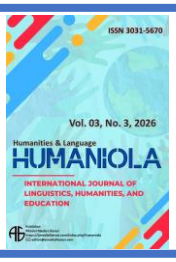
Humaniola Humanities and Language
International Journal of Linguistics, Humanities, and Education
Volume 3 Issue 3, September 2026
E-ISSN 3031-5670



From Thematic Content to Professional Accountability: A Conceptual Framework for Digital Sustainability in English for Computer Science

Dewi Sari Wahyuni[1*], T. Sy. Eiva Fatdha[2] & Susanti[3]

[1]*Informatics Engineering Study Program, Faculty of Engineering and Informatics, Universitas Sains dan Teknologi Indonesia, Pekanbaru, Indonesia*
[2]*Information Technology Study Program, Faculty of Engineering and Informatics, Universitas Sains dan Teknologi Indonesia, Pekanbaru, Indonesia*
[3]*Information System Study Program, Faculty of Engineering and Informatics, Universitas Sains dan Teknologi Indonesia, Pekanbaru, Indonesia*
*Correspondence author: dewisariwahyuni@usti.ac.id

ARTICLE INFO

Keywords:
Digital Sustainability; English for Specific Purposes; Computer Science Education; Education for Sustainable Development; Genre Analysis

Article history:
Received 6 August 2026
Revised 17 August 2026
Accepted 19 August 2026
Available online
30 September 2026

CC BY 4.0 DEED
licensed under CC BY 4.0
DOI: https://doi.org/10.32734/h57y1h22

ABSTRACT

Sustainability has entered computing education and English language teaching along separate paths. Computing educators treat it as technical knowledge about energy, hardware, and software; language educators, as thematic content for language work. Neither addresses computer science undergraduates, who will build the systems whose environmental costs are at issue and must account for them in English. This conceptual paper argues that English for Computer Science requires a distinct treatment, in which digital technology is the object whose sustainability is at stake rather than the medium through which it is discussed. Following a theory-adaptation design and a structured Scopus search executed on 30 July 2026, the paper distinguishes four competing senses of digital sustainability and proposes a working definition. It then transposes the sustainability competences of Wiek et al. (2011) and Brundiers et al. (2021), competence by competence, into three language dimensions: referential accuracy, discursive accountability, and critical evaluation. Each is specified with target genres, lexicogrammatical exponents, and assessable outcomes, and four principles for materials design follow. The framework is conceptual and unvalidated; it sets an agenda for Indonesian higher education, where English for Computer Science is typically a service course, and the computing sector is expanding.

How to cite:
Wahyuni, D.S., Fatdha, T.S.E., & Susanti. (2026). From thematic content to professional accountability: A conceptual framework for digital sustainability in English for computer science. *Humanities & Language: International Journal of Linguistics, Humanities, and Education*, *3*(3), 346-363.

1. Introduction

Digital technology carries a measurable environmental cost. Data centers consume electricity, model training consumes computation, and devices consume minerals before ending their lives as waste. Universities that prepare students for work in computing therefore face a curricular question that did not exist a generation ago: where in a degree program should students learn to reckon with the environmental consequences of what they build?

Computing educators have answered this question for more than a decade. Semerikov et al. (2020) framed sustainability as a general professional competence in software engineering education. Stahl et al. (2022) embedded sustainability concerns in project-based learning for software engineering curricula. Most comprehensively, Peters et al. (2024) reviewed the field systematically and documented substantial coursework addressing energy-aware programming, hardware lifespan, and green software design. The discipline that owns the problem has taken up its technical dimension.

Language educators have developed a parallel response. Kapranov (2022) analyzed discursive representations of sustainability in English language teaching at an elite university. Alharbi (2026) drew on ecological linguistics, critical pedagogy, and transformative learning theory in a mixed-methods study of the effect of sustainability pedagogy on language ability, motivation, and eco-literacy, and Triyono et al. (2023) conducted a multimodal eco-critical discourse analysis of environmental content in English textbooks used in Indonesia. Within English for Specific Purposes, Karasaliu et al. (2025) integrated sustainability with translation and digital media, and Balula et al. (2025) embedded sustainability awareness in an ESP course.

Two recent papers most closely align with the present argument and require separate treatment. Chiriac (2026) proposes a synergistic framework grounded in project-based learning and drawing on education for sustainable development and content-and-language integrated learning, in which green education is positioned as an authentic context for developing digital literacy among English language learners. The framework connects three literacies, namely digital literacy, ecological understanding, and English proficiency, and outlines design principles, benefits, and implementation challenges. Lașcu (2026) advances a comparable case for environmental awareness and digital competency, based on the evidence of a mixed-methods classroom study. In both, the direction of the relation is the same: environmental content supplies the setting, and language and digital skills are the outcome. The learner population in both is the general English language learner, without disciplinary specification. The present paper reverses that relation and specifies the population; section 3.2 explains why that reversal matters.

Despite these parallel developments, the two bodies of work have not met. Section 2 reports the search on which this observation rests, and section 3 discusses its implications; in summary, of 202 retrieved records on sustainability in computing education, two mention language education and one addresses it substantively, and of 1,347 records covering the terminology of digital sustainability, seven mention language education, three address it substantively, one of these in a computer-assisted language learning journal and and none in an English for Specific Purposes or applied linguistics journal.

A second difficulty is terminological. The phrase digital sustainability circulates in at least four distinct senses, treated in section 3.1: digital innovation serving sustainable development (George et. al., 2021), the durability of digital artifacts (Stuermer et al., 2017), the environmental footprint of computation itself, and the policy construct of twin transition. A related term, digitainability, has acquired its own literature (Gupta et al., 2020; Lichtenthaler, 2021) and has been applied to educational digital competences by Sá et al. (2021). However, it focuses on social rather than environmental sustainability. Using the phrase without stipulating its meaning invites misreading.

