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Designing a CLIL Based ESP Curriculum for Computer Science and Engineering Programs at Alamein International University

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Abstract

This study presents the design and implementation of a Content and Language Integrated Learning (CLIL) based English for Specific Purposes (ESP) curriculum tailored for Computer Science and Engineering (CSE) students at Alamein International University (AIU). The research was guided by a comprehensive needs analysis process, incorporating both student needs and faculty perspectives, employing a mixed-methods approach, combining both quantitative and qualitative data collection and analysis. The needs analysis involved a survey of (39) students and semi-structured interviews with four faculty members to identify specific linguistic and academic requirements. Findings highlighted the necessity for integrating specialized language skills with domain-specific content, emphasizing the importance of topics such as artificial intelligence, coding languages, professional communication, and industry terminology. The proposed curriculum framework combines the strengths of ESP and CLIL methodologies, fostering an interdisciplinary approach that enhances both linguistic proficiency and technical knowledge. This study aims to contribute to the evolving field of ESP by providing a model curriculum that aligns with industry demands and academic expectations, preparing students for global professional environments.

Keywords: ESP curriculum, CLIL, Computer Science, Engineering, needs analysis, language skills, content integration, higher education, Alamein International University, interdisciplinary learning.

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1. Introduction

English has long been the dominant language in numerous scientific disciplines across the globe and continues to hold that position. In today's globalized world, proficiency in English Language has become essential for professionals across various disciplines, particularly in the fields of computer science and engineering (CSE). As the primary language of international communication, research, and technology, English proficiency is crucial for students aiming to excel in their academic and professional careers.

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Alamein International University (AIU), recognizing this need, seeks to enhance its curriculums by integrating English language learning with domain-specific content.

According to Bakhramovna (2021) The demand for English language education around the world is increasing because it is the language of international business, technology and science. Therefore, English for Specific Purposes (ESP) will flourish and grow more in non- native English-speaking countries. Accordingly, and as emphasized by Rao (2014), Knezović, (2016) and Akbulut, (2016) ESP shall adopt more sophisticated, learner-centered approach for curriculum design, considering learners' backgrounds and contexts, making it attentive to cross-cultural issues. Developments in applied linguistics will certainly influence ESP teaching. Furthermore, Content based instruction and task-based instruction will become more popular in ESP.

ESP curriculums are usually designed for adults with limited learning time, focusing on their specialized fields of study. These curriculums should be goal-oriented and tailored to the students' specific needs (Brown, 2014). ESP instruction is divided into two main branches: English for Academic Purposes (EAP) and English for Occupational Purposes (EOP) (Dashtestani, & Stojkovic, 2016). The current study considers ESP as an umbrella term encompassing English for Academic Purposes (EAP) and English for Occupational Purposes (EOP).

As a global university, AIU incorporates technology into every teaching and learning activity across all programs and disciplines. Consistent with this, the use of technology in ESP has gained significant popularity among EFL researchers and scholars (Arno, 2012; Butler-Pascoe, 2009; Jarvis, 2009; Plastina, 2003). Butler-Pascoe and Wiburg (2003) contend that incorporating technology into the ESP curriculum provides a multitude of learning opportunities and advantages. These advantages encompass interactive, profession-specific activities, an appreciation of the socio-cultural dimensions of language, customized input to improve language production, strategies for specific-purpose learning, task-based instruction, authentic materials, access to global academic communities, the promotion of critical thinking, collaborative learning, easier language skill acquisition, learner-centered environments, adaptation to individual learning styles, and effective feedback and assessment tools.

Hutchinson and Waters (1987) assert that every language program should begin with an analysis of the learners' needs. Given that the defining characteristic of an ESP curriculum for CSE students is its content, it must always be aligned with what learners require. Needs analysis is a fundamental component in the design of an ESP curriculum, as it ensures that the program is tailored to the specific requirements of the learners. By identifying the specific linguistic and communicative needs of the learners, curriculum designers can develop a curriculum that is directly relevant to their professional or academic contexts. This targeted approach not only enhances the efficiency of the

learning process but also increases the learners' motivation, as they can see the direct application of their language studies to their personal and professional goals.

Furthermore, the process of needs analysis involves collecting detailed information about the learners' backgrounds, language proficiency levels, and the specific tasks they need to perform in English (Richards, 2001). This information can be gathered through various methods, such as surveys, interviews, observations, and diagnostic tests. The data collected enables curriculum designers to create materials and activities that are contextually relevant and practically applicable to students of a certain field of study and cultural context, ensuring that the language instruction is both meaningful and effective. As Brown (2016) emphasizes that a well-conducted needs analysis not only informs the content and structure of the ESP curriculum but also helps in setting realistic and achievable learning outcomes. Therefore, needs analysis is not just a preliminary step in curriculum design but a continuous process that guides the development and adaptation of ESP curriculums to meet the evolving needs of learners.

In modern ESP curriculum design, needs analysis methodologies incorporate diverse approaches to ensure that the instructional content aligns with the specific linguistic and communicative needs of learners. According to Basturkmen (2010), needs analysis in ESP typically includes target needs analysis, which focuses on the linguistic demands of specific tasks and contexts, and learner needs analysis, which addresses learners' perceived gaps in language proficiency. Furthermore, Dudley-Evans and St. John (1998) categorize needs analysis into objective needs, relating to the linguistic skills required for effective communication, and subjective needs, which consider learners' attitudes and motivations towards language learning. Additionally, Brown (2014) highlights the importance of situational analysis in ESP curriculum design, emphasizing the contextual factors and communicative challenges learners encounter in their professional or academic environments. By employing these comprehensive types of needs analysis, curriculum developers can design ESP courses to meet the precise language learning needs of learners, thereby enhancing their language proficiency and effectiveness in real-world applications.

