**Frontiers in Computer Science and Artificial Intelligence**
DOI: 10.32996/fcsai
Journal Homepage: www.al-kindipublisher.com/index.php/fcsai

**FCSAI**
**AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT**

**| RESEARCH ARTICLE**

# Human vs AI translation of Common Names of Chemical Compounds: A comparative Study

**Prof. Reima Al-Jarf**
*King Saud University, Riyadh, Saudi Arabia*
**Corresponding Author:** Prof. Reima Al-Jarf**, E-mail:** reima.al.jarf@gmail.com

**| ABSTRACT**

In a study by Al-Jarf (2022), undergraduate student-translators had difficulty translating English common names of chemical compounds (CNCC) to Arabic. They gave correct responses to fewer than 20% of the test items and left 55% blank. Their most common translation strategy was literal translation and transliteration of English names. The students reported that they are not familiar with most of the English and Arabic chemical compound names. Based on these findings, the current study aims to find out if student-translators can use Artificial Intelligence (AI) to translate CNCC from English to Arabic and vice versa, % of chemical compound names correctly translated by AI and the translation strategies used by AI. Two samples of English and Arabic CNCC were translated by Microsoft Copilot (MC). Data analysis showed that MC translated 72% of the chemical compounds in the sample correctly. It gave more Arabic-English than English-Arabic correct equivalents (40% & 32% respectively). It gave more correct equivalents when I specified the domain and when I asked for all the equivalents that MC knows. MC gave literal word-for-word translation to terms as (Lunar caustic > الكاوي القمري(نترات الفضة)); transliteration (Stearic acid >حمض الستيريك instead of حمض الشمع; a faulty derivative (Chlorinating powder > مسحوق التكلور instead of مسحوق الكلورة) and explanation (Ammonia liquor سائل الأمونيا). Although some English chemical compounds have multiple Arabic equivalents, MC gave only one unless prompted to give all. Even though MC is characterized by breadth of knowledge of English and Arabic chemical terminology and quick access to each term and in which context(s) it is used, in few cases, it failed to match the English chemical compound name with its Arabic equivalent and vice versa. Since translation-students' knowledge of CNCC is limited, they are advised to specify the kind of terms to be translated and to ask AI to give as many equivalents as possible. They should give AI the context, nuance, and direction so that it matches the term with its correct equivalent. Results and recommendations are given in detail.

**| KEYWORDS**

Chemical compounds, common names of chemical compounds, chemical terms, chemical translation, Artificial Intelligence, human translation, literal translation, word-for-word translation, transliteration

**| ARTICLE INFORMATION**

**ACCEPTED:** 29 November 2025 **PUBLISHED:** 02 December 2025 **DOI:** 10.32996/fcsai.2025.4.4.2

## 1. Introduction

A chemical compound is composed of atoms from two or more elements such as Ammonium Chloride (NH4Cl), Sodium Hydroxide (NaOH), and Acetic Acid ($CH_3COOH$). Some chemical compounds have a technical name used by specialists and a common name used by non-specialists in everyday life. For instance, the chemical name NaOH is Sodium Hydroxide and its common name is caustic soda الصودا الكاوية; $CH_3COOH$ is Acetic Acid and its common name is vinegarالخل حمض الخليك NH4Cl is Ammonium Chloride and its common name is ammonia الأمونيا، النشادر. Knowledge of at least some technical names of chemical compounds and their common names is important for students majoring in translation, and/or those majoring in chemistry. This knowledge is useful for everyday communication, working in translation, chemistry fields, medical labs, construction, and industry. Technical names learnt in chemistry courses, are identical in both English and Arabic and can be easily accessed in a specialized dictionary.

Moreover, Arabic common names of chemical compounds (CNCC) can be classified into pure Arabic equivalents (الخل, الحجر الجيري, النشادر); Arabized/naturalized forms (صودا, جبس, الطرطريك); borrowings and transliterations (فورمالين, لاتكس, هيماتيت); derived forms and neologisms (مكلور, سكروز, حمض الليمونيك); synonyms (multiple parallel forms for Asbestos, Caustic Soda, Copper Sulphate); color-based names (أصفر الكروم, الأبيض الكاوي, الزاج الأخضر); eponyms and toponyms (أخضر باريس, ملح جلوبر); calques and loan translations (زبدة الخارصين, مذيب الجليد); polysemes and old/modern equivalents (المُرْدَاسَنْج, السلقون, الزاج الأخضر); and compound structures mixing Arabic identifiers with borrowings or Arabized words (زيت وينترجرين, حليب المغنيسيوم, مسحوق الكلورة) (Al-Jarf, 2022c).
).

Despite the importance of acquiring and knowing technical terms, translation of technical terms, including chemical terms, pose several difficulties for both student and professional translators. These difficulties include problem of equivalence in translating specialized technological texts and terminology into Arabic (Ashqar, 2013; Hassan, 2017a; Hassan, 2017b); addition, omission, compound, synonym, collocation errors and inconsistencies in the translation of health documents by accredited translators in Australia (Alhihi, 2015); translating endocentric, verbal, metaphoric, rhyming, phrasal compounds, compounds with an exocentric determinant unit, and compounds with lexicalised bound morphemes from English to Arabic by M.A. students majoring in translation in Jordan and the UK (Al-Kharabsheh, 2003). In addition, translation-major students were less accurate than chemistry-major students in translating lexical and pragmatic features, but better at translating the syntactic features of the chemistry text (Namdari and Shahrokhi, 2015).

The revolution in Artificial Intelligence (AI) in the past few years made it easy for student as well as professional translators to utilize AI in translating a variety of texts from Arabic to English and vice versa. Several studies by Al-Jarf have demonstrated the application of AI tools such as Microsoft Copilot, Google Translate (GT), and DeepSeek (DS) in different domains. These include the translation of medical terms (Al-Jarf, 2024c), Arabic folk medical terms with *om* and *abu* (Al-Jarf, 2025l), Arabic *abu* brand names with different prompts (Al-Jarf, 2025d), and denotative and metonymic *abu* and *umm* animal and plant folk names (Al-Jarf, 2025f). Other investigations examined the translation of English and Arabic "sleep" terms and formulaic expressions (Al-Jarf, 2025m), zero-expressions (Al-Jarf, 2025n), Arabic grammatical terms used metaphorically (Al-Jarf, 2025g), Gaza-Israel war terminology (Al-Jarf, 2025b), and technical terms (Al-Jarf, 2021a; Al-Jarf, 2016a). AI translation of full-text Arabic research articles with a focus on educational polysemes was also explored (Al-Jarf, 2025a).

Another line of research compared the performance of AI and human translators across a wide range of genres. Examples include classical and dialect poetry (Farghal & Haider, 2024; Alowedi & Hassan Al Ahdal, 2023; AlAfnan & Alshakhs, 2012; Arabic podcast transcripts (El-Naby & Aly, 2025), and audiovisual translation of subtitles in Birdman (Al Sawi & Allam, 2024). Other studies investigated legal texts and terminology (Al-Maktary, Mohammed, Hassan, Almoughles & Almekdad, 2025; Altakhaineh, Alghathian & Jarrah, 2025; Moneus & Sahari, 2024; Haider & Alkhatib, 2024) and Qur'anic legal verses and Sharia terms in legislative documents (Abdalhussein, 2025; Amr, 2025). Further research compared AI and human translation of metaphors, euphemistic expressions, ambiguities, culturally loaded content, and post-editing, including English proverbs (Binhaidara, Al-Shahwan & Yousef, 2025; El-Saadany, 2024; Zibin; Ichien, Stamenković & Holyoak, 2024; Al-Wasy & Mohammed, 2024; Ennouari & Houssaini, 2024; Fakhrabadi & Sharifabad, 2023).). Other studies examined accuracy and strategies in Arabic-English translation (Ibrahim, 2025; Muftah, 2024; Sadiq, 2025; Yacine, 2024), post-editing and enhancement of AI-generated media texts (Zayed & Nuirat, 2024; Alqahtani, 2024).

