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A METHODOLOGICAL FRAMEWORK FOR DEVELOPING STUDENTS' PROFESSIONAL ENGLISH SPEAKING SKILLS THROUGH DIGITAL EDUCATIONAL TECHNOLOGIES: THE CASE OF ECOLOGY EDUCATION

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Abstract: Graduates of ecology and environmental science programmes increasingly work in internationalised professional settings in which English is the working language of environmental impact assessment, transboundary water management, climate finance and scientific collaboration. Yet the oral component of their language preparation remains the weakest link: conventional English for Specific Purposes (ESP) instruction offers each learner only minutes of authentic speaking time, rehearses decontextualised topics rather than professional genres, and provides feedback that is delayed, impressionistic and rarely discipline-sensitive. This article develops, on theoretical grounds, a methodological framework for forming the professional English speaking skills of ecology students through digital educational technologies. Drawing on ESP needs-analysis theory, Content and Language Integrated Learning (CLIL), sociocultural and output-based accounts of second language development, and technology-integration models (SAMR, TPACK), the study proposes the Digitally Mediated Professional Speech Development (DMPSD) model. The model comprises four interlocking components — a genre-based content architecture, a three-tier taxonomy of digital tools differentiated by didactic function, a five-stage instructional cycle, and a multi-source assessment system anchored in CEFR mediation descriptors — governed by seven design principles. The article specifies nine professional oral genres for the ecology field, maps each to appropriate digital mediation, and analyses the conditions, risks and teacher-competence requirements of implementation. The framework is offered as a theoretically motivated design that is directly operationalisable in curricula and empirically testable; the limitations of a purely conceptual study and an agenda for experimental validation are set out in the conclusion.

Keywords: professional speech skills; digital educational technologies; English for Specific Purposes; ecology education; CLIL; artificial intelligence in language learning; CEFR mediation; TPACK.

1. Introduction

1.1 The problem

Environmental problems are, by their nature, transboundary, and the professional community that addresses them is correspondingly international. A specialist trained in ecology today may be expected to present monitoring data to a donor consortium, defend the methodology of an environmental impact assessment (EIA) before a regulator, brief a multinational field team, explain a contamination risk to residents who have no scientific background, or take part in a negotiation

on water allocation. Each of these is an *oral* task, each is performed under professional accountability, and in a growing proportion of cases each is performed in English.

The language preparation such students receive is rarely designed for these tasks. Where ESP courses exist, they are typically weighted towards reading comprehension and terminology acquisition, on the tacit assumption that a specialist's principal need is to consume literature. Where speaking is addressed, it is often addressed through general conversational topics or through presentation practice that reproduces a single genre — the prepared monologue — while leaving untouched the interactive, contingent, high-stakes genres that dominate professional life. The structural constraints are severe: in a ninety-minute class with twenty students, arithmetic alone limits individual speaking time to a few minutes, and the only interlocutors available are peers of similar proficiency and identical cultural background.

Digital educational technologies are widely proposed as the solution, and the last decade has produced a substantial literature on their application to speaking instruction. That literature, however, is dominated by tool-by-tool effectiveness studies. What has been less developed is a *methodology* — a principled account of how technology, professional content, instructional sequence and assessment cohere into a system capable of forming professional speech competence in a specific disciplinary field.

1.2 Aim and research questions

The aim of this article is to construct such a methodological framework for the field of ecology education. Three questions guide the enquiry:

1. What constitutes professional English speaking competence for a graduate of an ecology programme, and how can it be specified in teachable terms?
2. By what didactic functions should digital educational technologies be classified so that their selection follows pedagogical rather than technological logic?
3. How can content, technology, instructional sequence and assessment be integrated into a coherent and implementable methodological model?

1.3 Scope and contribution

The study is theoretical. It does not report an experiment; it produces a design. Its contribution is threefold: a genre-based specification of professional oral competence for the environmental field; a functional taxonomy that resolves the "which tool for which purpose" problem; and an integrated instructional model, the DMPSD, that connects the two within an assessment system that is defensible against contemporary frameworks of reference. The article is intended as the conceptual foundation for a subsequent programme of empirical validation.

