherlands
15	BOIS ET FORETS DES TROPIQUES	1	Q3	0.7	15	France
16	Urban Geography	1	Q1	2.9	89	the UK
17	Science and engineering ethics	1	Q1	2.7	74	Netherlands
18	Acta Astronautica	1	Q1	3.1	105	the UK
19	Science, Technology, & Human Values	1	Q1	3.1	92	the US
20	Journal of language and cultural education	1	Q4	0.1	88	Germany
21	Academic Medicine	1	Q1	8.03	188	the US
22	Research in Science Education	1	Q1	2.2	67	Netherlands

Note: 1. The journal *Perspectives: Studies in Translation Theory and Practice* is also known as *Perspectives: Studies in Translatology*. The journal.
2. IF (Impact Factor) is a scientometric index calculated by Clarivate that reflects the yearly mean number of citations of articles published in the last two years in a given journal.
3. SJR=Scimago Journal Rank; For SJR Quartile, the reference year adopted was 2023.

Trends indicated by publications in high-impact, interdisciplinary journals point toward the continuation of integration into broader research domains such as artificial intelligence, health technologies, and ethics by the field of scientific and technical translation. This is supported by the growing presence of journals focused on AI, neuroscience, and healthcare that reflect an increasingly strong interface of these fields with translation studies.

Research Subjects

Past studies have emphasised the significance of interdisciplinary approaches when exploring trends in research subjects related to the conceptual evolution in scientific and technical translation. Consequently, this review presents all the research subjects of 22 articles to show the diverse landscape in translation studies (Table 4).

Table 4. Distribution of research area (2020-2024)

Research Area	**Number of Articles**

Artificial intelligence	7
biotechnology	4
Machine translation	3
Engineering	3
Environmental science	2
Fintech	1
Internet of Things (loT)	1
Infrastructure	1

As demonstrated in the Table, artificial intelligence emerges as the most studied subject, representing 32% of the articles. This is followed by biotechnology at 18%, while machine translation and engineering each account for 14%. In contrast, fewer than three studies focus on subjects such as environmental science, fintech, IoT, and infrastructure.

This distribution implies that artificial intelligence and biotechnology are currently driving much of the research interest in scientific and technical translation, likely due to their rapid advancements and growing significance across industries. On the other hand, the relatively limited focus on environmental science, fintech, and IoT suggests potential research gaps that warrant further exploration.

As AI continues to evolve, its potential to assist translators in managing the complexity of conceptual evolution is immense. Machine learning algorithms could be trained to recognise evolving terminologies and suggest accurate translations, minimising the gap between scientific advancements and translation practice.

Challenges and strategies of conceptual evolution in scientific and technical translation

Challenges of conceptual evolution

Translation of conceptual evolution in scientific and technical fields is confronted with challenges mainly from four aspects: technological advancements, cultural and contextual differences, complexity of technical language, and regulatory challenges. They were summarised in Table 5.

1. Technological Advancements

Technological advancements are a key challenge, such as AI, fintech, and biotechnology. One notable example of technological advancement creating translation challenges is the rapid development of gene-editing technology. The introduction of this revolutionary tool has led to the creation of new terms like "gene knockout" or "genomic scissors," which often lack direct equivalents in other languages. As CRISPR-related research expands globally, translators must work closely with geneticists to ensure accurate and comprehensible translations.

In the AI and fintech sectors, El Qasem (2023) noted the difficulties of translating fintech terms such as “smart contracts” and “blockchain,” which are rapidly evolving and highly specialised. Translators must collaborate with industry experts to ensure the terminology reflects the latest advancements while maintaining clarity for non-expert audiences. Gogalniceanu et al. (2021) further highlight that AI-based surgical tools, such as robot-assisted surgery, present unique challenges. Terminologies specific to AI-driven diagnostics and operational mechanisms require translators to work alongside both technologists and clinicians to convey highly technical and interdisciplinary information effectively.

