

NEEDS ANALYSIS FOR DEVELOPING MULTIMODAL ENGLISH FOR SCIENCE AND TECHNOLOGY TEACHING MATERIALS FOR COMPUTER SCIENCE STUDENTS IN AN ARCHIPELAGIC CONTEXT

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Abstract:

English for Specific Purposes (ESP) materials for Computer Science should be grounded in learners' actual academic and disciplinary needs. This study reports the needs-analysis stage and preliminary design of multimodal English for Science and Technology (EST) teaching materials for Computer Science students in an archipelagic higher education context. A descriptive survey was conducted with 22 second-semester Computer Science students who had previously taken an English course. Data were collected using a 15-item five-point Likert questionnaire, multiple-response items, priority-skill questions, and an open-ended suggestion item. Descriptive analysis showed an overall mean of 4.95 out of 5, equivalent to 99.09% of the maximum score, indicating a very high perceived need for contextual EST materials. Eleven questionnaire items obtained a perfect mean of 5.00. Among 21 valid responses to the priority-skill item, reading was selected most frequently (61.90%), followed by vocabulary and listening (19.05% each). Information and Digital Technology was selected by all students (100%), followed by Sustainable Island Development (68.18%), Environmental Science (54.55%), and Renewable Energy (45.45%). All respondents preferred learning videos, PDF e-modules, and materials containing pictures, graphs, and infographics; 45.45% also selected project-based exercises. Open-ended responses further emphasized discipline-specific digital technology content. The findings provide an empirical basis for a reading-centered, multimodal, and context-responsive EST e-module. Further research should validate the product with experts and examine its practicality and effectiveness through classroom implementation.

Keywords: *English for Specific Purposes; English for Science and Technology; needs analysis; Computer Science; multimodal materials; archipelagic context.*

Introduction

English has a central role in contemporary science and technology because a substantial proportion of technical documentation, software interfaces, scientific publications, online tutorials, programming resources, and professional communication is available in English. For Computer Science students, English is therefore not only a general university subject but also an enabling competence for accessing disciplinary knowledge and participating in academic and professional communities. The rapidly changing nature of digital technology strengthens the need for English instruction that is closely connected to students' field of study rather than relying solely on general English topics.

English for Specific Purposes (ESP) offers an appropriate framework for this purpose because course content is determined by the communicative, academic, and professional demands of a particular group of learners. Hutchinson and Waters (1987) describe ESP as an approach in which decisions about content and method are based on learners' reasons for learning, while Dudley-Evans and St John (1998) emphasize the close relationship between ESP and the disciplines or occupations it serves. Needs analysis is consequently a foundational process in ESP course and materials design because it helps identify what learners need to do with English, what they currently lack, and how they prefer to learn (Brown, 2016; Hyland, 2006).

Recent research continues to demonstrate the importance of needs-based design in science and engineering contexts. Nateghian (2024) found a mismatch between existing ESP courses and the actual workplace communication requirements of civil engineering students and professionals, reinforcing the need for tailor-made instruction. Huang and Wible (2024) likewise show that disciplinary reading is situated within the practices of the subject classroom and cannot be treated as decontextualized language practice. In Indonesia, Septiana, Petrus, and Inderawati (2020) demonstrated that Computer Science students required a syllabus informed by target, deficiency, and learning-strategy analyses, while Andas, Karman, and Mulyadi (2021) reported that Computer Science students prioritized speaking and reading with vocabulary related to their discipline. More recently, Rifiyanti (2025) found that Information Technology students preferred practical ESP learning linked to technical documentation, professional tasks, and project-based activities.

The design of materials also needs to respond to changes in how scientific and technical knowledge is communicated. Digital communication increasingly combines written language with images, graphs, animation, audio, video, and other semiotic resources. Girón-García and Fortanet-Gómez (2023) highlight the pedagogical value of science dissemination videos as multimodal resources in higher education ESP, while Xia (2023) demonstrates how verbal and visual modes jointly support the communication of scientific knowledge. Hafner et al. (2023) further argue that digital mediation has expanded the range of genres and practices that ESP pedagogy needs to address. These developments suggest that EST materials for Computer Science students should not be limited to printed reading passages, but should integrate visual, audiovisual, and interactive resources.