In teaching translation for specific purposes, students at the college of Language Sciences (CLS), at King Saud University in Riyadh, Saudi Arabia, take a variety of specialized translation courses as Islamic, literary, political and media, medical, scientific and technical, general English-Arabic and Arabic-English, legal, financial and economic, computer-aided translation, problems of translation, introduction to translation studies, in addition to semantics, syntax and morphology, linguistics, text linguistics, academic writing, readings in language and culture, discourse analysis, editing and revising, using dictionaries in translation courses and others. Nevertheless, numerous studies by the authors with student-translators at the college revealed many translation weaknesses, and failure to identify the meaning of more than 70% of the items on the tests as in expressions of impossibility in Arabic and English (Al-Jarf, 2024a); numeral-based formulaic expressions (Al-Jarf, 2023b), time metaphors (Al-Jarf, 2023c), ibn (son) and bint (daughter) fixed expressions (Al-Jarf, 2023a), om- and abu-expressions (Al-Jarf, 2017), dar (house) and bayt (home) expressions (Al-Jarf, 2022a), common names of chemical compounds (Al-Jarf, 2022c), color-based metaphorical expressions (Al-Jarf, 2019), polysemes (Al-Jarf, 2022b), binomials (Al-Jarf, 2016b), neologisms (Al-Jarf, 2010), word + particle collocation (Al-Jarf, 2022d; Al-Jarf, 2009) and others.

Furthermore, Al-Jarf (2025k) compared the translation of expressions of impossibility by student-translators and AI. DeepSeek, (DS), Microsoft Copilot (MC) and Google Translate (GT) gave similar translations. Arabic-English translation was easier for DS, MC and GT than English-Arabic translation. DS, MC and GT mostly gave literal word-for-word translation which sometimes sounded meaningless and culturally awkward. The students translated fewer than 35% of the expressions on the test correctly. They left many blank. English expressions were more difficult than Arabic expressions as they contain unfamiliar words. Expressions similar in both languages were easy to translate, whereas opaque expressions were more difficult. Both AI and human translations gave more correct Arabic-English than English-Arabic translations. The most common translation strategy used by AI and humans was word-for-word translation. Paraphrase/explanation, partial, and extraneous translation were the most frequently used strategies by students respectively. AI did not leave any expressions blank. Translation errors by students were due to lack of mastery of English, limited exposure to English idioms and proverbs, unfamiliar words, lack of background knowledge, cultural gaps, and inadequate translation competence. Although AI can explain the underlying meaning, it cannot make conceptual alignment due to prioritizing direct linguistic accuracy, i.e., word-for-word translation, over natural, culturally adapted phrasing.
Despite the growing body of research on AI translation and the documented weaknesses of both AI and student-translators in handling medical, legal and metaphorical expressions, there is still a lack of studies that directly compare AI and human performance in translating common names of chemical compound. While previous investigations have examined student difficulties with chemical terminology (Al-Jarf, 2022c) and compared AI and human translation in other domains such as expressions of impossibility (Al-Jarf, 2025k), no research has yet addressed how AI and student-translators perform side by side in this highly specialized area. Therefore, the current study aims to fill this gap by comparing the accuracy of AI and student-translators at the CLS, King Saud University, in translating common names of chemical compounds from English to Arabic and vice versa, identifying the translation strategies employed by both AI and students, and identifying the sources of errors in AI and student translations. Moreover, this study aims to determine whether students majoring in translation can effectively use Artificial Intelligence (AI) tools to translate CNCC from English to Arabic, highlight some implications of the study findings for teaching translation for specific purposes especially in the scientific, medical and technical translation courses, and Arabic to English and give recommendations for helping student-translators benefit from AI in chemical terminology translation.

This study is significant because CNCC are not just linguistic items. They carry precise scientific meaning. A mistranslation may lead to serious errors in laboratories, classrooms, or professional contexts (e.g., wrong chemical used, miscommunication in medical or industrial settings). Comparing AI and students will help identify which approach ensures greater accuracy and reliability.

Secondly, this study has educational relevance for students majoring in translation for specific purposes at King Saud University, because they study scientific, technical and medical translation courses where chemical terminology is essential. If the students struggle with common names of chemical compounds, their academic and professional performance will be directly affected. By comparing their translations with AI output, educators can pinpoint gaps in student competence and design targeted teaching interventions.

Thirdly, AI tools as Copilot, DeepSeek, Google Translate, ChatGPT, Gemini and others are increasingly used by students in real translation tasks. Understanding how AI handles chemical terminology, its strengths (speed, consistency) and weaknesses (literal translation, lack of conceptual alignment), allows instructors to guide students in using AI responsibly and effectively. The comparison shows whether AI can serve as a supportive aid or whether it risks reinforcing errors.

Fourth, many studies have compared AI and human translators in poetry, legal texts, and culturally loaded expressions. chemical terminology remains largely unexplored, despite its importance in scientific communication. This study addresses this gap, contributing new knowledge to both translation pedagogy by addressing an unexplored domain and AI evaluating AI as a supportive tool for student-transaltors.

Fifth, translators working in scientific fields as medicine, engineering, and chemistry must handle chemical terminology with precision. Comparing AI and students provides insights into whether AI can be trusted in professional contexts, or whether human expertise remains indispensable. This has direct implications for industries that rely on bilingual documentation and translation of chemical data.

Finally, this study is an addition to a new line of research by the author which included AI and students' translation of Arabic expressions of impossibility (Al-Jarf, 2025k). It also adds to a series of studies on AI as the translation of medical terms (Al-Jarf, 2024c); Arabic folk medical terms with *om* and *abu* (Al-Jarf, 2025l), denotative and metonymic *abu* and *umm* animal and plant folk names (Al-Jarf, 2025f); technical terms (Al-Jarf, 2021a; Al-Jarf, 2016a); Arabic *abu* brand names with different prompts (Al-Jarf, 2025d); sleep terms and formulaic expressions (Al-Jarf, 2025k); zero expressions (Al-Jarf, 2025n); Arabic grammatical terms used metaphorically (Al-Jarf, 2025g); Gaza–Israel war terminology (Al-Jarf, 2025b); full-text Arabic research articles with educational polysemes (Al-Jarf, 2025a); editors and publishers' views on the publication of AI-generated research articles in scholarly journals (Al-Jarf, 2025); Arab instructors' views on students' assignments and research papers generated by AI (Al-Jarf, 2024b); pronunciation errors in Arabic YouTube videos narrated by AI (Al-Jarf, 2025e; Al-Jarf, 2025h; Al-Jarf, 2025i); Arabic transliteration of borrowed English nouns with /g/ by AI (Al-Jarf, 2025c).

## 2. Methodology

### 2.1 *The Human Part of the Study*

The human part of the current study is based on a prior study by Al-Jarf (2022c) in which 67 undergraduate students majoring in translation at CLS, King Saud University (KSU), Riyadh, Saudi Arabia. The students were enrolled in a Natural Science Translation course (2 hours per week) in which they studied a sample of English and Arabic technical terms in physics, chemistry, biology, astronomy, earth science, oceanography, and materials science. The students were concurrently enrolled in Medical and Humanities Translation courses. They were given an Arabic and an English test, each consisting of 30 common names of chemical compounds that were randomly selected from a sample of 225 technical chemical compounds, with 400 English–Arabic common names, as some chemical compounds have two or more common names in Arabic and/or English. The English and Arabic test items covered pure (original) Arabic names, borrowings, Arabized names, polysemous common names, toponyms/eponyms, old names and new names, synonyms, neologisms, color-based names, and calques. The test items were presented in isolation, as presenting them in context might help the students infer their meaning. The test instructions specified what the items were. The students were asked to translate each English common name into one or more Arabic equivalents, and vice versa. The students were not allowed to use any online or paper dictionaries. No time limit was imposed on the test session. The results of students' translations will be reported in detail in the results' section to be able to compare them with AI transaltions.

### 2.2 *The AI Part of the Study*

The same English and Arabic test items of CNCC that were translated by student-translators were given to Microsoft Copilot (MC) to translate.

Translate the following into Arabic:

*Ammoniac, aqua ammonia, ammonia liquor, feldspar, lamp oil, slaked lime, chlorinating powder, soda water, sour salt, bluestone algicide, grain alcohol, lactic acid, marsh gas, spirit of niter, laughing gas, table salt, sulfur potash, battery acid, acetic acid, uric acid, quicksilver, blue vitriol, saltpetre, oil of wintergreen, arseneous anhydride, Aqua Tofani, litharge, cinnabar, lunar caustic, stearic acid.*

Translate the following into English:

النشادر، الحجر الكلسي، محلول برمنجنات البوتاس، الصودا الكاوية، قلي الصودا، الأبيض الكاوي، الشب، الملح المر، الملح الإنجليزي، الطباشير الفرنسي، الغاز المسيل للدموع، ماء النار، الماء القوي، الماء الملكي، ماء الفضة، حجر جهنم، حمض النمليك، زيت الزاج، زاج الخارصين، العطرون او النطرون، مسحوق القاصر، ملح البارود، مسحوق التبييض، الصخر الحريري، الجير المطفأ، الزنجار الفرنسي، حمض السلقون. القَلْقَنْ، الجاويك، حمض الدردي،

### 2.3 *Analysis of the Students' and MC's Responses*

The students' and MC's translations of the CNCC on the test were marked by the author. To be considered correct, each Arabic and English common name of a chemical compound had to be translated by a correct equivalent, a literal translation or explanation. Mistranslations were compiled and subjected to further analysis. Translation strategies were classified into: (i) leaving the answer blank (avoidance); (ii) literal, word for word translation; (iii) partial translation, (iv) transliteration, (v) paraphrase (explanation); and (vi) providing extraneous equivalents.