Recent trends in curriculum design emphasize flexibility, learner-centered approaches, and the integration of technology to enhance educational outcomes. According to Smith and Ragan (2019), contemporary curriculum design focuses on adapting to diverse learner needs and preferences through personalized learning experiences. This approach ensures that educational content is relevant and engaging, promoting deeper understanding and retention of knowledge. Furthermore, Mishra and Koehler (2006) argue for the integration of technological tools and digital literacies into curriculum design, facilitating interactive and collaborative learning environments that prepare students for the digital age. Additionally, Kirschner and Neelen (2018) advocate for the use of evidence-based practices in curriculum design, emphasizing the importance of

empirical research and data-driven decisions to improve teaching and learning effectiveness. These recent perspectives underscore the evolving nature of curriculum design, highlighting the need for innovation and responsiveness to educational advancements and learner dynamics in today's educational landscape.

Content and Language Integrated Learning (CLIL) has emerged as a prominent approach in curriculum design, particularly in the realm of ESP. CLIL integrates content learning with language development, providing learners with opportunities to acquire both subject-specific knowledge and language proficiency simultaneously (Coyle, Hood, & Marsh, 2010). This approach is increasingly recognized for its ability to enhance learners' cognitive and linguistic skills by engaging them in meaningful tasks and authentic contexts (Lyster, 2007). According to Dalton-Puffer (2011), CLIL promotes language learning through immersion in content-rich environments, where learners are motivated to use language as a tool for understanding and expressing ideas related to their fields of study. Furthermore, Lasagabaster and Ruiz de Zarobe (2010) highlight CLIL's role in fostering multilingual competence and intercultural awareness, as learners interact with content from diverse cultural perspectives. By integrating subject matter and language learning objectives, CLIL not only enriches educational experiences but also prepares learners to effectively communicate and navigate in globalized professional contexts (Nikula, Dalton-Puffer, & Klee, 2015). Thus, CLIL stands as a dynamic approach in ESP curriculum design, bridging the gap between language acquisition and disciplinary knowledge acquisition in meaningful and impactful ways.

The current study aims to contribute to the expanding body of knowledge on CLIL-based ESP curricula and provide practical solutions for enhancing curriculum design using the CLIL approach. The study identified the linguistic and academic needs of CSE students at AIU and determined how the CLIL approach can be adapted to meet these needs within an ESP curriculum framework. Ultimately, the study aims to establish the key components of a CLIL-based ESP curriculum for these disciplines.

2. Literature Review

This literature review examines recent research on ESP and CLIL methodologies, focusing on their application in higher education, particularly in the fields of CSE. By synthesizing pertinent findings, methodological issues, and major conclusions from previous studies, this review establishes a foundation for the current study and highlights its unique contributions to the field:

2.1. ESP in Higher Education

ESP has evolved significantly since its inception, becoming a vital component of language education, particularly in specialized fields such as computer science and

engineering. The primary goal of ESP is to meet the specific linguistic and communicative needs of learners in professional and academic contexts. According to Anthony (2018), ESP curriculums are tailored to the specific requirements of the learners, considering their professional goals and the linguistic demands of their disciplines. This targeted approach contrasts with general English curriculums, which often lack the specificity needed to address the unique language needs of specialized fields.

Several studies have highlighted the effectiveness of ESP courses in enhancing students' language skills relevant to their fields of study. For instance, Basturkmen (2010) emphasized that ESP courses in engineering significantly improve students' technical vocabulary and their ability to comprehend and produce technical texts. Furthermore, recent research by Hyland (2019) underscores the importance of genre analysis in ESP, which helps students understand the conventions and structures of texts within their specific fields.

2.2. ESP Curriculum Design

ESP curriculum design involves tailored approaches to meet the specific linguistic and communicative needs of learners within their professional or academic domains. Over the years, various approaches have emerged to address these unique requirements, ensuring that ESP curriculums are relevant, practical, and effective.

2.2.1. Language-Centered Approach

The language-centered approach, one of the traditional methods in ESP curriculum design, focuses primarily on language features and structures relevant to specific professional or academic contexts. This approach involves a detailed analysis of the target language use situations to identify the key linguistic elements that learners need to master. According to Hutchinson and Waters (1987), the language-centered approach involves a meticulous selection of grammar, vocabulary, and discourse patterns that learners will encounter in their specific fields. This method emphasizes language performance, aiming to equip students with the necessary language tools to function effectively in their specialized domains. However, while the language-centered approach provides a solid foundation in the specific linguistic features of a discipline, it has been critiqued for its narrow focus. Anthony (2018) argues that this approach can sometimes overlook the broader communicative and cognitive skills that are also crucial for professional success. Therefore, while it remains a valuable component of ESP course design, it is often integrated with other approaches to provide a more holistic learning experience.

2.2.2. Skills-Centered Approach

The skills-centered approach shifts the focus from specific language features to the

development of learners' competences in various language skills. This approach is based on the premise that learners need to develop a range of skills to effectively process and produce language in their specific professional contexts. Basturkmen (2010) highlights that the skills-centered approach involves teaching strategies and techniques that learners can apply across different tasks and situations. For example, in a computer science context, this approach might involve teaching students how to read and interpret technical manuals, write clear and concise project reports, deliver presentations on technical topics, and participate in technical discussions. By focusing on skill development, this approach aims to enhance learners' overall communicative competence, making them more versatile and effective in their professional roles.