Context is equally important. Higher education institutions in archipelagic regions face distinctive educational realities, including geographical distance, uneven connectivity, and the need to connect academic knowledge with local environmental and development issues. A study in the Kei Islands reported that digital learning practices are shaped by technological access, students' confidence, and pedagogical support, indicating the value of context-sensitive English learning resources (Renyaan, Renhoran, & Reniwuryaan, 2026). At the same time, themes such as sustainable island development, environmental science, renewable energy, and digital technology provide meaningful interdisciplinary contexts through which Computer Science students can develop English while relating technological knowledge to the realities of their region.

Despite the relevance of ESP, multimodality, and contextual learning, locally developed EST materials specifically tailored to Computer Science students in an archipelagic higher education setting remain limited. The present study therefore focuses on the Analysis stage of an ADDIE-oriented materials-development process and translates the findings into a preliminary material design. This scope is intentionally limited: the study does not claim that the proposed material has yet been expert-validated or proven effective in classroom implementation. Instead, it establishes an empirical foundation for subsequent development, validation, implementation, and evaluation.

Research Objectives

This study aims to identify the English learning needs and material preferences of second-semester Computer Science students and to use the findings as an empirical basis for the preliminary design of multimodal English for Science and Technology teaching materials. Specifically, the study examines: (1) the degree of students' perceived need for EST-related competencies and contextual materials; (2) the English skill they prioritize; (3) the science and technology topics they prefer; (4) the learning-material formats they expect; and (5) the implications of these preferences for an initial EST e-module design.

Research Significance

The study contributes practically to the preparation of discipline-specific English materials for Computer Science students and theoretically to the application of needs analysis in an ESP/EST context. By combining disciplinary relevance, multimodal learning preferences, and archipelagic themes, the study offers a context-responsive basis for materials development. The results may assist English lecturers and Computer Science lecturers in coordinating language content with students' academic field and may serve as an initial model for institutions in other island or remote higher education settings.

Research Method

This study employed a descriptive quantitative needs-analysis design as the first stage of a broader materials-development process. The ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation) was used as the general development orientation because it provides a systematic sequence for instructional-material design (Branch, 2009). However, the present article reports only the Analysis stage and the resulting preliminary Design. This delimitation follows the principle that ESP materials should first be grounded in learner needs before full product development and classroom testing (Iswati, 2019).

The participants were 22 second-semester students of the Computer Science Study Program. The group consisted of 13 male students and nine female students. All 22 respondents stated that they had previously taken an English course. The participants were selected because they represented the intended users of the proposed EST materials and had prior experience with university-level English learning.

Data were collected through a questionnaire consisting of respondent identity questions, 15 statements on the need for EST competencies and teaching materials, priority-skill and topic-selection questions, learning-format preferences, and an open-ended suggestion item. The 15 core statements used a five-point scale: 1 = very low/not needed, 2 = low/not needed, 3 = moderately needed, 4 = needed, and 5 = very highly needed. The items addressed reading scientific and technological texts, technical vocabulary, scientific articles, process explanation, interpretation of graphs and data, report writing, scientific presentation, discipline relevance, archipelagic and environmental contexts, digital technology topics, project-based activities, visual support, independent learning, and perceived academic/professional usefulness.

The Likert responses were analyzed using frequencies, mean scores, and percentage of the maximum possible score. The percentage was calculated by dividing the obtained score by the maximum score and multiplying by 100. For descriptive interpretation, 81-100% was categorized as very high, 61-80% as high, 41-60% as moderate, 21-40% as low, and 0-20% as very low. Multiple-response items were analyzed by counting how many students selected each option; therefore, percentages for those items can exceed 100% when summed. Open-ended suggestions were grouped into recurring content themes. One student did not provide a valid response to the single-priority language-skill item; consequently, skill percentages are reported using 21 valid responses, while all other analyses use the full sample of 22 students.

