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LEAPS AND STUMBLES IN THE APPLICATION OF TRANSLATION TECHNOLOGIES TO SCHOLARLY COMMUNICATION (Paper)

Abstract:
English plays the key role in scholarly communication and resource distribution, but using a single language for research has consequences for scholars, science and society. To create a more equitable and linguistically diverse scholarly communication ecosystem, support is needed to ensure that scholars can read each other's work. Language technologies such as machine translation tools (e.g. Google Translate) could potentially play a role, but little is understood about whether, how and to what extent these tools are used by scholars. This systematic review focused on the current state of language technologies within the scholarly communication ecosystem, uncovering both leaps and stumbles in the process.

Keywords: scholarly communication; multilingualism; translation technologies; machine translation; systematic review

1. Introduction
English has long occupied a privileged position in scholarly communication, but this is beginning to change as scholars who use other languages are advocating for multilingual scholarly communication. In principle, there is a logic to using one language for research (i.e., everyone who knows the language can participate in the conversation), but in practice, this model has inequities. For instance, non-Anglophones must invest more time and effort to read, publish, or present in English (Amano et al., 2023), and English may be used as a gatekeeper (Habibie & Hultgren, 2022). As a result, Anglo-Saxon/Western viewpoints have higher visibility, and this may influence what gets studied, which methods are used, where findings are shared, and which communities benefit from the research (Angulo et al., 2021).

Groups such as the Helsinki Initiative on Multilingualism in Scholarly Communication (Helsinki Initiative, 2019), UNESCO (2021), OPERAS SIG on Multilingualism (Balula, 2021), and Acfas (St.-Onge et al., 2021), are among those calling for linguistic diversity. Yet, to create a viable multilingual scholarly communication ecosystem, scholars will need practical support to find, read or write works in other languages. Can translation technologies help? Recently, AI-based data-driven tools (e.g., Google Translate, DeepL Translator, or ChatGPT) have brought dramatic improvements to the quality of machine-translated text, making it a viable starting point for

many purposes. However, little is known about how these tools are used in for scholarly communication.

2. Objectives

Our overarching research question is "How are translation technologies being used for multilingual scholarly communication in Canada and beyond?". Within this frame, we investigate the issue primarily from the perspective of tool *users* rather than developers. Our review considers the extent to which translation technologies are being used for scholarly communication, as well as which specific tool types, languages and text types are in play.

3. Methodology

We employ the systematic review approach to synthesize and provide a thorough and critical overview of previously published material on our topic of interest. This enables the identification of patterns and trends, as well as gaps. A systematic review of the literature can help to produce a reliable knowledge base by accumulating findings from a range of studies in a systematic and reproducible way (Briner & Denyer, 2012). The review was conducted in English, French, Spanish, and Polish in accordance with the languages known to team members. However, some databases include abstracts in English for articles written in other languages; therefore, we retrieved articles in other languages as part of the English-language search, and we translated them using machine translation.

Searches were conducted in nine bibliographical databases to ensure wide coverage and reduce the risk that relevant articles would be missed: a) Scopus, b) Web of Science core collections, c) ERIC (Education Resources Information Centre), d) MLA (Modern Language Association) International Bibliography database, e) PubMed, f) Dimensions, g) Érudit (for French content), h) Redalyc (for Spanish content), and (i) Google Scholar. The search strategy included the identification of search terms that represent the two main subjects of the systematic research: *machine translation* and *scholarly communication*. Table 1 presents the search terms used for conducting the search in the selected databases.

Table 1. Search strategy

Terms relating to machine translation	Terms relating to scholarly communication
automatic translation* OR automatic translator* OR DeepL OR DeepL Translator OR Google Translate OR Google translator OR machine translation* OR machine translator* OR neural machine translation* OR online translator* OR post-edit* OR translation engine* OR translation system* OR translation technolog* OR translation tool*	academic abstract* OR academic article* OR academic literature OR academic paper* OR academic publication* OR academic publishing OR academic writing OR journal article* OR journal publication* OR medical article* OR medical literature OR research article* OR research paper* OR research publication* OR science writing OR scientific abstract* OR scientific article* OR scientific literature OR scientific paper* OR scientific publication* OR scientific text* OR scholarly communication* OR scholarly publication* OR scholarly publishing OR scholarly writing OR writing for publication

