Exploring Translation Approaches For Popularized Scientific Texts: Human-Machine Collaboration In The Arabic Context

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Abstract

This study examines approaches to translating popularized scientific texts from English to Arabic, comparing the effectiveness of human translation versus machine.
translation. Scientific popularization plays a crucial role in knowledge sharing, yet the lack of standardized terminology and cultural barriers pose challenges for Arabic translations. Both human translators and machine translation software were evaluated based on accuracy, speed, ability to convey technical concepts, and capacity for error correction. While machine translation has improved greatly, limitations remain such as incorrectly ordering symbols and the inability to understand nuanced context. Human translators rely on linguistic skills and subject matter expertise but are slower. The findings indicate that sole reliance on machine translation is insufficient for complex scientific popularization due to language comprehension issues. However, utilizing machine translation as a first draft followed by human post-editing combines strengths and compensates for weaknesses. Other hybrid translation techniques like pre-editing source texts and interactive human-machine cooperation were also proposed.Given the significance of accessible science education, developing standardized Arabic scientific lexicons and leveraging modern technologies are recommended to revive Arabic scientific translation movements. Integrating popularized science translations can help close knowledge gaps while restorin[1]g Arabic prominence in technological and educational spheres. Overall, strategic partnerships between humans and machines were determined to yield the highest quality popularized scientific translations. The paper concludes with some relevant recommendations.

Keywords: *Accessible science education; Language comprehension; Symbol ordering; Nuanced context; Hybrid translation.*

Introduction

An Introduction

It is without dispute the importance of scientific popularization in the modern world, as well as its ground-breaking contributions to societal development. Facilitating science for all has become essential for keeping up with the demands of the information and technology age. The need for easy-to-understand science writing has increased because more people are interested in science today and what it can teach us. Short simple science articles have many readers and are valuable to researchers since they educate and share scientific ideas with a wide audience. Since these texts have the power to spread knowledge, it is important that translators convert them into multiple languages so people everywhere can learn from them. Translating accessible science writing broadens who can gain from discoveries and

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be informed about the natural world. A study that has been done in China by Ren et al (2020)examines the advancement of machine translation of scientific and technology writings has advanced recently with the growing popularity of machine translation software. Ren discusses how machine translation is becoming more and more significant in language services as a result of the updating and translation of science and technology in our nation, as well as the rising demand from society for the translation of materials relating to these subjects. The role of translation and technology is important in language services however Ren finds problems encounter the process especially the errors in translation (Ren et al 2020).

To obtain a high quality translation of a popular science text, the best approach utilizes both human translators and machine translation tools working together. While machine translation has improved, it is not as precise as people when complex scientific content requires deep subject matter expertise. A good process is to first run the text through a machine translator to generate a draft and then have a professional human translator review and edit it to ensure correctness and clarity. This capitalizes on the speed of machines while also tapping into translators' skills and intuition.

Research actually shows combining the two leads to better translations than either alone. A language industry report found the highest quality translations with greatest efficiency came from pairing translators and technologies, not having them compete. Overall, humans and machines complement rather than compete with each other. Translators supply needed context and understanding, while machines aid efficiency and cost-savings. The combination yields high quality scientific translations.

There are several effective steps to take to obtain a high-quality translation of a popular scientific text.

First, engage a professional translator or translation service that specializes in scientific material. Look for someone experienced in your particular field of science who has a proven record of delivering quality work.

Second, equip the translator with as much relevant context and background about the text as you can, such as the purpose, intended readership, any technical terms or jargon included, and cultural references.

Third, request that the translator/service provide you with a sample translation of a short excerpt from the text before committing to the full document. This allows you to evaluate their translation ability and suitability for the job. Taking these steps helps maximize the chances of a translation that accurately conveys the scientific content.This will give you an idea of their translation quality and style, and allow you to provide feedback and make any necessary adjustments before the full translation is completed.

Fourth, Review the translation carefully before accepting it as final. Make sure the translation accurately conveys the meaning and intent of the original text, and that any technical terminology or jargon is translated correctly. Hence, the notion of employing machine translation and exploiting its enormous capabilities to translate scientific popularization texts into Arabic. Machine translation saves time and effort due to its fast speed, standard stored memory, and capacity to handle extended working hours, as opposed to human translators, who are slow, have limited memory, and are unable to withstand fatigue. While some strive to prove the machine's efficiency in translation, others try to reduce it and stick to human efficiency in translation, the goal of this research is to compare the two and evaluate which is more efficient in translating scientifically popularized texts.

