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INVESTIGATING THE IMPACT OF 3D MODELS AND ANIMATIONS ON THE ORAL PERFORMANCE OF ALGERIAN ESP MEDICAL STUDENTS: A MIXED METHODS STUDY

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Abstract

3D dimensional technology is increasingly used in the educational domain. However, little is known concerning the actual importance for using 3D models and animations in English for Specific Purposes. Besides, the weakness of oral performance among ESP learners in non-English speaking countries is widespread in different educational institutions. Accordingly, this study aims to exploring the effects of integrating 3D based instruction into the speaking performance of Algerian ESP medical students. Utilizing a mixed methods approach, data were collected through a quasi-experimental one group pre-test and post-test design alongside a focus group interview. A total of 60 undergraduate students from the university of Ibn khaldoun participated in 3D models enhanced speaking tasks using sketchfab platform over six weeks. Quantitative data revealed a statistically significant improvement in students speaking, particularly in fluency, vocabulary and pronunciation, although grammar did not show a significant improvement. 3D models instruction also reduces students' anxiety levels, improves students' motivation, and created a more engaging and enjoyable learning environment. The results suggest that 3D model and animations can be a powerful pedagogical tool for promoting ESP medical students' communicative competence.

Keywords: 3D model; enhanced; ESP; Medical students; speaking skills

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Introduction

In the fast growing information society of today, enhancing scientific literacy became the cornerstone of numerous educational policies worldwide. Scientific literacy is the ability of users to use and apply the scientific knowledge. Communication in scientific literacy is recognized primary in medical education, students with higher communication skills can share knowledge and participate in meaningful discussion with peers, researchers, or future patients. In English for Specific Purposes (ESP) field particularly in non-English-speaking countries, ESP medical students often encounter hindrances while using English (Zolfaghari et al., 2025; Liu et al., 2020; García-Ostbye et al., 2023), though having strong content of the subject matter of their discipline. This difficulty is repeatedly pronounced in oral communication (Bekteshi et al., 2020; Djaileb, 2018; Rothinam & Maniam, 2025) where learners lack technical vocabulary and fail to produce fluent correct productions.

In Algeria, extensive studies outlined persistent barriers among ESP medical students in acquiring and applying oral communication skills in English (Outemzabet & Sarnou, 2023). The same students find difficulties with fluency, pronunciation, and the correct use of medical terminology during speaking tasks, thereby limiting their academic and professional performance. Further, teaching in most of higher education ESP institutions continues to focus on grammar, reading comprehension and often at the expense of speaking practice (Saraa, 2020; Djaileb, 2018; Assasi & Rouaghe, 2024). Addressing this critical issue in ESP education is of utmost importance to prepare students with the language needed in health and clinical environments.

To overcome these challenges, Algerian researchers and educators have increasingly turned to emerging educational technologies methods to improve learners' learning effectiveness. However, the current teaching approaches in Algerian ESP context depends heavily on fixed visual and written text depriving students from vivid and immersive learning environment (Boudersa, 2018; Saraa, 2020). With the continuous evolution of digital technology, three-dimensional (3D) interactive models emerges as innovative transformative tool to enhance language learning. It offers interactive, immersive, and visually rich learning experiences, 3D content can support learners in understanding complex concepts, reduce cognitive

overload, and foster higher engagement. When it is integrated into English for Specific Purposes (ESP) contexts, particularly in medical education, 3D models allow students to explore anatomical structures, practice professional terminology, and articulate descriptions more fluently and accurately.