Table 5. Challenges of Conceptual Evolution in Scientific and Technical Translation

Theme	Subtheme	Frequency (%)

Technological Advancements	a. Emergence of new technologies in AI, fintech, biotechnology	5(23%)
	b. AI integration in clinical, surgical, and technical fields.	3(14%)
	c. Machine learning for technical language extraction like loT	1(5%)
Cultural and contextual differences	a. Differing concepts of privacy, ethics and values across cultures (e.g., AI and Medtech)	3(14%)
	b. Translating concepts in urban development, environmental sciences, and infrastructure	2(9%)
Complexity of Technical Language	a. High technicality in scientific fields like MedTech, AR, spectroscopy	4(18%)
	b. Translating complex terminologies in interdisciplinary fields (engineering, healthcare)	2(9%)
Regulatory Challenges	Adapting translation to fit updated regulations (MedTech, engineering)	2(9%)

2. Cultural and Contextual Differences

Cultural and contextual differences are a significant challenge in conceptual translation, particularly in fields like AI and MedTech. For example, in AI-driven healthcare technologies, concepts such as patient privacy and informed consent can vary significantly across cultures. Hartmann et al. (2023) observed that translating AI tools for healthcare systems in Europe versus Southeast Asia requires a deep understanding of how each region's ethical standards and cultural values shape healthcare delivery. While Europe may emphasise stringent data protection under regulations like GDPR, Southeast Asian countries may prioritise community-centred healthcare.

In fields like urban development and environmental sciences, Diep et al. (2023) found that terms like "sustainability" and "green infrastructure" are interpreted differently depending on the region. For instance, the concept of "green infrastructure" in China often involves large-scale engineering solutions, while in Western countries, it may refer more to localised, community-based projects. These scenarios require translators to aligns with local environmental, political, and cultural contexts.

3. Complexity of Technical Language

The complexity of technical language, particularly in cutting-edge fields like spectroscopy and augmented reality (AR), poses a prominent challenge for translators. Translating research on AR application in medical imaging difficult due to highly specialised language and jargons (Seibold et al., 2023). Similarly, translating terms like "holographic display" and "real-time depth mapping" often requires collaboration with subject matter experts to preserve both precision and clarity.

In the engineering and biomedical fields, translators working on interdisciplinary projects such as on biomedical devices, must struggle with technical lexicon in mechanical engineering and healthcare (Cameron et al., 2022; Barreto et al., 2021). This complexity of technical language requires meticulous terminology management and coordination with both engineers and healthcare professionals.

4. Regulatory Challenges

Regulatory challenges are particularly evident in fields like MedTech and nanotechnology, where translations must align with national and international standards. For example, translators working on nanomedicine research for clinical trials need to meet the regulatory requirements of different countries. It is not easy, as translations on nanomedicine protocols are required to align with the FDA standards in the US, while ensuring compliance with EMA regulations in Europe (Seibold et al., 2023).

Furthermore, in the context of robot-assisted surgery, regulatory challenges are compounded by the need to translate clinical practice guidelines that vary from country to country. Translators must be familiar with the latest updates in regulatory policies across multiple jurisdictions, from CE markings in Europe to FDA approvals in the US.

Strategies of conceptual evolution

To address these challenges posed by continuous evolution of concepts, strategies are necessary especially in rapidly advancing fields like MedTech, AI, and fintech. This review found five main strategies: interdisciplinary collaboration, terminology standardisation and management, technological integration, ethical and cultural adaptation, and professional training and methodological innovation. They were presented in Table 6.

1. Interdisciplinary Collaboration

Collaboration between experts among various disciplines is important for translating complex and evolving scientific concepts. Hartmann et al. (2023) emphasised the need for cross-field expertise, especially in MedTech and AI, where the convergence of medical professionals, technologists, and translators ensures accurate concept translation. This interdisciplinary teamwork applies to translating concepts with no direct equivalents in the TL. Future work could benefit from interdisciplinary teamwork in adapting AI for surgical practices, and for translators to work closely with clinicians and technologists to navigate terminological and conceptual shifts.

2. Terminology Standardisation and Management

Terminology standardisation is another critical strategy. It contributes to consistency across languages and disciplines, particularly in specialised fields. Corpus-based approaches are useful to manage and extract terminology (Mikelionienė & Motiejūnienė, 2021). Furthermore, an established corpus is crucial for maintaining consistency in fintech translation (El Qasem, 2023). Future research could focus on refining corpus-based tools to better manage terminology and achieve terminology standardisation.

