



Embedding 21st-Century Skills into ESP Classes through AI: A Systematic Review

Tuğba Çıtlak 

Foreign Languages Department, University of Turkish Aeronautical Association, Ankara, Türkiye;

tubactlk@gmail.com

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Abstract

This study aimed to find out how 21st-century skills can be integrated into ESP teaching using AI. As is known, 21st-century skills have an undeniable place in the globalized world. It is also a must for ESP students to survive in their academic and postgraduate lives. In that sense, AI can be a helpful way to integrate 21st-century skills into ESP teaching. For this aim, this systematic review explored new trends in English for specific purposes in the context of 21st-century skills by searching for related study areas and focusing on how artificial intelligence was integrated into ESP. Therefore, the literature was scrutinized using two key terms involving “ESP and 21st-century skills” and “ESP and 21st-century skills through AI” in Google Scholar. The dates were determined between 2015 and 2025 due to the aim and scope of this study. In total, there were 92 articles found; however, when these articles were investigated, 53 of them were eliminated because they were not related to the topic, which made the total number of articles 39. As a result, by shedding light on the current applications of 21st-century skills in ESP classrooms and their implementation via AI, this study underscored pedagogical implications involving how ESP teachers can embed 21st-century skills into ESP classes through AI, which can aid ESP teachers in meeting the needs of ESP students regarding the necessities of the rapidly increasing and demanding business and academic world.

Keywords: 21st-century skills, artificial intelligence, English for specific purposes

1 Introduction

Quick changes in educational environments have become necessary in the 21st century due to the quick development, production, and dissemination of information (Wagner, 2009). In the educational context, the changes accompanied by globalization have led to the need to meet students' needs for employability and adaptability in the professional workplace. This means that students need to have the skills necessary in the 21st century.

In the context of English for Specific Purposes (ESP), it is a cornerstone of ESP to consider the needs of the students, especially in the 21st century, to be compatible with the skills required for real life in professional settings. When ESP is considered in depth, the needs of the learners and 21st-century skills are highly related. Learners' needs emerge from the skills required to be developed by the students to survive in both their academic and business life. Furthermore, ESP deals directly with learners' preparedness for subject-specific situations they encounter in their lives. Thus, it can be said that giving

learners the information and abilities they need to be ready for the future is one of the main goals of education.

When it comes to the integration of 21st-century skills into ESP classes, AI can be a valuable tool to make the learning process personalized according to the needs of the students. The use of AI to integrate 21st-century skills into ESP courses can be effective since students use information and communication technology (ICT) to show their collective knowledge production skills, interact with people from different cultures, and benefit from the education and training systems of different countries (Partnership for 21st Century Learning [P21], 2019a). AI-powered tools denote digital platforms or applications with sophisticated technology that can facilitate and improve the language learning process (Malik et al., 2023). Therefore, the use of AI tools can be suggested as a way to embed 21st-century skills into ESP classes so that ESP students may be equipped with the necessary skills in the 21st century, aligned with meeting the needs of both ESP students and their future employability.

2 Literature Review

2.1 Theoretical Concepts

Several definitions and classifications have been made to explain 21st-century skills. According to P21 (2019b, p. 2), 21st-century skills include "the skills, knowledge, and expertise students must master to succeed in work and life; it is a blend of content knowledge, specific skills, expertise, and literacies". This definition highlights the importance of communicating effectively, critical thinking, and academic knowledge that students are required to learn during their education. Namely, it is expected to equip students with all the necessary skills to survive and adapt in today's digitalized world. Hence, 21st-century skills involve the 12 competencies that students must possess in order to thrive in the digital age. (Prastiwi et al., 2021).

Along with the definition, several classifications have been made for 21st-century skills. One of them is specified by the OECD (2008) as twelve 21st-century skills made up of the following 12 sub-skills and 3L major skills. The major skills consist of learning skills (the 4Cs), information, media & technology skills, and life & career skills. Learning skills involve critical thinking, creativity, communication, and collaboration. The information, media & technology section includes information literacy, media literacy, and ICT literacy. The last primary skill specifies life and career skills involving flexibility & adaptability, initiative & self-direction, social & cross-cultural skills, productivity & accountability, and leadership & responsibility.

In addition to that classification, the P21 Framework for 21st Century Learning was developed with input from educators, education experts, and business leaders to describe and illustrate the skills, knowledge, and support systems that students need to succeed in the job, in life, and as citizens (P21, 2019a). It consists of the same major and sub-skills as the OECD (2008). However, it adds several key subjects and themes that should be learned by the students, such as reading, world languages, mathematics, history, and science. Moreover, the P21 Framework suggests several interdisciplinary themes to be integrated into these key themes, such as global awareness, civic literacy, and health literacy (P21, 2019a).

Concerning 21st-century skills, the integration of technology into English language teaching represents a shift towards the nature of education and the necessities of today's world. In that sense,

artificial intelligence plays a dominant part in education, making it more adaptive, personalized, and student-centered for learners by also supporting 21st-century skills (Chiu et al., 2023; Joksimović et al., 2023). On the other hand, artificial intelligence has several drawbacks when being exposed to it unconsciously. Even though it can enhance digital literacy and technology skills of learners, oversimplification of information and overreliance on artificial intelligence can cause the loss of critical thinking, which is one of the essential components of 21st-century skills (Lee et al.; Tuomi, 2024). Therefore, conscious use and integration of AI can support 21st-century skills, and it diminishes the barriers to language acquisition for learners by addressing different linguistic needs of the learners (Yang et al., 2024).