Building on the theoretical research frames, the present study investigates the impact of integrating three-dimensional animations using Sketchfab platform into ESP instruction on Algerian ESP medical students' oral communication skills. Specifically, it examines the effect of (3D) animation on students' pronunciation, fluency, and use of domain-specific vocabulary. In addition, the study assesses learners' perceptions of using 3D animation in their language learning environment. The goal is to determine not only the effectiveness of (3D) animation integration but also its acceptability and potential sustainability in Algerian ESP education. To reach the objective of the study, the following research questions are proposed

1. To what extent does the integration of 3D models and animation from Sketchfab enhance ESP medical students' speaking performance?
2. What is the effect of 3D model–based instruction on ESP medical students' fluency, vocabulary, grammar, and pronunciation?
3. What challenges or barriers do ESP medical students perceive when using 3D Sketchfab models for developing speaking performance

Accordingly, to examine the impact of (3D) models based instruction on ESP medical student's oral performance, the following hypotheses were outlined

Research hypotheses

H1: There is no statistically significant difference in speaking performance in the pre-test and post-test scores of the pilot group.

H2: There is statistically significant difference in speaking performance between the pre-test and post-test scores of the main group

H3: The main group has significant higher post-test speaking performance scores than the pilot group

Literature Review

The integration of digital technologies into language education has reshaped the ways in which learners acquire and practice communication skills, particularly in English for Specific Purposes (ESP). This literature review discusses three main strands relevant to the present study: (1) the role of 3D instructional technologies in language education, (2) the potential benefits of 3D resources for ESP learning, and (3) the specific application of 3D model visualization in English for medicine to stimulate authentic, real-life communication.

3D Instructional Technologies in Language Education

3D Instructional technology is an immersive learning experience which integrates 3D digital technology in education, this approach of 3D models technology brings learners stimulating realistic environments that makes learning interactive and engaging (Dargan et al., 2023; Porchesu et al., 2023; Wang et al., 2024). 3D visualization technologies often incorporate virtual reality (VR), augmented reality (AR), and mixed reality (MR). In particular, the integration of 3D visualization technologies in English language education has received considerable scholarly attention (Porchesu et al., 2023; Soboleva et al., 2020; Spivachuk et al., 2023). Research advocated the positive effects of the inclusion of 3D model based technology instruction at various educational sectors; however, its full potential in ESP context is not fully covered (Bonner & Reinders, 2018). In contrast to traditional classroom instructions, 3D digital technology offers multimodal frameworks that embraces constructivist and sociocultural theories. Drawing upon Vygotsky (1978) Sociocultural Theory, this study focused on active participation and situated cognition. For example, Nicolaidou et al. (2023) observed that AR environments, which include 3D visuals, audio, and text, were more effective than traditional mobile apps in enhancing vocabulary retention and learner motivation. This delivery mode encourages learners to connect new information to prior knowledge and strengthens their retention (Cai et al., 2022; Lin et al., 2020). Additionally, Chen et al. (2021) found that the integration of virtual reality into problem-based learning improved technical vocabulary acquisition and promoted sustained interest in language learning. Alternatively, studies of virtual 3D models in language learning indicate that such technologies can promote authentic interaction and improve communicative skills (Ochoa Alpala et

al., 2018). However, despite evidence for their benefits in vocabulary acquisition and content understanding, the potential of 3D visualization tools to enhance speaking proficiency in ESP contexts remains underexplored, highlighting a significant gap in the literature.

Potential Benefits of 3D in ESP education

To meet with recent advances in education and align with the evolving communicative needs of learners in academic and professional contexts, English for Specific Purposes (ESP), as a branch of English Language Teaching (ELT), has extensively recognized the use technology. In professional purposes, the mastery of technical terminology is of utmost importance, particularly in fields such as science, medicine, engineering, and business, where communicative competence is more than essential (Bekteshi & Xhaferi, 2020; Amin, 2025). Integrating 3D technology in ESP context can help students overcome difficulties with ESP vocabulary, concepts, and terms. Research across ESP educational domains indicates that three-dimensional (3D) learning resource such as animated models, virtual environments, and immersive visualization tools significantly enhance gains in intrinsic motivation and perceived competence among science students Teplá et al. (2022).