This paper addresses both difficulties. It is a conceptual paper proceeding by theory adaptation: an established competence framework; specifically the key competencies in sustainability set out by Wiek et al. (2011) and refined toward disciplinary consensus by Brundiers et al. (2021), with the future-oriented competences of Rieckmann (2012) and the competence–pedagogy mapping of Lozano et al. (2017) as supporting sources, is transposed to a domain it was not built for, and the resulting adjustments constitute the contribution. Three objectives are pursued. First, the paper maps the competing senses of digital sustainability and establishes a working definition appropriate to language pedagogy. Second, it argues that English for Computer Science constitutes a distinctive pedagogical site because its students will produce the artifacts whose sustainability is in question. Third, it derives a framework of language competences for digital sustainability and specifies design principles for course materials.

The novelty claimed is narrow. For a computer science undergraduate, energy consumption, hardware lifespan, and data volume are not topics encountered in a reading passage but consequences of professional decisions the student will make and be required to justify to clients, procurement officers, and regulators. Computing courses assess whether a design works. The account a graduate gives of it is delivered in English, and section 3.2 argues that no course in the standard curriculum assesses it.

Where these demands are met is not uniform across educational systems. Where English is a foreign rather than a second language, the account a graduate gives of a design decision must be produced in a language acquired through instruction, and that instruction is typically located in a service course at the margin of the degree. The consequences have been documented for ESP provision in non-English departments (Iswati & Triastuti, 2021), for engineering faculties (Rasyimah et al., 2018), and for Southeast Asian higher education more widely (Petraki & Khat, 2022), while even in well-resourced European systems experienced ESP teachers report unmet training needs (Bocanegra-Valle & Basturkmen, 2019). The question therefore presents itself most sharply where a fast-growing computing sector, a foreign-language English curriculum, and thinly resourced ESP provision coincide.

Indonesian higher education is such a case, and it is the context in which the agenda proposed here is framed. English for Computer Science is commonly delivered as a service course by language specialists to computer science undergraduates, a configuration that Iswati and Triastuti (2021) show generates persistent difficulties for ESP teachers in non-English departments, and that Rasyimah et al. (2018) document in the design of ESP provision for engineering students. Triyono et al. (2023) examined environmental content in Indonesian English materials, and Nilan (2017) describes Indonesian students' ecological dispositions more broadly. What remains unexamined is whether Indonesian computer science graduates can articulate the environmental consequences of their own technical work in English.

2. Method

The account that follows is set out in four subsections so that each step of the procedure can be assessed separately: the design of the study (2.1), the literature search (2.2), the screening and eligibility decisions (2.3), and the analytical procedure by which the framework was derived (2.4).

2.1 Design

This paper is conceptual rather than empirical. It proceeds by theory adaptation: an existing framework, here the key competencies in sustainability of Wiek et al. (2011) and Brundiers et al. (2021), is transposed to a domain it was not designed for, and the adjustments required constitute the contribution. No primary data were collected, and no empirical validation is claimed.

2.2 Literature search

The literature base was assembled through structured searching of Scopus, executed on 30 July 2026. Five search sets were used, reproduced in Table 1. No document-type filter and no lower date limit were imposed at the search stage, so foundational sources and non-article outputs could be retrieved; the counts in Table 1 therefore reflect all indexed document types. Journal articles, reviews, and conference papers make up the bulk of each set, and analytical attention was restricted to the period from 2011 onward except where earlier work established a term.

Table 1. Search sets, purpose, and record counts (Scopus, 30 July 2026)

Set	Searching string (TITLE-ABS-KEY)	Purpose	Records
S1	(“digitainability” OR “twin transition” OR “digital sobriety” OR “digital sustainability” OR “green digital skills” OR “sustainable digitalization”) AND (educat* OR curricul* OR pedagog*)	Terminology	1,347
S2	(“computer science education” OR “software engineering education” OR “computing education”) AND (sustainab* OR “green computing” OR “green software” OR “e-waste”)	Computing Education	202
S3	(“digital sustainability” OR “green computing” OR “green software”) AND (“English for specific purposes” OR “English language teaching”) AND NOT (“ESP32” OR “ESP-NOW” OR microcontroller)	Intersection	12
S4	(“English for specific purposes” OR “English for computer science”) AND (“need analysis” OR “material development OR corpus)	ESP design	390
S5	(“education for sustainable development”) AND (“higher education” OR “language education”) AND (SDG OR competenc*)	Competences	895

Two observations arising from the search process affect replicability and are recorded here because they are not, to the author’s knowledge, documented elsewhere. First, the abbreviations conventionally used in applied linguistics collide with unrelated abbreviations in engineering. A search using the bare token ESP returned a set in which thirty-three of thirty-six records concerned the Espressif ESP32 and ESP-NOW microcontroller families rather than English for Specific Purposes. A subsequent search using the bare tokens EFL and ESL returned records in which those strings denoted ensemble federated learning, edge server deployment, and electronic system level design; six or twelve records were false positives on this basis. Abbreviations were therefore expanded in full in all final searches, and hardware terms were explicitly

excluded, as shown in set S3. Researchers working across applied linguistics and computing should anticipate this collision.

Second, one preliminary search returned a result set at the database's export ceiling, which obscures the true size of the retrieved population. Counts reported here were read from the search interface rather than derived from exported files.

2.3 Screening and eligibility

Screening followed a stated but non-systematic procedure. Because the paper is a conceptual contribution rather than a systematic or a scoping review, no established review protocol was adopted, and the PRISMA extension for scoping reviews (Tricco et al., 2018) was not applied. The search was designed to assemble an adequate and traceable literature base for a conceptual argument, not to support a claim of exhaustive coverage. Because that decision limits what the retrieved counts can show, the steps taken are stated in full here.