In accordance with that, ESP is a language method of instruction that considers target groups' unique linguistic features, discourse patterns, and communicative capacities in addition to the needs and proficiency of students (Hyland, 2006). Thus, ESP is defined as “an approach” to language learning for a specific field and “not a product” (Hutchinson & Waters, 1987, p. 19). The focus, then, is on teaching students to communicate within communities rather than focusing on teaching vocabulary and language rules in isolation (Hutchinson & Waters, 1987). The central concept of learner needs acts as the center of attention for the language-related goals that different groups are pursuing.

Although there are several articles and systematic reviews on ESP and 21st-century skills, there is still room for in-depth analysis of current literature. In particular, a few studies highlight the use of AI to integrate 21st-century skills into ESP classes (Dewantara et al., 2024). Thus, this study aims to examine the literature to find out how 21st-century skills can be integrated into ESP teaching using AI. For this aim, this systematic review explores new trends in English for specific purposes in the context of 21st-century skills by searching for related study areas and by focusing on how artificial intelligence was integrated into ESP classes.

By shedding light on the current applications of 21st-century skills in ESP classrooms and their implementation via AI, this study underscored pedagogical implications involving how ESP teachers can embed 21st-century skills into ESP classes through AI, which can aid ESP teachers in meeting the needs of ESP students regarding the necessities of the rapidly increasing and demanding business and academic world.

3 Research Questions

To this end, this study aimed to answer the following research questions:

1. What are the characteristics and study focus of the included studies?
2. What are the prevailing trends in English for specific purposes in the context of 21st-century skills?
3. How were 21st-century skills integrated into ESP teaching?
4. How was artificial intelligence integrated into ESP for embedding 21st-century skills teaching?

4 Method

4.1 Criteria of the Review

This study employed a systematic review to scrutinize the literature to reveal the current trends and implications of the integration of 21st-century skills into English for Specific Purposes classes through the use of artificial intelligence by applying an inductive coding approach. The dates for the scope of the study ranged from 2015 to 2025. The scope for the criteria was broad to find out the trends because the topic covers the shifts that happened in the 21st century. The reason for dating back to 2015 was to show whether there is any change in trends relating to 21st-century skills, even though the use of AI is relatively new in today's world. The systematic review process adhered to the guidelines of PRISMA by Page et al. (2020) from the planning of the study to the very last step through its checklist.

4.2 Information Sources and Search Strategy

To gather the articles, Google Scholar was utilized as a search engine because it can provide more varied and related studies. The first keyword to search on Google Scholar was the term “ESP and 21st-century skills”. This keyword was searched to identify if there are any related articles about the topic in general. The main aim was to see the related articles with titles that do not mention AI even though the content of the article involves AI as a component. From this entry, the first thirteen pages of Google Scholar were scrutinized. In this way, the research was able to ensure comprehensiveness. The second search term was “ESP and 21st-century skills through AI” to include the AI component, to be more specific about the scope, and to obtain more related articles. For this entry, the first ten pages of Google Scholar were examined. Publications in the English language were selected in this study. The dates were selected between 2015 and 2025 on Google Scholar. Journal indices were not considered in this study due to the limited research on the topic searched.

4.3 Selection and Data Collection Process

The selection and data collection process involved an initial process of including articles, involving key terms, titles, and abstracts. After the initial process, the selected articles were downloaded to check if full texts are related to the scope of this study. To review full texts, the aim of the studies, the relation to the topics ESP, AI, and 21st-century skills were identified. The related ones were selected as the final articles that were used in this study. Moreover, review and meta-analysis articles were eliminated; only research articles were selected.

Table 1 below represents the key terms searched in Google Scholar along with the number of gathered and eliminated articles. Table 1 shows that when the term “ESP and 21st-century skills” was searched, 51 articles were gathered while 21 of them were eliminated due to the irrelevancy. When the second term “ESP and 21st-century skills through AI” was searched, 41 articles were found, but 32 of them were eliminated because they were related only to AI and ESP, not 21st-century skills. Therefore, 30 of the articles from the first entry and 9 of the articles from the second entry were used in total in this study.

Table 1*Key Terms and Articles*

Key terms	Gathered	Eliminated	Total
ESP and 21st-century skills	51	21	30
ESP and 21st-century skills through AI	41	32	9

a) Initial Selection

In the initial selection of articles, titles and keywords were examined first. Those whose titles and keywords were found to be related to the scope of this study were checked by scrutinizing their abstracts. In the abstracts, the researcher focused on whether the article was a research or review article and, most importantly, whether it involved all three of these subjects as the main components of the study: ESP, AI, and 21st-century skills. Articles that focused solely on ESP and 21st-century skills, were also selected to show how these components were studied, with any pedagogical implications suggested by the articles. In the initial selection, 92 articles were collected and downloaded to check their full texts.

b) The Review of the Full Texts

In reviewing the full texts of the articles, the researcher eliminated the review articles and chose research articles. Furthermore, even though the keywords were found in the titles and abstracts, those that did not use any of these components in their studies as a main variable were eliminated. This means that the studies that investigated ESP and 21st-century skills, or including AI, were selected in this study because it could be difficult to find enough articles that contain all three components in one study, and it may show more varied perspectives when focused on them separately.