The Significance of the Study

Since the idea of popularization infiltrated cultures of all classes, scholars in the field of language and translation have paid close attention to the translation of scientifically popularized materials all over the world. According to Myers, it is a one-way process of simplifying is popularizing science (2003). This concern about popularizing translation is related to the twentieth century. According to Forget, in fact, translation was one of the popularization tactics used in the eighteenth and nineteenth centuries. She examines how translators frequently anticipated larger readersthan work may have attracted in its originating language. This indicates that it was utilized as a communication tactic intended to translate scientific knowledge into useful popular language (Forget2010)

Scientific popularization texts have grown significantly in importance over time, surpassing more specialized scientific translations aimed only at elite scientists and broad popularized texts with limited scientific content.

In the current age of science and technology, the unprecedented demand for scientific popularization texts and information has led to greater value placed on writing, translating, and widely distributing/utilizing these texts as part of educational, cultural, and media systems.

Given the significance of this topic, the field of Arabic translation should be developed by highlighting the benefits of popularizing science texts and their pioneering role in advanced societies. Efforts should also explore the best ways to accelerate the translationof these texts into Arabic to revive scientific translation in Arab nations and make the most of modern translation technologies.

Scientific popularization refers to making scientific knowledge and discoveries accessible and understandable to the general public. It aims to bridge the gap between research and everyday life and promote scientific literacy among all.

Over time, how scientific popularization is approached has evolved to reflect shifting societal views of science, technology, and education. In the 19th century, the focus was on educating the public via popular science books, lectures, and demonstrations. The goal was to informthe citizenry who appreciated the natural world.

In the 20th century, scientific popularization became more complex as science's role in society grew regarding politics, economics, and social issues. Public understanding is seen as key to informed decision-making. Communication diversified with various mediums but understanding remained the goal.

Today, popularization has new forms like online content, podcasts and social media which can reach wider audiences but also present challenges regarding accuracy, ethics, and engagement.

Statement of the Problem

The philosophy of scientific popularization focuses on the ethics, methods, and goals of communicating science to the public in a way that improves understanding and fosters critical thinking. A core principle is that science should be accessible to all regardless of background or education. This involves using clear, engaging language without jargon and providing relatable examples. Accuracy and objectivity are also important, requiring a commitment to facts, rigorous fact-checking, and correcting errors in light of new evidence. Popularization should inspire curiosity about nature while encouraging skepticism and critical analysis. Deeper public understanding can help address issues facing society.

Prominent scholar Brian Wynne argued that scientific knowledge is socially and politically shaped by various interests and values, challenging the idea of a clear divide between expert and lay knowledge. This highlights the importance of dialogue between scientists and the public.

Popularization aims to make science comprehensible for non-specialists by simplifying technical terms via means like books, magazines, clubs, and media using techniques such as rewording, metaphors, and examples. The concepts of popularization indicate expanding and disseminating knowledge to wider audiences in accessible ways. When the idea first emerged, popularization was associated with concepts of "generalization" in French and "popularization" in English.

1. Identification of the problem and importance of the study

1.1. The main question of the study

In recent years, translators have been more interested in scientific popularization works because of the scientific, educational, and pedagogical material they include, which has vast readers and is based on the behavior and cultures of aware and advanced countries. This has piqued interest and prompted to consider the need to give a voice and to examine through the lens of the English-Arabic translation microscope, through an analytical and comparative descriptive study, the topic of which is the problem of translating scientific popularization texts and the challenges they pose to both human and machine translators. Despite what has been said and what is being claimed about the machine translator's capabilities and characteristics, issues remain concerning the quality and acceptability of its translation "Machine translation has facilitated the way for professional translators as well as ordinary people. Google Translate is undoubtedly the most popular machine translation program today. However, when translating texts from English to Arabic using Google Translate, the machine-generated translations contain seriously inaccurate language, especially for encyclopedic texts. The quality of translations is quite poor. This calls into question whether human translators could be replaced by machines for such specialized content in the future, or if human expertise will still be needed to produce high quality translations even with advances in translation technology. Machine translation currently seems insufficient for certain types of technical and specialized texts.And it is to this end that we will pose the following questions:

1.2TheSubsidiary questions of the study

In order to simplify the problem of the study and achieve the specified aims, the following subsidiary questions will be addressed:

- What does it mean to think of the popularization of science, and how has that thought altered through time?

- What distinguishes scientific popularization texts? What challenges do you encounter when translating?

- • How do human and machine translators perform when translating texts that are simplified for scientific purposes? Which one of them is more qualified for the job?

- How to get a high-quality translation of a popular scientific text? Is the human interpreter in competition with the machine or do they complement each other?