Records were screened in three passes. In the first pass, titles were read against the inclusion criteria, and clearly irrelevant records were removed. In the second, abstracts and author keywords were read for the records retained. In the third, records surviving both passes were read in full where full text was accessible. The reference lists of the retained reviews and framework papers were then checked for foundational sources predating the 2011 analytical window, which is the route by which sources such as Alakeson and Wilsdon (2002) and Mühlhäusler and Peace (2006) entered the corpus.

Inclusion required that a record address sustainability in an educational setting, or the terminology of digital sustainability, or English for Specific Purposes course and materials design. Records were excluded if they concerned hardware, network engineering, or corporate sustainability reporting without an educational dimension; if they used the retrieved abbreviations in their engineering senses, as described above; or if the database did not include an abstract.

Two features of the procedure limit what it can support. Screening was carried out by the author alone, so no second screener was involved and no inter-rater agreement can be reported; and the record counts given in section 1 and Table 1 were read from the search interface rather than derived from exported files, for the reason given above, although for sets S1 and S2 the interface counts and the exported record counts agree exactly, and it is the S1 export that the coding in section 2.4 was run on. Both are recorded as limitations in section 3.5.

2.4 Analytical procedure

The retained corpus was read analytically against the three objectives, with attention to how each source defined sustainability, which learner population it addressed, and whether it treated technology as a topic or as an object. The analysis proceeded in two stages, corresponding to the first and the third objectives.

The first stage addressed the terminology and was carried out on the full S1 export (n = 1,347) rather than on the analytically retained subset. Definitional statements in the highly cited records were read first and used to derive four candidate senses, distinguished by what each holds to be sustained. We then operationalized each sense as a set of surface markers, and coded every record in S1 automatically against all four sets across the concatenated title, abstract, author keywords, and index keywords.

The marker sets were as follows. Sense one, digital innovation serving sustainable development, was marked by the Sustainable Development Goals, digital innovation or

transformation, circular economy, and business-model vocabulary. Sense two, the durability of digital artifacts, by digital preservation, digital artifact, curation, repository, knowledge commons, and long-term access. Sense three, the environmental footprint of computation, by energy, carbon, emissions, electronic waste, green computing, green software, digital sobriety, and lifecycle assessment, subject to a co-occurrence requirement that the record also carry a computing referent, so that records about the carbon footprint of agriculture or construction were not counted. Sense four, the twin transition as a policy construct, by twin or dual transition, digitainability, sustainable digitalization, green digital skills, and competence-framework vocabulary.

A record was assigned to whichever sense returned the most marker hits. Where two or more senses tied, the record was assigned to the sense whose defining term was present verbatim, and to sense one where no such term was present; two records remained unresolved. Records returning no marker for any sense were kept as a separate residual category rather than forced into one, because their existence is itself a finding. The procedure is an automated proxy for definitional reading, not a substitute: it classifies by the vocabulary a record uses rather than by the definition its authors would give, and section 3.5 records the consequences. It was validated only by inspection: the most-cited record in each sense is the source the sense is named for in section 3.1.

The second stage addressed the framework, where the mapping from cognitive to linguistic constructs was performed. The competences specified by Wiek et al. (2011) and Brundiers et al. (2021), together with the additions of Rieckmann (2012) and Lozano et al. (2017), were taken as the source constructs. Each was interrogated with three questions. First, on what object does the competence operate, that is, what must the student reason about? Second, through what act is that reasoning made available to another party in professional practice, since a competence that is never externalized makes no language demand? Third, is that act realized in a genre whose structure has been described in the applied linguistics literature, and through which linguistic resources?

The third question is what constrains the mapping. A source competence was carried across into a language dimension only where an answer to it could be supported by the retrieved ESP, genre, or ecolinguistics literature, and where two competences yielded the same answer, they were collapsed. Systems thinking and anticipatory competence both operate on quantities and are both externalized as statements of magnitude under uncertainty, so they were collapsed into referential accuracy. Normative and strategic competence are both externalized as justification addressed to a party empowered to refuse, a genre family for which descriptions exist (Khany & Malmir, 2020; Yu & Bondi, 2017), so they were collapsed into discursive accountability. Critical thinking is exercised on claims that are themselves linguistic artifacts and is served by the ecolinguistic apparatus of Stibbe (2014) and Alexander and Stibbe (2014), yielding critical evaluation. Five source competences therefore reduce to three language dimensions, and this reduction results from the mapping rather than from a simplification imposed on it. Section 3.3 reports the derivation in full.

The target genres and assessable outcomes in Table 3 were then specified for each dimension. Both were derived analytically from the source literature and from the professional situations set out in section 3.2. Neither has been validated against practitioner judgment or classroom data, and section 3.5 records this.

3. Result and discussion

This section reports the analysis and discusses it against the three objectives, in five subsections. Section 3.1 addresses the first objective by distinguishing four competing senses of digital sustainability in the retrieved corpus and stipulating the sense adopted here. Section 3.2 addresses the second by setting English for Computer Science against general English language teaching and specifying what makes the former a distinctive pedagogical site. Section 3.3 addresses the third by deriving three language dimensions, competence by competence, from the sustainability competence frameworks, and section 3.4 states the four principles for materials design that follow from them. Section 3.5 records the limitations of the argument and sets out the empirical agenda by which it could be tested.

3.1 Four competing senses of digital sustainability

Digital sustainability is not a settled technical term. Four senses can be distinguished across the retrieved corpus, each with its own disciplinary home and citation network.

The first and most heavily cited sense belongs to entrepreneurship and management. George et al. (2021) use the phrase to denote digital innovation deployed in addressing climate change and sustainable development. The digital is instrumental here: technology is a means of pursuing sustainability outcomes. This sense dominates by citation weight.

The second derives from information science. Alakeson and Wilsdon (2002) used the phrase early, and Stuermer et al. (2017) developed it systematically, specifying basic conditions for sustainable digital artifacts and their ecosystems. Sustainability here concerns the durability, accessibility, and regenerative capacity of digital objects themselves.

