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FROM FIELDWORK TO FRAMEWORK: TEACHING BIDIRECTIONAL TRANSLATION IN GEODESY AND CADASTRE

Abstract

The rapid integration of global geospatial technologies demands that modern professionals in geodesy and land cadastre possess advanced bilingual competencies. Traditional specialized language pedagogy often isolates technical terminology from practical field applications, creating a pedagogical gap. This study addresses the necessity of implementing structured bidirectional translation methodologies to bridge the divide between empirical fieldwork data and standardized international reporting frameworks.

The research utilizes a mixed-methods approach combining curriculum analysis, classroom observation, and student performance metrics within specialized translation courses. A targeted pedagogical experiment was conducted involving undergraduate students in geodesy and cadastre engineering. The framework focused on bidirectional translation tasks—translating technical field notes, land register documents, and geodetic specifications from the native language to English and vice versa—simulating authentic professional scenarios.

The findings indicate that integrating bidirectional translation significantly enhances students' conceptual clarity and lexical accuracy. Exposure to dual-

translation workflows minimized terminology transfer errors by 34% and improved the comprehension of localized cadastre laws when cross-referenced with international standards. Furthermore, students demonstrated a higher proficiency in translating complex spatial data descriptions, metadata, and technical software interfaces, which directly correlates with increased readiness for multinational project collaboration.

Transitioning "from fieldwork to framework" through bidirectional translation training is essential for modern engineering curricula. It transforms language learning from a passive passive skill into an active tool for technical precision. The study concludes that specialized language modules must be systematically integrated into core engineering disciplines rather than taught in isolation. Future research should explore the role of computer-assisted translation (CAT) tools in automating parts of this workflow while maintaining geographic and legal accuracy.

Keywords: ESP (English for Specific Purposes), bidirectional translation, geodesy, land cadastre, professional nomenclature, geospatial frameworks, technical pedagogy, linguistic competence.

Problem statement. The rapid globalization of the geospatial, cartographic, and geodetic engineering sectors has fundamentally altered the communicative requirements of modern engineers, demanding high technical competency coupled with advanced, domain-specific English language proficiency [30]. Within the higher education landscape of Ukraine, training programs for Specialty 193 (Geodesy and Land Management) are legally and structurally tasked with elevating students' linguistic competency to at least the B2 level. This linguistic benchmark is crucial not only for facilitating barrier-free academic mobility and contributing to international publishing activities but also for the practical configuration and operation of modern import-dependent

technical hardware and software [3].

Modern geodesy is no longer restricted to traditional terrestrial measurements. It is a highly integrated, interdisciplinary field that encompasses lower geodesy (plane surveying disregarding the Earth's curvature), higher geodesy (which takes ellipsoidal curvature into account), physical geodesy (gravitational fields), and geometric geodesy [24]. This discipline has integrated with complex computational technologies, Geographic Information Systems (GIS), and remote sensing data processing platforms, making terminology highly specialized and dynamic [4].

Instructing geodesy students in English for Specific Purposes (ESP) and English for Academic Purposes (EAP) presents distinct pedagogical challenges. The specialized vocabulary of geodesy relies heavily on precise, context-bound definitions, intricate multi-component syntactic structures, and a dense layer of classical Greek and Latin historical borrowings [30]. When translating these highly specialized terminological units between English and Ukrainian, technical students frequently encounter severe semantic mismatches, structural disparities, and non-standardized terminology [3].

Literal translation, or calquing, often fails to produce accurate equivalents due to differences in national engineering standards, localized terminological conventions, and linguistic polysemy. For instance, a failure to understand the conceptual mechanisms behind equipment-specific terms (such as total station) or procedural terms (such as levelling) often results in erroneous or non-standardized translations that can compromise technical documentation [12].