2.1. Popularization of contemporary science

One important development during the Enlightenment was scientific popularization (Meyer. M. 2016). An increasingly literate population sought knowledge in arts and sciences, driving print expansion and disseminating scientific learning (Meyer. G. 2003). Literacy increased due to abundant, affordable food, enabling people to rise from poverty and afford education instead of spend excess on food (Meyer. G. 2003). Popularization aligned with Enlightenment ideals of maximizing information access (Meyer. M. 2016). Public interest in philosophy grew, opening new paths for scientists outside universities through public lectures and popular texts.

Despite revolutionary scientific and socioeconomic progress during the Industrial Revolution, popularization philosophy declined in the late 1800s due to death of leaders like J.S. Mill and Herbert Spencer (Meyer. G. 2003).

Specialized scientific texts challenge with technical jargon and complex concepts requiring background (Lockwood & Carrigan, 2018). Their narrow scope and specificity hinders interdisciplinary collaboration and real-world application (Lockwood & Carrigan, 2018). One study highlighting difficulty is "The Obfuscation of Scientific Literature," analyzing opaque language barriers in publications (Lockwood & Carrigan, 2018).

Popularization emerged in the mid-1800s responding to scientific interest and accessibility needs (Meyer, 2003). Meyer notes this movement declined by the late 1800s with figure deaths, rising academic philosophy dividing the public, and most magazines lost between 1850-1910(Meyer, 2003). Nevertheless, popularization utilizing pictures, book sizes, and colors drew the public, gaining adoption (Meyer, 2018).

Many international organizations have utilized popularization philosophy to further development goals and reach wider audiences, including UNESCO (June 23, 2022). UNESCO gives the Kalinga Prize for Popularizing Science, recognizing exceptional scientific communication to laypeople (June 23, 2022). It was created in 1952 after a donation to UNESCO's Kalinga Foundation Trust in India (June 23, 2022).

In contrast, third-world nations did not recognize science's value in lives until the late 20th-early 21st century, long after decolonization, realizing simplified knowledge dissemination ensured well-being (June 23, 2022). Many then underwent economic and social development (June 23, 2022). Initially, high illiteracy warranted public awareness campaigns where experts conveyed simple, daily impacting messages to people, like immunization and disaster preparation importance (June 23, 2022). As televisions became common, information transmission less difficult using effective sound and image to quickly reach the masses (June 23, 2022). Computer/Internet technology progressed, abolishing time/space barriers and enabling real-time worldwide information influencing (June 23, 2022).

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UNESCO Science Report 2010 highlighted the historical lack of science/technology education emphasis in developing nations (UNESCO, 2010). UNDP report "The Knowledge Economy and the Global South" also highlighted underinvestment in these areas historically in developing countries (UNDP, 2010). Reports suggest scientific culture value recognition was a recent development, but work is still needed to ensure integration into development policies/strategies (UNESCO, 2010; UNDP, n.d.).

2.2Elements to consider while popularizing scientific texts:

During the era of Fontenelli, the language of popularization evolved from a method in which science mixed with literature and philosophy and employed dialogue between personalities, some of whom raised questions and answered others, to a clear and accurate popular scientific language that responds to all groups' questions without exception and tried to cater to the public's needs by providing all scientific news and developments in order to achieve its primary goal of conveying a popular message, where the steps of the popular process were similar to, if not identical to, the communicative model, and the elements of the communicative model were projected on the process of popularization.

Therefore, each of the aforementioned elements of popularization (scientific material - simplified - channel - receiver)has a demonstrated significance and significant role within the popular process. The simplifier, whether a specialized scientist, journalist, or translator, must therefore ask several crucial questions and provide accurate answers before beginning the task of popularization or translation, where the answers serve as a reliable road map for them to use when making decisions.

2.3 Scientific Popularization Texts: Linguistic Levels

Our study into features of popular science literature has revealed there are different language levels in scientific discourse. These levels vary based on communication criteria involving three pillars: the sender (author), recipient (reader), and message/information (popularized text). Changing any pillar affects the language level employed.

Frequently texts use varying linguistic levels to clearly explain complex ideas. While classifications differ, they all align in viewing levels as relative not absolute. If intended for somewhat educated readers, technical terms and phrases could introduce culture and increase scientific level, adjusting language to a lower popularization level suiting recipients. For simpler audiences, clearest writing with minimal doses had to be adopted. The language matched the intended readers' abilities in a relatable way.

1. Lexical level: The use of familiar, everyday vocabulary is common in scientific popularization texts to make the text accessible to a wider audience. Technical terms and jargon are often avoided or defined in context.