The third, adopted in this paper, concerns the environmental footprint of computation: the energy intensity of data centers and model training, the material lifecycle of hardware, electronic waste, and software design for reduced resource consumption. This sense is established in computing education, as Peters et al. (2024) document, but the retrieved corpus indicates it has not crossed into applied linguistics.

The fourth is a policy construct positioning digitalization and greening as a twin transition, concerned with alignment between digital and sustainability competence frameworks. The term digitainability, coined within this space (Gupta et al., 2020; Lichtenthaler, 2021), has been extended to educational digital competences by Sá et al. (2021), whose concern is social sustainability, digital inclusion, and the digital divide rather than environmental impact.

The four senses are not evenly distributed. Table 2 reports the result of coding all 1,347 records in set S1 by the procedure described in section 2.4

Table 2. Senses of digital sustainability in set S1 (n=1,347), coded as in section 2.4

Sense (what is held to be sustained)	Records	% of set	Exemplar named in text; citation share
1. Digital innovation serving sustainable development	427	31.7	George et al. (2021); 47.9%
2. Durability of digital artifacts	20	1.5	Stuermer et al. (2017); 2.8%
3. Environmental footprint of computation	107	7.9	Peters et al. (2024); 5.5%

4. Twin transition as policy construct	570	42.3	Sá et al. (2021); 43.8%
No marker of any sense (term used without stipulation)	221	16.4	-
Unresolved after tie-breaking	2	0.1	-
Total	1,347	100	-

Note. Coding follows the marker sets in section 2.4. Citation shares are computed across the 1,124 records assigned to one of the four senses, not across the whole set. The exemplar column names the source by which each sense is identified in the text; Peters et al. (2024) is the exemplar of sense three but was retrieved in set S2 rather than S1, and no single S1 record accounts for a comparable share of that sense.

Three features of the distribution bear on the argument. First, the policy sense and the innovation sense together account for three quarters of the set and for the great majority of its citations; the two lead on different measures, sense four by volume of records and sense one by citation weight, the latter carried substantially by George et al. (2021), which alone attracts more citations than the whole of senses two and three combined. Second, the environmental sense adopted in this paper is the sparsest of the three substantive senses, at 107 records and under six per cent of the citations in S1. It is a minority usage within the terminology, not the dominant one, which is precisely why a paper adopting it must stipulate its sense rather than assume it. Third, a sixth of the set uses the phrase with no marker of any of the four senses at all, in domains from tourism to health services to organizational scale development, which supports the terminological caution stated in section 1 more directly than the four-way distinction does.

The computing education set S2 gives the counterpart picture, and it qualifies a claim that might otherwise be made too strongly. Of its 202 records, 29 carry an explicit environmental-footprint marker in title, abstract, or keywords, while 101 concern competences, curricula, or learning outcomes under a general heading of sustainability. The environmental sense is therefore established in computing education as a substantive strand, documented in detail by Peters et al. (2024) and Moreira et al. (2025), rather than as the field's dominant frame. The asymmetry between the two sets is nonetheless clear: the terminology of digital sustainability circulates chiefly in senses one and four, in applied and policy literatures, while the educational practice that addresses the environmental sense proceeds largely without the term.

Both sets lack a meeting point with language education. Of the 1,347 records in S1, seven mention language education, of which three treat it substantively; one appeared in a computer-assisted language learning journal and none in an English for Specific Purposes or applied linguistics journal. Of the 202 records in S2, two mention it, and one does so substantively. The intersection set S3 returned 12 records, none of which took computer science undergraduates as the learner population.

For present purposes, digital sustainability denotes the environmental consequences of computational artifacts and practices, together with the professional obligation to account for those consequences. The term digitainability is not adopted, because its educational usage is anchored in social sustainability and would import the wrong emphasis

3.2. English for Computer Science as a distinctive site

General English language teaching and English for Computer Science stand in different relations to sustainability content. In the general classroom, environmental

material functions as subject matter supplying texts to read and topics to discuss. Chiriac (2026) takes this position conceptually, and Lașcu (2026) empirically, and the pedagogical logic is sound: authentic content motivates language work, and the claimed outcomes are linguistic and digital.

Computer science undergraduates occupy a different position. They are not observers of digital environmental impact but its future producers. The energy profile of a training run, the lifespan of a deployed device, and the storage requirements of a logging strategy follow from design decisions the student will make in professional practice. Sustainability is therefore not thematic content for these learners but a property of their own output. This is precisely the situation for which English for Specific Purposes was developed, since ESP is defined by aligning language provision with the target discourse community and its tasks (Anthony, 2018; Dou et al., 2023; see Liu & Hu, 2021, for a bibliometric mapping of the field).

The difference has a direct language consequence. Peters et al. (2024) and Moreira et al. (2025) document what computing curricula cover: the knowledge and design practice required to make sustainable technical decisions. Neither review reports assessment of students' capacity to justify those decisions to audiences outside the discipline. The professional situations in which sustainability claims carry weight are communicative: a design rationale submitted to a client, a response to a procurement questionnaire, an impact statement for a regulator, a rebuttal of a supplier's environmental claim. Comparable professional genres have been shown to have distinctive and teachable structures, as work on corporate environmental reporting demonstrates (Yu & Bondi, 2017; Yu, 2020).

The claim advanced here is therefore a division-of-labor claim, and it is offered as a proposition open to disconfirmation rather than as an established finding. It has indirect support from accreditation practice. The computing accreditation criteria of ABET 2025 require baccalaureate programs to develop both the ability to design, implement, and evaluate a computing-based solution and the ability to communicate effectively in a variety of professional contexts. The two are stated as separate student outcomes, and the criteria specify topics without prescribing the courses in which either outcome is met. Accreditation therefore requires the communicative outcome without locating it, which is consistent with the pattern the two reviews leave visible. It does not establish that pattern: an accreditation requirement is evidence about what programs must claim, not about where or how they assess, and ABET criteria govern a set of programs that does not include most Indonesian informatics degrees. The claim is accordingly stated in the weaker form. On the evidence available, computing courses assess the design; the communicative outcome is required but unlocated, and the language course is a plausible, rather than demonstrated, site for assessing the account. Verification requires curriculum document analysis of the kind proposed in section 3.5, and the framework below should be read as conditional on it.