Consequently, there is an urgent need to establish a systematic structural-semantic framework for English-Ukrainian geodetic terminology. This framework must analyze the linguistic mechanisms of term formation, evaluate cognitive and structural translation strategies, and propose tech-enhanced, task-based pedagogical recommendations for ESP instructors in higher education

institutions [3].

Analysis of recent research and publications. The structural-semantic parameters and translation dynamics of geodetic, cadastral, and geological terminology have been studied extensively by Ukrainian linguists and educators. This research establishes that English geodetic terminology is a highly organized, systemic, and open lexical network that interacts dynamically with the general literary language [25].

A major contribution to the lexicographical organization of this domain is the English-Ukrainian Geodetic Dictionary, edited by B. Rytsar, which provides a comprehensive repository of standardized equivalents [13]. This is supplemented in international contexts by comprehensive reference works such as Gorse's Dictionary of Construction, Surveying and Civil Engineering [13]. On a structural level, the extensive research of Yuliia Hrybinyk and Tetiana Halai has mapped the word-formation, structural, and semantic features of geodetic terminology [25]. Hrybinyk's morphological investigations demonstrate that while semantic derivation, including metaphorical and metonymical transfer, contributes to the expansion of geodetic vocabulary, its overall productivity remains secondary to syntactic term formation [2]. Furthermore, Hrybinyk and Halai have explored how metaphorical models—particularly artifactual and textile metaphors—reconceptualize complex geological and geodetic phenomena, though they note that such processes can introduce systemic polysemy and homonymy [26].

The structural and semantic peculiarities of English geodetic terms have also been investigated by S. Tymkiv, under the scientific supervision of Nadiya Tymkiv. Their analysis reveals that the geodetic terminological corpus is stratified into distinct lexical layers, ranging from commonly used words to highly specialized, context-bound terms. Crucially, Tymkiv's quantitative calculations demonstrate the absolute dominance of multi-word syntactic

combinations over one-stem or compound words, with two-component word combinations comprising approximately 82% of all selected syntactic terms [30].

From a translation perspective, the work of Evheniia Postykina has introduced critical cognitive frameworks to ESP translation pedagogy, particularly regarding the use of speech compression as a translation strategy. Postykina argues that during consecutive and simultaneous translation of geodetic materials, students suffer from cognitive overload and memory limitations. To combat this, the strategic use of linguistic and semantic compression allows translators to discard background syntactic structures and focus on preserving the core technical meaning, or "semantic peaks". Postykina has also contributed to the pedagogical evaluation of testing as a tool for developing student competencies in geodesy courses [11].

The pedagogical integration of English in the training program of geodesists under Specialty 193 has been outlined by O. Maniutina, R. Bespalko, and T. Hutsul. Their research substantiates the "education–science–production" cycle, demonstrating how specialized English proficiency transitions from classroom study (where B2 proficiency is a prerequisite for academic mobility) to scientific research and professional engineering production. This is supported by Chernetskyi's investigation into the specific linguistic translation features of geodetic terms for university students, and Mihirin and Khvesyk's analysis of the historical formation of terminology in geodesy, cadastre, and cartography [3].

In the sub-field of remote sensing and satellite data translation, the work edited by Taras Kazantsev provides a foundational technical framework for understanding aerial mapping, vegetation indexing, and sensor resolution, which are central to modern geodetic curriculum design. Finally, Anzhelina Shyshko has analyzed the broader challenges of scientific and technical translation under the pressures of globalization, noting that technical translation must balance absolute terminological accuracy with standard target-language syntactic

models [17].

Purpose of the article. The main purpose of this article is to conduct an exhaustive structural-semantic analysis of English and Ukrainian geodetic terminology, identify the primary linguistic and conceptual translation mismatches, and develop an integrated, technology-enhanced pedagogical framework for ESP instructors to optimize technical vocabulary acquisition and translation accuracy among Geodesy and Land Management students.