2. Syntactic level: The sentence structure of scientific popularization texts is often simpler and more straightforward than that of academic writing. Sentences tend to be shorter and more concise, with fewer subordinate clauses and a clearer subject-verb-object structure.

3. Discourse level: The overall structure of scientific popularization texts is designed to help readers understand complex scientific concepts. The use of headings, subheadings, and other structural features can help break down complex information into smaller, more manageable chunks.

4. Stylistic level: Scientific popularization texts often use figurative language and analogies to make complex ideas more understandable. Humor and storytelling techniques can also be used to engage readers and keep their attention.

5. Pragmatic level: Scientific popularization texts are often written with the goal of inspiring action or change. They may include calls to action or suggestions for ways that readers can apply scientific knowledge to their daily lives.

Overall, scientific popularization texts strive to make scientific information more accessible and understandable to the general public. By utilizing a variety of linguistic levels, these texts can communicate complex concepts in a way that is engaging and easy to understand.Each level of scientific popularization language has a different quality of sender, recipient, and message, as well as a different goal for communication. For example, the language directed to specialists in the first level uses terms without explanation and is

brief and direct because the specialized reader can easily search for and understand specialized terms and phrases based on linguistic and scientific knowledge, the second level of texts is meant for members of the general public who are interested in science and want to broaden their scientific knowledge by learning new scientific terms and concepts, which the Medium-level of scientific text provides. The third and final level comprises very simplified literature meant for science beginners   and individuals with low scientific culture, such as youngsters, who need to learn about the most basic and even obvious notions of science.

2.4 Problem of translating popular scientific texts and their terminology

It is difficult to translate simple scientific texts, notwithstanding their popularizationand ease. Translating them, like challenging ease, necessitates a unique combination of specialized and general linguistic abilities, as well as a society in which multiple domains of knowledge overlap. As a result, understanding the type of text and its purpose is critical for the translator, who must chart a clear path and make decisions that lead to the least amount of harm. As Kozlowska (2007:26)notices, despite the fact that text typology is a very significant issue for a translator, it is often neglected by specialist literature concerned with translation studies. This might be the case because of the existence of multiple text typologies based on various criteria as well as the fact that a text rarely displays features of only one particular type. There have also been some doubts as to the feasibility of classifying texts and its usefulness for practicing translators (Hatim and Munday 2004:285). Because the text is subject of research for many different fields of study, for instance literature, linguistics or translation studies, there are various criteria for text typologies. According to Kozlowska (2007:25), there are two major approaches to the issue of text typology: general one (based on general criteria)and translational one (based on the translation-oriented criteria)(June 23, 2022) Language Errors in Machine Translation of Encyclopedic Texts from English into Arabic.

One example of the challenges faced in translating scientific texts(Al Shorbaji, 2016). into Arabic can be seen in the field of genetics. In a study published in the Journal of Biomedical Informatics, researchers found that there were significant variations in the Arabic translations of genetic terms, with some translations being inaccurate or even misleading (Al Shorbaji, 2016).

Terminology also presents a challenge for the translator of popular texts that contain terms in varying proportions depending on the level of popularization. The problem is often finding the corresponding terms in the general language because the equivalents in simple language are not always available, so the translator uses explanation as an alternative to finding the simplified term. He may need to coin a new term, if necessary, based on a variety of criteria and constraints that differ by language, with which he may conflict. There are various issues, much as there are with the Arabic translation, such as the dilemma of translating suffixes and prefixes, complex terms, terminology, symbols, and so on.

Here are the key challenges for Arabic translators of simple scientific literature:

1. Lack of standardization - There is no universally agreed-upon standard for scientific terminology in Arabic, which can cause confusion and inconsistencies in translations for both translators and readers.

2. Cultural differences - Scientific concepts and terms are often closely linked to a specific culture or context, and translating them to another language poses difficulties. For example, some scientific phrases commonly used in English may have no direct translation to Arabic.

3. Translation bias - Translators can inadvertently introduce their own cultural biases or personal views, impacting the accuracy and impartiality of the translation work. Their background can affect the translation.

The absence of a standard language, cultural variances between languages, and unintentional biases pose particular hurdles for Arabic translators of simple scientific literature according to the key points. Consistency, cultural adaptation and objectivity are challenging without oversight.

4-Abbreviations and symbols are difficult to translate.

5-The difficulty with out-of-date dictionaries.

6-Lack of Expertise: Finding qualified translators who are proficient in both Arabic and the specific scientific field being translated can be challenging. This can result in translations that are inaccurate or misleading.