In that sense, 51 articles were found when searching for the term “ESP and 21st century skills” in the first thirteen pages of Google Scholar. For the term “ESP and 21st century skills through AI”, 41 articles were gathered in the first 10 pages of Google Scholar. In total, there were 92 articles found; however, when these articles were investigated, 53 of them were eliminated because they were not related to the topic, and they were reviews of literature, which left a total of 39 articles.

In Table 2, the articles that were selected and used in this study can be seen. There were 39 articles in total.

Table 2*Included Articles*

	Researcher(s)	Journal	Type of Publication
1	Akhajam (2019)	International Arab Journal of English for Specific Purposes	Article
2	Benabdallah (2023)	Philosophy, Social and Human Disciplines	Article
3	Benabderahmane & Belarbi (2024)	AFAK for Social Sciences	Article
4	Dubskikh et al. (2021)	ELearning & Software for Education	Article
5	Christoforou (2025)	Pedagogies: An International Journal	Article
6	Costa et al. (2024)	17th annual International Conference of Education, Research and Innovation	Abstract

7	Dashtestani & Forutanian (2025)	Journal of Applied Linguistics and Applied Literature: Dynamics and Advances	Article
8	Dmitrenko et al. (2025)	Proceedings of the 16th International Scientific and Practical Conference	Article
9	Fatriana & Hamidy (2023)	ICOPE	Article
10	Gargallo-Camarillas & Silvestre-López (2025)	17th International Conference on Education and New Learning Technologies	Abstract
11	Lembarek & Ghani (2024)	Ilkogretim Online - Elementary Education Online	Article
12	Hardiyanti & Herda (2023)	Journal of Education	Article
13	Heckadon & Tuzlukova (2020)	Arab World English Journal (AWEJ) Proceedings of 2nd MEC TESOL Conference	Article
14	Hidayati (2024)	Paradigma: Jurnal Filsafat, Sains, Teknologi, dan Sosial Budaya	Article
15	Jamalai & Krish (2021)	Malaysian Journal of Learning and Instruction	Article
16	Jamalai & Krish (2023)	Journal of Social Sciences and Humanities	Article
17	Karapetian (2020)	European Journal of Educational Research	Article
18	Kóris (2023)	New to the LSP classroom? A selection of monographs on successful practices by Vernon Press	Article from the book
19	Kozachenko & Plokhuta (2025)	Analele Universității „Ovidius” Constanța. Seria Filologie	Article
20	Kulamikhina et al. (2020)	Advances in Social Science, Education and Humanities Research	Article
21	Lazareva & Kovtun (2017)	Collected Articles	Article
22	Léon-Henr (2019)	ESP teaching and teacher education: current theories and practices by Research-publishing.net	Article from the book
23	Liton (2015)	International Journal of Instruction	Article
24	Luka & Seniut (2019)	Acta Educationis Generalis	Article
25	Menggo (2022)	Voices of English Language Education Society	Article
26	Muniandy & Ramaya (2024)	International Journal of TESOL & Education	Article
27	Olizko (2022)	iJET	Article
28	Ouis (2023)	AFAK for Sciences Journal	Article
29	Papadaki (2023)	Hellenic Open University	Postgraduate Dissertation
30	Pollard & Olizko (2019)	Current Foreign Languages Teaching Issues in Higher Education	Article
31	Prastiwi et al. (2021)	Advances in Social Science, Education and Humanities Research	Article
32	Purnawati & Sari (2023)	Philosophica: Jurnal Bahasa, Sastra, dan Budaya	Article
33	Saenko et al. (2021)	IJEP	Article
34	Simkova & Tuliakova (2020)	Revista Dilemas Contemporáneos: Educación, Política y Valores	Article
35	Sridhivya et al. (2024)	Australian Journal of Applied Linguistics	Article

36	Sukarni (2020)	ENGLISH REVIEW: Journal of English Education	Article
37	Tapolcai-Malaczkov (2015)	Proceeding of Alkalmazott tudományok II. fóruma: Konferenciakötet	Article
38	Tuzlukova & Heckadon (2020)	Journal of Applied Studies in Language	Article
39	Živković (2016)	European Journal of Social Sciences Education and Research	Article

4.3 Data Extraction and Synthesis

The articles obtained after the elimination step were analyzed through an inductive coding approach (Phakiti & Paltridge, 2015). They were grouped into shared themes according to countries where the studies were conducted, the years of publication, the types of studies, search terms, and study focus. The countries of the articles that were grouped were decided by the country in which the study was conducted. When the number of articles for each country was only 1, it was categorized in the other countries section due to the limited number. As for the study focus of articles, it was decided by categorizing them into the topics, scope, integration method, teaching approaches and methods, and components of these topics, such as components of 21st-century skills. For data extraction, patterns were identified to find out the main themes of the articles. Then they were categorized according to their themes and components. Articles with similar themes and topics were categorized together. When one article had more than one theme or topic, they were categorized in one main category by identifying its domain.

Findings were evaluated by addressing previous studies on ESP, 21st-century skills, and the use of AI, and by focusing on the new trends in the integration of 21st-century skills into ESP lessons. Results were considered to give pedagogical implications for embedding 21st-century skills into ESP classrooms and how AI can be used for this aim.

5 Results

5.1 Characteristics of Included Articles (Addressing RQ1)

In this section, several characteristics of articles included in the study were presented. Thus, the country and the year in which the study was conducted were categorized. Moreover, the focus of the included studies was examined and categorized in this section, with citations of the related articles used in this study.