In language classes, 3D models can enhance the teaching methodologies and provide rich contextual learning experiences (Tsai, 2020; Solak & Cakir, 2015). Though several research has shown that 3D instructions within AR in language learning can improve English language acquisition (Wedyan et al., 2022), grammar (Wedyan et al., 2022) and also skill such as reading (Jamrus and Razali, 2019), writing (Yoke et al., 2019) and listening (Ismayatim et al., 2019), very few studies examined the effect of 3D visualization instructions as a pedagogical tool in ESP education. Additionally, there has never been research done in ESP learning context in Algeria that specifically addresses this technology to enhance medical students speaking skills. It is believed that the findings of the study will add to the huge body of knowledge and get vivid experience in medical English literacy, which in turn is highly beneficial for boosting multimodal digital literacy in ESP learning.

The 3D model visualization in English for Medicine: stimulating communicative Real life communication

The English for Medical Purposes (EMP) domain requires advanced spoken communication skills, as learners must interact with patients, collaborate with healthcare professionals, provide clear explanations, and react appropriately in urgent situations (Hsu, 2015). Traditional instructions typically rely on scripted role-plays, textbook dialogues, and non-authentic-classroom tasks that rarely capture the complexity of real clinical communication (Rothinam & Maniam, 2025). Research indicates that EMP students often experience difficulties with fluency, pronunciation, and language use, largely due to limited opportunities for authentic materials (Djaileb, 2018). Research has shown that 3D visualization and animations tools enhance learners' comprehension of complex subject matter and support knowledge retention, particularly in medical and anatomical education (Youn et al., 2023; Li et al., 2024). These tools have also been associated with increased motivation and satisfaction among learners (Küçük et al., 2016). Studies have demonstrated that using 3D based instruction enhances medical students' communicative competence by placing learners in authentic task-based situations where learners apply medical terminology and professional discourse in real-life context (Chen & Lai, 2025).

Method

Design and context of the study

In the present study, a sequential explanatory mixed-methods design was used to investigate the impact of three-dimensional 3D instruction on the speaking performance of Algerian ESP medical students. Also, a purposive sampling technique was employed by including 60 lower-intermediate ESP medical students who had achieved a CEFR B1 level on the Oxford Achievement Test. This criterion-based selection ensured group homogeneity in terms of language proficiency. The participants were then randomly assigned to a pilot group (n = 30) and a main group (n = 30). In addition, ten participants from each group (pilot and main) were invited to participate in semi-structured focus group interviews. These sessions explored themes such as speaking confidence, language accuracy, retention, motivation, the perceived challenges. Each session lasted

approximately 45–60 minutes, was audio-recorded, and subsequently transcribed verbatim for analysis. The students were enrolled at the Faculty of Medicine, Ibn Khaldoun University of Tiaret, Algeria. Most reported prior experience with online learning and technology-enhanced instruction, although none had previously engaged with three-dimensional (3D) instructions.

Participants

To ensure group homogeneity and minimise variation in language proficiency, only students who had achieved a CEFR B1 level on the Oxford Achievement Test were included in the study. A total of 60 lower-intermediate ESP medical students were therefore selected. All participants were enrolled in an English for Medical Purposes course, the majority of the students mother tongue language was Arabic and a small number were Tamazight L1 speakers. All had prior exposure to General English through secondary and elementary schooling. The selected students were then assigned to a pilot group (n = 30**)** and main group (n = 30)**.** Their ages ranged from 22 to 25 years, and they all provided informed consent to participate in accordance with ethical research standards.