2. Theoretical background

2.1 Professional speech competence as the object of instruction

The construct at issue is narrower than communicative competence and broader than speaking proficiency. Following the ESP tradition inaugurated by Hutchinson and Waters (1987) and

consolidated by Dudley-Evans and St John (1998), the object of instruction is defined by the target situation: the set of communicative events a learner will actually have to perform. Professional speech competence may therefore be defined as *the ability to accomplish, in English, the oral communicative tasks constitutive of a given professional field, at the standard of accuracy, appropriacy and effectiveness that the field's own discourse community recognises*.

Three features of this definition matter methodologically. First, it is **genre-bound**: competence is not general fluency but the capacity to realise specific, conventionalised speech events with their characteristic move structures. Second, it is **content-dependent**: one cannot brief a field team without knowing what is in the protocol, so language instruction cannot be separated from disciplinary substance. Third, it is **community-referenced**: the standard of success is set by professional peers, not by the language teacher, which has direct implications for the design of assessment and for the necessity of exposing students to real professional audiences.

Bachman and Palmer's (1996) model of language ability, with its strategic-competence component mediating between linguistic knowledge and the situational demands of a task, remains a useful analytic device here, since much of what distinguishes an effective professional speaker is strategic: the management of an interruption, the decision to simplify, the recovery from a question one cannot answer.

2.2 Content and Language Integrated Learning

If professional speech is content-dependent, then the methodology must integrate content and language. CLIL, systematised by Coyle, Hood and Marsh (2010) through the 4Cs framework — Content, Communication, Cognition, Culture — offers the most developed pedagogical account of such integration. Its value for the present purpose is that it treats subject content not as a topic for language practice but as the driver of cognitive demand, and it distinguishes the *language of* learning (the terminology and structures inherent to the content), the *language for* learning (the functional repertoire needed to operate in the learning situation) and the *language through* learning (the unpredictable language that emerges from genuine engagement).

Applied to ecology, CLIL yields a further advantage: the discipline's content is inherently controversial, quantitative and public-facing, and therefore generates authentic reasons for higher-order oral work — evaluating, arguing, negotiating trade-offs — rather than the descriptive tasks that dominate lower-level language teaching.

2.3 Second language acquisition foundations

Three theoretical positions justify the emphasis on structured, feedback-rich oral production.

Swain's (2005) **output hypothesis** holds that producing language pushes learners from semantic to syntactic processing, and that the act of speaking generates noticing of the gap between what one wants to say and what one can say. Professional genres, being lexically and rhetorically demanding, maximise this pressure.

Vygotskian **sociocultural theory** and the associated notion of scaffolding explain why unaided practice is insufficient: development occurs when performance is supported at a level slightly

beyond independent capability, and the support is progressively withdrawn. This is the theoretical warrant for a staged instructional cycle rather than a repetition of unsupported performances.

Willingness to communicate research (MacIntyre et al., 1998) identifies the affective barrier: learners who possess the linguistic resources frequently do not deploy them because of anxiety, particularly in high-stakes evaluative settings. Any methodology aimed at professional speech must therefore include low-stakes rehearsal environments in which failure carries no social cost.

2.4 Technology integration frameworks

Two models discipline the selection of technology. Puentedura's **SAMR** hierarchy distinguishes Substitution and Augmentation, where technology performs an existing task more conveniently, from Modification and Redefinition, where the task itself is transformed and becomes impossible without the technology. Much reported practice in ESP remains at the substitution level — a recorded presentation replacing a live one — and consequently produces no methodological change.

Mishra and Koehler's (2006) **TPACK** framework locates effective integration at the intersection of technological, pedagogical and content knowledge. In an ESP context, the content component is doubled: the teacher requires both language-pedagogical knowledge and sufficient understanding of ecology to judge whether a student's briefing is professionally credible. This double demand is one of the principal implementation constraints identified in Section 5.

2.5 Digital technologies and oral skills: the state of evidence

Research on technology-mediated speaking has moved through three phases. Early computer-assisted language learning focused on pronunciation drilling with automatic speech recognition. A second phase, associated with Web 2.0, emphasised asynchronous video, podcasting and digital storytelling; studies in this tradition report gains in fluency and confidence attributable largely to the removal of real-time performance pressure and to the possibility of rehearsal and self-review.