5.1.1 Countries and Years of Included Studies

The articles gathered from the literature were categorized according to the countries in which the studies were conducted (Table 1). It was found that most studies were conducted in Indonesia ($n = 7$) and Ukraine ($n = 7$). After these countries, Algeria ($n = 4$) was revealed as the third country in which the studies were primarily conducted. It was followed by Malaysia ($n = 3$). After that, the studies were conducted in Russia ($n = 2$), Hungary ($n = 2$), Oman ($n = 2$), and Portugal ($n = 2$). Moreover, there was one article for each country in the other countries part, involving Latvia and Lithuania, the United Kingdom, Serbia, France, Saudi Arabia, Iran, Morocco, Greece, Cyprus, Spain, and India.

Table 3*Countries and the Number of Articles*

Countries	Articles
Indonesia	7
Ukraine	7
Algeria	4
Malaysia	3
Russia	2
Hungary	2
Oman	2
Portugal	2
Other countries	10

The articles were also categorized by the year they were conducted. When looking at the years in which the studies were conducted, most studies were conducted in 2023 ($n = 8$), followed by 2024 ($n = 6$), 2020 ($n = 6$), and 2025 ($n = 5$) (Table 3). Moreover, several studies were conducted in 2019 ($n = 4$). This was followed by 2021 ($n = 3$), 2015 ($n = 2$), and 2022 ($n = 2$). There were two different years in which only one study was conducted for each: 2017 ($n = 1$) and 2016 ($n = 1$). In 2018, no studies were identified related to the selection criteria of this study.

Table 4*Years and the Number of Articles*

Years	Articles
2025	5
2024	6
2023	8
2022	2
2021	3
2020	7
2019	4
2017	1
2016	1
2015	2

5.1.2 Study Foci of Articles

Most articles focused on perceptions of students and teachers and needs analysis ($n = 8$) when the articles were searched for ESP and 21st-century skills (Table 4). Furthermore, several articles used other approaches and methods involving blended and flipped learning, a student-centered approach, and communicative teaching ($n = 6$). The other study focus was Project-based Learning (PbL) ($n = 6$), involving the integration of PbL in general to enhance 21st-century skills in ESP classes. In these articles, film and video projects and online magazines were highlighted as methods of integration. Apart from the AI component, the technology integration category was also identified among the articles ($n = 3$). In these articles, technology was integrated to support 21st-century skills in ESP classes with the help of the Education 4.0 curriculum, virtual storytelling, virtual exchange projects, virtual reality, and tech-supported learning. In relation to technology integration, several specific digital tools were identified in the articles for 21st-century skills and ESP ($n = 4$). Thus, these articles utilized Google Classroom, some

online forums, Wiki, and WhatsApp. As a component of 21st-century skills, creativity was studied in the articles ($n = 3$) to be enhanced in ESP classes through art-based teaching.

Table 5

Study Focus of Studies Related to ESP and 21st-Century Skills

Category	Study Focus	Articles	<i>f</i>
Perceptions and needs	Perceptions of students and teachers and needs analysis	(Akhajam, 2019); (Lembarek & Ghani, 2024); (Heckadon & Tuzlukova, 2020); (Lazareva & Kovtun, 2017); (Liton, 2015); (Tuzlukova & Heckadon, 2020); (Sukarni, 2020); (Tapolcai-Malaczkov, 2015)	8
Approaches and methods	Blended and flipped learning, student-centered approach, English professional discussions, and communicative teaching	(Benabderahmane & Belarbi, 2024); (Hardiyanti & Herda, 2023); (Karapetian, 2020); (Kulamikhina et al., 2020); (Luka & Seniut, 2019); (Simkova & Tuliakova, 2020)	6
Project-based learning	PbL, film and video projects, online magazines	(Hidayati, 2024); (Jamalai & Krish, 2021); (Léon-Henri, 2019); (Prastiwi et al., 2021); (Purnawati & Sari, 2023); (Puspa & Syahril, 2017)	6
Digital tools	Google Classroom, online forums, Wiki, WhatsApp	(Fatriana & Hamidy, 2023); (Jamalai & Krish, 2023); (Muniandy & Ramaya, 2024); (Papadaki, 2023)	4
Technology integration	Education 4.0 curriculum, virtual storytelling, virtual exchange project, virtual reality, and tech-supported learning	(Dashtestani & Forutanian, 2025); (Kóris, 2023); (Živković, 2016)	3
Creativity	Art-based teaching	(Olizko, 2022); (Pollard & Olizko, 2019); (Saienko et al., 2021)	3

In addition, articles that specifically focused on ESP and 21st-century skills through AI were identified and categorized into themes, topics, and AI tools. Most of the studies focused on several AI tools, such as Gen-AI, Elsa Speak, Busuu, and AI-integrated augmented reality ($n = 5$). This was followed by the use of ChatGPT ($n = 3$) and students' and teachers' perceptions of the use of AI in ESP classes for 21st-century skills ($n = 1$) (Table 4).