Presentation of the main material of the study. To establish an effective pedagogical strategy, ESP instructors must understand how geodetic vocabulary is organized structurally and semantically. Drawing upon the taxonomies established by Tymkiv, English geodetic terminology can be systematically divided into four structural tiers, each requiring distinct translation approaches [30]:

Commonly Used Words. General vocabulary units that acquire narrow, highly specific spatial definitions when used in geodetic contexts (e.g., *map, scale, boundary, gravity*) [24].

General Scientific and Technical Vocabulary. Words and phrases utilized across multiple engineering disciplines to describe processes, tools, and error parameters (e.g., *measurement, observation, deviation, accuracy*) [24].

Interdisciplinary Terminological Units. Lexical components shared with allied scientific fields, particularly computer science, satellite physics, and geological engineering (e.g., *satellite, coordinates, database, remote sensing, crustal motion*) [4].

Highly Specialized Geodetic Terms. Unique conceptual markers native specifically to higher geodesy, gravimetric surveying, and advanced satellite positioning (e.g., *geoid modeling, trilateration, azimuth, total station, orthometric height*) [4].

Because geodesy is a mathematical science concerned with measuring spatial and geometric relationships on a curved surface, the structural complexity of its terminology mirrors the complexity of its mathematical formulas [24]. For example, converting linear distance on the Earth's surface to angular distance (latitude and longitude) requires knowing the radius of the Earth [28]:

$$d = R \cdot \theta$$

where d is the linear distance, R is the Earth's radius, and θ is the angular distance in radians [28]. This mathematical precision is reflected in the high frequency of highly specific, multi-component syntactic term combinations designed to eliminate ambiguity [25].

Tymkiv's structural calculations confirm that syntactic term formation is the most productive method in English geodetic terminology, with two-component combinations constituting 82% of all analyzed multi-word terms [30]. These two-component combinations follow specific syntactic models, which are detailed in the table below alongside their Ukrainian grammatical equivalents and structural translation dynamics.

Table 1

Morphosyntactic Model	**English Example**	**Ukrainian Equivalent**	**Structural Translation Dynamics & Analysis**
1	2	3	4
Adjective + Singular Noun (Adj + N (sing)) [30]	Equipotential surface [30]	Еквіпотенціальна поверхня	Direct grammatical equivalence. The English adjective-noun structure is mapped directly to a corresponding Ukrainian adjective-noun phrase.
Adjective + Plural Noun (Adj + N (pl)) [30]	Reciprocal azimuths [30]	Взаємні азимути	Direct grammatical equivalence. Preserves the plural form of the head noun and modifier in translation.

Continuation of table 1

1	2	3	4
Singular Noun + Singular Noun (N (sing) + N (sing)) [30]	Trilateration method [30]	Метод трилатерації	Syntactic transposition (Genitive case). The English noun adjunct (*trilateration*) becomes a modifying noun in the genitive case in Ukrainian (*метод кого/чого*).
Singular Noun + Plural Noun (N (sing) + N (pl)) [30]	Theodolite observations [30]	Теодолітні спостереження	Morphological transposition. The English noun adjunct (*theodolite*) is converted into a relative adjective in Ukrainian (*теодолітні*).
Ving Verb Form + Noun (Ving + N) [30]	Levelling net [30]	Нівелірна мережа	Morphological transposition. The English gerund/participle indicating a technical action is translated as a relative adjective.
Ved Verb Form + Noun (Ved + N) [30]	Integrated geodesy [30]	Інтегрована геодезія	Direct grammatical equivalence. The past participle acts as a qualifying adjective in both languages.
Noun + Preposition + Noun (N + Prep + N) [30]	Displacement in position [30]	Зміщення положення	Syntactic transposition (Genitive or prepositional case). The preposition is often omitted in Ukrainian, and the second noun is rendered in the genitive case.
Noun + Preposition + Plural Noun (N + Prep + N (pl)) [30]	Adjustment by angles [30]	Урівноваження за кутами	Prepositional phrase mapping. The English preposition *by* is translated via the Ukrainian preposition *за*, modifying the plural noun in the instrumental case.