2.2.3. Learning-Centered Approach

The learning-centered approach, which has gained prominence in recent years, emphasizes the processes by which learners acquire language skills. This approach is grounded in the principles of constructivist learning theory, which posits that learners construct knowledge through active engagement and interaction with their environment. According to Hutchinson and Waters (1987), the learning-centered approach considers learners' cognitive processes, learning styles, and strategies, aiming to create a learning experience that is both effective and engaging.

In the context of ESP, the learning-centered approach involves designing activities and tasks that facilitate meaningful learning experiences. For instance, project-based learning, problem-solving tasks, and collaborative activities are often used to engage learners and promote deeper understanding. This approach also emphasizes the importance of context and authenticity, ensuring that learning activities closely resemble real-world tasks and challenges.

2.3. CLIL Methodology

The CLIL methodology, which is a pedagogical approach that integrates content learning with language acquisition, has gained widespread recognition in recent years. Coyle, Hood, and Marsh (2010) define CLIL as a dual-focused educational approach in which an additional language is used for the learning and teaching of both content and language. This methodology is particularly effective in higher education, where it facilitates the simultaneous development of subject-specific knowledge and language proficiency.

The CLIL (Content and Language Integrated Learning) 4Cs framework - Content, Cognition, Communication, and Culture - provides a comprehensive approach to integrating language learning with subject-specific content. Content refers to the subject matter being taught, ensuring that learners acquire relevant knowledge and skills within a specific discipline (Coyle, Hood, & Marsh, 2010). Cognition involves the development of

thinking skills, which enables learners to process and understand the content, fostering higher-order thinking and problem-solving abilities (Meyer, 2010). Communication emphasizes the use of language as a tool for learning and interaction, encouraging learners to engage in meaningful dialogue and practice their language skills within the context of the subject matter (Dalton-Puffer, 2011). Finally, Culture focuses on the inclusion of intercultural understanding and global awareness, helping learners appreciate and navigate diverse perspectives and cultural contexts (Coyle, 2007). By integrating these four dimensions, the CLIL 4Cs framework not only enhances content knowledge and language proficiency but also promotes cognitive development and cultural competence, preparing learners for success in a globalized world (Mehisto, Marsh, & Frigols, 2008; Ball, Kelly, & Clegg, 2015).

Numerous studies have demonstrated the benefits of CLIL in higher education settings. Lasagabaster and Sierra (2010) found that CLIL enhances students' motivation and language skills, leading to higher levels of language competence compared to traditional language instruction. Additionally, a meta-analysis by Ruiz de Zarobe (2013) concluded that CLIL positively impacts students' content knowledge and cognitive skills, making it a valuable approach for teaching complex subjects like computer science and engineering.

2.4. Integration of ESP and CLIL

Based on the current study's philosophy, combining ESP and CLIL methodologies may provide a well-rounded framework for developing curricula that meet both the linguistic and content-related needs of students. This combined approach leverages the strengths of both methodologies, providing a more holistic learning experience. Dalton-Puffer et al. (2014) argues that CLIL enhances the effectiveness of ESP courses by embedding language learning within meaningful content, thereby increasing students' engagement and retention of both language and subject matter.

Recent studies have explored the application of CLIL based courses. Banegas (2014) reported that a CLIL-based curriculum led to significant improvements in students' technical language skills and their ability to apply these skills in professional contexts. Similarly, research by Pérez-Cañado (2016) demonstrated that CLIL-based courses not only enhanced the students' language proficiency but also improved their understanding of technical concepts and their ability to communicate effectively in their field.

2.5. ESP Curriculum Design Methodological Considerations

Designing a CLIL-based ESP curriculum requires careful consideration of several methodological issues. One critical aspect is the selection of appropriate content and language objectives. Coyle et al. (2010) recommend a balanced focus on the 4Cs

framework - Content, Cognition, Communication, and Culture - to ensure a comprehensive learning experience. This involves identifying key content areas relevant to the field of study, developing cognitive skills through problem-solving and critical thinking activities, enhancing communication skills through interactive tasks, and fostering cultural awareness.

Another important consideration is the assessment of students' language and content learning. Morton (2016) emphasizes the need for integrated assessment methods that evaluate both language proficiency and content knowledge. This can include formative assessments, such as peer reviews and self-assessments, as well as summative assessments, like exams and project-based evaluations.

2.6. Practical Implementation and Challenges

Implementing ESP courses requires careful planning and consideration of various factors. One key challenge is the need for collaboration between language teachers and subject specialists. Effective ESP course design often involves input from both language experts and professionals in the specific field to ensure that the course content is relevant and practical. According to Dudley-Evans and St John (1998), successful ESP courses require ongoing needs analysis to stay aligned with the evolving demands of the target profession or academic discipline.

Accordingly, the literature on ESP and CLIL methodologies provides a robust foundation for designing effective curricula that address the specific linguistic and content-related needs of students in specialized fields. By integrating these methodologies, the current study aims to develop a CLIL-based ESP curriculum for CSE students at AIU that is both relevant and effective. This literature review highlights the logical continuity between previous and present work, demonstrating how the current study builds on established principles while introducing new insights and addressing specific gaps in the literature.