The current phase is dominated by conversational artificial intelligence. Recent syntheses of chatbot-mediated language learning report positive aggregate effects on oral outcomes and, notably, on affective variables including anxiety reduction and willingness to communicate (Lyu et al., 2025; Jeon, 2025; Şahin Kızıl, 2025). Reviews caution, however, that effects vary substantially with pedagogical design: unstructured "chat with the bot" tasks produce little, whereas role-plays with defined personas, task outcomes and post-task feedback produce more. This finding is central to the present framework, which treats AI not as a tutor but as an infinitely available *interlocutor* embedded in a designed task cycle.

Alongside these, corpus tools have matured into practical classroom instruments. Corpus-derived specialised word lists — notably the environmental academic word list of Liu and Han (2015), built specifically from environmental science texts — make it possible to define the lexical syllabus of an ecology ESP course empirically rather than intuitively, complementing Coxhead's (2000) general Academic Word List.

2.6 The research gap

Three gaps emerge. First, the literature on digital speaking instruction is largely discipline-neutral, and the specific communicative profile of environmental professionals is under-described. Second, tool studies rarely articulate a functional rationale for tool selection, leaving practitioners without a decision procedure. Third, and most consequentially, integrated methodologies — in which content specification, technology, instructional staging and assessment are designed as a single system — are scarce. The DMPSD model is proposed to address these gaps.

3. Methodology of the study

The study employs conceptual-analytical methods appropriate to theory-building research in applied linguistics and pedagogy.

Literature synthesis. Sources in ESP methodology, CLIL, computer-assisted language learning and AI-mediated language instruction were analysed thematically, with priority given to systematic reviews, meta-analyses and foundational theoretical works.

Documentary genre analysis. Professional artefacts of the environmental sector — EIA reports and their public-hearing procedures, monitoring and sampling protocols, IPCC and UNEP communication materials, environmental conference programmes and calls for papers, and job descriptions for environmental specialists — were examined to identify the oral communicative events they presuppose, the participants involved, and the discourse demands each event places on the speaker.

Framework construction. The genre inventory, tool taxonomy, instructional cycle and assessment system were derived from the foregoing and organised into a single model through a design logic in which each component must be justified by an explicit theoretical warrant and must connect functionally to the others.

Internal validation. The resulting model was checked for consistency against the theoretical positions in Section 2, for coverage against the genre inventory, and for feasibility against the typical resource conditions of a regional university.

The principal limitation of this design is stated plainly: a conceptual framework establishes plausibility and coherence, not effectiveness. The empirical claims it invites are set out as an agenda in Section 6.

4. The DMPSD model

4.1 Overview and design principles

The Digitally Mediated Professional Speech Development model consists of four components — content architecture, tool taxonomy, instructional cycle, assessment system — governed by seven principles:

P1. Professional authenticity. Every speaking task realises a genre that exists in the environmental profession, with a plausible audience and a real communicative purpose.

P2. Content–language integration. Language work is organised around disciplinary content the students are simultaneously studying, following the 4Cs.

P3. Digital–pedagogical congruence. Technology is selected because a specified didactic function requires it, and integration is targeted at the Modification and Redefinition levels of SAMR.

P4. Progressive autonomy. Support is dense at the start of a cycle and systematically withdrawn, so that the final performance is unaided.

P5. Multimodality. Professional oral communication is accompanied by data, visuals and gesture; tasks and assessment treat these as part of the message, not as decoration.

P6. Feedback plurality. Machine, peer, teacher and self-assessment are combined, each applied to the dimensions it evaluates most validly.

P7. Critical and ethical digital literacy. Students learn to use AI as a rehearsal partner and a draft-checker while retaining authorship, to verify machine-generated content against disciplinary knowledge, and to observe the integrity norms of their future profession.

4.2 Component 1: Content architecture

The content architecture specifies nine professional oral genres organised by audience relation.

Expert-to-expert genres.