Following a set of inclusion criteria using a multilingual search, 875 papers were retrieved, of which 160 articles were subjected to full-text screening which was carried out independently by two authors (PA and LB), and the third author (EK) was consulted as needed throughout the process of coding, analysis, and interpretation. The reasons for inclusion or exclusion were

provided, which then allowed the authors to compare, discuss and resolve any differences. At end of the full-text assessment of 160 potentially relevant articles, 120 articles were excluded and 40 were retained for closer investigation. The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) protocol was used to present the search process and outcomes (Moher et al., 2009). See Figure 1 for the PRISMA flow of search process and outcomes. Next, the included studies were coded using a pre-developed coding scheme. Qualitative analysis of the codes was carried out in NVivo software. Several themes emerged, some of which are discussed in the next section.
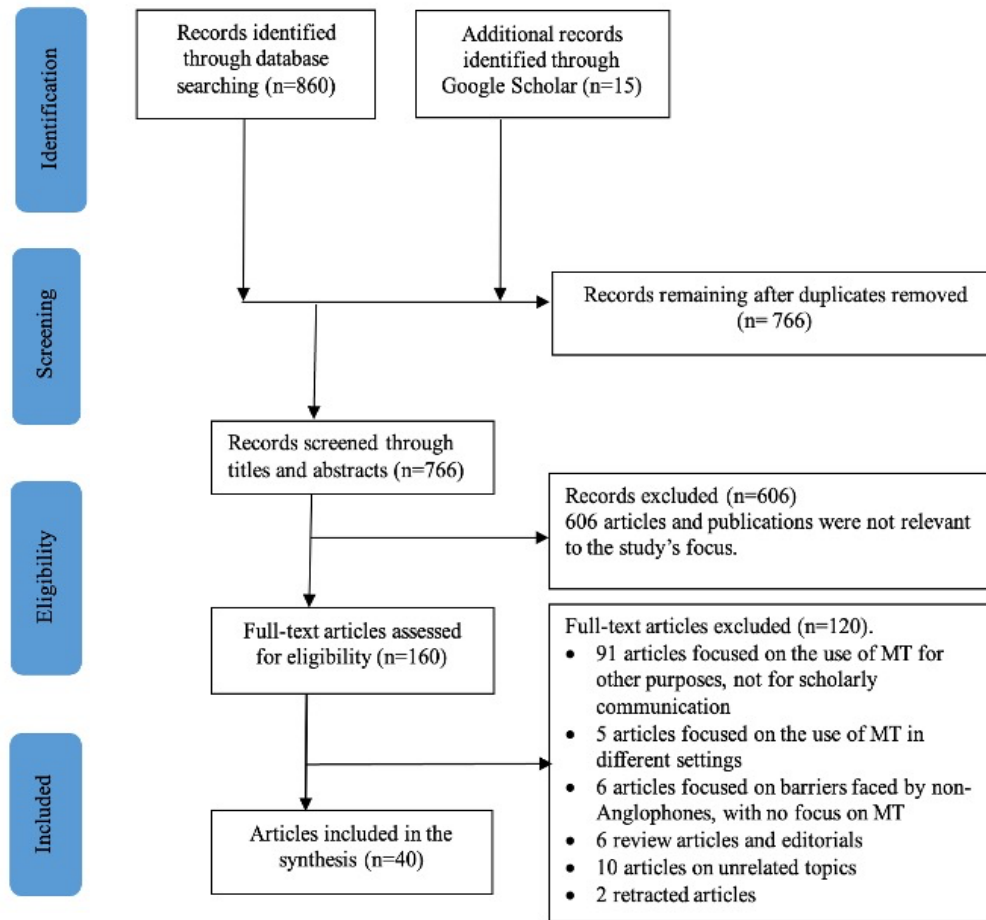

Figure 1. PRISMA flow of search process and outcomes

4. Findings

This section presents the findings from the analysis of the 40 retained studies. It first presents some general characteristics of these studies. Next, it discusses three themes that emerged from the qualitative coding and analysis: 1) translation tools, 2) languages, and 3) text types.

4.1. Study Characteristics

As presented in Figure 2, five studies (12.5%) were conducted by first authors based in Japan, three studies (7.5%) each in Canada, China, Taiwan, UK, and USA, followed by two studies (5%) each in Brazil, Germany, Ireland, and Russia. One study was conducted in each of the other countries. It is of interest to note that while English-speaking countries are represented, there is a