While previous studies have explored various aspects of ESP and CLIL, the current study aims to fill specific gaps in the literature by designing a CLIL-based ESP curriculum tailored for CSE students at AIU. This study builds on the foundational principles established by earlier research but introduces new dimensions by focusing on the specific linguistic and academic needs of CSE students. One unique contribution of this study is its emphasis on the gap between Target Situational Analysis (TSA) and Present Situational Analysis (PSA). By identifying the specific language skills required in professional contexts (TSA) and assessing students' current abilities (PSA), this study provides a detailed understanding of the linguistic needs of CSE students. This approach ensures that the curriculum is highly relevant and tailored to the specific demands of the field. Furthermore, the use of thematic analysis for qualitative data from faculty interviews provides rich and in-depth insights into the integration of language skills

within the CSE curriculum. This qualitative approach complements the quantitative analysis of survey data, offering a comprehensive understanding of the needs and challenges faced by CSE students.

3. Theoretical framework

The theoretical framework underpinning this study is primarily based on the acquisition theory, which is well-suited for the design of an ESP curriculum that incorporates various pedagogical approaches. Acquisition theory, as proposed by Krashen (1982), emphasizes the naturalistic acquisition of language through meaningful interaction, which aligns with the goals of the current study to enhance students' language skills in a content-rich environment. This framework is particularly relevant as it supports three main approaches in ESP curriculum design: the language-centered approach, the skills-centered approach, and the learning-centered approach.

The language-centered approach focuses on student performance, ensuring that learners achieve specific linguistic outcomes. This method is complemented by the skills-centered approach, which emphasizes student competences in various language skills necessary for their field. Finally, the learning-centered approach concentrates on how students acquire these competences, considering their cognitive processes and learning strategies (Hutchinson & Waters, 1987). By integrating these approaches, the curriculum aims to provide a holistic language learning experience that is both effective and relevant to the students' academic and professional needs.

Incorporating the CLIL approach further substantiates the use of acquisition theory in this study. CLIL, as defined by Coyle, Hood, and Marsh (2010), involves teaching subjects through a foreign language, enabling students to master both the subject content and the language. The CLIL approach is structured around the 4Cs: Content, Cognition, Communication, and Culture. These components ensure that students not only learn the technical content of the CSE field but also develop cognitive skills, communicative abilities, and cultural awareness regarding the discipline. The acquisition theory aligns well with CLIL as it promotes language mastery through immersion in meaningful, context-rich activities, facilitating deeper learning and integration of language skills.

The needs analysis conducted in this study also supports the application of acquisition theory. By identifying the gap between Target Situational Analysis (TSA) and Present Situational Analysis (PSA), the study highlights the specific linguistic and academic needs of the students. TSA focuses on the language skills required in their future professional contexts, while PSA assesses their current language abilities and learning conditions (Dudley-Evans & St John, 1998). Addressing this gap ensures that the curriculum is tailored to meet the actual needs of the students, promoting effective language acquisition in line with Krashen's theory. Overall, the acquisition theory provides a robust theoretical framework for this study, as it integrates the principles of

language-centered, skills-centered, and learning-centered approaches within the CLIL methodology. By focusing on the naturalistic acquisition of language through meaningful interaction and addressing the specific needs of students, this framework ensures a comprehensive and effective ESP curriculum design.

4. Method

4.1. Research Design

This study employs a mixed design approach, integrating both quantitative and qualitative methods to provide a comprehensive analysis of the needs of CSE students at AIU. A mixed design approach combines the strengths of quantitative and qualitative research, allowing for a more robust understanding of the research problem by drawing on both numerical data and in-depth, descriptive insights (Creswell & Plano Clark, 2018).

The needs analysis for this study incorporates both quantitative and qualitative approaches. For the quantitative component, surveys were administered to students enrolled in the CSE programs at AIU. These surveys aimed to gather broad, numerical data regarding the students' linguistic and academic needs, preferences, and challenges. For the qualitative component, semi-structured interviews were conducted with faculty members. These interviews provided detailed, nuanced insights into the educational context, the specific requirements of the curriculum. This combination of quantitative and qualitative data ensures a comprehensive understanding of the needs and expectations of both students and faculty members, facilitating the design of an effective and targeted curriculum. By employing a mixed design approach, this study aims to capture the complexity of the educational needs within the CSE programs at AIU, ultimately informing the development of a curriculum that addresses both the technical and linguistic proficiency required for students to succeed in their academic and professional pursuits.

4.2. Study Setting

This study was conducted at Alamein International University (AIU), one of the fourth-generation Egyptian university located in New Alamein City. The university is renowned for academic excellence and innovative educational practices, AIU offers diverse undergraduate and graduate programs and features state-of-the-art facilities and advanced technological resources. The university promotes interdisciplinary education and continuous learning. The focus of this study is on the Computer Science and Engineering (CSE) programs at the university, which combine theoretical and practical education with access to high-performance computing, robotics, and software development labs. The proposed curriculum, designed specifically for CSE students, aims

to enhance their educational experience using the CLIL approach, addressing their linguistic and academic needs to prepare them for global careers in the rapidly evolving field of computer science and engineering.

4.3. Population, Sampling and Data Collection

Participants in this study were selected randomly from a population comprising more than (658) students across the four academic years of computer science program and five academic years of computer engineering program at AIU. This sampling approach aimed to ensure representation from various stages of academic progression within both programs, providing a comprehensive view of student needs and perspectives. For the quantitative aspect of the study, surveys were distributed among the selected students (N=39). The following table illustrates the nine dimensions of the questionnaire and their corresponding questions.