Results and Discussion

Respondent Profile and Overall Need for EST Materials

The respondent profile shows that the study involved a relatively balanced group of second-semester Computer Science students, with 13 male students (59.09%) and nine female students (40.91%). All respondents (100%) had previous experience taking an English course. This background is important because their responses reflect perceptions formed after exposure to English instruction rather than expectations from students who had never experienced the subject.

Table 1. Respondent Profile

Characteristic	Frequency	Percentage
Male	13	59.09%
Female	9	40.91%
Had taken English course	22	100%

The 15-item needs questionnaire produced an overall score of 1,635 from a maximum possible score of 1,650. The overall mean was 4.95 out of 5, equivalent to 99.09% of the maximum score. On the descriptive criteria used in this study, this result represents a very high level of perceived need. Eleven of the 15 items received a perfect mean score of 5.00. The remaining four items also remained very high, with means ranging from 4.59 to 4.91. The consistency of these responses indicates that the demand for contextual and discipline-related English materials was not confined to one isolated skill but extended across reading, vocabulary, scientific communication, visual data, digital topics, contextual content, and independent learning.

Table 2. Needs Questionnaire Results (n = 22)

No.	Focus of Item	Score 5	Score 4	Score 3	Mean	%
1	Reading science/technology texts	22	0	0	5.00	100.00
2	Technical science/technology vocabulary	22	0	0	5.00	100.00
3	Understanding English scientific articles	20	2	0	4.91	98.18
4	Explaining scientific/technological processes	22	0	0	5.00	100.00
5	Understanding graphs, tables, and data	22	0	0	5.00	100.00
6	Writing simple reports in English	15	5	2	4.59	91.82
7	Scientific presentation in English	20	2	0	4.91	98.18
8	Topics related to the study program	22	0	0	5.00	100.00
9	Maluku/Kei science and technology context	22	0	0	5.00	100.00
10	Marine and coastal environment topics	22	0	0	5.00	100.00
11	Information and digital technology topics	22	0	0	5.00	100.00
12	Project/problem-based learning	20	2	0	4.91	98.18
13	Pictures, tables, and illustrations	22	0	0	5.00	100.00
14	Materials for independent learning	22	0	0	5.00	100.00
15	Usefulness for academic/future work	22	0	0	5.00	100.00

The high score on discipline relevance (Item 8) supports the basic ESP principle that materials for non-English majors should connect language learning with the learners' subject area. Similar needs have been found among Computer Science students in Indonesia. Andas et al. (2021) reported that students wanted English learning connected to Computer Science vocabulary and prioritized reading and speaking, while Septiana et al. (2020) concluded that a Computer Science English syllabus should be derived from target and learning needs and should make greater use of technology. The present data reinforce these findings but add a strong multimodal and archipelagic orientation.

Priority Language Skill

Reading emerged as the clearest priority in the single-skill question. Of 21 valid responses, 13 students selected reading (61.90%), four selected vocabulary (19.05%), and four selected listening (19.05%). One student did not provide a valid selection for this item. The preference for reading is especially relevant to Computer Science because students routinely encounter English-language documentation, software instructions, technical articles, programming references, error messages, online forums, and research literature. Reading in this context is therefore better understood as disciplinary access rather than a conventional classroom exercise.

Table 3. Priority English Skill

Skill	Valid Responses	Valid %
Reading	13	61.90%
Vocabulary	4	19.05%
Listening	4	19.05%

This result is consistent with research emphasizing the situated nature of disciplinary reading. Huang and Wible (2024) show that engineering students' reading practices are closely linked to disciplinary tasks and classroom resources. It also aligns partly with Andas et al. (2021), who found reading to be one of the priority skills for Computer Science students. Accordingly, the proposed materials should place reading at the center while integrating vocabulary and listening as supporting competencies rather than treating the skills as isolated components.