greater volume of research on this topic taking place in countries where English is not the (only) national language. In other words, it appears as though researchers from nations that are not (exclusively) Anglophone are motivated to find ways of facilitating multilingualism in scholarly communication.
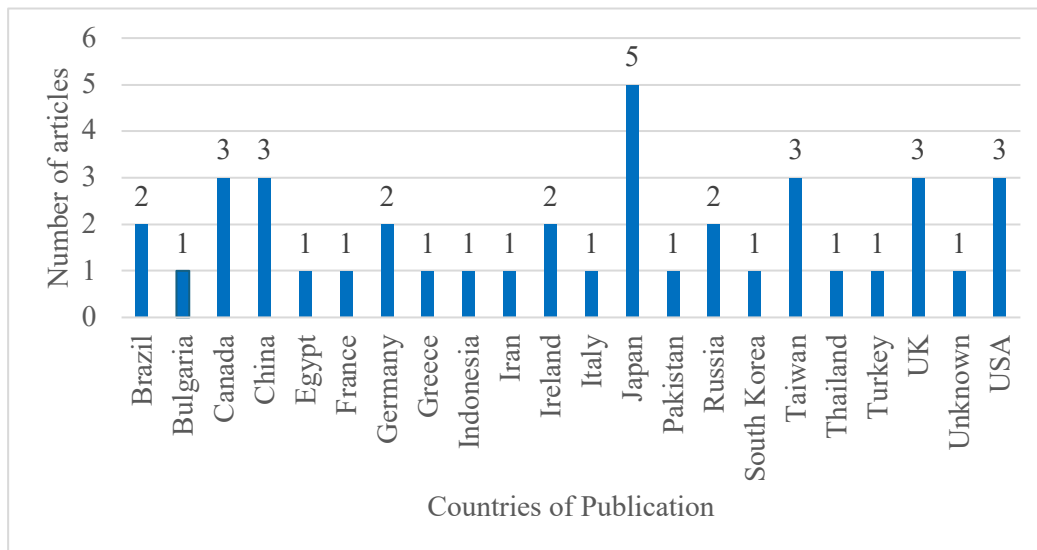

Figure 2. Countries of publication of the included studies

4.2. Translation tools
Findings show that, overwhelmingly, the main type of translation tool in use in scholarly communication is machine translation, and more specifically neural machine translation (NMT). Only three studies involve older machine translation architecture (e.g., Neves et al., 2018; Soares et al., 2018), while just one study (Takeshita et al., 2022) incorporates Large Language Models (LLMs), which only appeared in late 2022. The most frequently used NMT tool is Google Translate, with 18 (45%) of the included studies using it for translating scholarly texts or evaluating its translation quality (e.g., Chang et al., 2020; Daniele, 2019; Soares et al., 2018; Sun et al., 2022). The high use of Google Translate in the included studies could be because this tool is easily accessible and free of charge and because it can translate in more languages than its competitors (Winiharti, Syihabuddin, & Sudana, 2021).

4.3. Languages
All 40 studies included in this review feature English as one of the languages. As illustrated in Figure 3, in the majority of cases (25/40 or 62.5%), English is the target language, while in only nine (22.5%) studies, English is the source language. Three additional studies are bidirectional (i.e., translation into and out of English). The remaining three studies use multiple language pairs, including some that involve English. The high proportion of studies that use English as the *target* language is striking because it suggests that translation tools are not necessarily helping to displace English as the key language of scholarly communication. Instead, non-Anglophone scholars are using machine translation tools to reduce the burden of preparing English-language publications, but this is not creating a genuinely multilingual scholarly communication ecosystem.
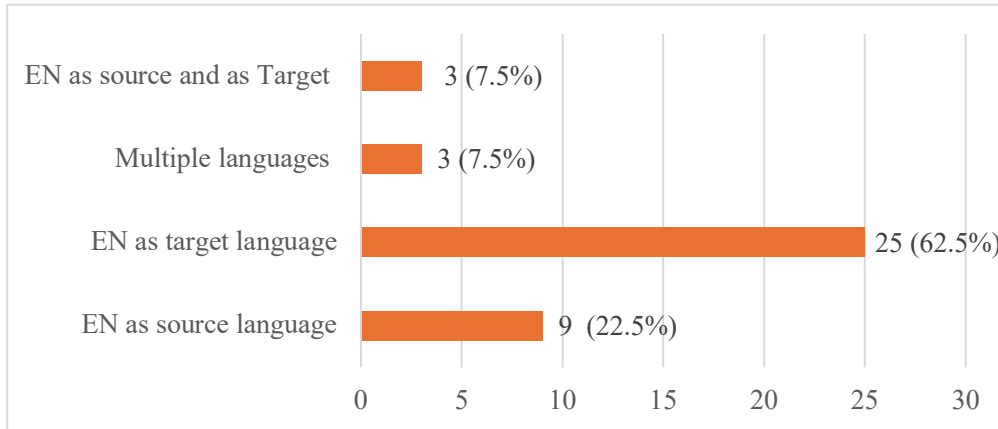
Figure 3. Distribution of studies involving English by translation direction

With regard to other languages, most studies combine English with another widely used language, including French (8/40 or 20%). Meanwhile, only one quarter of the studies involve less widely used languages (e.g. Basque, Thai), but none include Indigenous languages.