Table 1. Characteristics of the Participants

Number of the participants	60
Proficiency	lower Intermediate
Gender	Males and females
Age	22-25
Mother tongue language	Arabic, Tamazigh
Major	Medicine
Location	Ibn khaldoun University

Material

The instructional material used with the pilot and main groups of the study was *Professional English in Use – Medicine* (Glendinning & Howard, 2007), Cambridge University Press. Glendinning & Howard (2007). This textbook aligns with the objectives of the national curriculum standards for ESP courses in Algerian higher education. It was selected because it is a Cambridge-published, ESP-oriented resource designed specifically for medical professionals. In addition, the treatment included a series of three-dimensional (3D) speaking tasks designed using high-quality 3D

anatomical models available on Sketchfab https://sketchfab.com/. Students performed 3D enhanced individual and pair speaking activities, including the description of anatomical structures (e.g., the respiratory and digestive systems), doctor/patient consultations, and short oral presentations on physiological functions. To ensure content validity, all tasks were aligned with the learning outcomes of the EMP curriculum and were reviewed by two ESP specialists and a medical professional. Minor adjustments were made to terminology load and communicative complexity based on their feedback. All performances were audio-recorded and assessed by two experienced raters using an adapted IELTS speaking rubric (fluency, vocabulary, grammar and pronunciation), and inter-rater scores were calculated to ensure rating reliability.

