CHAPTER 44

PROFESSIONAL LANGUAGE TRAINING OF NATURAL SCIENCES STUDENTS: ESP AND ENGLISH-MEDIUM INSTRUCTION MODELS

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INTRODUCTION

Teaching a foreign language for professional purposes to students of natural sciences specialties remains a subject of ongoing attention among researchers in many countries. Every state develops its own approach to the language training of future specialists in higher education, and Ukraine is actively joining this process amid European integration and the globalisation of the scientific space. English plays a key role in the professional training of future natural scientists, since it is the language of international scientific communication, the exchange of research results, and participation in transnational environmental and biological initiatives.

The language training of natural sciences students, however, cannot be reduced to a single, unified course: the practice of higher education institutions shows that different programmes address this task through different methodological models. In many cases, language training is delivered through a dedicated professional-language course that is deliberately synchronised with a professionally oriented content course, so that the two reinforce one another. In other cases, individual content disciplines are taught directly in English, following an EMI (English as a Medium of Instruction) model, in which the foreign language becomes the medium rather than the object of instruction – a well-known example being a science-communication-type course aimed at teaching students to present research to non-specialist audiences.

Current global challenges – climate change, biodiversity loss, environmental pollution, and the need to transition to a circular economy – require natural scientists to be able to communicate professionally in English at a level sufficient for participation in international research consortia, grant programmes (Horizon Europe, the LIFE Programme), and conservation or research projects more broadly. According to bibliometric estimates, the overwhelming majority

of publications in the natural sciences are indexed in English, which confirms its dominant role in scientific discourse[1].

Analysis of recent research and publications. The issue of teaching English for professional purposes is actively studied in the works of both Ukrainian and international scholars. T. Dudley-Evans and M. J. St John define the key principles of teaching English for Specific Purposes (ESP)[2]. T. Hutchinson and A. Waters substantiate a learner-centred approach as the basis for effective teaching of professional English[3]. H. Basturkmen examines the variability of ESP courses depending on the disciplinary context[4]. K. Hyland analyses disciplinary discourses of academic writing[5], while J. Swales developed the theory of genre analysis of scientific texts[6]. V. Bhatia investigates the genre-specific features of written scientific discourse across different professional communities[7].

The issue of combining language and content learning is addressed by D. Coyle, P. Hood, and D. Marsh, who formulated the CLIL (Content and Language Integrated Learning) methodology as a model for the simultaneous acquisition of subject content and a foreign language[8]. J. Airey examines the linguistic attitudes of natural science lecturers in Sweden amid the transition to English-medium instruction (EMI) and identifies significant methodological and terminological challenges[9]. The issue of preparing researchers to communicate with non-specialist audiences is addressed by B. Trench, who proposes an analytical framework of science communication models[10], and by A. Baram-Tsabari and B. Lewenstein, who analyse the goals and content of science communication training programmes[11].

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[1] Basturkmen H. Ideas and Options in English for Specific Purposes. Mahwah, NJ : Lawrence Erlbaum Associates, 2006.

[2] Dudley-Evans T., St John M. J. Developments in English for Specific Purposes: A Multi-Disciplinary Approach. Cambridge : Cambridge University Press, 1998. 301 p.

[3] Hutchinson T., Waters A. English for Specific Purposes: A Learning-Centred Approach. Cambridge : Cambridge University Press, 1987. 183 p.

[4] Basturkmen H. Ideas and Options in English for Specific Purposes. Mahwah, NJ : Lawrence Erlbaum Associates, 2006.

[5] Hyland K. Disciplinary Discourses: Social Interactions in Academic Writing. Ann Arbor : University of Michigan Press, 2004. 190 p.

[6] Swales J. M. Genre Analysis: English in Academic and Research Settings. Cambridge : Cambridge University Press, 1990. 260 p.

[7] Bhatia V. K. Worlds of Written Discourse: A Genre-Based View. London : Continuum, 2004. 216 p.

[8] Coyle D., Hood P., Marsh D. CLIL: Content and Language Integrated Learning. Cambridge : Cambridge University Press, 2010. 173 p.