Results of the students' and MC translations are reported quantitatively and qualitatively.

### 2.4 *Reliability*

Reliability of the students' and MC's CNCC test scores was calculated using the Kuder–Richardson 21 formula, which estimates the internal consistency of the responses to the test items from a single administration of the test. The reliability coefficient of the test scores was .76. Inter-rater reliability was calculated by having a colleague who taught translation mark a sample of students' and MC's translations and by comparing both analyses. There was a 97% agreement between the two scorers in identifying meanings and expressions available in both English and Arabic and those that were available in one language only, and in classifying the faulty responses into translation strategies. ..Disagreements were resolved by discussion

## .3Results

This section presents a comparative analysis of the responses produced by student-translators and the MC. Each group's output is examined independently to highlight distinct patterns, translation choices, and performance characteristics.

### *3.1 Analysis of Students-translators & AI Responses*

### *3.1.1 Students' Responses*

Analysis of the students' responses to the English and Arabic CNCC tests showed that undergraduate student-translators have considerable difficulty in translating English CNCC to Arabic and vice versa. The students gave a total of 690 and 824 incorrect responses to the English and Arabic test items, respectively, as opposed to 420 and 411 total correct responses to the English and Arabic test items, respectively. There were 2211 or 55% blank responses on both tests. The typical student responded to 35% of the CNCC on the whole test (correct and incorrect). However, less than 20% of the attempts, i.e., test items which they responded were fully correct.

In addition, test results showed that many undergraduate translation students in the present study did not notice that some items on both tests are equivalents or synonyms as they left some blank of they gave partial or faulty translation as in the following examples that are synonyms: *aqua ammonia & ammonia liquor;*; ماء النار& الماء القوي، الماء الملكي، ماء الفضة; الملح الإنجليزي & الملح المر; قلي الصودا، الصودا الكاوية & الأبيض الكاوي; مسحوق القاصر & مسحوق التبييض; and the following items on the English and Arabic tests that are equivalents: *chlorinating powder &* مسحوق القاصر مسحوق التبييض; *spirit of niter &* حجر جهنم*;* saltpetre & ملح البارود and that *the equivalent of lunar caustic is* حجر جهنم although it literally means *stone from hell.*

### *3.1.1 MC's Responses*

Data analysis showed that MC translated 72% of the chemical compounds in the sample correctly. MC gave more Arabic-English than English-Arabic correct equivalents (40% & 32% respectively). It gave more correct equivalents when the author specified the type and domain of the terms and when she asked for all the equivalents that MC knows. Examples of correct Arabic-English translations by MC are:

> برمنجنات البوتاس *Potassium permanganate;* الحجر الكلسي *Limestone (Calcium carbonate);* حمض النمليك *Formic acid;* زاج الخارصين *Zinc vitriol (Zinc sulfate);* الزنجار الفرنسي *French verdigris (Basic copper carbonate);* زيت الزاج *Vitriol oil (Sulfuric acid);* الشب *Alum (Potassium aluminum sulfate);* الصودا الكاوية *Caustic soda (Sodium hydroxide);* الطباشير الفرنسي *French chalk (Talc);* الغاز المسيل للدموع *Tear gas (e.g., Chlorobenzylidene malononitrile);* الماء الملكي *Aqua regia (Nitric + Hydrochloric acid);* مسحوق القاصر *Bleaching powder (Calcium hypochlorite).*

Examples of correct English-Arabic translations by MC are:

> Acetic acid حمض الخليك; Battery acid حمض البطارية (حمض الكبريتيك); Blue vitriol الزاج الأزرق (كبريتات النحاس); Bluestone algicide كبريتات النحاس (مبيد الطحالب); Feldspar الفلسبار; Grain alcohol كحول الحبوب (الإيثانول النقي); Laughing gas; غاز الضحك (أكسيد النيتروز)**;** Marsh gas غاز المستنقعات (الميثان); Quicksilver الزئبق; Saltpetre ملح البارود (نترات البوتاسيوم); Soda water ماء الصودا; Sour salt ملح الليمون (حمض الستريك); Sulfur potash بوتاس الكبريت; Table salt ملح الطعام (كلوريد الصوديوم); Aqua Tofani ماء توفاني (سم تاريخي يحتوي على الزرنيخ); Cinnabar الزنجفر (كبريتيد الزئبق); Oil of wintergreen زيت النعناع البري (ميثيل الساليسيلات); Slaked lime الجير المطفأ; Litharge; الليثارج (أكسيد الرصاص الثنائي) .

When the author explained the items to MC and asked it to provide all possible equivalents, MC corrected several faulty translations and expanded its output with multiple synonyms or technical explanations. This shows that MC can adjust and improve its translations when guided. Examples include:

- Corrections of faulty equivalents:
  - السلقون→ Sal ammoniac (Ammonium chloride)
  - حمض الدردي (Tannic acid) → corrected to Tartaric acid
  - حمض الجاويك(Gallic acid) → expanded to حمض العفص, حمض العفصيك, حمض الغاليك, with explanation of its botanical origin
- Expansion with multiple equivalents:
  - الصخر الحريري (Silky rock) → Talc, Serpentine, الأميانت, حجر الفتيل, الحَرِيرُ الصَّخْرِيُّ, Asbestos, Silicate minerals
  - ماء الفضة (Silver nitrate solution) → Silver nitrate, Colloidal silver, Lunar caustic
  - Litharge الزاج الرصاصي, الرصاص الأصفر, أول أكسيد الرصاص, مرتك → (الليثارج)
- Clarification with chemical identity:
  - Soda ash كربونات الصوديوم → (الصودا/رماد الصودا), with explanation of its forms (anhydrous, decahydrate)
  - قلي الصودا→ Soda ash (Sodium carbonate), with detailed description of its chemical composition
  - القَلْقَنْد→ Green vitriol (Ferrous sulfate), noting its synonym الزاج الأخضر

Overall, the analysis revealed a clear performance gap between student-translators and AI. While students struggled with accuracy, leaving more than half of the test items blank and producing fewer than 20% fully correct responses, AI (MC) achieved a much higher success rate, correctly translating about 72% of the chemical compound names. Students frequently relied on literal translation and failed to recognize synonyms or equivalent terms, whereas AI, although initially resorting to literal renderings, was able to generate multiple equivalents and refine its output when prompted by the author. This contrast highlights both the persistent weaknesses in student mastery of chemical terminology and the relative advantage of AI in providing consistent, retrievable equivalents, even if cultural or contextual adaptation remains limited.

### *3.2 Translation Strategies Used by Student-translators & MC*

#### *3.2.1 Student-translators' Strategies*

The strategies that student-translators utilized were as follows:

**(i)** ***Avoidance*** which constituted the most common strategy, as there were 55% blank responses on both tests by all students. Many students left the following items on both tests blank: *slaked lime, chlorinated soda, bluestone algicide, ammonia liquor, Arseneous Anhydride*, *spirit of niter, acetic acid, lactic acid, sulfur potash, feldspar, chlorinating powder, citric acid, blue vitriol, saltpeter,* العطرون او النطرون،، حجر جهنم، الزنجار، مسحوق القاصر الزرنيخ اللامائيزيت الزاج، زاج الخارصين ،

**(ii)** ***Literal translation*** where the subjects tended to translate the English and Arabic CNCC word-for-word, i.e. as two single words, not as a unit, although Arabic and/or English equivalent common names exist, as in the following English and Arabic faulty responses:

- English as ST: *Soda water* was translated as *Acetic acid* حمض الاستيك; *Ammonia liquor* كحول الأمونيا; *Sour salt* الملح الحامض أو الملح المر not ملح الليمون; *Quicksilver* الفضة السريعة not الفضة الحية; *Table salt* ملح الطاولة not ملح الطعام; صودا الماء *rather than* المياه الغازية.
- Arabic as ST: حمض النمليك *ant acid* not *formic acid;* الحجر الكلسي *kils stone* not *limestone;* ماء الفضة *silver water* not *spirit of niter;* الماء الملكي *royal water* not *water regia;* الطباشير الفرنسي *French chalk* not *talc;* حجر جهنم *hell/hot* stone not *lunar caustic.*

**(iii)** ***Partial translation*** where part of the compound common name, mostly the identifier such as: *gas, alcohol, water, salt*, *oil*, was translated; the other part was left blank. For instance:

- English as ST: *Quicksilver* الفضة*; Bluestone algicide* الحجر الأزرق*; Chlorinating powder* مسحوق*; Slaked lime* الحجر الجيري *; Spirit of niter* روح.
- Arabic as ST: زيت الزاج *oil;* مسحوق القاصر *powder;* الأبيض الكاوي white.زاج الخارصين *zinc;* قلي الصودا *soda.*

**(iv)** ***Transliteration***. Here the students transcribed the English common names: *Ammoniac, aqua Tofani, citric acid, sulfur potash, uric acid, aqua ammonia, Feldspar, lactic acid, acetic acid, vitriol, saltpetre* with Arabic letters; and the Arabic common names الزنجار، نطرون، السلقون حمض الجاويك، الشب with Latin letters.

**(v)** Giving one equivalent only, in the case of **multiple equivalent** in which case the equivalent given was the borrowed (English) common name rather than the pure Arabic or Arabized equivalent. e.g.:

- *Acetic acid* was translated as حمض الاستيك rather than حمض الخليك أو حمض الخل
- *Battery acid* was translated as حمض البطارية rather than حمض المراكن
- *Citric acid* was translated as حمض الستريك rather than حمض الليمونيك
- *Lactic acid* was translated as حمض اللاكتيك rather than حمض اللبن أو حمض اللبنيك
- *Uric acid* was translated as يوريك أسيد rather than حمض البوليك أو حمض البول

**(vi)** **Explanation (paraphrase)** as in:

- حجر جهنم *hot* stone instead of *lunar caustic*
- *Chlorinated soda* إضافة الكلور إلى الصودا or صودا الكلور instead of الصودا المكلورة
- *Chlorinating powder* إضافة الكلور الى المسحوق *or* مسحوق الكلور instead of مسحوق الكلورة

**(vii)** **Transposition and Translation Shift**

- Changing the word type in the compound. *Sulfur potash* was translated into a compound using a noun rather than the new derived form (past participle) as in بوتاس الكبريت instead of البوتاس المكبرت
- *Aqua ammonia* was translated by reversing (transposing) the two words of the compound thus changing the part of speech and definiteness of the two words of the compound such as saying الامونيا المائية instead of ماء الأمونيا.
- Changing the number of a component of the compound as in saying *Battery acid* حمض البطارية in the singular rather than using the plural حمض البطاريات.

### *3.2.1 MC Translation Strategies*

**(A) Supplying chemical technical term alongside common names** as *calcium carbonate, zinc sulfate, copper carbonate, sulfuric acid, potassium aluminum sulfate, sodium hydroxide, calcium hypochlorite, nitric acid, chlorobenzylidene malononitrile, magnesium sulfate, potassium nitrate, calcium hydroxide, silver nitrate, copper sulfate pentahydrate, ferrous sulfate, sodium carbonate, tannic acid, ammonium chloride, gallic acid*, كبريتات النحاس, نترات البوتاسيوم, حمض الستريك, كلوريد الصوديوم, كربونات الصوديوم, حمض النيتريك, نترات الفضة, أكسيد الرصاص الثنائي, أول أكسيد الرصاص, حمض الستيريك, كبريتيد الزئبق) to 51.5% of the common name of a chemical compound in the sample, whether the source compound is Arabic or English and whether the translation rendered is correct or incorrect as in the following examples:

- Litharge الليثارج (أكسيد الرصاص الثنائي).
- Oil of wintergreen زيت النعناع البري (ميثيل الساليسيلات)
- Aqua Tofani ماء توفاني (سم تاريخي يحتوي على الزرنيخ)
- Cinnabar الزنجفر (كبريتيد الزئبق)
- Grain alcohol كحول الحبوب (الإيثانول النقي)
- Laughing gas غاز الضحك (أكسيد النيتروز)
- Bluestone algicide كبريتات النحاس (مبيد الطحالب)
- Battery acid حمض البطارية (حمض الكبريتيك)

**(B) Literal word-for-word translation: Sometimes produced awkward equivalents** as in:

- Ammonia liquor > سائل الأمونيا instead of ماء النشادر or محلول النشادر
- caustic soda الصودا الكاوية الصودا قلي الصودا الفلاش الكاوي الأبيض محاليل الصابون
- Lamp oil زيت المصابيح instead of كيروسين – كاز
- Lunar caustic > الكاوي القمري (نترات الفضة) instead of حجر جهنم
- Spirit of niter روح النترات (حمض النيتريك المركز) instead of الماء القوي ماء الفضة حمض الآزوت
- الأبيض الكاوي caustic white (often Sodium hydroxide) instead of الصودا الكاوية الفلاش قلي الصودا محاليل الصابون
- حجر جهنم > Hell stone (Silver nitrate stick)
- الصخر الحريري > Silky rock (Talc or Serpentine)
- الماء القوي >Strong water (Nitric acid) instead of الماء القوي
- ماء النار > Acidic firewater (Sulfuric acid)
- الملح المر > Bitter salt (Magnesium sulfate) instead of الملح المر الملح الإنجليزي ملح ابسوم

**(C) Transliteration, i.e., rendering English names in Arabic script** as in:

- Ammoniac الأمونياك instead of محلول النشادر - ماء النشادر
- Aqua ammonia محلول الأمونيا instead of محلول النشادر - ماء النشادر
- Lactic acid حمض اللاكتيك instead of حمض اللبن/اللبنيك
- Litharge الليثارج (أكسيد الرصاص الثنائي)
- Stearic acid > حمض الستيريك instead of حمض الشمع
- Stearic acid حمض الستيريك
- Uric acid حمض اليوريك
- حمض الجاويك Gallic acid

**(D) Use of English Equivalents to Arabized Names:**

- العطرون أو النطرون Natron (Sodium carbonate decahydrate)
- القَلْقَنْ Calcanthite (Copper sulfate pentahydrate)

**(E) Mixed strategy consisting of a partial translation + transliteration)** as:

- Aqua ammonia >محلول الأمونيا
- Arseneous anhydride > أنهيدريد الزرنيخ الثلاثي
- Spirit of niter >روح النترات (حمض النيتريك المركز)
- قلي الصودا > Soda ash (Sodium carbonate)
- ماء الفضة > Silver nitrate solution

**(F) Combining the common name of the chemical compound with an explanation** as in:

- حمض الجاويك Gallic acid: حمضُ العَفْص (ويُستخرج من مواد عفصية دِباغية في النبات) حمض الغاليك ,حمض الجاليك ,حمض ,حمض العفصيك

**(G) Rendering a faulty derivative:** Occasionally produced incorrect morphological forms (Chlorinating powder > مسحوق التكلور).

To summarize, English chemical compounds have multiple Arabic equivalents, both student-translators and MC gave only one equivalent unless the author prompted MC to give all. Student-translators were not prompted. It was noted that even though MC is characterized by breadth of knowledge of English and Arabic chemical terminology and quick access to each term and in which context(s) it is used, in few cases, it failed to match the English chemical compound name with its Arabic equivalent and vice versa as in the following:

- Arsenious anhydride: سم توفاني ,زجاج الزرنيخ ,سم الجرذان ,سم الزرنيخ اللامائي ثلاثي أكسيد الزرنيخ.الزرنيخ
- *caustic soda* الصودا الكاوية ,الفلاش ,قلي الصودا ,محاليل الصابون , الأبيض الكاوي .
- Cinnabar: الزنجفر ,لون قرمزى ,لون أحمر قاني , كبيرتيد الزئبقيك سنابار
- *Epsom salt (Magnesium sulfate)* ملح ابسوم ,الملح المر الملح الإنجليزي الملح.
- *limestone* الحجر الجيري ,الرخام الطباشير ,مضاد للحموضة ,حجر الجير ,الحجر الكلسي ,أزرق باريس.
- *Slaked lime (Calcium hydroxide):* الجير المطحون ,الجير (لبن) الجير حليب , ماء الجير ماء الكلس - الجير المطفأ - الكلس الكاوية
- حمض الجاويك Benzoic Acid, flowers of benzoin (benzoic acid), عِطري يوجد طبيعيًّا ,حامض اللُّبّان الجاوي وهو مركب، البنزويك (حَمْضُ البِنْزويك) زَهْرُ الجَاوِيّ ,حمض الصمغ الجاوي ,الجاوي /حمض البنزويك- الصمغ البنزويني , ويكون صناعيًّا
- العطرون أو النطرون washing soda, ملح الصودا, صودا الغسيل.