G1. Research presentation and poster talk. Move structure: context and gap → aim → methods → results → interpretation → limitations → implications. Demands: precise data commentary, hedged claim-making, defence under expert questioning.

G2. Fieldwork and sampling-protocol briefing. Move structure: objective → site conditions and hazards → equipment → step sequence → quality control → contingencies → task allocation. Demands: imperative and sequencing language, absolute clarity, checking of comprehension.

G3. Data and results reporting. Demands: description of trends, magnitudes and anomalies; expression of uncertainty and confidence intervals; comparison across sites and periods.

Expert-to-decision-maker genres.

G4. EIA findings presentation and defence. Demands: structuring of significance judgements, justification of methodology, response to challenge, articulation of mitigation hierarchies.

G5. Project pitch to a donor or grant panel. Demands: concise problem framing, theory of change, budget justification, persuasion under strict time limits.

G6. Regulatory interview and compliance negotiation. Demands: interactional management, concession and counter-proposal, careful commitment language, politeness under pressure.

Expert-to-public genres.

G7. Risk and crisis communication. Demands: plain-language reformulation of technical findings, acknowledgement of uncertainty without loss of credibility, empathic register.

G8. Environmental interpretation and eco-tour commentary. Demands: narrative structure, vivid description, audience engagement, responsive question handling.

G9. Stakeholder consultation and public hearing participation. Demands: active listening and summarising, managing hostile or emotional contributions, mediating between conflicting interests.

Each genre is populated with content drawn from the students' own curriculum and from regionally salient cases — for example, Aral Sea basin water management, transboundary air quality, soil salinisation, protected-area management, carbon accounting in agriculture — so that language instruction reinforces disciplinary study.

Three lexical layers are specified: general academic vocabulary (Coxhead, 2000); the environmental academic word list (Liu & Han, 2015); and case-specific technical terminology. The grammatical syllabus is functionally derived: hedging and epistemic modality for uncertain findings; passive voice and nominalisation for protocol and process description; comparatives, trend verbs and approximation for data commentary; conditionals for scenario modelling; and the interpersonal repertoire of qualified disagreement for consultation and negotiation.

4.3 Component 2: Tool taxonomy

Tools are classified by didactic function, not by technical type.

Tier 1 — Input and noticing. Function: to make professional discourse available and salient. Instruments: curated video archives of environmental conference talks and institutional briefings; subtitled documentary and news material; specialised podcasts; concordancers (AntConc, Sketch Engine) and reference corpora (COCA), applied to a self-compiled corpus of ecology research articles and impact reports; 360° and VR recordings of field sites and laboratories. Typical activity: students identify the move structure of three authentic EIA presentations and extract the formulaic sequences used to express significance.

Tier 2 — Production and interaction. Function: to multiply and authenticate speaking opportunities. Instruments: asynchronous video-response platforms (Flip, VoiceThread, Padlet) that give every student a full turn; conversational AI agents with speech interfaces, prompted to adopt a defined professional persona (a sceptical regulator, an anxious resident, a time-pressed donor); virtual exchange and telecollaboration with partner institutions abroad; simulation environments including virtual laboratories, GIS and remote-sensing platforms (for example Google Earth Engine) that generate the data students report on; and structured negotiation simulations on the Model-UN pattern for climate and water policy.

Tier 3 — Feedback and analytics. Function: to make performance visible and self-regulable. Instruments: automatic speech recognition and pronunciation-scoring applications; AI evaluation of recorded performances against a supplied discipline-specific rubric; annotation tools that allow time-stamped teacher and peer comments on video; e-portfolios (Mahara or LMS-native) that accumulate longitudinal evidence; and learning-analytics dashboards tracking participation, revision cycles and rubric-band movement.

The taxonomy yields a decision rule: identify the didactic function required at the current stage of the cycle, then select from the corresponding tier. It also yields a diagnostic: a course drawing tools from only one tier is structurally incomplete.

4.4 Component 3: The five-stage instructional cycle

Each genre is taught through a recurring cycle that operationalises scaffolding and progressive autonomy.