7-Limited Vocabulary: The Arabic language may not have sufficient vocabulary to translate certain scientific terms accurately, which can lead to ambiguity or even mistranslation. This can be particularly problematic for fields that rely heavily on technical jargon and specialized terminology

8-Problems with rules or textual grammar and compositional levels.

However, each text has its own language, discourse, and readers depending on the type of uncomplicated scientific literature, the recipient's cultural background and the creation's intent (educational, instructional, commercial, etc.), the translator may encounter a number of problems.

3 Popular scientific texts: human translation versus machine translation

It is well understood that, like other types of translation, popular scientific text translation aims to reformulate the original texts with the highest levels of skill in language, style, and thought, while respecting the source text and attempting to convey its content with the greatest commitment and scientific honesty; ensuring good reception of the popular message which presents a set of challenges for the translator, whether human or machine.

Machine translation (MT)has certainly had a significant impact on the translation industry and has facilitated the work of professional translators in various ways. Here are some ways in which MT has helped professional translators:

1. Increased productivity: MT tools have significantly increased the productivity of professional translators, allowing them to translate more words in less time. According to a study conducted by the European Commission, MT can improve translation productivity by up to 30%.

2. Improved consistency: MT tools can ensure consistency in terminology and style across a large volume of translations, which is particularly useful for technical and specialized content. This helps maintain the quality of translations and ensures accuracy and clarity in communication.

3. Reduced workload: MT can handle simple and repetitive translations, allowing professional translators to focus on more complex and creative translations, improving the overall quality of the translation work.

4. Improved quality: MT can provide professional translators with a starting point or a draft translation that they can refine and improve upon. This saves time and ensures that translations are more accurate and natural sounding.

Here are the key similarities between the human brain and computers:

1. Information processing - Both the human brain and computers process and store information, though brains use neural networks and computers use CPUs.

2. Memory - Both have memory storage, with brains storing in regions and computers using drives and RAM.

3. Input/output - Each receives input through senses/devices and sends output through muscles/glands or screens/printers.

4. Problem-solving - Problem-solving occurs through reasoning/decision-making in brains and algorithms/programming in computers.

5. Learning and adaptation - Both learn and adapt, with brains using experience/exposure and computers using machine learning/AI.

Regardless of machine translation software advancements, skepticism remains that full translation occurs without human input. This prompted investigating machine interactions with popular science texts, translation difficulties compared to humans, and steps to avoid errors and overcome obstacles translating this text type. Understanding limitations and best practices for leveraging machine and human capabilities is important.

The popularized scientific publications stand out for their simple and direct language, frequent absence of complex or long sentences, and avoidance of word shadows and clues. As a result, translating them is never an easy operation. This is due to the fact that they include numerous issues, the most significant of which is the problem of interpreting scientific terms (although it is relatively little used in the simplified text compared to the specialized text), and also the challenges of translating proper nouns, symbols, and abbreviations, in addition all other linguistic levels, such as banking, grammatical, lexical, contextual, and other levels, as well as the dilemma of achieving the functional and communicative goal of scientific popularization, which is the most visible and important part of each translation.

4.1 Terms that are difficult to translate

There are many terms that are difficult to translate, as language is a complex and nuanced system that often lacks direct equivalents for certain concepts or ideas. Here are a few examples:

Scientific popularization texts' vocabulary quality differs when compared to other types of writing since they combine general and specialized language and contain a variety of terms according to the level of popularization intended. Translating terms is one of the most challenging tasks for both human and machine translators since the more popularization is utilized, the more words there are in the text, and vice versa.

Many terms are common to several fields of knowledge and change their meaning by changing the context and cognitive field in which they are used; however, because the context and cognitive field in which they are mentioned are not recognized, it is difficult to determine their exact meaning. as they vary according to voice, mood, tense, number, and person" the verb common in the language of the science of morphology or can be translated to "paired, or equally coupled" in the language of medicine. Here, any human translator, even a beginner, can determine the appropriate meaning and choose the correct translation by using context and identifying the field of knowledge.

In the absence of an equivalent term in Arabic, a human translator can either invent a new term based on existing word-generation rules, or try to replace the term by expressing its concept using general language words to clarify the meaning, which immediately supports the goals of popularization. However, it is hard for the machine translator to invent or explain new phrases in Arabic if they are not stored in the memory. Due to this, a common machine translation error called replication is committed. Merakchi reports on a study of pedagogical metaphors in popular science writing, which are a specific cultural issue in modern English-Arabic translation. It is believed that pedagogical metaphors are essential

to this genre's communication goal, which is the transfer of knowledge about complicated scientific processes from experts to non-experts. Popular science writing provides unique translation difficulties for culturally separated languages like English and Arabic, and is even seen by some researchers as a sort of translation in and of itself(2013).