Table 1. Needs Analysis survey description

N	Dimension	Corresponding Questions
1	Language proficiency and background	Questions (1) to (3)
2	Academic context	Questions (4) to (6)
3	Challenges and needs	Questions (7) to (11)
4	Vocabulary and terminology	Questions (12) to (14)
5	Communication skills	Questions (15) to (16)
6	Writing requirements	Questions (17) to (18)
7	Listening practice	Questions (19) to (20)
8	speaking opportunities	Questions (21) to (22)
9	Preferred learning materials	Questions (23) to (25)

Table (1) outlines the dimensions and questions of the needs analysis survey for CSE students at AIU. The survey covers nine dimensions: language proficiency and background, academic context, challenges and needs, vocabulary and terminology, communication skills, writing requirements, listening practice, speaking opportunities, and preferred learning materials. This comprehensive structure ensures a thorough understanding of students' linguistic and academic needs. For the semi-structured interviews, four faculty members were selected. They were chosen based on recommendations from the faculty dean, ensuring that a range of perspectives from experienced educators within the department were captured. The interviews were guided by open-ended data-collection questions, allowing for detailed exploration of the faculty members' insights on the educational context, curriculum requirements, and needs for the ESP curriculum. Prior to the interviews, the participants were introduced to the interview questions to facilitate thoughtful responses and ensure the discussion covered relevant aspects comprehensively. Records of the interview responses were maintained to

facilitate analysis and ensure accuracy in capturing the qualitative data from the faculty members' perspectives.

Table 2. Semi-structured interview guide

N	Question	Objectives
1	Could you tell me a brief about AIU computer science and engineering courses, and main programs?	Understand the main criteria of courses and programs of the field
2	How do you rate your students' English proficiency regarding English four skills?	Identify the faculty members point of view about the students' proficiency regarding the main four skills of language (listening, speaking, reading, writing)
3	How far are English language skills integrated into your computer science curriculum?	Identify the level of integration between English and the nature of taught courses within the field.
4	What do you think the specific language needs of computer science students?	Understanding their academic context and the language skills they frequently use will guide the course design
5	Which language skills (listening, speaking, reading, writing) are most relevant for computer science students?	Prioritize these skills while designing the syllabus.
6	What specific areas of English do you think are most important for your students (e.g., technical vocabulary, reading scientific papers, writing reports)?	Prioritize these areas while designing the syllabus.
7	How can we integrate real-world applications into the course material?	Explore connections between coursework and practical scenarios in the field.
8	Are there additional resources (books, articles, websites) that complement the course textbook?	Recommendations from faculty can enhance students' learning experience.
9	What topics fundamental to computer science should be covered in the ESP course?	Identify essential subjects to tailor the content effectively.
10	Looking forward, what changes or improvements would you like to see in the ESP courses for computer science students?	Meet expectation of faculty members for their students is very vital for the course design.
11	How can we better tailor ESP courses to meet the evolving needs of the industry and academia?	Explore the gabs between the industry and academia and have an input using English for specific purposes.
12	Do you have any additional comments or suggestions?	Seeking recommendations or ideas for improvement in aim to positive change.

The semi-structured interview guide illustrated in table (2) was designed to gather insights from AIU's CSE faculty members to inform an ESP curriculum. It covered themes such as the structure of AIU's programs, students' English proficiency, and the integration of language skills into the curriculum. The guide aimed to identify specific language needs, prioritize essential skills, and focus on areas like technical vocabulary and writing reports. It also explored practical applications, supplementary resources, and fundamental topics in computer science, while gathering suggestions for course improvements and ensuring the curriculum meets industry and academic demands. This approach aimed to develop a relevant and effective ESP curriculum for AIU's students.

4.4. Data Analysis

The data collected from the survey and the semi-structured interviews were analyzed using distinct but complementary methods to provide a comprehensive understanding of the linguistic and academic needs of CSE students at AIU. The survey data were analyzed quantitatively using the Statistical Package for the Social Sciences (SPSS). That method facilitated the calculation of percentages and other related statistical measures, enabling a clear and precise presentation of the students' responses. The quantitative analysis provided an overview of the general trends and patterns in students' language proficiency, academic context, challenges, needs, and preferences.

The responses from the semi-structured interviews with faculty members were analyzed using thematic analysis, as described by Clarke and Braun (2014). This qualitative method involves identifying, analyzing, and reporting patterns (themes) within the data. Thematic analysis allowed for the extraction of rich and in-depth ontological and epistemological viewpoints from the faculty members, providing deeper insights into the integration of English language skills in the CSE curriculum, specific language needs, and recommendations for curriculum improvement.

4.5. Ethical Consideration

According to Creswell (2014), researchers must conduct research in an ethical manner that respects the dignity, privacy, and rights of participants. In this study, ethical considerations were carefully addressed to ensure the protection and well-being of all involved. Ethical clearance for this study was obtained from the Vice President for Academic Affairs at Alamein International University (AIU), confirming that the research adhered to institutional ethical standards and guidelines.