3. Technological Integration in Translation

Technological integration is becoming increasingly vital in translation processes. It focused on using AI and machine learning to enhance translation accuracy, particularly in technical fields like IoT and fintech. Jian (2022) demonstrated how AI can facilitate the identification of precise terms for technical language extraction. Additionally, the application of technical indicators from sectors such as IoT and fintech helps translators navigate complex terminologies and reflect the latest advancements in the field (Lee et al., 2022). Future studies could explore how translators can better harness AI and machine learning to increase efficiency and accuracy, particularly when dealing with emerging technologies.

4. Ethical and Cultural Adaptation

Ethical and cultural adaptation is a critical strategy, especially in sensitive fields like AI and MedTech. It involves adapting translations to align with ethical concerns, privacy regulations,

Table 6. Strategies of Conceptual Evolution in Scientific and Technical Translation

Theme	Subtheme	Frequency (%)

Interdisciplinary Collaboration	a. Collaboration between policymakers, technologists, and stakeholders from diverse fields	2 (9%)
	b. Cross-field expertise for translating complex scientific concepts (e.g., MedTech)	2 (9%)
Terminology Standardisation and Management	a. Standardise terminology across languages and disciplines	3 (14%)
	b. Corpus-based approaches for managing and extracting terminology	2 (9%)
Technological Integration in Translation	a. Utilise AI and machine learning in translation processes	2 (9%)
	b. Apply technical indicators (e.g., loT, fintech)	1 (5%)
Ethical and Cultural Adaptation	a. Adapt translation to address ethical concerns, privacy, and cross-cultural values	3 (14%)
	b. Adjust translations to fit local regulatory and cultural frameworks	2 (9%)
	c. Apply top-down approach to fit broader cultural frameworks and regulatory compliance	1 (5%)
Professional Training and Methodological Innovation	a. Develop training programs for translators in evolving fields	2 (9%)
	b. Use network science and Action Research (AR) to innovate translation methods	1 (5%)
	c. Track the progress of scientific concept evolution through top-down and bottom-up approaches	1 (5%)

and cross-cultural values. Despite the necessity of technical accuracy, it does not overshadow its ethical and cultural relevance. Hartmann et al. (2023) emphasised the importance of translating AI-based healthcare technologies to align with different cultural and legal frameworks. Moreover, adjusting translations to fit local regulatory standards is crucial, particularly in regions where ethical norms and privacy regulations vary. According to Letourneur et al. (2021), a top-down approach is necessary in certain contexts to align with broad cultural and regulatory frameworks.

5. Professional Training and Methodological Innovation

Professional training and methodological innovation are essential for translators working in rapidly evolving fields. The targeted training programs helps translators keep pace with the rapid development of new technologies. in specialised areas like AI, AR, and MedTech. Consequently, translators are better equipped to handle the complexity of technical language and interdisciplinary concepts.

Additionally, innovations in translation methods, such as using network science and Action Research (AR), are key for improving the accuracy and relevance of translations in these fields. Furthermore, tracking the progress of concept evolution through both top-down and bottom-up approaches allows translators to adapt to the ongoing advancements in their respective fields (Colldén & Hellström, 2022).

Future studies should explore the integration of neural machine translation (NMT) with real-time terminology management tools to tackle the challenges posed by evolving scientific concepts. These technologies could provide translators with updated term glossaries and contextual meaning in real-time, to enhance translation accuracy and consistency.

Conclusion

This study reviewed 22 studies on conceptual evolution in scientific and technical translation, focusing on research trends, challenges and strategies. It has contributed to the growing body of literature on scientific and technical translation on how conceptual evolution impacts translation practices. It identified key challenges such as interdisciplinary collaboration and the integration of AI technologies. This review offers practical suggestions that can be implemented by researchers and practitioners to improve translation accuracy and terminology management in rapidly evolving technical fields like biotechnology and AI.

Conceptual evolution requires further investigation, due to the evolving nature of concepts and the complexities of interdisciplinary communication. There is also a lack of research on top-down approaches to regulating technical translations across different languages and regions.

The successful translation of evolving scientific concepts relies not only on technological solutions but also on interdisciplinary collaboration. Translators must work closely with subject matter experts and technologists to ensure that both linguistic accuracy and conceptual integrity are maintained.

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