Table 6*Study Focus of Studies Related to ESP and 21st-Century Skills through AI*

Focus	Articles	<i>f</i>
Different AI tools	(Dubskikh et al., 2021); (Christoforou, 2025); (Costa et al., 2024); (Kozachenko & Plokhuta, 2025); (Sridhivya et al., 2024)	5
ChatGPT	(Dmitrenko et al., 2025); (Gargallo-Camarillas & Silvestre-López, 2025); (Ouis, 2023)	3
Students and teachers' perceptions	(Benabdallah, 2023)	1

All in all, the articles were categorized according to the patterns that were identified in the full texts. It was found that the studies about the integration of 21st-century skills into ESP classes were conducted mostly in 2023 and 2024 in Indonesia and Ukraine. The studies were mostly about perceptions and needs of students and teachers, the integration of project-based learning, and the use of digital tools to enhance 21st-century skills in ESP classes. When AI-related articles were considered separately, the articles mostly focused on ChatGPT, perceptions, and other AI tools in general.

5.2 The Integration of 21st-Century Skills into ESP Teaching (Addressing RQ2)

As the main aim of this study, this section examines the prevailing trends identified in the included studies to show how 21st-century skills were integrated into ESP teaching and how artificial intelligence was used to integrate 21st-century skills into ESP teaching. Thus, in this section, each category from the study focus of the included articles was presented with the findings from the studies.

5.2.1 Perceptions and Needs

Regarding the perceptions and needs of students and teachers, 8 of the 39 studies were devoted to investigating perceptions of the integration of 21st-century skills and conducting needs analysis to determine the necessary components for embedding 21st-century skills into ESP teaching. In one study, ESP teachers' perceptions of the prospects of ESP students in the marketplace were examined (Akhajam, 2019). The findings revealed a need to develop students' soft skills, especially critical thinking, problem-solving, and communication skills. In another study, ESP students' needs were analyzed, and it was found that the most needed skill was speaking to enhance communication skills (Sukarni, 2020). Furthermore, one study highlighted that they showed an understanding of the role of 21st-century skills in future employability. They suggested that the lessons should be learner-centered, interactive, and experiential (Tuzlukova & Heckadon, 2020). However, one study emphasized that current ESP teaching mainly focuses on teacher-centered and theoretical instruction, although the ESP teachers had the endeavour to integrate 21st-century skills into their classes (Lembarek & Ghani, 2024). Furthermore, students thought more engaging and differentiated activities should be applied in the classes to support active learning and soft skills development. Thus, more training programmes were suggested to enhance both ESP and novice teachers' teaching methods. Similarly, Heckadon and Tuzlukova (2020) conducted a study to investigate students' perceptions of the development of their skills in ESP classrooms. It showed that the students were aware that they needed to develop their time management, critical thinking, problem-solving, and communication skills; yet, they also thought that the ESP course did not provide such opportunities to apply and develop these skills. In the same vein, one study highlighted the gaps between the lessons and needs of the ESP students in the workplace (Liton, 2015). Therefore, Liton

(2015) highlighted that there should be continuous needs analysis, a more student-centered approach, and more ICT and communication skills integration. Tuzlukova and Heckadon (2020) added experiential instruction, innovative tools, and creative thinking to that list. In addition, another study suggested self-study, blended learning, and flipped learning through a needs analysis conducted with students (Tapolcai-Malaczkov, 2015). Nevertheless, a study by Lazareva and Kovtun (2017) found that students thought several techniques, such as role-plays, brainstorming, and group work, to apply a student-centered approach were less compelling, while they were also aware that these techniques were more effective than the traditional ones to enhance soft skills.

5.2.2 Approaches and Methods

The studies included in this article also focused on different approaches and methods to implement 21st-century skills into ESP teaching. In one study, the flipped classroom model in an ESP class was evaluated regarding the integration of critical thinking skills (Karapetian, 2020). It was revealed that the model supported students' critical thinking and problem-solving skills, along with shifting from a teacher-centered to a student-centered approach. As an approach, communicative teaching and a critical thinking approach were implemented in another study (Kulamikhina et al., 2020). Therefore, they (2020) applied four strategies concerning communicative teaching to promote ESP students' communicative and critical thinking skills, and it was found to be effective in developing both 21st-century skills and language skills. As for the techniques that can be applied to ESP classes, one study implemented the Jigsaw technique to enhance effective communication and collaboration through academic writing of ESP students and found that it had a positive effect on academic writing proficiency to support cooperative learning (Benabderahmane & Belarbi, 2024). Adhering to the 4Cs, Hardiyanti and Herda (2023) utilized flashcards to teach vocabulary in ESP classes and concluded that it enhanced their vocabulary knowledge and enthusiasm in exams. Differently, a study investigated ESP students' evaluations of the implemented interactive teaching course, which involved interactive platforms, online tasks, and group meetings. It was revealed that it enhanced students' problem-solving skills and collaboration. As a different method, English professional discussion was implemented to promote the 4Cs by Simkova and Tuliakova (2020). 3 stages of English professional discussion were applied: pre-, active, and post-. Results of the study showed that it enhanced 21st-century skills in ESP teaching, autonomy, and motivation. In addition, for communicative skills, other studies suggested self-study, blended learning, and flipped learning through a needs analysis (Karapetian, 2020; Luka & Seniut, 2019).