The above analysis reveals that both student-translators and MC relied heavily on literal translation and transliteration, but the outcomes differed. Students' strategies were dominated by avoidance (55% blank responses) and faulty literal renderings, which often produced meaningless or culturally awkward equivalents. They also tended to provide only one borrowed equivalent when multiple Arabic options existed, reflecting limited knowledge of common names of chemical compounds. By contrast, MC consistently produced responses, rarely left items blank, and when prompted and given the types of items, it combined technical names with common names or explanations and sometimes transliteration. MC also demonstrated flexibility by correcting faulty equivalents and offering multiple synonyms, whereas students struggled to recognize equivalents and synonyms. Overall, while students and AI showed dependence on surface-level strategies, AI displayed greater consistency, adaptability, and explanatory capacity compared to the students' limited and error-prone approaches.

### 3.3 *Sources of Errors in Students' and AI's Translation*

#### 1) *3.3.1 Errors Sources in Students' Translations*

Students' errors stemmed primarily from insufficient knowledge of the CNCC and their conceptual bases. Questionnaire responses confirmed unfamiliarity with items such as *blue vitriol, saltpetre, oil of wintergreen, Arseneous anhydride* and Arabic equivalents like العطرون، حجر جهنم، الماء الملكي، ماء النار. Other sources of translation errors and leaving items blank are not knowing whether to translate, transliterate, or borrow terms.; their preference for borrowings. Loanwords (ammonia, zinc) were more familiar than original Arabic equivalents (نشادر، خارصين). They had difficulties with neologisms, i.e., newly Arabized terms such as حمض الليمونيك، الجاويك were rarely recognized. Some items have opaque meanings. They lacked one-to-one correspondence, unlike technical terms (e.g., Sodium Chloride كلوريد الصوديوم vs. lunar caustic > حجر جهنم).

### 3.3.2 *Errors Sources in AI Translations*

AI errors arose from model limitations rather than subject-matter ignorance. The literal translations produced awkward equivalents (lunar caustic > الكاوي القمري instead of حجر جهنم). MC applied direct matches without recognizing metaphorical bases (quicksilver > الفضة السريعةinstead of الزئبق). Although MC generated multiple options it failed to prioritize conventional equivalents (soda ash > رماد الصودا without clarifying كربونات الصوديوم). MC relied on transliteration to reproduced English terms in Arabic script (Uric acid > حمض اليوريك instead of حمض البوليك). MC also has contextual weakness. It could not consistently align translations with professional or cultural usage. Additionally, MC showed weaknesses in handling synonyms and multiple equivalents. While it could generate several options when prompted, it sometimes failed to prioritize the most widely used or culturally appropriate equivalent. For example, soda ash was translated as رماد الصودا but without clarifying its chemical identity as كربونات الصوديوم.

The analysis shows that both student-translators and AI encountered significant challenges in handling CNCC, though for different reasons. Students' errors stemmed from insufficient knowledge of terminology in both English and Arabic, limited chemistry background, and uncertainty about whether to translate, transliterate, or borrow terms. Their reliance on avoidance and literal translation reflected gaps in subject-matter competence. By contrast, AI errors arose from model limitations—overreliance on literal rendering, inconsistent selection of culturally conventional equivalents, and occasional transliteration of English terms instead of established Arabic names. Unlike students, AI did not leave items blank and could refine its output when prompted, but it lacked contextual awareness to align translations with professional usage. Together, these findings highlight that while students struggle with knowledge gaps, AI struggles with contextual adaptation, underscoring the complementary potential of human expertise and AI assistance in chemical terminology translation.

### 3.4 *Results Conclusion*

Taken as a whole, the findings demonstrate a clear contrast between student-translators and AI in handling Common Names of Chemical Compounds. Students showed limited accuracy, frequent avoidance, and reliance on faulty literal or transliteration strategies, reflecting gaps in chemical knowledge and translation competence. AI, while also prone to literal rendering and occasional transliteration, achieved higher accuracy, produced multiple equivalents when prompted, and never left items blank. The sources of error differed: students struggled with subject-matter unfamiliarity, while AI lacked contextual adaptation to conventional usage. These results highlight both the persistent weaknesses of student-translators and the relative strengths and limitations of AI, underscoring the need for pedagogical approaches that integrate AI tools with targeted training in chemical terminology.

## 4. Discussion

### *4.1 Comparison with Prior Studies*

The current study demonstrated that undergraduate student-translators gave correct translations to fewer than 20% of the chemical common names, while MC achieved 72% accuracy. Students left 55% of items blank, whereas MC produced responses for all items. Both groups performed better in Arabic–English than English–Arabic translation, and both relied heavily on word-for-word strategies. Students additionally used paraphrase, partial, and extraneous translation. These findings align with Al-Jarf (2025k), where AI also outperformed students in translating expressions of impossibility.

This study extends prior research by showing that in chemical nomenclature, a new domain, AI not only surpassed students in accuracy but also generated broader sets of equivalents when prompted. This highlights AI's comparative strength in technical terminology and underscores the pedagogical need to train students in effective prompting strategies to bridge everyday language and specialized precision.

By contrast, the findings diverge from prior studies in domains such as poetry (Farghal & Haider; Alowedi & Hassan Al Ahdal; AlAfnan & Alshakhs), legal texts (Al-Maktary et al., 2025; Altakhaineh et al., 2025; Moneus & Sahari, 2024; Haider & Alkhatib, 2024), and culturally loaded content (Binhaidara et al., 2025; El-Saadany, 2024; Zibin; Ichien et al., 2024; Al-Wasy & Mohammed, 2024; Ennouari & Houssaini, 2024; Fakhrabadi & Sharifabad, 2023). In those studies, human translators outperformed AI in contextual relevance, metaphorical depth, and cultural sensitivity, while AI translation outputs were faster but prone to semantic ambiguity, syntactic misalignment, and pragmatic distortions (Sadiq, 2025; El-Naby & Aly, 2025).

Within the author's prior work on student-translators at CLS, the difficulties and strategies observed here mirror those found in translating idiomatic and fixed expressions (Al-Jarf, 2023a, 2023b, 2023c, 2022a, 2016b, 2022d, 2009). Similarly, in earlier studies on AI translation, MC achieved high accuracy in domains such as sleep idioms (91%), formulaic expressions (79%), and medical terms (68.6%), but lower performance in metaphorical or culturally loaded domains (2025d, 2025g, 2025n). Other AI tools (GT, Deepseek) also tended to rely on literal, word-for-word translation rather than conceptual equivalents (Al-Jarf, 2021a, 2016a).

### *4.2 Why Copilot Outperformed Student-Translators in Translating*

Data analysis revealed that MC outperformed student translators in rendering CNCC, unlike many prior in which human translators surpassed AI. In both the author's previous study and the current one, however, MC achieved higher accuracy. The following factors explain this reversal. First, MC benefits from breadth of exposure. Unlike students who rely on coursework, dictionaries, or limited corpora, MC draws from massive multilingual datasets, textbooks, scientific glossaries, academic papers, and even alchemical treatises. This access provides historical and modern equivalents, cross-linguistic patterns, and variants across disciplines. For instance, when confronted with حجر جهنم, MC has encountered both its literal use and its function as a cauterizing agent, enabling it to match the term with "silver nitrate stick," even if such knowledge is not taught in classrooms. Secondly, MC demonstrates consistency in pattern recognition. Students often fall into traps such as avoiding uncommon entries altogether, transliterating unknown terms, or translating metaphorical names literally. MC, however, is trained to recognize thousands of chemical naming patterns, prefixes, suffixes, and regional usages, and to match them algorithmically to equivalents, even when terms are obscure or archaic. Thirdly, students' curricula are domain-specific. Chemistry and translation are often taught separately, leaving students unaware of mappings such as "talc" = الصخر الحريري or "spirit of niter" = nitric acid. MC, by contrast, functions at the intersection of disciplines, which is why this study demonstrates its forward-looking potential.