3.3. Deriving a framework of language competences

The sustainability competence literature provides the starting point. Wiek et al. (2011) proposed a reference framework of key sustainability competencies for academic program development, which Brundiers et al. (2021) refined toward disciplinary consensus. Rieckmann (2012) identified future-oriented key competencies for university teaching, and Lozano et al. (2017) connected competences to pedagogical approaches.

These frameworks converge on systems thinking, anticipatory reasoning, normative judgment, strategic action, and critical thinking.

None specifies language. Their competences are cognitive and dispositional, and the discursive work through which sustainability judgments are communicated and contested remains implicit. Adaptation for English for Computer Science requires making that work explicit, and the derivation proceeds competence by competence.

Systems thinking, in Wiek et al.'s formulation, is the capacity to analyze complex systems across domains and scales. Anticipatory competence, elaborated by Rieckmann (2012), concerns reasoning about future states under uncertainty. Both are exercised on quantities: energy drawn, hardware lifespan, data volume, projected growth. Neither framework asks whether the student can express those quantities. Yet a claim about energy reduction that cannot be stated with correct units, correct order of magnitude, and hedging proportionate to measurement uncertainty cannot be verified by any reader. The language correlate of these two competences is therefore referential accuracy, and its resources are lexical, numerical, and modal.

Normative competence concerns the capacity to specify and negotiate sustainability values, and strategic competence the capacity to design and implement interventions (Wiek et al., 2011; Brundiers et al., 2021). Both are realized, in professional practice, as justification addressed to an audience with the power to accept or reject. Justification is a generic activity: it has a move structure, a stance repertoire, and conventions of evidence and concession, and these have been described for professional and academic genres (Khany & Malmir, 2020; Yu & Bondi, 2017). The language correlate of the normative and strategic competences is therefore discursive accountability, and its unit of instruction is the genre rather than the topic.

Critical thinking appears across the frameworks as the capacity to question norms and practices (Brundiers et al., 2021; Lozano et al., 2017). Applied to technology sustainability claims, this capacity is exercised on language, because the claims themselves are linguistic artifacts. Ecolinguistics supplies the analytic apparatus. Stibbe (2014) sets out an ecolinguistic approach to critical discourse studies; Alexander and Stibbe (2014) distinguish the analysis of ecological discourse from the ecological analysis of discourse; Steffensen and Fill (2014) and Penz and Fill (2022) survey the field, and Mühlhäusler and Peace (2006) situate environmental discourse anthropologically. Yu (2020) examines corporate environmental communication through this lens, as do Triyono et al. (2023) on Indonesian English textbooks; the approach has also been applied to Indonesian tourism discourse (Isti'anah, 2020) and to the conservation discourse of an Indonesian indigenous community (Prastio et al., 2023). The language correlate of critical thinking is therefore critical evaluation, and its objects are nominalization, agent deletion, and metaphor.

Table 3 sets out the three dimensions with their source competences, target genres, and assessable outcomes.

Table 3. Dimensions of digital sustainability language competence in English for Computer Science

Dimension	**Source competence adapted**	**Target genres**	**Lexicogrammatical exponents**	**Assessable outcome**
Referential accuracy	Systems thinking (Wiek	Technical description;	Units and measure nouns	Student states energy, lifecycle

	et al., 2011); anticipatory competence (Rieckmann, 2012)	specification; measurement report	(kWh, gCO2e, TB); expressions of change and baseline (a reduction of, rising to, relative to the 2023 figure); approximators (approximately, in the order of); hedging modals and verbs (may, is likely to, estimated, projected)	and data quantities with correct units, magnitude, and hedging appropriate to measurement uncertainty
Discursive accountability	Normative and strategic competence (Wiek et al., 2011; Brundiers et al., 2021)	Design rationale; proposal justification; procurement response; oral briefing	Move signals of claim, ground, and concession (on this basis, admittedly, we accept that); concessive conjunctions (although, whereas, even so); modals of obligation (must, should, would need to); first-person agency (we chose, the team accepted)	Student constructs a defensible account of a design trade-off, anticipates objection, and concedes within the move structure of the genre
Critical evaluation	Critical thinking and normative competence (Brundiers et al., 2021; Lozano et al., 2017)	Supplier sustainability claim; corporate environmental report; product marketing	Nominalisation of process (emissions reduction, optimisation); agentless passives (emissions were reduced by 40%); quantification without a comparator (up to, as much as, significantly); metaphor in the	Student identifies nominalization, agent deletion, and metaphor through which environmental claims are inflated or responsibility displaced

	green lexis (clean, journey, footprint)

One worked example indicates what the fourth column adds. A supplier statement of the form emissions from our data centers were reduced by 40% in 2025 contains an agentless passive and a nominalization, and the two work together: no party is named as having reduced anything, and the figure carries no baseline, no boundary of measurement, and no distinction between an absolute reduction and a reduction per unit of computation. The teachable operation is restoration. The student rewrites the clause with an agent and a comparator; for instance, we moved 60% of our workload to a provider whose grid mix is cleaner, so emissions per request fell by 40% against our own 2023 figure, and then states which of the restored elements the original does not supply. The exercise is linguistic throughout, and success depends on identifying the missing elements, not on whether the student approves of the supplier.

Taken together, the dimensions describe a graduate who can state what a system costs environmentally, justify the trade-offs accepted in its design, and recognize when a competing claim will not withstand scrutiny. Each is a language outcome, and each is assessable by language criteria.