5.2.3 Pbl

Moreover, 5 studies focused on project-based learning to implement 21st-century skills into ESP. In one study, tasks that foster critical thinking skills were embedded in the projects as a 21st-century skill through problem analysis, problem solving, finding a solution, and evaluating the solution (Hidayati, 2024). At the end of the implementation, students showed more engagement in the activities thanks to the authentic tasks and development in their critical thinking skills. Similarly, a study utilized online discussion forums to enhance 21st-century skills through group work by adhering to social constructivism theory (Jamalai & Krish, 2021). Online discussion forums consisted of different discussion topics about which they could share their ideas online as a group and individually, with three different stages of discussion. It was found that the students' critical thinking skills, digital skills, and leadership components were developed. Differently, one study implemented a video film project

through a student-centered approach (Léon-Henri, 2019). There were several stages before the project itself to prepare students for the project. After the preparation, the video project was given to groups of students, who were asked to record their own one-minute films. At the end of the study, it was revealed that it supported their content knowledge and soft skills. Similarly, a study implemented video projects for ESP students in groups and found both positive and negative perceptions among the students. Students showed positive responses toward being autonomous, teamwork, collaboration, and digital literacy, although they mentioned several difficulties they encountered limited time, lack of digital knowledge, and memorizing the lines. In the same vein, Prastiwi et al. (2021) utilized online magazines about civil engineering news from the ESP students to foster 21st-century skills of ESP students. Thus, they were able to experience 21st-century skills and develop content knowledge. Other than that, Purnawati and Sari (2023) asked ESP students to create an online tour package as groups to make them ready for the workplace with the aim of developing the students' 4Cs. It was concluded that students developed their 4Cs and readiness to work.

5.2.4 Technology Integration and Digital Tools

Regarding the integration of technology and digital tools, there were 4 studies for each. In several studies, technology was integrated into ESP teaching via several approaches and methods. One study evaluated their ESP curriculum by implementing Education 4.0 with a project-based teaching method (Dashtestani & Forutanian, 2025). The students showed positive attitudes towards the development of soft skills and content knowledge through Education 4.0. and project-based tasks. On the other hand, it was also concluded that they showed difficulties in digital skills and soft skills. Similarly, a study utilized project-based tasks completed by international groups of students via an online platform (Kóris, 2023). These online projects among the international ESP students promoted their digital skills, teamwork, and 21st-century skills, although there were several challenges regarding the time zones, intercultural communication, and understanding the group dynamics. Moreover, students' perceptions towards the integration of technology in ESP classes were positive, enhancing 21st-century skills, autonomy, and their motivation (Živković, 2016). Concerning the digital tools, in one study, ESP students were asked to prepare ESP lesson materials as projects assigned to their groups and to complete their projects in Google Classroom (Fatriana & Hamidy, 2023). These projects and the use of Google Classroom enhanced their motivation and 21st-century skills along with their IT skills. Similarly, a study utilized an online forum as a platform for enhancing collaboration and communication skills (Jamalai & Krish, 2023). Online group projects were given to the ESP students, and they were asked to complete the projects via this online forum. At the end of the implementation, it was revealed that it enhanced 21st-century skills, especially collaboration and communication components. In a similar study, several tasks related to the ESP subject were given to the students via WhatsApp (Muniandy & Ramaya, 2024). The students completed the tasks by sharing reports, videos, and sharing related files, and they gave feedback and asked questions to each other. At the end, it was found that it promoted their leadership and critical thinking skills. Differently, a study focused on collaborative writing skills by utilizing Wiki (Papadaki, 2023). It investigated teachers' opinions of the use of Wiki in ESP classes to enhance collaboration, and it was found that teachers showed positive attitudes towards its effectiveness on the students even though there were several challenges involving time limitations and lack of training and equipment.

5.2.5 Creativity

There were 2 studies specifically focused on creativity using art-based teaching in ESP. A study investigated Portuguese and Ukrainian ESP teachers' ways to enhance ESP students' creative thinking skills (Saenko et al., 2021). It was revealed that Portuguese teachers apply more innovative ways, such as PbL and role-plays, while Ukrainian teachers use both traditional and innovative ways. Also, ESP students suggested newer ways of obtaining information and solving problems with an interdisciplinary approach to improve their creativity. Additionally, a study integrated art into a conference project by making students attend a conference, analyzing the conference in several stages, and creating their creative reflections through art on their analysis and presenting them (Olizko, 2022). At the end, it was found that it developed their creative thinking skills along with the 4Cs. Similarly, one study integrated an art project related to their subjects to enhance their creativity, intellectuality, and collaboration skills (Pollard & Olizko, 2019). It gave positive results even though there were several obstacles, such as a lack of materials and not being used to art integration.