Stage 1 — Orientation and diagnosis. The professional situation is established and its stakes made concrete. Students attempt a short, unassessed baseline performance of the genre, recorded asynchronously. The recording serves both as a needs diagnosis for the teacher and as a reference point for the student's later self-comparison.

Stage 2 — Input and noticing. Using Tier 1 tools, students analyse authentic exemplars for move structure, functional language and lexis. Corpus work makes the target formulaic sequences explicit. Output: a co-constructed genre map and a phrase bank.

Stage 3 — Guided rehearsal. Using Tier 2 tools with maximum support, students perform the genre repeatedly under low-stakes conditions: scripted-to-unscripted AI role-plays with an assigned interlocutor persona; short asynchronous video recordings with unlimited retakes; peer micro-teaching. Tier 3 tools provide immediate machine feedback on intelligibility and rubric bands. Scaffolds — outlines, phrase banks, sentence frames — are withdrawn across iterations.

Stage 4 — Authentic professional performance. The genre is performed once, unaided, for a real or realistic audience: a synchronous virtual exchange session with students or professionals abroad; a live simulated public hearing with assigned adversarial roles; a recorded pitch submitted to an external panel. Multimodality is required — data visualisation, maps, imagery — and contingencies are introduced deliberately.

Stage 5 — Reflection and data-driven feedback. Students receive teacher, peer and machine feedback against a single shared rubric, compare the final performance with the Stage 1 baseline, and record a short spoken reflection identifying two consolidated strengths and one target for the next cycle. Artefacts are deposited in the e-portfolio.

The cycle is recursive: genres are revisited across semesters at increasing cognitive demand, so that G3 (data reporting) first appears as a descriptive task and returns as a contested interpretation defended before a hostile audience.

4.5 Component 4: Assessment system

Assessment is anchored in the CEFR Companion Volume (Council of Europe, 2020), whose **mediation** descriptors — explaining data, relaying specific information, facilitating pluricultural space, managing interaction — correspond closely to the professional reality of environmental specialists, whose distinctive value lies in moving information across the boundaries between science, policy and the public.

The analytic rubric comprises six criteria:

4. **Professional content accuracy** — disciplinary correctness and adequacy of the substance conveyed.
5. **Genre and discourse competence** — realisation of the expected move structure, coherence, signposting.
6. **Lexical and grammatical range and accuracy** — including control of the specialised lexical layers.

7. **Intelligibility and delivery** — pronunciation, pace, stress and prosody sufficient for international professional comprehension, rather than native-speaker approximation.
8. **Interaction and mediation** — turn management, response to challenge, reformulation for the audience, handling of contingency.
9. **Multimodal and digital delivery competence** — integration of visuals and data, appropriate use of the platform.

Criteria 1 and 6 are assessed by teacher and, where possible, subject-specialist or external professional judgement; 3 and 4 admit reliable machine contribution; 2 and 5 combine teacher and peer assessment. The e-portfolio supplies formative, longitudinal evidence; a small number of summative performances anchor certification. This division of labour operationalises principle P6 and protects the validity of the whole against over-reliance on any single feedback source.

5. Discussion

5.1 What the model claims to change

The model's central claim is that the three chronic deficiencies of professional speaking instruction are addressed by different components acting together. Insufficient practice time is addressed structurally by Tier 2 asynchronous and AI-mediated tools, which decouple speaking opportunity from classroom minutes. Inauthentic content is addressed by the genre architecture, which replaces topics with professional speech events. Weak feedback is addressed by the plural feedback system and the longitudinal portfolio, which convert single judgements into visible trajectories.

The model also claims a specific advantage for the ecology field. Environmental work is data-intensive, spatially situated and publicly contested. Digital technologies give a language classroom access to all three: remote-sensing platforms supply real data, virtual field environments supply spatial situation, and virtual exchange supplies genuinely external, non-complicit audiences. No conventional classroom arrangement can do this.

5.2 Implementation conditions

Four conditions govern feasibility.

Teacher competence. The TPACK demand is substantial and, in ESP, doubled by the need for disciplinary literacy. Realistic responses include team teaching with subject specialists, structured teacher development in genre analysis and AI prompt design, and shared banks of validated task materials rather than individual improvisation.