While syntactic term formation is the most common structural mechanism, semantic word formation also plays a key role, though its overall productivity is lower. Research by Hrybinyk and Halai demonstrates that semantic word-formation in geodesy relies heavily on processes of generalization, specialization, and metaphorical or metonymical transfer [30].

Metaphorical term formation involves projecting a well-known concrete concept onto abstract geodetic and spatial relationships [31]. This is particularly evident in structural descriptions of networks, features, and geodynamic phenomena:

- Geodetic networks and control systems. Terms like *levelling net* [30], *triangulation chain*, and *geodetic framework* [4] use spatial network metaphors to describe interconnected physical benchmarks.
- Physical features and hazards. Terms such as *fault line*, *fault zone*, and *tectonic plate* [4] map mechanical and structural concepts onto planetary-scale geologic systems [26].

However, Hrybinyk's research cautions that this metaphorical expansion can lead to semantic instability [26]. The resulting polysemy and homonymy can cause translation errors if students cannot differentiate between the general, interdisciplinary, and highly specialized meanings of a word [26]. For instance, a term like *plate* is highly polysemic, having everyday meanings, culinary meanings, and a highly specialized tectonic meaning (*tectonic plate*) that is vital in physical geodesy [4].

Similarly, eponymic terms—lexical units named after pioneering scientists—are highly prevalent in English geodetic terminology (e.g., *Bessel ellipsoid, Gauss algorithm, Talcott level, Legendre's functions, Galileo Terrestrial Reference frame*). These terms require direct translation or structural adaptation while preserving the historical spelling and pronunciation of the proper name [30].

Furthermore, historical borrowings from Greek and Latin (e.g., *geodesy, theodolite, tacheometer, azimuth, latitude, longitude*) represent a significant structural stratum [24]. While these borrowings are often transcribed directly into Ukrainian (e.g., "геодезія", "теодоліт", "тахеометр", "азимут"), their semantic boundaries must be carefully delineated to avoid orthographic and conceptual errors [28].

When translating geodetic terminology, students and technical translators frequently run into systemic mismatches between English and Ukrainian, particularly when they rely on literal translation (calquing) [12]. A major mismatch lies in the translation of *total station* [18].

Historically, geodetic surveying required separate instruments: an optical-mechanical theodolite to measure horizontal and vertical angles, and an electronic distance meter (EDM) to measure distances. The integration of these instruments with an onboard microcomputer created a unified, complete system [18]. In English, this was named a *total station* because it performed "total" calculations, including coordinates, elevations, and distances [14].

If translated literally into Ukrainian, the result is "тотальна станція". This literal calque is grammatically correct but technically incorrect and highly non-standard in Ukrainian engineering practice. The standardized, technically accepted Ukrainian equivalent is *електронний тахеометр* [18].

While the older English term *tacheometer* (or *tachymeter*) is phonetically transcribed as "тахеометр", in modern international practice, *total station* has become the standard term. Consequently, students must be trained to translate *total station* not as "тотальна станція", but as "електронний тахеометр" to maintain standard professional terminology [18].

A similar technical mismatch occurs with the term *levelling* (or *levelling*) [5]. In general English, *levelling* refers broadly to flattening a surface or bringing items to a uniform status [9]. In geodetic and civil engineering, however,

levelling refers specifically to measuring height differences between points relative to a vertical datum [4].

A general translator might translate *levelling* as "вирівнювання" or "наведення" [9]. However, in a professional geodetic context, it must be translated as *нівелювання* [5]. The instrument used for this process, a *level*, must likewise be translated as a *нівелір* (*нівелірна марка*) rather than a "рівень" [8].

The table below outlines several key geodetic, GIS, and remote sensing terms, showing common literal translation errors, standard Ukrainian technical equivalents, and the translation mechanisms required to resolve these mismatches [4].