4.4. Text types

Of the 40 included studies, 13 (32.5%) explore how machine translation can help produce written texts such as articles (e.g., Esmailpour et al., 2020; Lin & Morrison, 2021: O'Brien et al., 2018). However, a number of the studies involve using tools that had been trained using only abstracts (9 or 22.5%) (e.g., Bawden et al., 2020; Sun & Yang, 2023; Xu et al., 2021) or theses/dissertations (4 or 10%) (e.g., Chang et al., 2020: Sel & Hanbay, 2022), which do not necessarily share the same textual features. All of the included studies focused on written texts, and none considered spoken or multimodal formats (e.g., subtitles). In addition, posters, slides, plain language summaries, and popularized science communication texts, were overlooked. There is a need to investigate how translation tools process these other relevant text types.

5. Conclusion

Our review reveals both leaps and stumbles. One the one hand, there is a growing desire to spring towards a more multilingual scholarly communication ecosystem, along with a leap of faith that new translation technologies will help. On the other hand, we seem to have stumbled into the trap of considering only prototypical scholarly texts (i.e., scientific abstracts and journal articles) with no attention paid to how these tools might support oral forms of scholarly communication (e.g., conferences) or less prototypical texts (e.g., slides, posters, popularized texts). Translation technologies have the potential to help non-Anglophone scholars soar by enabling discovery of and access to works written in other languages; however, at present, the primary use of these tools is to overcome the hurdle of publishing in English. In other words, translation tools are not yet significantly displacing English as the central language for scholarly communication, and the responsibility for translating remains firmly on the shoulders of non-Anglophone scholars. Our review illustrates that while translation tools can help, technology alone is not enough to launch us into a multilingual scholarly communication ecosystem. To help us take flight and stick the landing, technology use must be supported by meaningful policies that value multilingual contributions to scholarly communication.

References

Amano, T., Ramírez-Castañeda, V., Berdejo-Espinola, V., Borokini, I., Chowdhury, S., Golivets, M., González-Trujillo, J. D., Montaño-Centellas, F., Paudel, K., White, R. L., & Veríssimo, D. (2023). The manifold costs of being a non-native English speaker in science. *PLoS Biology* 21(7): e3002184 https://doi.org/10.1371/journal.pbio.3002184

Angulo, E., Diagne, C., Ballesteros-Mejia, L., Adamjy, T., Ahmed, D. A., Akulov, E., Banerjee, A. K., Capinha, C., Dia, C. A. K. M., Dobigny, G., Duboscq-Carra, V. G., Golivets, M., Haubrock, P. J., Heringer, G., Kirichenko, N., Kourantidou, M., Liu, C., Nuñez, M., Renault, D., Roiz, D., Taheri, A., Verbrugge, L. N. H., Watari, Y., Xiong, W., & Courchamp, F. (2021). Non-English languages enrich scientific knowledge: The example of economic costs of biological invasions. *Science of the Total Environment* 775: 144441. https://doi.org/10.1016/j.scitotenv.2020.144441

Balula, A., Caliman, L., Costa, C., Fiorini, S., Jarmelo, S., Leão, D., Mounier, P., Nomine, J.F., Padez, M.J., Plag, C., Pölönen, J., del Rio Riande, G., Silva, M., Stojanovski, J., Szulińska, A., Volt, I., Toledo, E.G., and Withanage, D. (2021). Innovative models of bibliodiversity in scholarly publications. *SIG Multilingualism White Paper*. https://doi.org/10.5281/zenodo.4817508

Bawden, R., Di Nunzio, G. M., Grozea, C., Jauregi Unanue, I., Jimeno Yepes, A., Mah, N., Martinez, D., Névéol, A., Neves, M., Oronoz, M., Perez-de-Viñaspre, O., Piccardi, M., Roller, R., Siu, A., Thomas, P., Vezzani, F., Vicente Navarro, M., Wiemann, D., & Yeganova, L. (2020). Findings of the WMT 2020 Biomedical translation shared task: Basque, Italian and Russian as new additional languages. *Proceedings of the Fifth Conference on Machine Translation*, 660–687. https://aclanthology.org/2020.wmt-1.76

Briner, R. B., & Denyer, D. (2012). *Systematic review and evidence synthesis as a practice and scholarship tool*. In D. Rousseau (Ed.), The Oxford Handbook of Evidence-Based Management: Companies, Classrooms, and Research (pp. 112-129). (Oxford Library of Psychology). Oxford University Press.