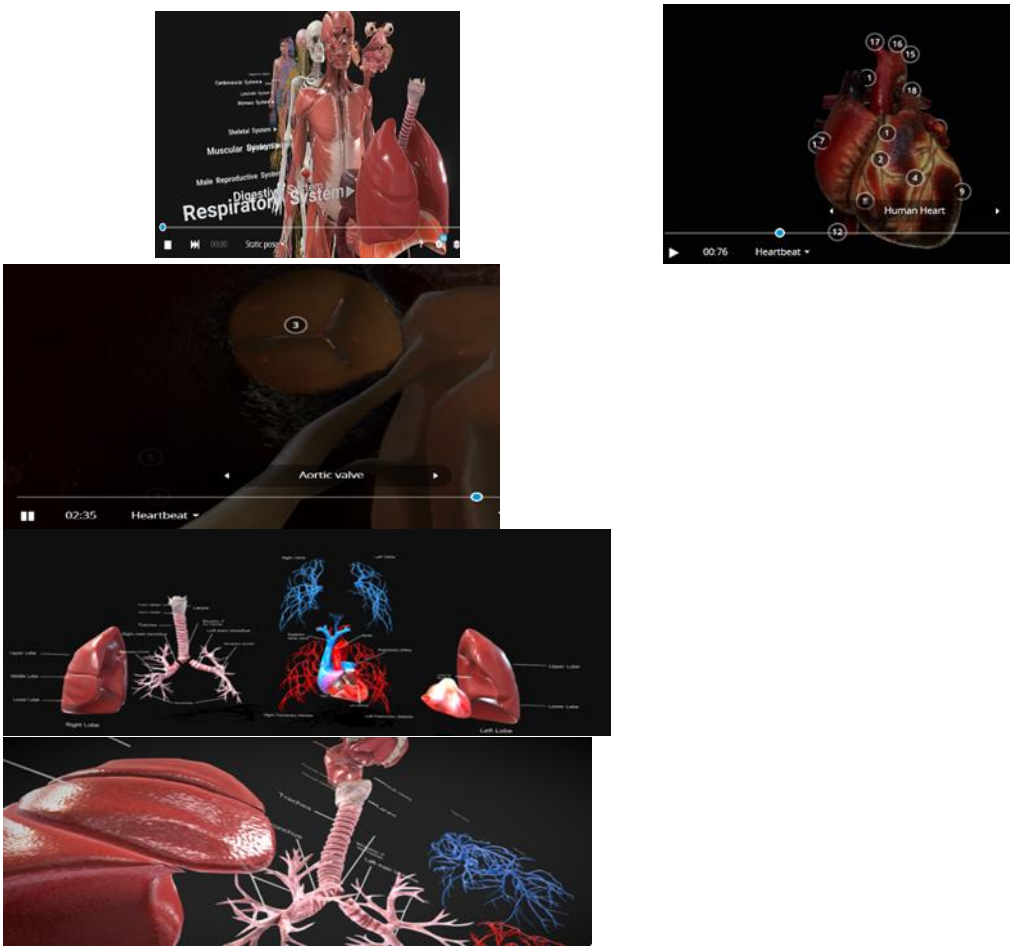

Figure 1. Screenshots of AR 3D Models of Respiratory System

Treatment

Both the pilot and main groups followed the same instructional approach, combining textbook-based lessons with (3D) based speaking tasks delivered through Sketchfab. The pilot group treatment was used to test the feasibility of the (3D) based speaking tasks and inform minor adjustments to task design and lesson sequencing. The treatment was conducted over six weeks; the distribution of the sessions is shown in the course syllabus (see Appendix A). Students used 3D models of the respiratory and digestive systems then completed speaking tasks such as doctor–patient consultations, symptom explanations, and short oral presentations on anatomical functions. The treatment focused on developing medical vocabulary, fluency, and communicative confidence in professional medical contexts. Table 2 demonstrates the weekly distribution of the framework of the study.

Table 2. Distribution of the Framework

1st Week	2nd Week	3rd 4th and 5th Weeks	6th week
Group assignment	Pre-assessment	Course orientation	Post- assessment

Data Collection Procedure

Pre- and post-tests were used to measure changes in speaking performance. To ensure content validity of the pre- and post-test speaking tasks, the content was reviewed and validated by two ESP specialists and one medical professional, who confirmed that the tasks accurately reflected the learners' target proficiency level. The pre-test, as shown in appendix A, consisted of an individual description of a static anatomical image (1–2 minutes) and a pair role-play simulating a general doctor–patient interaction (3–5 minutes). The post-test, shown in appendix A, followed the same structure but incorporated 3D models of the respiratory and digestive systems. All speaking performances were audio-recorded and assessed using an adapted IELTS rubric covering fluency, vocabulary, grammar and pronunciation. Following the intervention, focus group interviews were conducted to obtain students' perceptions of 3D based tasks. They were then transcribed verbatim and coded thematically.

Results

Comparison of Pre-and Post-tests Scores between Pilot and Main Groups

The quantitative analysis of a paired samples t-test was conducted to compare the pre-and post-test speaking scores in both the pilot and main groups. Results showed that both groups improved significantly from pre-test to post-test. Table 3 showed that the Pilot group demonstrated a statistically significant improvement (t = 3.40, p = .002), indicating a moderate increase in speaking performance. The Main group showed a highly significant improvement (t = 11.42, p < .01), reflecting a stronger effect of 3D model–based instruction on students' speaking performance as showed in Figure 1.

Table 3. Paired sample t-test between the pilot and main group

Group	Test	Mean	SD	T-value	*Sig.
Pilot	Pre-test	20.18	1.23	3.40	.002
	Post-test	21.28	1.28		
Main	Pre-test	20.43	1.48	11.42	< .01
	Post-test	23.41	0.95		

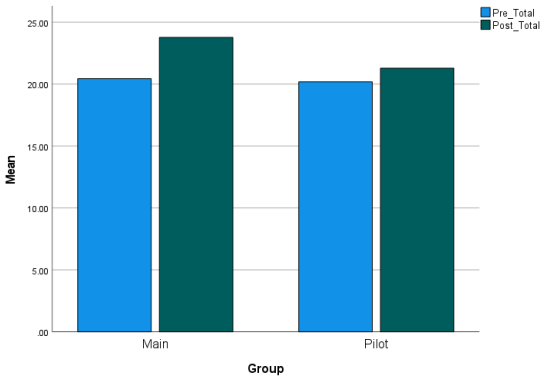

Figure 2. Pre and Post-test Speaking Scores of the groups

Comparison of the Speaking Sub-Skills in Pre-and Post-Test

Fig indicates That the analysis of the speaking skill components for each criterion, results showed a varying degrees of improvement across the pilot and main group. In the pilot group, the paired samples t-test was conducted to assess improvements in speaking skills after the intervention.