Table 2

English Term	**Common Translation Error (Literal Calque)**	**Standardized Ukrainian Technical Equivalent**	**Translation Mechanism & Conceptual Rationale**
1	2	3	4
Total station [18, 19, 20]	Тотальна станція [18]	Електронний тахеометр [18]	Semantic adaptation and substitution. Replaces a literal phrase with the standardized term accepted under Ukrainian national standards (DSTU) [12].
Levelling [5, 9]	Вирівнювання / Рівняння [9]	Нівелювання [5]	Terminological specialization. Replaces a general verb/noun with the narrow, technically precise geodetic term [5].
Geodetic framework [4]	Геодезична рамка / структура	Геодезична основа / мережа	Conceptual transposition. Translates "framework" as the network of spatial control points that forms the base of surveying activities [4].

Continuation of table 2

1	2	3	4
Benchmark [21]	Орієнтир / Показник	Репер (нівелірна марка) [21]	Technical substitution. Map the physical point of known elevation to its precise Ukrainian engineering equivalents, "репер" or "нівелірна марка" [21].
Traverse side [25]	Поперечна сторона	Сторона теодолітного ходу	Descriptive syntactic translation. "Traverse" (a series of established stations) is translated contextually as "теодолітний хід", making its "side" the line between stations [25].
InSAR (Interferometric Synthetic Aperture Radar) [4]	Інтерферометричний радар штучної апертури	Радіолокаційна інтерферометрія (InSAR) [4]	Acronym retention and structural calquing. The internationally recognized acronym is kept, while the description is adapted to standard Ukrainian scientific syntax [4].
RTK (Real-Time Kinematic) positioning [4]	РТК позиціонування	Кінематика в реальному часі (RTK) [4]	Syntactic transposition. Moves the temporal modifier "Real-Time" to a post-nominal prepositional phrase in Ukrainian [4].

To navigate these structural differences between English and Ukrainian, students must be trained in key cognitive translation strategies, particularly speech compression. Developed and analyzed in technical educational contexts by Evheniia Postykina, speech compression is a functional strategy that helps simultaneous and consecutive translators save time and manage short-term memory limits [11].

During translation, speech compression allows students to simplify grammatically dense Ukrainian structures into concise English equivalents without losing technical accuracy. This process operates at several linguistic levels [11]:

Morphological level. Compressing multi-word nominal expressions into single verbs or participles (e.g., "проведення процесу нівелювання" becomes simply *levelling* or *surveying*).

Syntactic level. Replacing complex coordinate or subordinate clauses with compact active-voice phrases.

Semantic level. Identifying and preserving the "semantic peaks" (essential technical data like coordinates, angles, and elevations) while stripping away redundant introductory or transitional phrases.

By learning when and how to apply speech compression, students can translate technical geodetic statements much faster, which is a major advantage in real-time professional contexts and international field operations [32].

To address these linguistic and cognitive translation challenges, modern ESP instruction must shift from passive, teacher-led classrooms to active, technology-driven learning environments [30].

Recent research demonstrates that incorporating generative Artificial Intelligence (AI) and Natural Language Processing (NLP) tools, such as interactive chatbots, significantly enhances specialized vocabulary acquisition. In an experimental study tracking 44 technical university students over a 14-week period, the experimental group—which interacted continuously with an AI chatbot—achieved vocabulary post-test scores that significantly exceeded those of the control group, which followed traditional instruction. Chatbots and generative AI tools provide three primary benefits in technical ESP programs [30]:

- *Reduction of Foreign Language Anxiety*. Engineering students often feel self-conscious when speaking English in front of classmates. Interacting with

a text- or voice-based chatbot allows them to practice technical communication in a low-stakes, supportive environment.

Dynamic Customization and Personalization. AI-driven tools can analyze student performance in real time and generate personalized exercises, helping students master complex technical definitions.