Chang, C.-M., Chang, C.-H., & Hwang, S.-Y. (2020). Employing word mover's distance for cross-lingual plagiarized text detection. *Proc Assoc Inf Sci Technol. 2020;57:e229* https://doi.org/10.1002/pra2.229

Daniele, F. (2019). Performance of an automatic translator in translating medical abstracts. *Heliyon*, *5*(10), e02687. https://doi.org/10.1016/j.heliyon.2019.e02687

Esmailpour, R., Ebrahimy, S., Fakhrahmad, S. M., Mohammadi, M., & Abbaspour, J. (2020). Developing an effective scheme for translation and expansion of Persian user queries. *Digital Scholarship in the Humanities*, *35*(3), 493–506. https://doi.org/10.1093/llc/fqz041

Habibie, P., & Hultgren, A. K. (eds). (2022). *The inner world of gatekeeping in scholarly communication*. Cham: Palgrave Macmillan.

Helsinki Initiative. (2019). Helsinki initiative on multilingualism in scholarly communication. Helsinki: Federation of Finnish Learned Societies, Committee for Public Information, Finnish Association for Scholarly Publishing, Universities Norway & European Network for Research Evaluation in the Social Sciences and the Humanities. https://doi.org/10.6084/m9.figshare.7887059

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., & The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine* 6(7), e1000100. https://doi.org/10.1136/bmj.b2535

Neves, M., Jimeno Yepes, A., Névéol, A., Grozea, C., Siu, A., Kittner, M., & Verspoor, K. (2018). Findings of the WMT 2018 Biomedical Translation Shared Task: Evaluation on Medline test sets. *Proceedings of the Third Conference on Machine Translation: Shared Task Papers*, 324–339. https://doi.org/10.18653/v1/W18-6403

O'Brien, S., Simard, M., & Goulet, M.-J. (2018). Machine translation and self-post-editing for academic writing support: Quality explorations. In J. Moorkens, S. Castilho, F. Gaspari, & S. Doherty (Eds.), *Translation Quality Assessment: From Principles to Practice* (pp. 237–262). Springer International

Sel, İ., & Hanbay, D. (2022). Fully attentional network for low-resource academic machine translation and post editing. *Applied Sciences*, *12*(22), Article 22. https://doi.org/10.3390/app122211456

Soares, F., Yamashita, G. H., & Anzanello, M. J. (2018). A parallel corpus of theses and dissertations abstracts. In A. Villavicencio, V. Moreira, A. Abad, H. Caseli, P. Gamallo, C. Ramisch, H. Gonçalo Oliveira, & G. H. Paetzold (Eds.), *Computational Processing of the Portuguese Language* (pp. 345–352). Springer International Publishing. https://doi.org/10.1007/978-3-319-99722-3_35

St-Onge, S., Forgues, É., Larivière, V., Riddles, A. & Volkanova, V. (2021). *Portrait et défis de la recherche en français en contexte minoritaire au Canada*. Acfas. https://www.acfas.ca/sites/default/files/documents_utiles/rapport_francophonie_final_1.pdf

Sun, Y.-C., & Yang, F.-Y. (2023). Exploring the process and strategies of Chinese–English abstract writing using machine translation tools. *Journal of Scholarly Publishing*, *54*(2), 260–289. https://doi.org/10.3138/jsp-2022-0039

Sun, Y.-C., Yang, F.-Y., & Liu, H.-J. (2022). Exploring Google Translate-friendly strategies for optimizing the quality of Google Translate in academic writing contexts. *SN Social Sciences*, *2*(8), 147. https://doi.org/10.1007/s43545-022-00455-z

Takeshita, S., Green, T., Friedrich, N., Eckert, K., & Ponzetto, S. P. (2022). X-SCITLDR: Cross-lingual extreme summarization of scholarly documents. *Proceedings of the 22nd ACM/IEEE Joint Conference on Digital Libraries*, 1–12. https://doi.org/10.1145/3529372.3530938

UNESCO. (2021). Recommendation on Open Science. https://unesdoc.unesco.org/ark:/48223/pf0000378841

Winiharti, M., & Sudana, D. (2021). The English google translation of Indonesian lecturer's academic writing: A preliminary study. *Journal of Language and Linguistic Studies*, *17*(2), 706–719. https://doi.org/10.3316/informit.215875937433823

Xu, J., Abdul Rauf, S., Pham, M. Q., & Yvon, F. (2021, November). LISN @ WMT 2021. *6th Conference on Statistical Machine Translation*. https://hal.science/hal-03430610