Informed consent was practiced throughout the data collection process. Prior to participating in the study, all students and faculty members were informed about the aim and objectives of the research. For students participating in the survey, a note was provided at the beginning stating:

> *"This survey is conducted to analyze the linguistic needs of the program's students. It is not a test and is not subject to marking criteria. It is not linked to your university performance at all. The data will be treated with the utmost confidentiality and will only be used for scientific research purposes."*

This statement ensured that participants understood the nature and purpose of their involvement in the study, emphasizing confidentiality and the voluntary nature of their participation. Students were assured that their responses would remain confidential and would solely contribute to scientific research endeavors. Throughout the study,

confidentiality of participant data was strictly maintained. Personal information and responses gathered from surveys were anonymized and stored securely, accessible only to the researcher for data analysis. By adhering to these ethical principles and practices, this study aimed to uphold the integrity of research while respecting the rights and privacy of participants, contributing valuable insights to the development of educational practices at AIU.

5. Results

The current study aimed to design a CLIL-based ESP curriculum for computer science and engineering programs at Alamein International University. Guided by a multi-approach needs analysis using both quantitative and qualitative methods, the research focused on three key questions: the specific linguistic and academic needs of the students, how CLIL methodology can be adapted to meet these needs within an ESP framework, and the key components of an effective CLIL-based ESP curriculum for these disciplines.

5.1. Students linguistic and academic needs, preferences, and challenges

The needs analysis survey data, analyzed quantitatively using the Statistical Package for the Social Sciences (SPSS), provided a comprehensive overview of the general trends and patterns in students' language proficiency, academic context, challenges, needs, and preferences. The survey responses were collected from a random sample of (39) computer science and computer engineering students at Alamein International University. The results for main dimensions of the survey showed the following:

5.1.1. Language proficiency and background

The results showed that most of the students (59%) come from Arabic schools, suggesting that their primary language of instruction may not have been English, potentially impacting their initial comfort and proficiency with English in a specialized academic context. Most students (59%) rate themselves as intermediate, indicating a moderate level of English proficiency. The lower number of advanced students (18%) suggests a need for improvement in academic and professional contexts. Finally, a significant portion of students (67%) have not previously studied English for Specific Purposes (ESP), implying a gap in familiarity with specific terminology and communication skills required in their field.

5.1.2. Academic context

The results indicated that a significant majority of students (94.87%) primarily use English in lectures, highlighting the importance of language proficiency in this area. Presentations and group discussions are also significant, with 71.79% and 48.72% of students using English, respectively. Additionally, 92.31% of students find English

essential for understanding and participating in lectures and seminars. Equally important are textbooks and research papers, as well as coding and documentation (both 74.36%), suggesting that reading and writing skills in English are critical for academic success and technical work. Over half of the students (51.28%) recognize the importance of English in collaborative and presentational tasks, emphasizing the need for strong communication skills. Moreover, 61.54% of students indicate the importance of English for technical interviews, job applications, and online learning, showing a need to be prepared for the global job market. Finally, 56.41% see English as essential for disseminating research, while lower percentages in conferences, workshops, technical blogs, and forums suggest these areas are less common but still relevant for some students.

5.1.3. Challenges and needs

The results showed that students feel more confident in reading (3.49) and listening (3.44) compared to speaking (2.97) and writing (3.21). This indicates a struggle with productive skills (speaking and writing) despite being somewhat comfortable with receptive skills (reading and listening). Speaking is the most challenging skill for 49% of students, highlighting a significant need for improvement in this area. Listening is the second most challenging skill for 41% of students, despite its relatively higher proficiency rating. Reading and writing also pose challenges for 41% and 36% of students, respectively, indicating these skills require attention, though not as urgently as speaking and listening.

5.1.4. Vocabulary and terminology

The results indicated that while just over half of the students feel comfortable with the technical vocabulary, a significant minority (49%) struggle with specific terminology in computer science, suggesting a need for targeted vocabulary instruction. Java and Python are the most frequently encountered programming languages, with 87.18% and 66.67% of students respectively reporting their use, indicating that these languages should be prioritized in the ESP curriculum. Although less central, C, SQL, and R are still relevant for some students. Integrated Development Environments (IDEs) and code editors are the most used tools, with 74.36% of students using them frequently, suggesting that training on these tools is essential. Code Sharing and Collaboration Platforms are significant for 41.03% of students, highlighting the importance of collaborative and version control tools. Other tools, such as communication and collaboration tools, and data parsing and conversion tools, are less frequently encountered but still important for some students.

5.1.5. Communication skills

The results indicate that students have a moderate level of comfort explaining complex technical concepts in English, with an average rating of 5.9 out of 10. This suggests some

confidence but also a need for improvement in communication skills. Additionally, 74% of students do not participate in group discussions or collaborate with peers in English, highlighting a significant gap in practical use of English in collaborative settings. This underscores the need for an ESP curriculum that emphasizes developing communication skills and encourages more group discussions and peer collaborations to enhance confidence and proficiency in technical English communication.

5.1.6. Writing requirements

The results indicate that the most frequently encountered writing tasks among students are university assignments (76.92%), writing code comments (74.36%), and reports (74.36%), suggesting the need for the ESP curriculum to focus on these areas to support academic and technical writing. Documentations (61.54%) and project presentations (66.67%) are also significant, highlighting the importance of skills for effective documentation and presentation. Students express a strong desire to improve their vocabulary (71.79%) and grammar and spelling (64.10%), underscoring the need for vocabulary-building exercises and grammar instruction. Additionally, writing professional emails (58.97%) and using accurate terminology (51.28%) are key areas for improvement, reflecting the professional communication needs of the students. The data also shows a need for enhancing editing techniques (46.15%) and blog writing skills (46.15%), indicating a desire among students to improve overall writing quality and versatility.