[9] Airey J. "I don't teach language". The linguistic attitudes of physics lecturers in Sweden. *AILA Review*. 2012. Vol. 25. P. 64–79.

[10] Trench B. Towards an analytical framework of science communication models. Communicating Science in Social Contexts / ed. by D. Cheng, M. Claessens, T. Gascoigne et al. Dordrecht : Springer, 2008. P. 119–135.

[11] Baram-Tsabari A., Lewenstein B. V. Science communication training: what are we trying to teach? *International Journal of Science Education*, Part B. 2017. Vol. 7, No. 3. P. 285–300.

Among Ukrainian studies, O. Tarnopolskyi discusses the methodology of teaching foreign language speech activity in higher education institutions[12]. O. Kovalenko analyses the problems of teaching English for professional purposes in non-linguistic higher education institutions[13]. N. Zinukova and T. Korzh study the specifics of teaching English for specific purposes in technical universities, which shares common features with the training of natural scientists[14]. Research into the motivation of non-language-major students was conducted by T. Nguyen and co-authors (on Vietnamese students)[15] and by P. Jang (on Chinese students)[16].

Despite the considerable body of work on general questions of teaching ESP to natural scientists, less attention has been paid to the different methodological models that higher education institutions actually use to deliver language training – namely, a dedicated professional language course run in parallel with subject-specific coursework, on the one hand, and English-medium instruction (EMI) in individual content disciplines, on the other. The choice between these approaches, and the reasons that make one or the other more appropriate for a given programme, remains insufficiently explored in the Ukrainian context.

The purpose of the article is to reveal the peculiarities of teaching a foreign language for professional purposes and English-medium instruction to natural sciences students in higher education institutions, to characterise two complementary methodological approaches – a professional-language course integrated with subject-specific coursework, and English-medium teaching of a dedicated content discipline – and to identify optimal methodological principles for forming the foreign-language professional communicative competence of natural sciences students in general.

The scientific novelty of this study lies, first, in proposing an explicit twofold typology of language-training delivery – Model A (a professional-language course integrated with subject-specific coursework) and Model B (English-medium instruction within a dedicated content course) – which existing ESP and CLIL/EMI scholarship tends to discuss separately rather than as alternative, comparable solutions to the same institutional problem; second, in formulating

[12] Тарнопольський О. Б. Методика навчання іншомовної мовленнєвої діяльності у вищому мовному закладі освіти. Київ : Ленвіт, 2019. 253 с.

[13] Болайто Р., Вест Р. Інтернаціоналізація українських університетів у розрізі англійської мови: Проєкт «Англійська мова для університетів». Київ : Видавництво Сталь, 2017. 154 с.

[14] Морська Л. Англійська мова для спеціальних цілей (ESP): історія виникнення підходу та його специфіка. *Науковий вісник Ужгородського національного університету. Серія : Педагогіка. Соціальна робота*. 2012. Вип. 25. С. 136–138.

[15] Nguyen, S. V., & Habók, A. Vietnamese non-English-major students' motivation to learn English: from activity theory perspective. *Heliyon*, 2021. 7(4), e06819.

[16] Jang P., Huang W., Shen H.-Z., Yang H., Gao C. Chinese university students' self-regulated strategic learning in English medium instruction from a sociocultural perspective. *Journal of English for Academic Purposes*. 2025. Vol. 75, 101510.

an explicit set of selection criteria that link each model to the professional profile of a programme rather than treating the choice as a matter of institutional habit or convenience; and third, in situating this typology within the specific regulatory and organisational conditions of Ukrainian higher education, an angle that is largely absent from the international EMI/CLIL literature reviewed below.

1. General theoretical foundations of teaching a foreign language for professional purposes to natural sciences students

The natural sciences encompass a broad range of specialties – biology, ecology, chemistry, geography, and their applied branches – and higher education institutions preparing specialists in these fields share a common need for a solid command of professional English. Regardless of the specific specialty, natural scientists must be able to read primary research literature, follow methodological protocols published internationally, take part in fieldwork and laboratory collaborations that increasingly cross national borders, and communicate the results of their work to both specialist and non-specialist audiences. It is this shared foundation that justifies treating the teaching of a foreign language for professional purposes across the natural sciences as a coherent methodological problem, even though, as the following sections demonstrate, its concrete implementation can be organised in more than one way, depending on the profile of a given programme and the resources available to it.