5.2.6 AI Integration

When it comes to AI, there were 10 studies investigating the integration of AI into ESP to promote 21st-century skills. Several AI tools were identified from these studies ($n = 5$), especially the use of ChatGPT ($n = 3$), along with the students' and teachers' perceptions of the use of AI for 21st-century skills ($n = 2$). One of the studies focused on the implementation of AI-supported virtual and augmented reality (Dubskikh et al., 2021). It helped students who were distant join together and do the tasks and projects collaboratively by engaging them in an active learning process and preparing them for 21st-century skills. Differently, another study examined the use of Gen-AI multimodal video composition by the ESP students (Christoforou, 2025). They were asked to choose one from the given topics and create a video as groups by using different AI tools. It was found that it supported 4Cs and semiotic awareness by making the ESP students more engaged and active learners instead of passive recipients. In line with this study, a study implemented a course especially for the use of AI to enhance 21st-century skills (Costa et al., 2024). Students met in virtual environments in which they could complete AI-driven tasks and projects with international students. At the end, it was concluded that it enhanced their 4Cs, digital skills, and collaboration. Another study showed that the critical thinking of ESP students can be developed via AI tools, along with supporting active engagement and field-related language (Kozachenko & Plokhuta, 2025). More specifically, a study was conducted within the SAMR model to support professional communicative skills via ElsaSpeak and Busuu (Sridhivya et al., 2024). It showed positive results in developing students' language skills, communicative skills, and field-related job skills. As for the use of ChatGPT, a study investigated ESP students' critical thinking by using ChatGPT (Dmitrenko et al., 2025). Prospective mathematics students used ChatGPT to solve problems and analyze stages. It was found that it developed their critical thinking and analytical skills. In another study, the effects of ChatGPT on ESP students' writing skills were investigated, and it was revealed that there was a positive impact on their writing skills, vocabulary knowledge, communicative skills, and evaluative skills, although it warned about the field-related content selection and controlling the effect of ChatGPT on critical thinking skills (Ouis, 2023). Similarly, a study investigated the use of ChatGPT for developing writing skills in different stages of writing, and both positive and negative sides were identified, such as being an autonomous learner, high engagement, digital skills, and difficulty in dealing with the technology (Gargallo-Camarillas & Silvestre-López, 2025). Differently, a study was conducted to examine ESP teachers' perceptions of the use of AI in ESP teaching (Benabdallah, 2023). It was

found that teachers were highly aware of the support of AI in ESP teaching, such as promoting students' 21st-century skills, meeting their needs, and helping teaching practices, even though it suggested more teacher training programs to help them use AI tools effectively so that ESP teachers can fill the gap between the students' needs in the real world and classroom practices.

6 Discussion

6.1 RQ1: Characteristics of Studies

Results related to the characteristics of included studies suggest that most of the studies on the integration of 21st-century skills into ESP teaching, and especially the use of AI to implement it, were conducted in Indonesia and Ukraine, although other countries also investigated that area of research with a limited number of studies. Differently, in the study of Mehrabian (2026), international communicative competence and ESP teaching were examined through a review article, and most of the studies were conducted in Asian countries. Specifically, for the 21st-century skills, the results of a study conducted by Karmilah et al. (2024) were found to be similar to Mehrabian's (2026) study, since Asian countries were the most represented, followed by European countries. When it comes to the years in which the included studies were conducted, most studies related to 21st-century skills, the use of AI, and ESP teaching were conducted after the year 2020. In line with this result, other studies found that most studies were conducted after the year 2020 (Karmilah et al., 2024). In the study of Mehrabian (2026), 2025 and 2024 were the years when most studies were conducted. In the study of Zeng and Della (2024), the years identified in the study were 2024 and 2023.

6.2 RQ2: Current Trends Related to 21st-Century Skills and ESP Teaching

As for the focus of the included studies, perceptions and needs of the ESP teachers and students were mostly studied, as found in this study. Teachers can personalize their teaching based on students' needs (Supunya, 2023). Furthermore, materials and courses should be designed according to the needs of the students to promote 21st-century skills (Sukarni, 2020). One study suggested that materials should be designed as multimodal materials to improve digital literacy, soft skills, and 21st-century skills (Akhajam, 2019; Heckadon & Tuzlukova, 2020). In line with the study of Menggo (2022), other studies suggested that ESP course materials should match the needs of the students and comply with the 21st-century skills for meaningful practice (Kustini & Musthafa, 2020; Yılmaz Yakışık, 2023).

Related to that, several studies examined approaches and methods to implement 21st-century skills so that new approaches align with the global environment (Tuzlukova & Singh, 2018). The integration of 21st-century skills into ESP learning outcomes can be helpful for ESP teachers to apply a suitable approach or method (Altay & Mirici, 2024). Among these approaches, project-based learning has been studied the most. Similarly, Drinovac Topalović and Ljubas (2024) mention ways to integrate culture into ESP teaching by suggesting a needs analysis, clarifying the cultural objective, collaborative learning, and critical thinking. Differently, a study implemented translation into ESP via translanguaging and code-switching, resulting in a better understanding of the topics and an increase in student engagement (Gvelesiani, 2023). Moreover, there were other studies implementing PbL into ESP, finding an increase in students' motivation and academic performance (Kavlu, 2020; Rodríguez-Peñarroja, 2022; Shalaan, 2020; Zulfa et al., 2025). The study of Shalaan (2020) indicated similar results to the included studies in this article because it found that PjBL promoted critical thinking and problem-solving

skills, along with the autonomy of the students and their creativity. A study also highlighted the use of project-based learning in the improvement of speaking and 4Cs (Waly, 2025). Therefore, projects and project-based tasks in ESP classes might be a step toward encouraging students to acquire the skills they will need in the workplace of the future and increasing their self-confidence through context-rich authentic materials that support interdisciplinary collaboration (Altay & Mirici, 2024; Tuzlukova & Singh, 2018).

The findings of this study revealed that ESP teaching can be conducted through several digital tools and technology integration involving artificial intelligence. In line with the results of this study, several studies have utilized the TPACK framework developed by Mishra and Koehler (2006). On the other hand, a study highlighted not only positive feedback from ESP teachers on the use of AI, especially ChatGPT, but also concerns about its reliability, how to internalize the information gathered from it, and its applicability to pedagogy (Assassi, 2026). Although these studies highlighted the use of digital tools and sophisticated technologies, the study conducted by Hutaurok et al. (2026) found that the way to implement TPACK may not be ensured by the use of more sophisticated technologies but be guaranteed by the successful alignment of the other components, such as content and teaching, with the technology. In line with that, the findings of Al Haris et al. (2026), Apgrianto et al. (2021), and Sitepu et al. (2020) indicated that ESP teachers who utilized different digital tools, including AI, had positive results by combining technology, pedagogy, and content through multimodal materials.