### 4.3 Why MC Produced More Arabic–English than English–Arabic Correct Equivalents

When MC was asked to provide all English equivalents of الصخر الحريري and الحَرِيرُ الصَّخْرِيُّ, the task was inherently Arabic-to-English. This direction encouraged MC to generate terms that render the Arabic metaphor or scientific label into English, naturally prioritizing richer English interpretations and variants. If MC had been asked for English-to-Arabic equivalents of "asbestos" or "rock silk," it would have approached the task differently, beginning with industrial terms such as asbestos or mineral fiber and then mapping them back to Arabic counterparts like الأميانتor الصخر الحريري. Thus, the imbalance stems largely from the translation direction requested.

MC's stronger performance in Arabic-to-English translation also reflects data bias toward English sources and the relative scarcity of standardized Arabic nomenclature. Most scientific databases, glossaries, and educational materials are originally written in English. When given Arabic names such as السلقون or المُرْدَاسَنْج, MC can tap into rich English-language repositories to match them precisely. Arabic chemical terms, however, are more fluid and regionally diverse. Usage varies across Egypt, Morocco, Iraq, and the Levant, and formal glossaries are not always consistent. This means that when translating into Arabic, MC must choose carefully among formal, colloquial, poetic, or industrial variants. Because the author consistently requested Arabic-to-English translations with layered explanations, MC developed stronger contextual mapping in that direction—similar to a translator who has spent more time reading Arabic and writing in English.

Nevertheless, English-to-Arabic performance is improving. Through ongoing interaction, MC is building a richer web of Arabic chemical synonyms, recognizing that الصخر الحريري andالأميانت both denote asbestos, or that المُرْدَاسَنْج corresponds to *litharge*. It now responds with both formal terms (e.g., أول أكسيد الرصاص) and poetic ones (e.g., الرصاص الأصفر) side by side. This growth reflects the mentoring process: the more the author asks, challenges, and clarifies, the more accurate and culturally attuned MC becomes.

In practice, Arabic-to-English translation draws on well-established English databases, glossaries, and corpora, yielding precise equivalents such as *Litharge* or *Arsenic*. English-to-Arabic translation, however, is complicated by multiple synonyms, the coexistence of formal and archaic terms, and limited indexed glossaries. The asymmetry is not due to lack of knowledge but to the way knowledge is organized and retrieved. Most of MC's chemical indexing is in English, while Arabic terms often appear only as labels without depth of usage or citation. When the Arabic term is introduced first, however, it provides context, nuance, and direction, enabling MC to match it confidently to the English equivalent.

### 4.4 Why Sleep and Medical Terms Are Easier for MC than Common Names of Chemical Compound

Although MC performed well in translating CNCC, its performance was even stronger with sleep terms and idioms and medical terminology. Both domains are scientific or formulaic in nature, but medical terms and sleep expressions are more standardized and widely disseminated than CNCC. Several factors contribute to this difference. Medical terminology benefits from global standards such as the International Classification of Diseases (ICD) and from the consistent use of Latin and Greek roots. Terms like *diabetes mellitus*, *gout*, or *eczema* have stable meanings and translations across languages and cultures. Similarly, sleep idioms and formulaic expressions are frequent in everyday discourse, richly represented in literature, media, and multilingual corpora, which gives AI abundant exposure and clearer usage examples. MC and DS, for instance, rendered 91% correct equivalents to English sleep idioms and 79% of English formulaic expressions respectively (Al-Jarf, 2025m). Medical terms also appear more frequently in general discourse, health literature, and media than mineralogical or chemical terms such as *litharge* or *calcanthite*. The more a term or expression is used in everyday or clinical settings, the easier it becomes to associate it with the correct equivalent. Furthermore, global health organizations publish multilingual resources designed for both specialists and laypeople, reinforcing clear mappings such as "حمض اللاكتيك = lactic acid."

By contrast, CNCC are more complex due to polysemy, historical naming conventions, regional folk terminology, and ambiguity without context. A single compound may have three to five common names depending on era, region, or usage. For example, روح النترات could refer to nitric acid, spirit of niter, or aqua fortis, each slightly different in tone and context. Arabic terms such as حجر جهنم carry symbolic or metaphorical weight, especially in traditional medicine or alchemy, requiring careful navigation between literal meaning and intended chemical identity. Unlike uric acid, which almost always refers to a medical analyte, a term like الصخر الحريريmay denote talc, mica, or even a poetic description of texture unless clarified.

**5. Implications for Translation Pedagogy**

The current study shows that both student-translators and AI encountered significant challenges in handling common names of chemical compounds, though for different reasons. Students' errors stemmed from insufficient knowledge of terminology in both English and Arabic, limited chemistry background, and uncertainty about whether to translate, transliterate, or borrow terms. Their reliance on avoidance and literal translation reflects gaps in subject-matter competence. By contrast, AI errors arose from model limitations, overreliance on literal rendering, inconsistent selection of culturally conventional equivalents, and occasional transliteration of English terms instead of established Arabic names. Unlike students, AI did not leave items blank and could refine its output when prompted, but it lacked contextual awareness to align translations with professional usage. Together, these findings highlight that while students struggle with knowledge gaps, AI struggles with contextual adaptation, underscoring the complementary potential of human expertise and AI assistance in chemical terminology translation.

It is noteworthy to take into consideration that chemical terminology in Arabic presents two distinct translation realities. On the one hand, technical terms such as برمنجنات الصوديوم (sodium permanganate), حمض النتريك (nitric acid), and هيدروكسيد الصوديوم (sodium hydroxide) are straightforward to translate. They follow the International Union of Pure and Applied Chemistry (IUPAC) standardized nomenclature, exhibit one-to-one correspondence between English and Arabic, and can be found in any dictionary. These terms pose no significant challenge for either human translators or AI systems.

On the other hand, CNCC are far more complex. They are commonly used in everyday language, in the house, the kitchen, the bathroom and so on, and are shaped by tradition, local usage, and historical practice. Terms such as مسحوق القصر (bleaching powder), النشادر (ammonia), حمض الخليك (acetic acid), حمض الطرطريك (tartaric acid),صودا الغسيل (washing soda), الملح الإنجليزي (Epsom salt), الجير المطفأ (slaked lime), and الحجر الجيري (limestone) are part of ordinary vocabulary, and are not learnt in specialized chemistry courses. Unlike technical terms, they often lack standardized equivalents and may carry multiple synonyms or metaphorical meanings, making their translation a more challenging task for both human translators and AI.

Findings of this study show that while MC often recognized the technical term behind a common name, it sometimes struggled to consistently connect the common name in Arabic with its parallel common name in English. Students, by contrast, frequently lacked knowledge of the technical terms altogether and tended to provide only one equivalent or avoid difficult entries. Both student translators and MC reduced the richness of synonyms unless prompted to explore further.

For this reason, this study recommends training students to prompt AI assistants such as Copilot, Gemini, DeepSeek, ChatGPT, Alice, LLama and others effectively. Rather than just saying translate the following to English/Arabic, they should specify the type of term they want AI to translate by saying translate the following CNCC to English/Arabic), request multiple equivalents, and provide contextual clues such as usage domain, regional variation, or historical background. By guiding AI with clear instructions, for example, "give me the common equivalent name in English and list all the synonyms that you know", the students will obtain richer translation outputs that reflect the diversity of chemical nomenclature. This practice not only improves translation accuracy but also teaches students to think critically about the relationship between chemical names used in everyday language and those used as scientific terminology.

Chemical terminology, particularly in Arabic, is characterized by richness of synonyms shaped by tradition, local usage, and historical practice. Because translation students often have limited knowledge of the common names of chemical compounds, they should be encouraged to specify the type of terms they wish to translate and to ask AI systems to provide as many equivalents as possible. Supplying AI with context, nuance, and translation direction will help ensure that the term is matched with its most accurate equivalent. However, students may not yet possess the analytical tools or curiosity to scrutinize translations and probe deeper, as an experienced researcher would. This raises the question of how best to help them benefit from AI in translating chemical compounds.

Translation instructors can scaffold this process by modelling effective prompts, designing assignments where students double-check AI translation outputs and compare them with textbooks, glossaries, specialized dictionaries and encouraging reflection on why certain terms yield multiple equivalents. Such strategies will help students move beyond passive reliance on AI and develop active translation skills, while also benefiting from AI's breadth of exposure and systematic recall. Ultimately, the goal is not to replace human judgment but to cultivate AI performance, enabling students to use AI as a tool for exploring the complexity of CNCC and for bridging the gap between everyday discourse and technical precision.