Table 4. Paired Samples *t*-Test Results for Speaking Sub-Skills

Group	Skill	Pre- test Mean	Post- test Mean	T-value	P	sig
Pilot	Fluency	4.88	5.22	2.51	.018	Significant
	Vocabulary	5.10	5.38	1.93	.061	Non-significant
	Grammar	4.95	5.23	2.01	.053	Significant
	pronunciation	5.23	5.42	1.09	.281	Non-significant
Main	Fluency	4.91	6.25	9.29	< .001	Significant
	Vocabulary	5.24	6.17	9.77	< .001	Significant
	Grammar	5.11	5.21	0.79	.430	Non-significant
	pronunciation	5.16	6.12	5.69	< .001	Significant

The results showed a significant improvement in fluency and grammar, with scores increasing from pre- to post-test, t (29) = 2.51, p = .018 and t (29) = 2.01, p = .053 respectively. However, vocabulary and pronunciation p-values were p = .061 and p = .281, respectively, indicating that the improvements were not statistically significant. The overall speaking score also improved moderately, t(29) = 3.40 , p=.002. These findings suggest a modest positive effect of the treatment in the pilot group, particularly in fluency and grammar.

For the main group, paired samples t-test results indicated statistically significant improvements in most speaking criteria. Specifically, fluency increased significantly, t (29) = 9.29, p < .001; vocabulary, t(29) = 9.77, p < .001; and pronunciation, t(29) = 5.69, p < .001. The overall speaking score also improved markedly, t(29) = 11.42, p < .001. However, grammar did not show a significant change, t(29) = 0.79, p = .430. These results indicate that the treatment had a strong positive impact, in fluency, vocabulary, and pronunciation.

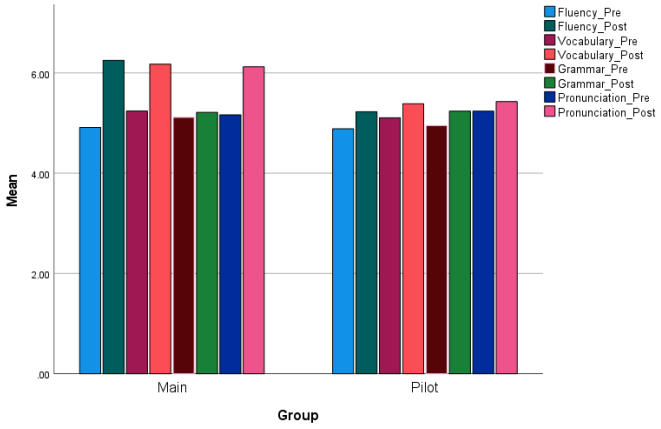

Figure 3. Speaking scores in pre-and post-tests

Effect Size Analysis Using Cohen's d

The effect size analysis was conducted using Cohen's d to assess the magnitude of improvement between pre-test and post-test scores in both the pilot and main groups. In the pilot group, the mean post-test score (M = 21.28, SD = 1.29) showed a moderate improvement compared to the pre-test score (M = 20.19, SD = 1.23), with a Cohen's d value of 0.62, indicating a medium effect size. In contrast, the main group demonstrated a substantial increase from pre-test (M = 20.43, SD = 1.48) to post-test (M = 23.77, SD = 0.95), with a Cohen's *d* of 1.55, reflecting a large effect size. These findings suggest that the 3D based instruction had a considerable greater impact on the main group compared to the pilot group.