5.1.7. Listening practice

The results for the seventh category, listening practice, indicate that online tutorials are the most used resource, with 87.18% of students engaging with them. Technical talks are utilized by 48.72% of students, while podcasts are used by 41.03%. This preference for structured, on-demand content suggests its effectiveness for listening practice. A small percentage (5.13%) reported using other forms of listening practice, indicating that the provided options meet most students' needs. The average confidence level in understanding spoken English in academic contexts is 6.36 out of 10, suggesting a moderate level of confidence and a need for further improvement in listening proficiency for students.

5.1.8. speaking opportunities

The survey revealed that 41% of students have already engaged in presentations or group discussions, indicating a significant level of prior experience. Moreover, a notable 67% expressed a desire for additional speaking opportunities, highlighting a strong interest in improving English speaking skills. These findings underscore both existing participation in speaking activities and a substantial demand for further opportunities to enhance speaking proficiency among respondents.

5.1.9. Preferred learning materials

The survey revealed a strong preference (72%) for videos among students, indicating they find visual and auditory learning aids highly effective and engaging. Homework assignments were also highly valued (38%), emphasizing their role in reinforcing learning through practice. PowerPoint lessons (28%) were appreciated for their structured delivery of information. Textbooks (26%) and articles (21%) were less dominant but valued for their detailed content. Classroom worksheets (18%) were seen as useful for practical application and immediate feedback. Overall, the data underscores a diverse preference for multimedia formats and structured learning tasks, suggesting a blended approach could effectively meet varied learning preferences.

5.2. Thematic Evaluation of Faculty Interview Insights.

The thematic analysis of faculty interviews employed a qualitative approach to uncover patterns and insights. It revealed rich perspectives on integrating English language skills into the computer science and engineering curriculum, specific language requirements, and suggestions for curriculum enhancement. From the interviews with four faculty members, three main themes emerged: English proficiency and curriculum integration, practical application and curriculum design, and aligning ESP courses with industry and academic expectations. These themes collectively provided comprehensive insights into enhancing ESP courses tailored for computer science students. The results were as follows:

Theme 1: English Proficiency and Integration in Computer Science Education:

Participants assessed their students' English proficiency across listening, speaking, reading, and writing skills. They noted that students exhibit strong listening skills but face challenges in reading and writing effectively. Faculty members emphasized the critical need to concentrate on improving reading and writing abilities to better integrate English language skills into the computer science curriculum. Their responses indicated the importance of these skills not only for academic success but also for preparing students to meet the professional demands of the field. This insight highlights the faculty's perspective on enhancing language proficiency as integral to the comprehensive education of computer science students.

Theme 2: Curriculum Design and Practical Application:

Faculty members strongly encouraged the incorporation of real-world applications into ESP course materials to enhance both relevance and student engagement. They emphasized the importance of practical, real-life scenarios in helping students understand and apply language skills within the context of their field. Furthermore, faculty highlighted several essential topics and specific language needs that are crucial for computer science education. They identified mastering technical vocabulary, reading

scientific papers, and writing reports as key areas that the ESP course should focus on. By addressing these specific needs, the ESP course can better prepare students for both academic challenges and professional demands in the computer science industry.

Theme 3: Enhancing ESP Courses for Industry and Academic Alignment:

Faculty members provided valuable insights on enhancing the ESP course to align with industry demands and academic expectations. They emphasized the need for teaching specialized language skills tailored to computer science, covering current industry topics like AI and coding languages, and preparing students for international settings by familiarizing them with writing professional emails and delivering conference speeches. The importance of using common terminology in the field was also highlighted. For additional resources and curriculum changes, faculty recommended incorporating online tools, encouraging membership in professional associations and networking groups, and promoting project-based learning for hands-on experience. They stressed the importance of regularly updating the curriculum to keep up with industry advancements, emphasizing practical application of concepts, and adopting an interdisciplinary approach. These recommendations aim to ensure that the ESP course remains relevant and effectively prepares students for the demands of the computer science field.

5.3. The course framework, and key components

Based on the needs analysis process encompassing both students' needs and faculty members' perspectives, the ESP course framework for computer science students has been designed to integrate content and language learning effectively. The course aims to enhance students' language proficiency while simultaneously building their technical knowledge. Here are the key components and structure of the suggested course:

5.3.1. Course Framework

The course is structured around a series of thematic units, each focusing on a specific area of computer science while incorporating relevant language skills. The framework ensures a balanced approach to learning, blending technical content with language development.

5.3.2. Key Components

Content and Language Integration: Each unit combines reading, writing, listening, and speaking activities centered on computer science topics. This integration helps students apply language skills in relevant contexts, reinforcing both their technical and linguistic abilities.

Thematic Units: The course is divided into thematic units, each focusing on critical topics within computer science, the unites were as follows:

- *History of Java and Python*: Emphasizes reading historical essays, writing future-oriented essays, and practicing group discussions.
- *Coding and Language Skills*: Focuses on reading about coding, writing formal emails, and engaging in discussions about algorithms.
- *Coding Communication*: Centers on writing effective code comments and group discussions about algorithm efficiency.
- *Cloud Computing*: Involves writing conference speeches and discussing cloud computing concepts.
- *Ethical Considerations in Technology*: Includes writing learning summaries and discussing data privacy and security.
- *Cybersecurity:* Focuses on explaining code snippets and discussing encryption and security.
- *Machine Learning*: Involves writing project proposals and discussing the relationship between AI and machine learning.
- *Human and Robotics*: Centers on writing reflections on tech news and discussing biomimetic designs in robotics.