AI can serve as a powerful scaffold for student learning if instructors guide its use intentionally. One important strategy is to teach students how to ask better questions. Instead of just requesting a translation, they should be trained to begin with guided prompts such as "What is the chemical formula of this compound?" or "What are its uses?" Instructors can model how to probe further by asking about historical meanings, industrial applications, or regional naming differences. Encouraging curiosity over correctness transforms mistakes into teaching moments and helps students develop a more investigative approach to terminology.

Providing a context is another essential step. Students can be asked to compile lists of Arabic CNCC and then use AI to generate bilingual glossaries that include formulas, uses, and warnings. Worksheets can include notes sections where AI explains when a name might have multiple meanings, such as السلقون, which can refer to $Pb_3O_4$ or $NH_4Cl$ depending on context. Collaborative assignments also offer opportunities for active engagement. For example, groups of students can work together to create a bilingual chemistry lexicon, with each student responsible for researching one compound through AI. The AI can provide draft entries, which students then verify, annotate, and refine, turning passive translation into active learning.

Equally important is teaching AI literacy. Students should understand what AI can and cannot do, how it gathers information, and why discrepancies may occur. Exercises that compare AI's answers with textbooks or journal articles can help students critically evaluate translation outputs and recognize limitations. Reflection should also be incorporated into assignments, with students writing short responses such as "This translation helped me understand…" or "I am curious why AI gave me two answers." Such reflections encourage metacognition and deepen students' engagement with the translation process.

When using AI to translate CNCC, students should be trained to specify key parameters to ensure accuracy. These include the context of the term (scientific textbook, traditional recipe, industrial manual, or historical alchemy), the purpose of translation (academic publishing, classroom learning, glossary building, or casual understanding), and the desired level of precision (IUPAC nomenclature, common names, or both). They should also provide dialectical or regional clues, since Arabic chemical terms vary across Egypt, Morocco, Iraq, and the Levant. Known synonyms or associated applications should be mentioned as well, such as whether a compound is used in food, medicine, or traditional crafts like tanning or dyeing. By articulating these details, students can guide AI toward more accurate and contextually appropriate translations.

## 6. Conclusion

Findings of this study highlight the dual challenge of translating chemical terminology: students struggle with knowledge gaps and limited familiarity with common names, while AI systems struggle with contextual adaptation and cultural nuance. These complementary weaknesses point to a new pedagogical opportunity, training students not only in chemical nomenclature but also in AI literacy and prompting strategies. By integrating AI into translation pedagogy as a scaffold rather than a substitute, instructors can help students develop critical awareness, deepen subject-matter knowledge, and engage actively with the complexity of chemical language. Ultimately, the goal is to cultivate translators who can harness AI intelligently, bridging everyday discourse and scientific precision while maintaining human judgment and contextual sensitivity.

**Conflicts of Interest:** The author declares no conflict of interest.
**ORCID ID:** https://orcid.org/0000-0002-6255-1305


## References

[1] Abdalhussein, H. (2025). Comparative analysis of AI and human translations of Qur'anic legal verses in Surah Al-Ma'idah. *Ijaz Arabi Journal of Arabic Learning*, *8*(1).

[2] Al Sawi, I. & Allam, R. (2024). Exploring challenges in audiovisual translation: A comparative analysis of human-and AI-generated Arabic subtitles in Birdman. *Plos one*, *19*(10), e0311020.

[3] AlAfnan, M. & Alshakhs, T. (2012). *Bridging Linguistic and Cultural Nuances: A Comparative Study of Human and AI Translations of Arabic Dialect Poetry. Advances in Artificial Intelligence and Machine Learning. 2025; 5 (1): 186*. Computational Linguistics.

[4] Albalawi, A. F. (2025). Bringing meanings: AI and human collaboration in unveiling Qur'anic synonymy and polysemy. *Ijaz Arabi Journal of Arabic Learning*, *8*(1).

[5] Al-Jarf, R. (2025a). AI translation of full-text Arabic research articles: The case of educational polysemes. *Journal of Computer Science and Technology Studies*, 7(1), 311-325. Google Scholar

[6] Al-Jarf, R. (2025b). AI translation of the Gaza-Israel war terminology. *International Journal of Linguistics, Literature and Translation*, 8(2), 139-152. Google Scholar

[7] Al-Jarf, R. (2025c). Arabic transliteration of borrowed English nouns with /g/ by Artificial Intelligence (AI). *Journal of Computer Science and Technology Studies*, 7(9), 245-252. Google Scholar

[8] Al-Jarf, R. (2025d). Can Artificial Intelligence (AI) translate Arabic abu-brand names with different prompts. *Journal of Computer Science and Technology Studies*, 7(9), 768-779. Google Scholar

[9] Al-Jarf, R. (2025e). Can students learning Arabic as a foreign language use Arabic YouTube videos narrated by Artificial Intelligence (AI) for listening practice. 2nd International Forum on Teaching Arabic in the Modern World: Traditions and Innovations. Sheikha Fatima bint

Mubarak Center for Education. Primakov International School Moscow, Russia.November 15–16, 2025. https://www.researchgate.net/publication/398106697. Google Scholar

[10] Al-Jarf, R. (2025f). Copilot vs DeepSeek's translation of denotative and metonymic abu- and umm- animal and plant folk names in Arabic. *Journal of Computer Science and Technology Studies*, 7(10), 367-385. Google Scholar

[11] Al-Jarf, R. (2025g). DeepSeek, Google translate and Copilot's translation of Arabic grammatical terms used metaphorically. *Journal of Computer Science and Technology Studies*, 7(3), 46-57. Google Scholar

[12] Al-Jarf, R. (2025h). Pronunciation errors in Arabic YouTube Videos Narrated by AI. *Frontiers in Computer Science and Artificial Intelligence*, *4*(2), 01-12. https://doi.org/10.32996/fcsai.2025.2.2.1. Google Scholar

[13] Al-Jarf, R. (2025i). Pronunciation errors in AI-narrated Arabic YouTube videos. LICCS Online Conference on Teaching and Research in Language and Culture: Past, Present and AI. Babeș-Bolyai University, Cluj-Napoca, Romania. September 11-12, 2025. Google Scholar

[14] Al-Jarf, R. (2025j). To publish or not to publish AI-generated research articles in scholarly journals: A perspective from editors and publishers. 2nd I2COMSAPP International Conference on Artificial Intelligence and its Practical Applications in the Age of Digital Transformation. Faculty of Sciences and Techniques. Nouakchott University, Nouakchott, Mauritania. October 22-24, 2025. Google Scholar

[15] Al-Jarf, R. (2025k). Translation of Arabic expressions of impossibility by AI and student-translators: A comparative study. *Journal of Computer Science and Technology Studies*, 7(8), 288-299. Google Scholar

[16] Al-Jarf, R. (2025l). Translation of Arabic folk medical terms with om and abu by AI: A comparison of Microsoft Copilot and DeepSeek. *Journal of Medical and Health Studies*, 6(4), 45-58. Google Scholar

[17] Al-Jarf, R. (2025m). Translation of English and Arabic "sleep" terms and formulaic expressions by Artificial Intelligence: A comparison of Copilot and DeepSeek. *International Journal of Linguistics, Literature and Translation*, 8(11), 95-108. Google Scholar

[18] Al-Jarf, R. (2025n). Translation of zero-expressions by Microsoft Copilot and Google Translate. *Journal of Computer Science and Technology Studies*, 7(2), 203-216. Google Scholar

[19] Al-Jarf, R. (2024a). Expressions of impossibility in Arabic and English: unveiling students' translation difficulties. *International Journal of Linguistics, Literature and Translation*, 7(5), 68-76. Google Scholar

[20] Al-Jarf, R. (2024b). Students' assignments and research papers generated by AI: Arab instructors' views. *Journal of Computer Science and Technology Studies*, 6(2), 92-98. Google Scholar

[21] Al-Jarf, R. (2024c). Translation of medical terms by AI: A comparative linguistic study of Microsoft Copilot and Google Translate. *I2COMSAPP'2024 Conference*, Nouakchott, Mauritania. Google Scholar

[22] Al-Jarf, R. (2023a). Equivalence problems in translating ibn (son) and bint (daughter) fixed expressions to Arabic and English. *International Journal of Translation and Interpretation Studies*, 3(2), 1-15. Google Scholar

[23] Al-Jarf, R. (2023b). Numeral-based English and Arabic Formulaic Expressions: Cultural, Linguistic and Translation Issues. *British Journal of Applied Linguistics*, 3(1), 25-34. Google Scholar