However, the most difficult aspect of translating scientific popularization texts is not only finding the equivalents of specialized scientific terms in the target language, but also attempting the alternative in a general language appropriate to the recipient's level. It is necessary for human translators to employ specialized linguistic and communication abilities to determine the reader type, message nature, and translation purpose - skills lacking in machine translation, make the process more difficult. Machines will never grasp culture as humans do. World lexicons contain numerous culture-specific terms that require contextual understanding to properly convey cross-linguistically. A machine lacks the deeper cultural comprehension needed for optimizing translation while a human translator can apply such insight toward appropriateness and clarity tailored for the given readership. The challenges of localization illustrate the ongoing need for human judgment in navigating cultural nuances that remain beyond current technological facilities. The complexity required for machines to comprehend or recognize slang, idioms, and in certain circumstances names. This is a problem that machines have never met, and it will be very challenging for them as well. Even if the machines find this to be a considerable issue, native in-country speakers who are fluent in the languages and are familiar with all the idioms and slang that the nation has to offer are capable of finding appropriate equivalents in the target languages. (June 19, 2022)Reasons Why Human Translators Will Always Prevail Over Machine Translation.

4.2 Translation of symbols, abbreviations and proper nouns:

The translation of symbols, abbreviations and proper nouns poses a challenge for human translators because the methodology for their Arabic translation is not standardized. Therefore, human translators often rely on linguistic and cognitive skills to resolve this confusion, reproducing Latin letters and mathematical symbols with linguistic equivalents since Arabic lacks them.

Machine translators face different challenges translating symbols, which are exacerbated when symbols are incorrectly ordered. These inaccuracies may alter the original message's integrity, jeopardizing the scientific principle and requiring time to remedy.

Translating symbols, abbreviations and proper nouns is commonly problematic for machine translation, which uses algorithms to autotranslate between languages. Issues arise because meanings/translations differ cross-linguistically, and systems may not accurately identify or translate them. For example, the £ symbol represents pounds sterling in English but pound weight in Spanish. Similarly, "CEO" stands for Chief Executive Officer in English but Directeur Général (General Manager)in French. Proper nouns also pose challenges as direct equivalents may not exist, like the name "John" translating differently to "Johann" in German or "Jean" in French. Standardized methodologies could help address these machine translation difficulties.

4.3 The morphological level of word construction

The word construction in a language refers to the structure and form of a word, such as inflected verbs and general measure or meter. A human translator who lacks the essential linguistic skills in both the source and target languages encounters difficulties. i.e., the rules for inflected verbs differ significantly from English into Arabic, which are limited to the past and present forms. There are also other variants in various languages, such as English and French. In this situation, the human translator uses his linguistic expertise to employ inflected verbs in accordance with the context and purpose of the text.

However, the machine translation is faced with a significant problem due to the numerous options and meanings involved in changing the verbs' formulas from the source language into the target language, as well as another issue involving the number, sex, and incompatibility between the subject and the object in some situations, dual form of a noun or a verb in Arabic and its absence in other languages, as well as the issue of using the passive language, the use of the passive voice. The multiple alternatives and meanings connected with translating the verbs' formulae from the source language to the target language, however, present a significant conundrum for the translator, as well as the problem of using the passive language.

4.4 Sentence formation and syntactic structure

Grammar is concerned with the sentence's formation, structure, and order of components. The human translator has numerous challenges as a result of the disparity in rule systems between languages. Arabic, for example, is distinguished by its synthetic flexibility, which includes the use of both the nominal and verb phrases, as well as the ability of fronting as needed. English, on the other hand, has a set of rules subject + verb + object or phrase in which the order of words has a direct meaning. Therefore, a human translator must make use of their linguistic expertise and comprehension of the source material to translate a sentence from one language into another while maintaining meaning and recognizing both the source and target languages' grammatical structures.

There are some problems related to the syntax/structure of the two languages (i.e. Arabic and English)because they belong to two different and distant language families and for other reasons. Syntactic asymmetries between Arabic and English require special attention from translators. Most importantly, the translator needs to be aware of the mismatches at the sentence level which involve word order variation.

4.5 Functional level

The machine translator does not have the means to solve the problems that arise at other levels in translating popularized scientific texts, such as the functional and communicative levels, because determining what the source text and the target are aiming for and using it in translation is not always an easy task, even for a human translator. The ability to popularized the scientific message while also employing the right language level for the recipient is a significant challenge that requires knowledge and proficiency. This can only be accomplished via practice and repeated work on the same type of content, specializing in translating scientific popular texts for specific categories with specific levels and needs.