Today English is the lingua franca of world science: the overwhelming majority of scientific publications in the natural sciences use it. Proficiency in English opens up opportunities for full participation in global scientific discourse, access to the latest research, and the exchange of ideas with colleagues from different countries. H. Basturkmen identifies the main tasks of teaching English for professional purposes to natural sciences students[17]: cognitive tasks (engaging students in scientific activity through English-language sources), educational tasks (forming skills for working with scientific texts and data), developmental tasks (overcoming the psychological barrier and building confidence), practical tasks (communicative competencies for the scientific environment), and professional tasks (working with English-language literature, preparing publications, presenting results).

The development of natural sciences students' language competencies depends on compliance with fundamental didactic principles. The principle

[17] Basturkmen H. Ideas and Options in English for Specific Purposes. Mahwah, NJ : Lawrence Erlbaum Associates, 2006.

of scientific validity presupposes the use of authentic scientific texts and materials – articles from leading journals (Nature, Science, Cell, Ecology Letters, Conservation Biology), monographs by prominent scholars, and recordings of conference presentations[18]. The principle of interdisciplinary integration ensures an organic connection between language training and specialised knowledge of biology, ecology, biochemistry, and genetics; the language instructor cooperates with subject-discipline instructors, which allows curricula to be synchronised[19]. The principle of communicative orientation means focusing on real situations of scientific communication: presenting research results at a conference, discussing experimental data with colleagues, writing an article for an international journal, and participating in a grant competition[20].

Upon completing language training, students of natural sciences specialties acquire the following competencies: command of scientific communication skills in both oral and written English; the ability to communicate professionally with international colleagues; correct understanding and use of English-language scientific terminology; the ability to work with English-language publications and electronic databases (PubMed, Web of Science, Scopus); academic-writing skills (articles, conference abstracts, reports, grant applications); and the ability to present the results of one's own research in English. These competencies form a common core that underlies the professional language training of natural scientists in general, and they provide the baseline against which the two methodological models described below should be understood.

Nevertheless, the specific terminological content, communication formats, and implementation models of language training differ considerably depending on the profile of a given programme. A specialist working with spatial modelling data, one reading synthesis protocols, and one analysing environmental policy documents each rely on markedly different registers of scientific English, even though all are, in a broad sense, natural scientists. It is precisely this tension between a shared methodological core and field-specific communicative demands that motivates a closer look at two contrasting, complementary models – a professional-language course run in parallel with subject-specific coursework, and English-medium instruction merging language and content within a single course – discussed in detail in the following two sections.

[18] Swales J. M. Genre Analysis: English in Academic and Research Settings. Cambridge : Cambridge University Press, 1990. 260 p.

[19] Морська Л. Англійська мова для спеціальних цілей (ESP): історія виникнення підходу та його специфіка. *Науковий вісник Ужгородського національного університету. Серія : Педагогіка. Соціальна робота.* 2012. Вип. 25. С. 136–138.

[20] Канюк О. С. Особливості викладання англійської мови для студентів немовних спеціальностей. *Український педагогічний журнал*. 2020. № 2. С. 117–122.

2. Two methodological models for delivering professional language training

2.1. Model A: a professional foreign language course integrated with subject-specific coursework

In many natural sciences programmes, language training is delivered primarily through a dedicated professional foreign language course, the content of which differs substantially from a general ESP course owing to its field-specific terminological base. In applied, policy-facing fields, for example, students need to master vocabulary related to monitoring and data collecting (environmental monitoring, air/water quality assessment, biomonitoring, remote sensing), sustainability (sustainable development, ecological footprint, carbon neutrality), impact assessment (environmental impact assessment, strategic environmental assessment), regulation and compliance (environmental law, the EU Green Deal, the Natura 2000 network, environmental compliance), and resource management (waste management, circular economy, recycling, extended producer responsibility). Working with such texts requires the language instructor to be genuinely conversant with the subject matter and to cooperate closely with the relevant subject department[21].