Furthermore, ESP teachers may use AI tools (e.g., ChatGPT, Gen-AI videos, Elsa Speak) to support learner autonomy and digital literacy (Altay & Mirici, 2024) by adopting learner-centered approaches informed by needs analysis and student perceptions. For assessment, ESP teachers can develop suitable assessments using digital portfolios and conduct performance-based evaluations. Through more personalized instruction, a controlled learning environment in ESP policy can evolve into more authentic career-like instruction, which can reinforce 21st-century skills (Supunya, 2023). In line with the current literature, the study by Synekop (2020) showed that the use of digital technology, such as WebQuest, improved students' professional communication skills in many work-related situations. Most of the studies found in the literature suggested more personalized ESP instruction through technology-based approaches and methods. These studies are also in line with the studies of Kakoulli Constantinou and Papadima-Sophocleous (2020). Similarly, the other studies also showed that the use of ChatGPT can enhance 4Cs and linguistic competence involving discipline-specific terminology (Aydın Yıldız, 2024; Dziubata, 2024; Enamorado, 2025; Kozachenko & Plokhuta, 2025; Pondelíková & Luprichová, 2025). On the other hand, several studies mentioned the cons of AI usage. One of these studies was conducted by Kalla et al. (2023), maintaining that disadvantages of using AI can include biased information, a lack of empathy and emotional intelligence, and a limited knowledge base. Similarly, Vuletić and Janković (2026) emphasized that ESP students were suspicious about the reliability, transparency, and ethical considerations of AI when implemented into their ESP class. Moreover, a study highlighted the need for accurate interpretation of content-related terminology by AI, a decrease in conventional approaches due to overreliance on AI, and equal accessibility (Sim et al., 2025). Similarly, a study utilized AI for constant needs analysis, resulting in its success in target situation analysis, although there were teachers' concerns about the accuracy of data shared by ChatGPT (Assassi, 2026). Meanwhile, in another study, it was suggested that AI can help create ESP materials by using specialized terminology since finding pre-made materials for specific fields may create difficulty for ESP teachers (Chirobocea-Tudor, 2024). Apart from the disadvantages, ESP teachers' application of AI

can be impeded due to several obstacles, such as inadequate teacher training for the effective use of AI, unequal access to technology, and a lack of related studies (Haryani, 2025). Thus, Costantini et al. (2025) indicated that there should be clear guidelines for AI integration into ESP teaching, ethical assurance, and AI literacy so that ESP students can be equipped with 21st-century skills.

7 Conclusions and Implications

The findings of this study revealed that 21st-century skills can be implemented into ESP teaching through several approaches, methods, and tools. In this respect, it was found that there were several AI tools to implement 21st-century skills into ESP teaching. Innovative teaching strategies help develop important 21st-century abilities in English for Specific Purposes (ESP) by transitioning the educational emphasis from passive knowledge acquisition to active engagement and practical learning. According to the statistics, there is a significant association between ESP research trends and the incorporation of 21st-century skills—particularly the 4Cs—supported by technology-enhanced practices. In ESP situations, the application of project-based learning and authentic materials has a direct bearing on professional relevance and real-world communication to promote teamwork, problem-solving, and learner autonomy. Frequent focus on perceptions, needs analysis, and student-centered approaches indicates a shift toward personalized, reflective, and adaptive learning environments. This suggests that ESP teaching is evolving to balance language-specific goals with broader skill development. Traditional ESP practices (e.g., academic writing, professional discussions) are increasingly supported by innovative, technology-mediated, and interactive designs.

The synthesis of these studies reveals that ESP instruction is no longer confined to linguistic or occupational content but is becoming a multimodal, technology-rich, and skill-oriented practice. The integration of AI, digital tools, and learner-centered methodologies demonstrates how 21st-century skills are operationalized within ESP classrooms to prepare learners for real-world professional communication and lifelong learning. Therefore, stakeholders can support teacher development in technology integration and ethical AI use. Technology support teams should be established in schools, and teachers should develop themselves professionally and technologically (Mirici & Kızılışıkoğlu, 2025). Therefore, collaboration between ESP teachers and domain teachers is necessary (Altay & Mirici, 2024; 2023). All in all, ESP teachers can plan and structure their classes to develop students' 21st-century skills by leveraging AI (Tuzlukova & Singh, 2018). As for the limitations of this study, this review could have involved more quality-indexed journals; however, due to the limited reach of studies, studies from more varied journals were included. Future studies can categorize the studies according to their indexes and look for the studies that specifically focus on approaches/methods that are used in ESP classes to enhance 21st-century skills. Also, this study was only a snapshot of the current trends; thus, future studies can focus on more variables, such as type of research, longitudinal studies, participants, settings, and specific tools for specific skills. Since 21st-century skills are considered composed of different components, these components, such as 4Cs, sustainability, leadership, information literacy, and technology literacy, can be investigated separately to investigate micros of 21st-century skills.

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Authors' Contributions

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The authors declare that there is no conflict of interest.

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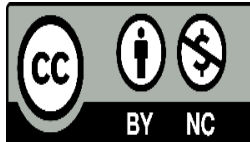
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