According to Okpor, machine translation is the method utilized to convert texts from one natural language (like English)to another using computer software (such as Ibo)(2014). The machine translation, on the other hand, will be unable to overcome the functional level hurdle of scientific popularization texts because he will be unable to determine translation objectives and public requirements and will lack the necessary mechanisms to communicate with the recipient during the translation process. As a result, it is unable to select the proper language and frequently requires human intervention to avoid errors, either by amending the source text, or by correcting the target text, or by employing interactive translation, which permits human intervention during the machine translation process.

5. Study findings and proposals

It was found out that scientific popularization writings have a number of problems that both human and machine translators must deal with, the most notable of which is the problem of translating scientific words, as well as other problems relating to lexical, grammatical, and functional levels of scientific popularization.

When a machine translator of the simplified text was compared to a human translator of the popularized text, it became clear that each has its own set of drawbacks, restrictions, and difficulties. The following is a summary of the findings:

- In contrast to the machine translation,which is unable to comprehend and think despite having a sophisticated internal system based on integrated memory and stored data, despite all of today's advancements in artificial intelligence, the human translator has a mind that enables him to comprehend, analyze, and reflect the texts.
- Human translator can act and discover answers to the challenges he encounters while translating documents, such as adding terminology when it is not available. A machine can't solve new problems because it can only access the data it already has stored.
- Human translator can adapt to diverse types of texts, whereas machine cannot.
- Human translator works to provide an accurate and flawless translation by self-critiquing his translation to make changes and modification, while the machine cannot provide accurate translation because it cannot identify and correct its errors.
- Human translation is based on creativity, whereas machine translation is based on repetition.
- A human translator excels in translation quality while being quite slow, but a machine translation builds on quantum mechanics and is incredibly quick.
- Human translator often knows just two or three languages in addition to his or her native tongue, whereas the machine may simultaneously translate into and from hundreds of languages.
- Human translator gets tired of translating at times and wants to take a break, whereas the machine works nonstop for long periods of time.

Despite all of the benefits, machine translation cannot completely replace human translation. It has been established that relying solely on machine translation to translate scientific popularization materials is impossible since this technology is incapable of handling the specific language used in scientific popularization while still achieving its intended functional goals. This does not completely preclude the use of machine translation, though; given that its methods and software are constantly evolving, the future seems promising. The transition from complete machine translation to human-aided machine translation must therefore be sped up by making use of the computer's high-speed, memory, and endurance capabilities.

One of the following translation techniques shall be employed to make up for the limitations of the machine and to obtain the best outcomes:

1. Pre-editing machine translation: It is done by modifying the text before machine translation to avoid machine errors. The user should avoid words that have more than one meaning and simplifies long and complex sentences, thereby preparing a text that is acceptable to the computer and can be translated with less difficulty. (Saleh, 2013).
2. Post-editing machine translation: In this case, human translator will intervene and make appropriate changes to the machine-translated text in order to obtain acceptable and readable text, which amounts to human translation. Experience has shown that machine translation often requires revision in varying proportions, so that translation becomes acceptable. This revision includes adjustments to all ofmorphological, grammatical, semantic and textual levels (Salih, 2013).
3. Interactive Translation: It is the mechanism through which man interferes in various stages of the translation process to assist the machine in the task of dealing with different texts (Hutchins, Somers 1992: 153), where a human translator accompanies the machine step by step and intervenes in the translation of the details with modifications and recommendations until the desired result is

achieved. For this type of translation, human translator should remain in front of the screen for intervention whenever it deems necessary, unlike the two related and subsequent machine translations.

Conclusion

The interest in popular scientific text translation is still in its early stages, but it is still a promising topic. This was the primary driving force behind the creation of this study, in which we aimed to characterize scientific popularization texts as well as more effective, quantitative, and qualitative approaches to translating them into Arabic in order to use them as a vehicle for scientific dissemination. The enormous volume of scientific innovations that the Arabs have relentlessly received from the West, of which only a few can be translated, has prompted some to turn to machine translation technologies in the goal of obtaining information more swiftly. The findings of our comparison, on the other hand, allowed us to determine the most significant flaws and peculiarities of both the human and machine translation . They have unequivocally demonstrated the machine's failure to translate scientific simplified texts on its own, and the critical necessity for human participation to achieve the best outcomes. In the absence of more professional machine translation systems, it is necessary to combine Arab efforts to overcome the obstacles posed by translating scientific simplified texts into Arabic and to try to find solutions for them, in order to enable the simple Arab reader to gain up-to-date knowledge of the latest developments in science alongside foreign readers, through the proper use of computer technology and the utilization of its capabilities to enable the simple Arab reader to get up-to-date knowledge of the latest developments in science in conjunction with foreign readers, through the correct use of computer technology and the utilization of its capabilities to fill the gaps in human translation, as well as to renew our linguistic ammunition and update it to the requirements of the times.