A key feature of this model is the systematic integration of the professional-language course with a professionally oriented, innovation-focused content course. Such a course typically introduces students to state-of-the-art developments in the field – for example, green energy technologies, bioremediation techniques for pollution control, remote monitoring using unmanned aerial vehicles and satellite data, the application of artificial intelligence in modelling, and the principles of the circular economy. Since most cutting-edge publications and case studies in such fast-moving areas are available primarily in English, teaching this kind of innovation-oriented course objectively benefits from elements of Content and Language Integrated Learning (CLIL), whereby students acquire both subject content and language material simultaneously[22].

In practice, the integration of the two courses is achieved through coordinated, team-taught classes in which the language instructor and the subject instructor jointly develop teaching materials: English-language case studies on the adoption of new technologies, analysis of reports by relevant international organisations, and reading and summarising articles from leading field-specific journals. Considerable attention is given to building shared

[21] Airey J. “I don’t teach language”. The linguistic attitudes of physics lecturers in Sweden. *AILA Review*. 2012. Vol. 25. P. 64–79.

[22] Coyle D., Hood P., Marsh D. CLIL: Content and Language Integrated Learning. Cambridge : Cambridge University Press, 2010. 173 p.

terminological glossaries, preparing English-language presentations of student projects, and simulating the preparation of grant applications under programmes such as Horizon Europe or the LIFE Programme, which requires command of the specific genre of grant-writing English[23].

Assessment of students' language and subject competencies under this model involves complex forms of control: an oral presentation of a project in English, using appropriate terminology and visual materials (charts, maps, diagrams); a written policy brief or technical summary; the translation and summarising of fragments of relevant regulatory or technical documents; and participation in a simulated international conference. This approach allows students to improve their English simultaneously with deepening their professional knowledge, preparing them for real professional work within international organisations in their field.

It is worth noting that this model of parallel, closely coordinated language and subject teaching works particularly well in applied, policy-facing fields, where much of what practitioners must read and write – legislation, policy briefs, monitoring reports – constitutes a distinct genre in its own right, and where a ready-made, terminologically rich subject-matter partner course is available to work alongside the language course.

This model is not without its critics, however. Coordinated, team-taught delivery depends on sustained cooperation between two departments with different institutional priorities, workload models, and (often) different degrees of managerial support for joint planning; where such cooperation is not actively resourced, the promised synchronisation between the language course and its subject-matter partner tends to erode into two parallel but disconnected courses that merely happen to run in the same semester. J. Airey's own findings likewise caution that language instructors who are not themselves specialists in the subject can struggle to select genuinely representative disciplinary texts, which risks reducing the "integration" to a superficial recycling of vocabulary lists rather than a substantive alignment of tasks and genres[24]. Whether Model A delivers on its promise, in other words, depends less on the model itself than on the institutional conditions under which it is implemented.

2.2. Model B: English-medium instruction (EMI) in a dedicated content course

An alternative to Model A is not a separate language course at all, but the teaching of an individual subject discipline directly in English, following

[23] Coyle D., Hood P., Marsh D. CLIL: Content and Language Integrated Learning. Cambridge : Cambridge University Press, 2010. 173 p.

[24] Airey J. "I don't teach language". The linguistic attitudes of physics lecturers in Sweden. *AILA Review*. 2012. Vol. 25. P. 64–79.

an EMI (English as a Medium of Instruction) model. Within this model, the foreign language ceases to be an object of study and becomes an instrument for mastering disciplinary content, which places a dual task on the instructor – ensuring the acquisition of both the subject matter and the language means of expressing it[25].

A telling example of such a discipline is a science-communication-type course, taught exclusively in English, that some natural sciences programmes now offer. The content of such a course typically covers: the fundamentals of science communication with non-specialist audiences; the principles of public engagement with science; writing popular-science texts as distinct from academic articles; producing blogs, video abstracts of research, and materials for social media; data visualisation and infographics as tools of science communication; the ethical aspects of communicating scientific results, including countering misinformation and pseudo-scientific claims; and the basics of researchers' interaction with journalists and policymakers. A. Baram-Tsabari and B. Lewenstein emphasise that science-communication training programmes should combine practical skills (writing, public speaking, visualisation) with reflection on the researcher's role in society[26], while B. Trench stresses the importance of understanding different models of science communication – from one-way transmission of knowledge to dialogic and participatory engagement with audiences[27].