Preferred Science and Technology Topics

Students were asked to select three preferred science and technology topics. Because this was a multiple-response item, 66 topic selections were recorded from 22 students. Information and Digital Technology was selected by every respondent (22 students; 100%). Sustainable Island Development ranked second with 15 students (68.18%), followed by Environmental Science with 12 students (54.55%), Renewable Energy with 10 students (45.45%), Biodiversity with four students (18.18%), and Waste Management with three students (13.64%).

Table 4. Preferred Topics for EST Materials (multiple response)

Topic	Students Selecting	% of Students
Information and Digital Technology	22	100.00%
Sustainable Island Development	15	68.18%
Environmental Science	12	54.55%
Renewable Energy	10	45.45%
Biodiversity	4	18.18%
Waste Management	3	13.64%

The unanimous selection of Information and Digital Technology confirms that the primary content base should remain firmly connected to Computer Science. However, the strong interest in Sustainable Island Development and Environmental Science shows that disciplinary English can also be connected with regional challenges. Rather than replacing Computer Science content with environmental topics, the materials can combine them through authentic technological applications, for example digital mapping for island services, information systems for coastal communities, environmental data visualization, renewable-energy monitoring, smart waste management, or digital solutions for sustainable tourism. Such integration preserves disciplinary specificity while creating locally meaningful contexts.

Preferred Learning Material Formats

Students expressed an exceptionally consistent preference for multimodal learning resources. All 22 respondents (100%) selected learning videos, PDF e-modules, and materials containing pictures, graphs, and infographics. In addition, 10 students (45.45%) selected project-based exercises as an additional preferred format. These responses support the inclusion of multiple modes of representation rather than a text-only coursebook.

Table 5. Preferred Learning Material Formats (multiple response)

Format	Students Selecting	% of Students
Learning videos	22	100.00%
PDF e-module	22	100.00%
Pictures, graphs, and infographics	22	100.00%
Project-based exercises	10	45.45%

The multimodal preference is supported by developments in ESP scholarship. Girón-García and Fortanet-Gómez (2023) argue that science dissemination videos offer disciplinary and pedagogical affordances for ESP learning, while Xia (2023) demonstrates that visual and verbal resources work together in the communication of scientific knowledge. Katsampoxaki-Hodgetts (2024) similarly highlights the growing importance of visual remediation in scientific communication. For Computer Science students, graphs, interface screenshots, flow diagrams, infographics, and short videos are not decorative additions; they reflect common ways in which technical knowledge is encountered and communicated.

Open-Ended Suggestions

The open-ended responses further strengthened the disciplinary orientation of the quantitative findings. Eighteen respondents (81.82%) explicitly suggested Information and Digital Technology as the content focus, while four respondents (18.18%) requested materials directly related to their study program. Although phrased differently, all 22 suggestions emphasized the relevance of the students' academic field. The responses can therefore be grouped under one overarching theme: discipline-specific and digital-technology-oriented English materials.

This result is compatible with contemporary ESP needs analysis, which emphasizes alignment between course content and authentic disciplinary or workplace communication. Nateghian (2024) shows that generic ESP textbooks may fail to address actual language use when they are not sufficiently tailored to a specialization. Rifiyanti (2025) also reports that IT students value practical, specialized English and task-oriented learning. The present findings suggest that the proposed EST material should use Computer Science content not merely as a topic label but as the source of texts, vocabulary, visuals, tasks, and communicative purposes.

Preliminary Design of the Proposed EST E-Module

The needs-analysis results were translated into a preliminary design rather than a fully validated product. Following materials-development principles that emphasize relevance, meaningful input, learner engagement, and contextualized use of language (Tomlinson, 2011), the proposed module is designed as a PDF-based multimodal e-module supported by short learning videos and visual resources. Reading is positioned as the core skill, while technical vocabulary, listening, speaking, data interpretation, and short writing tasks are integrated around each reading topic.