[24] Al-Jarf, R. (2023c). Time metaphors in English and Arabic: Translation challenges. *International Journal of Translation and Interpretation Studies*, 3(4), 68-81. Google Scholar

[25] Al-Jarf, R. (2022a). Arabic and English dar (house) and bayt (home) expressions: Linguistic, translation and cultural issues. *Journal of Pragmatics and Discourse Analysis*, 1(1), 1-13. Google Scholar

[26] Al-Jarf, R. (2022b). Challenges that undergraduate student translators face in translating polysemes from English to Arabic and Arabic to English. *International Journal of Linguistics, Literature and Translation*, 5(7), 84-97. Google Scholar

[27] Al-Jarf, R. (2022c). Issues in translating English and Arabic common names of chemical compounds by student-translators in Saudi Arabia. In Kate Isaeva (Ed.), *Special Knowledge Mediation: Ontological & Metaphorical Modelling.* Springer. Google Scholar

[28] Al-Jarf, R. (2022d). Undergraduate student-translators' difficulties in translating English word + preposition collocations to Arabic. *International Journal of Linguistics Studies*, *2*(2), 60-75. Google Scholar

[29] Al-Jarf, R. (2021). An Investigation of Google's English-Arabic translation of technical terms. *Eurasian Arabic Studies*, 14, 16-37. Google Scholar

[30] Al-Jarf, R. (2019). Translation students' difficulties with English and Arabic color-based metaphorical expressions. *Fachsprache*, 41 (Sp. Issue), 101-118. Google Scholar

[31] Al-Jarf, R. (2017). Issues in translating Arabic om- and abu-expressions. *ALATOO Academic Studies*, 3, 278-282. Google Scholar

[32] Al-Jarf, R. (2016a). Issues in translating English technical terms to Arabic by Google Translate. *TICET 2016 Conference*, Khartoum, Sudan. Google Scholar

[33] Al-Jarf, R. (2016b). Translation of English and Arabic binomials by advanced and novice student translators. In Larisa Ilynska & Marina Platonova (Eds.), *Meaning in Translation: Illusion of Precision.* Cambridge Scholars Publishing. Google Scholar

[34] Al-Jarf, R. (2010). Translation students' difficulties with English neologisms. *Analele Universităţii "Dunărea De Jos" Din Galaţi*, Fascicula XXIV, III(2), 431-437. Google Scholar

[35] Al-Jarf, R. (2009). Word+particle collocation errors in English-Arabic translation. *40 Years of Particle Research*, Bern, Switzerland. Google Scholar

[36] Al-Kharabsheh, A. (2003). *The translation of different types of technico-scientific compounds from English into Arabic.* Ph.D. Thesis. University of Salford, UK.

[37] Alhihi, Nidal. 2015. Lexical problems in English to Arabic translation: A Critical analysis of health documents in Australia. *Arab World English Journal* 6, 2: 316 –328.

[38] Al-Maktary, M., Mohammed, Z., Hassan, A., Almoughles, A., & Almekdad, A. (2025). Human Versus Artificial Intelligence (AI): Challenges in the Legal Translation of English to Arabic Terminology at Yemeni Universities, Taiz. *Saeed University Journal of Humanities, 8*(1), 177-212.

[39] Alowedi, N. & Al Ahdal, A. (2023). Artificial Intelligence based Arabic-to-English machine versus human translation of poetry: An analytical study of outcomes. *Journal of Namibian Studies*, *34*.

[40] Alqahtani, D. (2024). Transcending ambiguities: Enhancing AI-driven Arabic to English translations with human expertise. *Journal of Languages and Translation*, *11*(3), 59-81.

[41] Altakhaineh, A., Alghathian, G. & Jarrah, M. (2025). A comparative study of accuracy in human vs. AI translation of legal documents into Arabic. *International Journal of Language & Law (JLL)*, *14*, 63-80.

[42] Al-Wasy, B. & Mohammed, O. (2024). Strategies of translating euphemistic expressions from Arabic into English: A comparative study of artificial intelligence models with human translation. *Journal of Educational Sciences and Humanities, 40*, 826-855.

[43] Amr, F. M. (2025). A study of the English translation of Arabic Sharia terms in legislative documents: Human versus Artificial. *Bulletin of The Faculty of Languages & Translation*, *28*(2), 31-58.

[44] Ashqar, Amani. 2013. *The problem of equivalence: The translation into Arabic of specialized technological texts.* M.A. Thesis. An-Najah National University.

[45] El-Naby, H., & Aly, E. (2025). Functionalism and accuracy in human translation vs. AI translation of Arabic podcast transcript: A contrastive study. *Transcultural Journal of Humanities and Social Sciences*, *6*(2), 145-164.

[46] El-Saadany, M. (2024). A comparative study between Chat GPT and human translation in translating English proverbs into Arabic. *Journal of Scientific Research in Arts*, *25*(5), 24-54.

[47] Ennouari, A., & Houssaini, K. (2024). Translating cultural-loaded content from Arabic to English: Striking the balance between machine translation and human expertise. *International Journal for Multidisciplinary Research, 6*(6), 1-28.

[48] Fakhrabadi, F. & Sharifabad, E. (2023). Assessing the quality of hidden proverbs translation in the Holy Qur'ān: Human vs. Artificial Intelligence English Translations. Intern*ational Journal of Textual and Translation Analysis in Islamic Studies, 1*(4), 351-367. doi: 10.22081/ttais.2024.69975.1036

[49] Farghal, M. & Haider, A. (2024). Translating classical Arabic verse: Human translation vs. AI large language models (Gemini and ChatGPT). *Cogent Social Sciences*, *10*(1), 2410998.

[50] Haider, A. & Alkhatib, R. (2024). Subtitling English legal acronyms into Arabic: Human vs machine. *Kutafin Law Review*, *11*(4), 810.

[51] Hassan, B. (2017a). Translating scientific terminology: Examples from the Arabic versions of two international magazines. *Mediterranean Journal of Social Sciences* 8, 2: 183-193.

[52] Hassan, S. (2017b). Translating technical terms into Arabic: Microsoft terminology collection (English Arabic) as an example. *The International Journal for Translation & Interpreting Research* 9, 2: 67-86.

[53] Huang, J. (2013). *Terminology issues unique to medical translation*. https://termcoord. wordpress. com/2013/06/11/terminology-issues-unique-to-medical-translation/

[54] Ibrahim, S. N. (2025). On assessing the accuracy of Arabic-English translation by machine and human. In *Role of AI in Translation and Interpretation* (pp. 119-146). IGI Global Scientific Publishing.

[55] Ichien, N., Stamenković, D., & Holyoak, K. (2024). *Interpretation of novel literary metaphors by humans and GPT-4.* In L. K. Samuelson, S. Frank, M. Toneva, A. Mackey, & E. Hazeltine (Eds.), 46th Annual Meeting of the Cognitive Science Society. Cognitive Science Society.

[56] Mai, Luu H., Ngoc, L. & Tuan, L. (2014). Translating scientific terms. *Journal of Language Teaching and Research* 5, 3: 572-580.

[57] Moneus, A. & Sahari, Y. (2024). Artificial intelligence and human translation: A contrastive study based on legal texts. *Heliyon*, *10*(6).

[58] Muftah, M. (2024). Machine vs human translation: a new reality or a threat to professional Arabic–English translators. *PSU Research Review*, *8*(2), 484-497.

[59] Namdari, Rasool and Shahrokhi, Mohsen (2015). Differences in translation by translation specialized and non-specialized students in terms of accuracy of pragmatic equivalence and lexico-syntactic properties. *International Journal of English Language and Translation Studies* 3, 2: 67-73.

[60] Sadiq, S. (2025). Evaluating English-Arabic translation: Human translators vs. Google Translate and ChatGPT. *Journal of Languages and Translation*, *12*(1), 67-95.

[61] Yacine, A. (2024). *Exploring the comparative efficacy of human translators and artificial intelligence in translation processes Arabic-English English-Arabic*. Doctoral dissertation. Cadi Ayyad University.

[62] Zayed, M., & Nuirat, W. (2024). Human touch in AI translation: Strategies employed by professional translators in post-editing Arabic-English AI generated translations of media texts.

[63] Zibin, A., Binhaidara, N., Al-Shahwan, H., & Yousef, H. (2025). Metaphor interpretation in Jordanian Arabic, Emirati Arabic and Classical Arabic: artificial intelligence vs. humans. *Humanities and Social Sciences Communications*, *12*(1), 1-12.