Language Skills Focus

Each unit targets specific language skills necessary for computer science:

- *Reading:* Enhances comprehension of technical essays and scientific papers.
- *Writing:* Develops skills in writing reports, emails, comments, proposals, and summaries.
- *Listening and Speaking:* Improves abilities through listening to transcripts and engaging in group discussions.

Technical Vocabulary and Concepts

Each unit introduces and reinforces key computer science terms and concepts. For instance, students will learn about:

- Programming languages and terminologies (e.g., Java, Python, Algorithms, Data Structures).
- Cloud computing concepts (e.g., SaaS, PaaS).
- Ethical considerations and cybersecurity terms (e.g., Data Privacy, Encryption).
- Advanced topics such as Machine Learning and Human-Robot Interaction.

Practical Applications and Real-World Scenarios

The course incorporates practical exercises and real-world applications to enhance relevance and engagement. This includes:

- Writing reports and manuals.

- Preparing and delivering speeches.
- Drafting project proposals and technical reports.

Communication, Cognition, and Culture

Each unit not only focuses on technical and language skills but also addresses broader communication strategies, cognitive skills, and cultural aspects relevant to the field of computer science. Accordingly, this course framework, with its integration of content and language learning, thematic structure, focus on practical applications, and emphasis on technical vocabulary, aims to equip computer science students with the essential language skills required for academic and professional success.

In conclusion, the proposed ESP course framework is aligned with both academic and industry needs. By integrating content and language learning, organizing the curriculum into thematic units, and emphasizing practical applications, the course is trying to equip computer science students with the skills they need to succeed. The thoughtful inclusion of communication, cognitive, and cultural aspects further enhance its relevance and effectiveness. This comprehensive approach ensures that students are not only competent in their technical field but also proficient in the language skills required to thrive in a global professional environment.

6. Discussion

The primary aim of this study was to design a CLIL-based ESP curriculum tailored for computer science and engineering students at Alamein International University. Through a comprehensive needs analysis involving both quantitative and qualitative methods, the researcher has gained insights into the specific linguistic and academic needs of students, as well as the key components necessary for an effective CLIL-based ESP curriculum.

The findings revealed that most students came from Arabic-medium schools, which might explain their intermediate level of English proficiency. The students demonstrated stronger skills in listening and reading compared to speaking and writing. This aligns with previous studies indicating that non-native English speakers often struggle more with productive skills due to limited practice opportunities in academic and professional contexts.

The thematic analysis of faculty interviews underscored the need to focus on improving reading and writing skills. This is critical for both academic success and professional development in the computer science field. Faculty members emphasized that integrating these skills into the ESP curriculum is essential for preparing students to meet the demands of their field. Accordingly, the proposed curriculum was structured around a series of thematic units, each focusing on a specific area of computer science while incorporating relevant language skills. This integration of content and language learning

is a standout feature, ensuring that students apply language skills in relevant contexts. Thematic units such as "History of Java and Python," "Cloud Computing," and "Machine Learning" are highly relevant and reflect the evolving landscape of the field.

Each unit targets specific language skills necessary for computer science, enhancing reading comprehension of technical essays, writing formal reports, and engaging in discussions about complex algorithms. This focus on practical applications and real-world scenarios bridges the gap between theoretical knowledge and practical use, reinforcing both technical and linguistic abilities.

It's worth mentioning that while the study provides valuable insights, there are limitations that need to be acknowledged. The sample size was relatively small, and the study was confined to a single institution, which may limit the generalizability of the findings. Future research could involve a larger and more diverse sample across multiple institutions to validate and extend the findings.

7. Conclusions

The current study proposed curriculum framework, built on thematic units that integrate language skills with core computer science content, addresses these gaps by offering a balanced and contextually relevant learning experience. By focusing on practical applications and real-world scenarios, the curriculum aims to enhance students' linguistic capabilities while simultaneously deepening their technical knowledge. This dual focus not only prepares students for academic success but also equips them with the communication skills essential for professional environments.

Key insights from faculty members emphasized the importance of aligning the ESP course with current industry demands. The integration of specialized language skills, such as technical vocabulary and the ability to read scientific papers and write reports, reflects a practical understanding of what students need to succeed. Moreover, the inclusion of contemporary topics like AI and coding languages ensures that the curriculum remains relevant in a rapidly evolving field.

The recommendations for continuous curriculum updates, the incorporation of online tools, and the promotion of project-based learning further enhance the dynamic nature of the proposed curriculum. These elements are crucial for fostering a learning environment that is both adaptable and responsive to technological advancements and industry trends.

The study also highlighted the need for an interdisciplinary approach, encouraging collaboration across different fields to broaden students' perspectives and skill sets. This approach not only benefits language learning but also fosters innovation and critical thinking, essential qualities for future professionals in computer science and engineering.

In conclusion, the proposed CLIL-based ESP curriculum represents a forward-thinking

approach to integrating language and content learning. It addresses the specific needs of computer science students, preparing them for both academic excellence and professional success. By aligning with industry demands and incorporating practical, real-world applications, the curriculum ensures that students are well-equipped to navigate and contribute to the global tech industry. The insights gained from this study can serve as a model for similar initiatives in other technical fields, highlighting the importance of contextualized language learning in higher education.

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