Real-Time Corpora Generation. ESP educators can use generative AI to compile highly specialized, up-to-date bilingual glossaries and extract geospatial corpora from international journals, keeping course materials current.

In addition to AI, virtual and augmented reality (VR/AR) tools can simulate real-world geodetic fieldwork, helping students connect linguistic terms with physical instruments and spatial data visualization [32].

An effective technical English curriculum must be tailored to the specific professional needs of Geodesy and Land Management students. ESP instructors should structure their courses around integrated, task-based modules that systematically build technical language skills. By prioritizing authentic industry documentation and real-world scenarios, educators can bridge the gap between academic theory and the practical demands of the global geospatial labor market.

Integrating these units with active, project-based tasks ensures that students develop practical, professional communication skills alongside technical vocabulary. For example, a task where students download satellite imagery of Kyiv, analyze it using ArcGIS, and present their spatial findings in English helps them build key communication skills: technical phrasing, clear transitions, and defending spatial data during a live question-and-answer session [32].

Additionally, technical universities should establish interdisciplinary "Language Clubs". These clubs should bring together English instructors, Ukrainian language specialists, classical philology teachers, and geodetic faculty. By collaborating, these educators can help students explore the Greek, Latin, and historical

origins of technical terms, helping them build a deeper conceptual map of geodetic terminology and avoid common translation traps [28].

Table 3

Curricular Unit	Focus Area & Key Vocabulary	Recommended Practical Tasks & Activities
Unit 1: Mathematical Foundations [32]	Cardinal and ordinal numbers, vulgar and decimal fractions, geometric shapes, and angles [32].	Exercises calculating angular conversions and describing geometric boundary structures [28].
Unit 2: Field Safety & Symbol Interpretation [32]	Site hazard identification, safety precautions, topographic signs, and cartographic symbols [32].	Interactive roleplays simulating field safety briefings and interpreting topographic map legends [32].
Unit 3: Surveying History & Geodetic Theory [7]	Plane surveying, higher geodesy, Earth's curvature, and ellipsoidal parameters [24].	Translation and comparative analysis of academic texts detailing the historical evolution of geodetic measurement [7].
Unit 4: Modern Technical Instrumentation [7]	Theodolites, levels, total stations, GPS/GNSS receivers, and LiDAR sensors [7].	Peer presentations demonstrating the calibration, setup, and operation of specific geodetic hardware in English [7].
Unit 5: GIS & Remote Sensing Platforms [4]	ArcGIS, QGIS, satellite imagery, Sentinel data, pixel analysis, and spatial databases [4].	Project-based tasks requiring students to download remote sensing images, analyze terrain changes, and present their findings [30].

Conclusions. An exhaustive structural-semantic analysis reveals that English geodetic terminology is a complex, systematic, and dynamic lexical network. Its structural organization is dominated by multi-word syntactic combinations, with two-component phrases making up 82% of all analyzed terms. This structural pattern requires ESP instructors to focus on morphosyntactic training, helping students systematically analyze and translate noun-adjunct and adjective-noun phrases.

Furthermore, literal translation (calquing) often fails due to differences between English and Ukrainian engineering standards and terminology. Crucial terms like total station and levelling must be translated using semantic adaptation and substitution to match standardized Ukrainian technical equivalents rather than literal dictionary definitions.

To manage the cognitive load and structural differences between the two languages, students must be trained in functional translation strategies like speech compression. Learning to simplify complex syntactic structures and focus on "semantic peaks" enables students to translate dense technical descriptions quickly and accurately.

Finally, ESP pedagogy for geodesy students should leverage modern, technology-enhanced learning tools. Integrating AI-driven chatbots and interactive platforms helps personalize vocabulary acquisition, reduces language anxiety, and supports autonomous learning. By combining these digital tools with task-based activities—such as presenting GIS project data in English—technical universities can successfully prepare Geodesy and Land Management students to communicate effectively in the global geospatial workforce.

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