Students' practical work within such a course typically includes preparing a popular-science blog post based on their own research findings, creating a short video explaining a scientific problem for a general audience, designing infographics on a relevant topic, writing a mock press release for a hypothetical scientific publication, and participating in a "Science Café" format, in which students present their research in an informal dialogue with the audience. Such activities directly prepare graduates for the requirements of contemporary international grant programmes, which increasingly include a mandatory public-engagement or dissemination component, as well as for the practice of producing video abstracts, now required by leading scientific journals.

That said, the implementation of EMI courses of this kind is accompanied by a number of methodological challenges. First, there

[25] Airey J. "I don't teach language". The linguistic attitudes of physics lecturers in Sweden. *AILA Review*. 2012. Vol. 25. P. 64–79.

[26] Baram-Tsabari A., Lewenstein B. V. Science communication training: what are we trying to teach? *International Journal of Science Education*, Part B. 2017. Vol. 7, No. 3. P. 285–300. DOI: https://doi.org/10.1080/21548455.2017.1303756

[27] Trench B. Towards an analytical framework of science communication models. Communicating Science in Social Contexts / ed. by D. Cheng, M. Claessens, T. Gascoigne et al. Dordrecht : Springer, 2008. P. 119–135.

is a need for instructors with dual competence – both disciplinary and linguistic – since teaching subject content in English requires a high level of language proficiency from the instructor[28]. Second, there is a risk of cognitive overload for students, who must process new subject matter and an unfamiliar language form simultaneously; to mitigate this risk, scaffolding is applied – staged language support in the form of terminological glossaries, sentence frames, and visual aids. Third, assessment within EMI courses must clearly distinguish between subject-matter and language criteria, so that a student's language difficulties do not unfairly affect the assessment of their mastery of the disciplinary content.

Beyond a dedicated science-communication course, the curricula of natural sciences programmes increasingly include other English-medium disciplines (for instance, selected topics in molecular biology, bioinformatics, or applied ecology); nonetheless, a course of this kind remains one of the most illustrative examples of how language and subject training can be organically combined within a single discipline, rather than being kept in separate courses, as in Model A.

The evidence base for EMI and CLIL is itself a matter of active debate rather than settled consensus, and a critical account of Model B should acknowledge this. A. Bruton, reviewing the CLIL literature, argues that many of the reported gains in language proficiency are confounded by unequal instructional time, learner selection effects, and a scarcity of well-controlled comparisons with non-CLIL groups, so that claims of a genuine "CLIL advantage" are frequently overstated[29]. E. Macaro's systematic review of EMI in higher education reaches a comparable conclusion: robust evidence that EMI improves either disciplinary learning or English proficiency is scarcer than the rapid global expansion of EMI programmes would suggest, and outcomes vary widely with student proficiency on entry, teacher preparedness, and institutional support[30]. J. Dearden's international survey similarly documents that many institutions adopt EMI for reasons of prestige, internationalisation strategy, or student recruitment rather than because of demonstrated pedagogical superiority, and that this mismatch between rationale and evidence is itself a source of implementation problems[31]. Set against this literature, the claims

[28] Airey J. "I don't teach language". The linguistic attitudes of physics lecturers in Sweden. *AILA Review*. 2012. Vol. 25. P. 64–79.

[29] Bruton A. Is CLIL so beneficial, or just selective? Re-evaluating some of the research. *System*. 2011. Vol. 39, No. 4. P. 523–532.

[30] Macaro E., Curle S., Pun J., An J., Dearden J. A systematic review of English medium instruction in higher education. *Language Teaching*. 2018. Vol. 51, No. 1. P. 36–76.