Infrastructure and equity. Bandwidth, device access and quiet recording space are unevenly distributed. The model should degrade gracefully: asynchronous audio-only recording, offline corpus tools and mobile-first platforms preserve most of the design where bandwidth is limited, and institutional recording space addresses the practical barrier of students who cannot record at home.

Curricular integration. The framework presupposes coordination with the subject curriculum, since the content architecture draws on it. Where such coordination is institutionally impossible, the

model can be implemented with case content curated by the language teacher, at some cost to principle P2.

Time and workload. The five-stage cycle is longer than a conventional lesson sequence; a realistic implementation covers four to six genres per academic year rather than all nine, with the remainder distributed across a two-year programme.

5.3 Risks and limitations

Over-reliance on AI. An AI interlocutor is endlessly patient and never genuinely surprised; students may develop fluency in a socially frictionless environment that does not transfer to a hostile public hearing. The model mitigates this by confining AI to Stage 3 and reserving Stage 4 for human audiences.

Authorship and integrity. Generative tools can produce the content of a briefing as easily as they can rehearse it. Principle P7, the requirement of unaided Stage 4 performance, and the retention of process evidence in the portfolio together make substitution detectable and pedagogically pointless.

Assessment validity. Machine scoring is reliable on phonological and lexical dimensions and weak on professional content adequacy; assigning it authority beyond its competence would degrade the construct. The criterion-by-source mapping in Section 4.5 is therefore not an administrative convenience but a validity requirement.

Cognitive load. A cycle that combines a new genre, unfamiliar content, several platforms and multimodal production can overwhelm learners. Sequencing tool introduction, reusing a stable platform set, and separating content-new from genre-new tasks are necessary controls.

The limits of a conceptual study. The model is internally coherent and theoretically warranted; it is not yet demonstrated to work. Its components have differing evidential support — the effects of asynchronous video and of corpus-informed lexis are relatively well attested, while the specific configuration proposed here is not.

5.4 Transferability

Although specified for ecology, the model's architecture is field-general. Substituting the genre inventory, the specialised word list and the case content yields analogous frameworks for medicine, engineering, law or agriculture. What is not transferable without re-derivation is the genre inventory itself, which must be established from the documentary reality of each profession.

6. Conclusion

This article has proposed a methodological framework for developing the professional English speaking skills of ecology students through digital educational technologies. The framework rests on a definition of professional speech competence as genre-bound, content-dependent and community-referenced, and it operationalises that definition through four integrated components: a content architecture of nine professional oral genres with corpus-derived lexical specification; a three-tier taxonomy classifying digital tools by didactic function into input, production and

feedback instruments; a five-stage instructional cycle enacting progressive autonomy from diagnosis through noticing and guided rehearsal to unaided professional performance and reflective feedback; and a six-criterion assessment system anchored in CEFR mediation descriptors with feedback sources matched to the dimensions they judge validly. Seven design principles govern the relations among these components, the most consequential being that technology selection follows a specified didactic function rather than preceding it.

Three conclusions follow. First, digital technologies transform professional speaking instruction only when they operate at the transformative levels of technology integration; substitution-level use leaves the methodology, and therefore the outcome, unchanged. Second, the decisive contribution of digital mediation in the ecology field is access to disciplinary reality — data, sites, and external audiences — rather than convenience. Third, artificial intelligence is most defensibly positioned as a rehearsal interlocutor within a designed cycle, not as a substitute for the human professional audience against which competence is ultimately measured.

The study's limitation is that of any conceptual design: it establishes coherence, not efficacy. Four lines of empirical work follow directly. A survey of employers and graduates in the environmental sector should validate and weight the genre inventory. A quasi-experimental study should compare the full cycle against conventional ESP instruction on rubric-based oral outcomes. A component analysis should isolate the contribution of AI-mediated rehearsal from that of asynchronous video and corpus-informed input. And a longitudinal portfolio study should examine whether gains achieved in mediated settings transfer to unmediated professional performance. Until such evidence exists, the DMPSD model should be read as a testable proposal rather than a validated method.

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