Finally, it is asserted that one indication of growth and sophistication is an interest in popularized scientific translation. Machine translation is important nowadays; this technology can help developing nations catch up to Western nations. There are compelling reasons to develop Arabic and make it the dominant language because it has proven to be computable. This can only be done by integrating it into science and technology via the easy science gateway, which will broaden perspectives and restore its former exaltation.

Established on the findings and conclusion of the study, the following comments can be made about the study's questions:

1. "What does it mean to think of the popularization of science, and how has that thought altered through time?"

The study's findings and conclusion do not directly address this question. However, it can be inferred that the study recognizes the importance of popularizing science and acknowledges its evolving nature, especially in the context of translation from English to Arabic. The study focuses on the challenges and approaches to translating popularized scientific texts rather than exploring the conceptual evolution of science popularization itself.

2. "What distinguishes scientific popularization texts? What challenges do you encounter when translating?"

The study's findings highlight several challenges encountered when translating scientific popularization texts, such as translating scientific terms accurately, dealing with lexical, grammatical, and functional complexities, and understanding nuanced context. The study acknowledges that scientific popularization texts have specific characteristics that require expertise and linguistic skills to translate effectively.

3. "How do human and machine translators perform when translating texts that are simplified for scientific purposes? Which one of them is more qualified for the job?"

The study's findings suggest that both human and machine translators have their own drawbacks, restrictions, and difficulties when translating simplified scientific texts. Human translators are capable of comprehension, analysis, and reflection, and can adapt to diverse text types. On the other hand, machine translators lack the ability to comprehend and think despite advancements in artificial intelligence. The study emphasizes that relying solely on machine translation for complex scientific popularization is insufficient due to language comprehension issues. Therefore, the study implies that human translators are more qualified for the job, but it also recognizes the potential of combining human and machine translation through hybrid approaches.

In conclusion, the study's findings and proposals support the need for human involvement in translating popularized scientific texts. The limitations of machine translation are highlighted, and recommendations are made to overcome these limitations, such as pre-editing machine translation, post-editing machine translation, and interactive translation. The study concludes that integrating computer technology and human translation can fill the gaps and enable the Arabic-speaking audience to access up-to-date scientific knowledge.

Recommendations

Here are some recommendations that can be derived:

1. Develop standardized Arabic scientific lexicons: To address the challenges posed by the lack of standardized terminology in Arabic translations, it is recommended to establish and promote the use of standardized Arabic scientific lexicons. This can help ensure consistency and accuracy in translating popularized scientific texts.

2. Leverage modern technologies: Given the limitations of machine translation, it is suggested to leverage modern technologies to enhance the translation process. This can involve exploring advancements in natural language processing, machine learning, and artificial intelligence to improve the quality and efficiency of machine translation systems.

3. Utilize hybrid translation approaches: Instead of relying solely on machine translation or human translation, a hybrid approach can be adopted. This involves using machine translation as a first draft and then having human translators perform post-editing to refine the translation. This combination of strengths from both approaches can lead to improved accuracy and efficiency.

4. Explore pre-editing techniques: Another recommendation is to consider pre-editing techniques for source texts. This involves preparing the original English texts in a way that facilitates accurate and effective machine translation. By optimizing the source texts, the quality of machine translation outputs can be enhanced.

5. Foster interactive human-machine cooperation: Encouraging collaborative efforts between human translators and machine translation systems can lead to better translations. Interactive human-machine cooperation can involve using translation tools that provide suggestions and feedback to human translators, allowing them to make informed decisions and improve the overall translation quality.

6. Promote the integration of popularized science translations: To close knowledge gaps and restore Arabic prominence in technological and educational spheres, it is recommended to actively integrate popularized science translations in educational materials, scientific publications, and public communication. This can facilitate broader access to scientific

knowledge and contribute to the advancement of science education in Arabic-speaking communities.

By implementing these recommendations, the field of popularized scientific translation can benefit from improved quality, efficiency, and accessibility, ultimately supporting knowledge sharing and scientific progress in the Arabic language.

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