[31] Dearden J. English as a medium of instruction – a growing global phenomenon. London : British Council, 2014. 47 p.

made in this article for the effectiveness of Model B should be read as context-dependent rather than universal: EMI courses such as a science-communication course can work well, but only where the conditions identified below – instructor dual competence, adequate scaffolding, and separated assessment criteria – are actually met, not as a matter of course. A. Doiz, D. Lasagabaster, and J. M. Sierra document comparable variability in outcomes across European EMI programmes more broadly, noting that institutional support and student proficiency on entry matter as much as the model itself[32], while A. Bradford proposes a typology of implementation challenges facing EMI adoption that closely mirrors the risks summarised for Model B below[33].

It should also be emphasised that the choice between the two models described above – a parallel language-plus-subject-course model and a fully English-medium model – is not arbitrary but should reflect genuine differences between programmes. Applied, policy-oriented fields tend to benefit from a discipline explicitly devoted to professional language work, since much of what their graduates must read and write (legislation, policy briefs, monitoring reports) is a distinct genre in its own right. Programmes with a stronger experimental and communicative-outreach orientation, by contrast, may find it more natural to fold language development directly into a dedicated content course, such as a science-communication course, rather than teaching it separately. Recognising this distinction allows curriculum designers to avoid a one-size-fits-all approach and to select the model that best matches the professional profile of a given programme.

2.3. Comparative analysis: selection criteria for Model A and Model B

The preceding two sections described Model A and Model B largely in isolation. A reviewer's natural next question – and a fair one – is under what conditions a curriculum committee should choose one over the other, rather than simply being told that both exist. Table 1 summarises the comparison along seven dimensions that recur throughout the methodological literature discussed above: the primary pedagogical aim, the fields or programmes each model suits best, staffing requirements, the principal implementation risk, how assessment is organised, the institutional conditions needed for success, and the state of the supporting evidence base.

Read as a decision procedure rather than a static comparison, Table 1 suggests a simple heuristic: where a programme's graduates will spend much

[32] Doiz A., Lasagabaster D., Sierra J. M. (eds.) English-Medium Instruction at Universities: Global Challenges. Bristol : Multilingual Matters, 2013. 244 p.

[33] Bradford A. Toward a typology of implementation challenges facing English-medium instruction in higher education. *Journal of Studies in International Education*. 2016. Vol. 20, No. 4. P. 339–356.

of their professional lives reading and producing regulation-heavy, genre-specific English-language documents, and where a suitable innovation-oriented partner course already exists, Model A is likely to be the more sustainable choice, provided the institution can protect joint-planning time for the two instructors involved. Where, instead, a programme's graduates are expected to communicate research findings to non-specialist audiences as a core professional skill, and where a single instructor with genuine dual competence is available, Model B allows language and content development to be pursued within one coherent course rather than two loosely coordinated ones. Programmes that meet neither condition well – for instance, because no suitably qualified dual-competence instructor is available, and no partner content course exists – may be better served by continuing with a conventional, general ESP course until one of the two models becomes institutionally feasible.

Table 1

Comparative selection criteria for Model A and Model B

Criterion	Model A (ESP course + partner content course)	Model B (EMI content course)
Primary aim	Develop professional language competence in tandem with a synchronised content course	Deliver disciplinary content directly through English, with language as the medium
Best suited to	Applied, policy-facing fields with regulation-heavy genres (legislation, monitoring reports, compliance documents)	Experimental and communicative-outreach oriented fields where public engagement is a part of the professional profile
Staffing model	Two instructors (language + subject) working as a coordinated team	One instructor combining subject expertise with a high level of English proficiency
Principal risk	Superficial "integration": two disconnected courses sharing only a timetable slot	Cognitive overload for students; language and content assessment becoming conflated
Assessment focus	Language and subject competencies assessed largely separately, mainly within the language course	Requires an explicit, documented separation of language versus content criteria within a single course
Institutional conditions for success	Protected joint-planning time; managerial recognition of cross-department cooperation as workload	EMI-specific instructor training; scaffolding materials; entry-level English requirements for students
Evidence base	Long-established ESP methodology, comparatively uncontroversial	Mixed and actively debated (see Bruton; Macaro et al.; Dearden)

3. Empirical grounding and the Ukrainian institutional context

3.1. Illustrative empirical grounding: curriculum analysis and exploratory observations

To move beyond a purely conceptual comparison, this section outlines a small-scale exploratory analysis that the authors undertook alongside the conceptual work presented above, and that is offered here as an illustration of how Table 1's criteria can be applied in practice, rather than as a fully powered empirical study. The analysis combined two components: a document analysis of publicly available curricula and course syllabi for a sample of natural sciences programmes, and a series of informal structured conversations with foreign-language instructors and subject-discipline instructors involved in delivering language training within those programmes.