3.4 Design principles for course materials

Four principles follow, and each connects to established practice in ESP materials development (Stoller & Robinson, 2018; Kırkgöz & Dikilitaş, 2018). Materials should take the students' own artifacts as primary content. Where a general English course supplies a reading passage about climate change, an English for Computer Science course can take a piece of code, a system architecture, or a deployment configuration produced by the students themselves and require an environmental account of it. Authenticity derives from ownership rather than from source, and the specialized language required can be established through corpus-informed description of the target domain (Flowerdew, 2017).

Tasks should be organized around professional communicative situations rather than topics. A task specified as a response to a client sustainability query generates different language demands and assessment criteria than a task specified as a discussion of environmental issues. The route from needs analysis to task design described by Malicka et al. (2019) offers a procedure; the divergence between classroom or testing language and target-domain discourse documented by Staples et al. (2017) indicates what is at stake in specifying the task correctly, and the project-based structure used by Stahl et al. (2022) in software engineering education offers a delivery model that computing students already recognize.

Assessment should target the account rather than the position. A student who defends a design decision that increases energy consumption, and does so with accurate evidence and appropriate concession, demonstrates the competence at issue. Materials rewarding environmentally approved conclusions rather than defensible reasoning collapse a language objective into an attitudinal one, and forfeit the disciplinary credibility on which ESP provision depends.

Critical evaluation should use authentic promotional material. Supplier sustainability claims, product marketing, and corporate environmental reporting supply

texts in which the mechanisms of overstatement can be examined directly (Yu, 2020), connecting the third dimension to material students will meet in practice.

A short illustration shows how the four principles combine in a single task. Students work in pairs, each pair bringing a machine learning model it trained in an earlier programming course. The pair prepares a five-minute oral briefing addressed to a corporate sustainability officer who has asked why the training run consumed the energy it did and whether that expenditure is justified. The role is specified rather than left open: the officer is not hostile, is not a specialist, and has the authority to require that the model be retrained under a constraint. Preparation exercises all three dimensions. The pair must state the figure with a unit and a stated baseline, hedged to the precision the measurement supports; it must construct a justification that names the trade-off accepted, anticipates the officer's most obvious objection, and concedes what cannot be defended; and it must prepare for a follow-up in which the officer cites a competitor's advertised claim of a carbon-neutral training pipeline, which the pair is required to evaluate rather than to accept or dismiss. The artifact is the students' own, the situation is professional rather than topical, the promotional text is authentic, and the criteria are those in Table 3. In keeping with the third principle, a pair concluding that the expenditure was justified and a pair concluding that it was not can receive the same mark.

3.5 Limitation and research agenda

Five limitations qualify the framework. It rests on literature retrieved from a single database, so coverage of regional, non-English, and non-indexed scholarship is incomplete, and Indonesian-language scholarship is particularly underrepresented. It assumes a professional trajectory for computer science graduates that may not hold uniformly; graduates entering domestic small-enterprise employment may encounter the posited genres rarely or not in English. The division-of-labor claim in section 3.2 rests on the absence of reported assessment in two review articles, and the absence of a report is weaker evidence than examination of curricula. The three dimensions have not been operationalized as measurable constructs, so their separability is asserted rather than demonstrated. And the literature search followed no established review protocol and was screened and coded by a single analyst without a second rater, so the record counts reported above should be read as indicative of the shape of the field rather than as the output of a systematic review; and the coding reported in Table 2 is an automated marker-based proxy applied by a single analyst, which classifies records by the vocabulary they use rather than by the definitions their authors hold, was not checked against manual reading of a validation sample, and leaves a sixth of the set unassigned, so the percentages should be read as orders of magnitude rather than as measurements. The target genres and assessable outcomes in Table 3 were likewise derived analytically rather than validated against practitioner judgment. These limitations are not merely to be registered, because the third of them fixes the order of the agenda that follows. So long as the division-of-labor claim rests on the absence of report in two reviews rather than on examination of what programs actually assess, the framework has no warrant to be implemented. The immediate next step for research is therefore not a classroom trial but an empirical document analysis of computer science curricula and of the English provision attached to them, which is where the agenda below begins.

Four lines of work follow, in order of priority. A document analysis of English for Computer Science syllabi and of informatics curricula in Indonesian universities would

test the division-of-labor claim directly and establish the current baseline. A needs analysis with informatics undergraduates, graduates in employment, and their employers would establish whether the communicative situations posited here are those graduates actually encounter, following the procedure of Malicka et al. (2019). A small corpus of authentic professional texts in which computing sustainability decisions are justified would allow the move structures assumed in dimension two to be described rather than presumed. And a design-based study implementing the framework across one semester would test whether the three dimensions can be taught and assessed as specified. Only after the first two should the framework be treated as more than a proposal.

4. Conclusion

Sustainability has entered computing education and language education along separate paths that have not converged. Computing education has treated it as technical knowledge. Language education has treated it as thematic content supporting language development. Computer science undergraduates fall between these treatments, because they will build the systems whose environmental costs are at issue and will be required to account for these costs in English to audiences outside their discipline.

This paper has argued that English for Computer Science should treat digital sustainability as an object of professional accountability rather than as classroom subject matter. It has distinguished four competing senses of the term and stipulated the environmental sense for pedagogical use. It has derived, competence by competence, three language dimensions from established sustainability competence frameworks, covering referential accuracy, discursive accountability, and critical evaluation, and specified target genres and assessable outcomes for each. Four principles for materials design follow.

The contribution is terminological, pedagogical, and methodological. The methodological element is modest but transferable: researchers searching across applied linguistics and computing should expect the abbreviations of one field to denote unrelated objects in the other, and should expand them. Whether the framework holds under classroom conditions is an empirical question, and the agenda in section 3.5 indicates how it might be answered. What can be claimed at this stage is narrower: the language demands of digital sustainability are real, the computing curriculum does not appear to address them, and English for Specific Purposes provision for computer science students is the appropriate place to do so.