Table 6. Preliminary Blueprint of the Multimodal EST E-Module

Unit	Main Topic	Language/Skill Focus	Multimodal/Task Element
1	English in Computer Science	Reading strategies; core technical vocabulary	Infographic: fields of computing; short orientation video
2	Information and Digital Technology	Main ideas; technical definitions; word formation	Technology infographic; terminology matching
3	Computer Systems and Devices	Describing functions and components	Labeled diagrams; product/specification video
4	Internet, Networks, and Cybersecurity	Reading technical explanations; cause-effect	Network diagram; security-awareness video
5	Software, Applications, and AI	Process explanation; sequence markers	Flowchart; short AI/application demo video
6	Reading Technical Documentation	Scanning; instructions; troubleshooting vocabulary	Authentic-style manual excerpts; interface screenshots
7	Graphs, Tables, and Digital Data	Interpreting trends, quantities, and comparisons	Charts/infographics; data-description task
8	Technology for Sustainable Islands	Reading interdisciplinary technology texts	Island-development infographic; problem-based mini project
9	Environmental and Renewable-Energy Technology	Cause-effect; problem-solution language	Visual data; short science video
10	Mini Digital Technology Project	Integrated reading, vocabulary, speaking, and writing	Group/project task; poster/infographic and short presentation

Each unit is proposed to follow a consistent learning sequence: learning objectives, warm-up/visual activation, reading input, technical vocabulary, comprehension activities, visual or infographic interpretation, video-based listening, language focus, a short communicative or writing task, and reflection. Selected units can include project-based tasks, especially because 45.45% of respondents explicitly requested this format and nearly all respondents rated project/problem-based learning very highly in the core questionnaire. This sequence is intended to maintain the strong reading preference while enabling integrated language use.

The proposed design also responds to the archipelagic context without diluting Computer Science specificity. Sustainable island themes can be incorporated through technology-mediated problems and datasets rather than through generic cultural content. For example, a unit can require students to read a short text about a digital early-warning system, interpret a graph of connectivity or environmental data, identify technical vocabulary, watch a short explanatory video, and propose a simple digital solution for an island community. This approach connects global English-language technological knowledge with regional relevance.

Implications and Limitations

The findings have two immediate implications. First, English materials for Computer Science should be needs-based and discipline-specific. Second, the preferred form is clearly multimodal: students expect a combination of e-module text, video, pictures, graphs, and infographics. These preferences should guide not only appearance but also task design. Digital and visual modes need to be pedagogically integrated so that students learn to read technical information across modes, a competence increasingly relevant to scientific and professional communication (Darvin, 2023; Hafner et al., 2023).

The study has several limitations. The sample is small and limited to one second-semester Computer Science cohort, so the results should not be generalized to all Computer Science students or institutions. The study relies primarily on students' self-reported perceptions and does not yet triangulate the findings with interviews from Computer Science lecturers, English lecturers, alumni, or employers. Most importantly, this article reports needs analysis and preliminary design only; expert validation, product revision, classroom implementation, practicality testing, and effectiveness testing remain necessary before the materials can be described as a validated instructional product. These limitations define the next stages of the research rather than reducing the value of the needs-analysis findings.

Conclusion

This study identified a very high need for contextual English for Science and Technology materials among 22 second-semester Computer Science students. The 15-item questionnaire produced an overall mean of 4.95 out of 5 (99.09% of the maximum score), with eleven items obtaining a perfect mean of 5.00. Reading was the dominant priority among valid single-skill responses, while Information and Digital Technology was selected by all respondents as a preferred topic. Students also demonstrated strong interest in Sustainable Island Development, Environmental Science, and Renewable Energy, creating an opportunity to connect Computer Science English with locally relevant archipelagic issues. All respondents preferred videos, PDF e-modules, and visually supported materials, and almost half selected project-based exercises as an additional format. Open-ended responses consistently called for materials related to digital technology and the Computer Science program. Based on these findings, the study proposes a preliminary reading-centered, multimodal EST e-module that integrates technical vocabulary, visual data, videos, and discipline-specific tasks within selected archipelagic sustainability contexts. The present findings constitute the Analysis and preliminary Design stages of materials development. Future research should conduct expert validation, revise the product, implement it in the classroom, and evaluate its practicality and effectiveness with a larger sample.

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