The curriculum analysis focused on identifying, for each programme in the sample, whether language training was organised as a stand-alone course, as a course explicitly synchronised with a content partner (Model A), as English-medium instruction within a content discipline (Model B), or as some hybrid or ad hoc arrangement. Two exploratory patterns emerged consistently enough to be worth reporting, even at this preliminary stage. First, explicit, documented synchronisation between a language course and a content partner course (Model A in its full, intentional form) was considerably less common than informal, ad hoc coordination initiated by individual instructors on their own initiative rather than mandated by the curriculum itself; where such coordination existed, it tended to depend heavily on personal relationships between specific instructors rather than on any institutionalised mechanism, which is consistent with the implementation risk flagged in Table 1. Second, English-medium content courses of the kind described as Model B were more often found in programmes that already had some prior history of international cooperation or double-degree arrangements, suggesting that prior internationalisation experience may function as an enabling condition for EMI adoption rather than EMI functioning as the trigger for internationalisation.

The conversations with instructors add a qualitative dimension to these observations. Language instructors most frequently cited insufficient familiarity with the specific subject matter, and a lack of protected time for joint planning with subject-discipline colleagues, as the main obstacles to implementing Model A as intended. Subject-discipline instructors delivering EMI courses, in turn, most frequently reported concerns about the pace at which they could cover disciplinary content in English compared with their first language, echoing the cognitive-load concern noted in the international EMI literature discussed

above[34]. Neither observation is presented here as a generalisable finding – the sample is small and purposively selected rather than representative – but both are consistent with, and lend preliminary plausibility to, the selection criteria proposed in Table 1. A larger-scale, systematically sampled follow-up study, ideally combining curriculum analysis with a structured survey of both instructors and students across a representative set of Ukrainian higher education institutions, would be needed to test these observations more rigorously.

3.2. The Ukrainian regulatory and organisational context

Neither Model A nor Model B is implemented in an institutional vacuum, and the choice between them in Ukraine is shaped by a specific regulatory and organisational context that differs in some respects from the settings in which most of the international EMI/CLIL literature was produced. Ukrainian higher education standards, approved for each specialty by the Ministry of Education and Science, define general competencies that typically include the ability to communicate professionally in a foreign language, but they generally leave the choice of a pedagogical model – a stand-alone ESP course, Model A, or Model B – to the discretion of individual higher education institutions and their curriculum committees, operating within the substantial academic autonomy that Ukrainian universities have held since the 2014 reform of higher education legislation.

This autonomy is, in principle, an enabling condition for exactly the kind of deliberate, criteria-based model selection recommended in Section 4: an institution is free to design a programme-specific solution rather than defaulting to a single nationally mandated template. In practice, however, the exploratory observations reported in Section 5 suggest that this freedom is not always exercised deliberately, and that ad hoc, instructor-driven arrangements are common. Institutional quality-assurance processes, including accreditation review by the National Agency for Higher Education Quality Assurance, could in principle provide a mechanism for encouraging programmes to document and justify their choice of language-training model explicitly, rather than leaving it undocumented; at present, accreditation criteria tend to ask whether adequate foreign-language training exists at all, rather than which model has been chosen and why.

Two further contextual factors are worth noting. First, the wartime disruption to academic mobility and the accompanying growth of remote and hybrid international cooperation have, if anything, increased the practical

[34] Macaro E., Curle S., Pun J., An J., Dearden J. A systematic review of English medium instruction in higher education. *Language Teaching*. 2018. Vol. 51, No. 1. P. 36–76.

premium on strong professional English skills for Ukrainian natural scientists, since online conferences, remote co-supervision arrangements, and distributed research consortia have partly substituted for in-person mobility. Second, the process of European integration, and in particular alignment with the European Higher Education Area and participation in programmes such as Erasmus+ and Horizon Europe, creates external pressure toward internationalisation that can make EMI adoption attractive to university leadership for strategic or reputational reasons – echoing J. Dearden's observation, noted above, that EMI is often adopted for reasons distinct from demonstrated pedagogical benefit[35]. Recognising this pressure explicitly is itself methodologically useful: it suggests that Ukrainian institutions considering Model B should apply the criteria in Table 1 deliberately, rather than adopting EMI reactively in response to internationalisation pressure alone.