One implication returns the argument to where it began. The agenda is set in Indonesian higher education not only because it is the context the author knows but because what is at stake there is not only curricular. The forums in which environmental claims about computing systems are contested, and in which procurement, reporting, and regulation are settled, operate in English and are largely located elsewhere. A graduate who can state what a system costs, defend the trade-offs accepted in building it, and show where a competitor's claim will not hold has standing in those forums; a graduate who cannot is spoken for in them by somebody else. Provision that develops this capacity therefore bears on who is able to speak with authority about the environmental consequences of the systems the global industry deploys, which is a question of distribution as much as of pedagogy.

Conflicts of Interest: The authors declare no conflict of interest.

References

ABET. (2025). Criteria for accrediting computing programs, 2025–2026. ABET. https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-computing-programs-2025-2026/

Alakeson, V., & Wilsdon, J. (2002). Digital sustainability in Europe. Journal of Industrial Ecology, 6(2), 10–12. https://doi.org/10.1162/108819802763471744

Alexander, R., & Stibbe, A. (2014). From the analysis of ecological discourse to the ecological analysis of discourse. Language Sciences, 41, 104–110. https://doi.org/10.1016/j.langsci.2013.08.011

Alharbi, M. S. (2026). Greening the classroom: Cultivating sustainable futures through English language teaching. Social Sciences and Humanities Open, 13, Article 102491. https://doi.org/10.1016/j.ssaho.2026.102491

Anthony, L. (2018). Introducing English for specific purposes. Routledge. https://doi.org/10.4324/9781351031189

Balula, A., Vasconcelos, S., & Costa, R. (2025). Embedding sustainability awareness into English for specific purposes learning. In A. Reis, J. P. Cravino, L. Hadjileontiadis, P. Martins, S. B. Dias, S. Hadjileontiadou, & T. Mikropoulos (Eds.), Technology and innovation in learning, teaching and education (Communications in Computer and Information Science, Vol. 2480, pp. 371–379). Springer. https://doi.org/10.1007/978-3-032-02672-9_29_27

Bocanegra-Valle, A., & Basturkmen, H. (2019). Investigating the teacher education needs of experienced ESP teachers in Spanish universities. Ibérica, 38, 127–150.

Brundiers, K., Barth, M., Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S., Dripps, W., Habron, G., Harré, N., Jarchow, M., Losch, K., Michel, J., Mochizuki, Y., Rieckmann, M., Parnell, R., Walker, P., & Zint, M. (2021). Key competencies in sustainability in higher education: Toward an agreed-upon reference framework. Sustainability Science, 16(1), 13–29. https://doi.org/10.1007/s11625-020-00838-2

Chiriac, T. (2026). Integrating digital and green education: A conceptual framework for English language learners. Proceedings of the International Conference on Virtual Learning, 21, 201–212. https://doi.org/10.58503/icvl-v21y202617

Dou, A. Q., Chan, S. H., & Win, M. T. (2023). Changing visions in ESP development and teaching: Past, present, and future vistas. Frontiers in Psychology, 14, Article 1140659. https://doi.org/10.3389/fpsyg.2023.1140659

Flowerdew, J. (2017). Corpus-based approaches to language description for specialized academic writing. Language Teaching, 50(1), 90–106. https://doi.org/10.1017/S0261444814000378

George, G., Merrill, R. K., & Schillebeeckx, S. J. D. (2021). Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development. Entrepreneurship Theory and Practice, 45(5), 999–1027. https://doi.org/10.1177/1042258719899425

Gupta, S., Motlagh, M., & Rhyner, J. (2020). The digitalization sustainability matrix: A participatory research tool for investigating digitainability. Sustainability, 12(21), Article 9283. https://doi.org/10.3390/su12219283

Isti'anah, A. (2020). (Re)evaluating language attitudes on Indonesian tourism website: A study on ecolinguistics. Studies in English Language and Education, 7(2), 622–641. https://doi.org/10.24815/siele.v7i2.16683

Iswati, L., & Triastuti, A. (2021). Voicing the challenges of ESP teaching: Lessons from ESP in non-English departments. Studies in English Language and Education, 8(1), 276–293. https://doi.org/10.24815/siele.v8i1.17301

Kapranov, O. (2022). The discourse of sustainability in English language teaching (ELT) at the University of Oxford: Analyzing discursive representations. Journal of Teacher Education for Sustainability, 24(1), 35–48. https://doi.org/10.2478/jtes-2022-0004

Karasaliu, A., Pylli, E., & Burda, M. (2025). Preparing real-world professionals: Integrating translation, sustainability, and digital media in English for specific purposes (ESP) education. Studies in Media and Communication, 13(4), 83–93. https://doi.org/10.11114/smc.v13i4.7637

Khany, R., & Malmir, B. (2020). A move-marker list: A study of rhetorical move-lexis linguistic realizations of research article abstracts in social and behavioural sciences. RELC Journal, 51(3), 381–396. https://doi.org/10.1177/0033688219833131

Kırkgöz, Y., & Dikilitaş, K. (2018). Recent developments in ESP/EAP/EMI contexts. In Y. Kırkgöz & K. Dikilitaş (Eds.), Key issues in English for specific purposes in higher education (English Language Education, Vol. 11, pp. 1–10). Springer. https://doi.org/10.1007/978-3-319-70214-8__1

Laşcu, T. (2026). Developing environmental awareness and digital competency through English language education. Proceedings of the International Conference on Virtual Learning, 21, 601–612. https://doi.org/10.58503/icvl-v21y202650

Lichtenthaler, U. (2021). Digitainability: The combined effects of the megatrends digitalization and sustainability. Journal of Innovation Management, 9(2), 64–80. https://doi.org/10.24840/2183-0606_009.002_0006

Liu, Y., & Hu, G. (2021). Mapping the field of English for specific purposes (1980–2018): A co-citation analysis. English for Specific Purposes, 61, 97–116. https://doi.org/10.1016/j.esp.2020.10.003

Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2017). Connecting competences and pedagogical approaches for sustainable development in higher education: A literature review and framework proposal. Sustainability, 9(10), Article 1889. https://doi.org/10.3390/su9101889

Malicka, A., Gilabert Guerrero, R., & Norris, J. M. (2019). From needs analysis to task design: Insights from an English for specific purposes context. Language Teaching Research, 23(1), 78–106. https://doi.org/10.1177/1362168817714278

Moreira, A., Lago, P., Heldal, R., Betz, S., Brooks, I., Capilla, R., Coroamă, V. C., Duboc, L., Fernandes, J. P., Leifler, O., Nguyen, N.-T., Oyedeji, S., Penzenstadler, B., Peters, A.-K., Porras, J., & Venters, C. C. (2025). A roadmap for integrating sustainability into software engineering education. ACM Transactions on Software Engineering and Methodology, 34(5), Article 139. https://doi.org/10.1145/3708526

Mühlhäusler, P., & Peace, A. (2006). Environmental discourses. Annual Review of Anthropology, 35, 457–479. https://doi.org/10.1146/annurev.anthro.35.081705.123203

Nilan, P. (2017). The ecological habitus of Indonesian student environmentalism. Environmental Sociology, 3(4), 370–380. https://doi.org/10.1080/23251042.2017.1320844

Penz, H., & Fill, A. (2022). Ecolinguistics: History, today, and tomorrow. Journal of World Languages, 8(2), 232–253. https://doi.org/10.1515/jwl-2022-0008

Peters, A.-K., Capilla, R., Coroamă, V. C., Heldal, R., Lago, P., Leifler, O., Moreira, A., Fernandes, J. P., Penzenstadler, B., Porras, J., & Venters, C. C. (2024). Sustainability in computing education: A systematic literature review. ACM Transactions on Computing Education, 24(1), Article 13. https://doi.org/10.1145/3639060

Petraki, E., & Khat, K. (2022). Challenges and constraints in the design of an ESP course in Cambodia: Implications for higher education institutions. Asia Pacific Journal of Education, 42(2), 260–275. https://doi.org/10.1080/02188791.2020.1798738

Prastio, B., Santoso, A., Roekhan, M., A., N., I. W., & Suardana, I. P. O. (2023). An ecolinguistic study: The representation of forest conservation practices in the discourse of Anak Dalam Jambi tribe, Indonesia. Cogent Arts & Humanities, 10(1), Article 2262788. https://doi.org/10.1080/23311983.2023.2262788

Rasyimah, A. J., & Sari, D. K. (2018). Challenges in designing an ESP course for first-year students of the Faculty of Engineering at Malikussaleh University. Emerald Reach Proceedings Series, 1, 563–568. https://doi.org/10.1108/978-1-78756-793-1-00020

Rieckmann, M. (2012). Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? Futures, 44(2), 127–135. https://doi.org/10.1016/j.futures.2011.09.005

Sá, M. J., Santos, A. I., Serpa, S., & Ferreira, C. M. (2021). Digitainability: Digital competences post-COVID-19 for a sustainable society. Sustainability, 13(17), Article 9564. https://doi.org/10.3390/su13179564

Semerikov, S., Striuk, A., Striuk, L., Striuk, M., & Shalatska, H. (2020). Sustainability in software engineering education: A case of general professional competencies. E3S Web of Conferences, 166, Article 10036. https://doi.org/10.1051/e3sconf/202016610036

Stahl, D., Sandahl, K., & Buffoni, L. (2022). An eco-system approach to project-based learning in software engineering education. IEEE Transactions on Education, 65(4), 514–523. https://doi.org/10.1109/TE.2021.3137344

Staples, S., LaFlair, G. T., & Egbert, J. (2017). Comparing language use in oral proficiency interviews to target domains: Conversational, academic, and professional discourse. Modern Language Journal, 101(1), 194–213. https://doi.org/10.1111/modl.12385

Steffensen, S. V., & Fill, A. (2014). Ecolinguistics: The state of the art and future horizons. Language Sciences, 41, 6–25. https://doi.org/10.1016/j.langsci.2013.08.003

Stibbe, A. (2014). An ecolinguistic approach to critical discourse studies. Critical Discourse Studies, 11(1), 117–128. https://doi.org/10.1080/17405904.2013.845789

Stoller, F. L., & Robinson, M. S. (2018). Innovative ESP teaching practices and materials development. In Y. Kırkgöz & K. Dikilitaş (Eds.), Key issues in English for specific purposes in higher education (English Language Education, Vol. 11, pp. 29–49). Springer. https://doi.org/10.1007/978-3-319-70214-8_3

Stuermer, M., Abu-Tayeh, G., & Myrach, T. (2017). Digital sustainability: Basic conditions for sustainable digital artifacts and their ecosystems. Sustainability Science, 12(2), 247–262. https://doi.org/10.1007/s11625-016-0412-2

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., … Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and

explanation. Annals of Internal Medicine, 169(7), 467–473. https://doi.org/10.7326/M18-0850

Triyono, S., Sahayu, W., Margana, & Fath, S. N. (2023). Ecological discourse and environmental education in English textbooks: A multimodal eco-critical discourse analysis. 3L: Language, Linguistics, Literature, 29(3), 213–227. https://doi.org/10.17576/3L-2023-2903-15

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. Sustainability Science, 6(2), 203–218. https://doi.org/10.1007/s11625-011-0132-6

Yu, D. (2020). Corporate environmentalism: A critical metaphor analysis of Chinese, American, and Italian corporate social responsibility reports. IEEE Transactions on Professional Communication, 63(3), 244–258. https://doi.org/10.1109/TPC.2020.3012728

Yu, D., & Bondi, M. (2017). The generic structure of CSR reports in Italian, Chinese, and English: A corpus-based analysis. IEEE Transactions on Professional Communication, 60(3), 273–291. https://doi.org/10.1109/TPC.2017.2702040