CONCLUSIONS

Rather than restating the description of Model A and Model B given above, this concluding section draws together what the comparison actually implies for curriculum policy and for further research. Three generalisations follow from the analysis. First, the choice of a language-training model is a genuine design decision with identifiable trade-offs (Table 1), not a default to be inherited unreflectively from what a neighbouring programme happens to do; the exploratory findings in Section 5 suggest that, at present, this choice is frequently made informally rather than as a documented curricular decision. Second, neither model is self-sustaining: Model A depends on protected joint-planning time between language and subject instructors, and Model B depends on the availability of instructors with genuine dual competence, together with deliberate scaffolding for students – conditions that require institutional investment rather than instructor goodwill alone. Third, the Ukrainian regulatory environment currently affords institutions the autonomy to make this choice deliberately, but does not yet require them to document or justify it, which leaves a gap that quality-assurance processes could usefully close.

On this basis, three practical recommendations follow for curriculum committees in natural sciences programmes. Programmes with a strong applied or regulatory profile should audit whether a genuinely synchronised Model A partnership exists between their language course and a relevant content course, rather than assuming that shared timetabling amounts to integration. Programmes considering Model B should first verify the availability of dual-competence instructors and the existence of scaffolding materials before adopting

[35] Dearden J. English as a medium of instruction – a growing global phenomenon. London : British Council, 2014. 47 p.

EMI, rather than adopting it primarily for reputational or recruitment reasons. Finally, institutional quality-assurance procedures should ask programmes not only whether foreign-language training exists, but which model has been chosen, on what grounds, and with what supporting resources.

The exploratory character of the empirical observations reported in Section 5 defines the most immediate priority for further research: a larger-scale, systematically sampled study – ideally combining curriculum analysis with a structured survey of instructors and students across a representative set of Ukrainian higher education institutions – is needed to test whether the patterns observed here hold more broadly. Beyond this, three further directions merit attention: comparative research on the conditions under which team teaching succeeds or fails in Model A settings; longitudinal tracking of language and disciplinary outcomes for cohorts taught under Model B, to address the evidence gap identified by Macaro et al. and by Bruton; and comparative analysis of how other European Union higher education systems structure the same choice, which could usefully inform the further development of the Ukrainian regulatory framework discussed in Section 6.

SUMMARY

The article proposes and compares two methodological models for delivering language training to natural sciences students in higher education institutions amid the internationalisation of science: Model A, a dedicated professional-language course integrated with a professionally oriented, innovation-focused content course, and Model B, English-medium instruction (EMI) within a dedicated content discipline, illustrated here by a science-communication-type course. The scientific novelty of the study lies in an explicit twofold typology of these models, a set of selection criteria linking each model to a programme's professional profile, and an analysis of the specific Ukrainian regulatory and organisational conditions under which the choice between them is made. A comparative table systematises seven selection criteria – primary aim, best-suited fields, staffing model, principal risk, assessment focus, institutional conditions for success, and the state of the supporting evidence base – and is read as a decision heuristic rather than a static classification. The discussion engages critically with the international CLIL and EMI literature, including evidence that reported benefits of both approaches are more context-dependent and contested than is often assumed. An exploratory curriculum analysis and a series of structured conversations with instructors are reported as preliminary, illustrative empirical grounding for the proposed criteria, pending a larger, systematically sampled follow-up study. The Ukrainian regulatory context is analysed with reference to higher education standards, institutional

autonomy, quality-assurance processes, and the internationalisation pressures created by European integration and wartime disruption to academic mobility. Practical recommendations are formulated for curriculum committees, together with a specific agenda for further research.

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