Table 5: Paired Sample T-Test with Effect Sizes for Pilot and Main Group

	Test	Mean	SD	Mean Difference	p-value	Cohen's *d*
Pilot	Pre-test	20.18	1.23			
	Post-test	21.28	1.29	1.09	.482	0.62
Main	Pre-test	20.43	1.48			
	Post-test	23.41	0.95	2.98	< .001	1.55

Discussion

Contrary to our first hypothesis, findings displayed moderate effect of the pre-test and post-test scores of the 3D instruction treatment on the speaking performance of the pilot group. Specifically, results showed positive effect on students speaking fluency, and grammar, while negative scores were observed on vocabulary and pronunciation. These findings indicate that 3D instruction has the potential to enhance the language production, such as fluency by immersing learners into interactive 3D visualizations tasks of authentic medical content where students have strong prior knowledge this encourage spontaneous speech and natural use of grammar. Thefindings corroborate with the study of (Wu et al., 2013; Wedyan et al., 2022; Ustun et., 2022; Khodabandeh, 2025). However, negative effects of3D instruction on vocabulary and pronunciation suggest that 3D instruction, when used in isolation, may not reinforce lexical retention and phonological input. This result contrast with the study of Chen and Lai (2025) who found that 3D game design had positive effect on ESP learners' vocabulary acquisition and critical thinking skills. In Algerian ESP environments, ESP students have

little exposure and interaction with authentic pronunciation materials which in turn led to inaccurate pronunciation and insufficient recall of vocabulary. The findings highlight the need to integrate AR with explicit vocabulary and pronunciation support to ensure effective speaking development of the subskills.

The Findings confirmed the second hypothesis, showing statistical significant difference in the speaking performance scores in the pre-test and post-test scores of the main group. In particular, positive effects were observed in students' speaking fluency, vocabulary and pronunciation, indicating that 3D based instruction offers meaningful and interactive learning opportunities that enhances oral language output. 3D visualization tasks foster authentic interaction, allowing students to use English in realistic medical context. This authenticity promotes their oral production of medical terminology, and encourages them to actively practice pronunciation. Although 3D models in Sketchfab does not provide audio description, the immersive context and rich clinical scenarios in the class elicits spoken responses through individual and peer practices. Unlike Algerian ESP classroom practices which often prioritize text and grammar-driven tasks (Rothinam & Maniam, 2025), 3D visualization created conditions that closely mirrored real-life professional tasks, thereby enhancing communicative competence. These findings are consistent with the growing body of evidence highlighting the role of immersive technologies in supporting situated language learning. (Khodabandeh, 2025).

Alternatively, findings showed that while 3D instruction fosters communicative skills, it may not sufficiently reinforce structural accuracy (i., e grammar). The divergence between fluency and accuracy reflects a common challenge in ESP communicative-oriented instruction, where learners prioritize conveying meaning over maintaining grammatical form (Djaileb, 2018; Assasi & Rouaghe, 2024). The findings highlight the need to integrate 3D instruction with explicit grammar-focused activities to achieve a more balanced and a more effective development of speaking skills in Algerian ESP classrooms.

The analysis confirmed the third hypothesis which highlights large significant effect of 3D instruction of the post test scores on the speaking performance of the main group than the pilot group. Although 3D

instruction was used with the pilot and main group, the pilot group served as a refinement stage to adjust the treatment with the main group, on the other hand, the main group received a more systematic application. This difference is likely explained why the main group showed significant gains. The findings suggest that the effectiveness of 3D instruction in ESP context is closely tied to consistent and accurate integration which in turn can lead to improvement in the speaking performances of learners.

Results of the Focus Group Discussion

The focus group interviews provided qualitative insights into students' perspectives regarding their speaking confidence, improved pronunciation, vocabulary retention and motivation**,** and the barriers they encountered while engaging with 3D-based speaking tasks. A thematic analysis of the transcripts revealed three important themes shared across both phases of the study. The following description illustrated the major the

Theme 1: Speaking Confidence

The theme speaking confidence was highlighted across both pilot and main groups. Many students noted that the 3D models and animations reduces their stress level when speaking, and the visual presentation allowed them to focus more on expressing ideas rather than worrying about correctness or judgment. For example, a participant from the pilot group shared *"I usually feel uncomfortable when speaking in front of my classmates, but with 3D visualization, I felt like I was explaining my knowledge, so I was confident"*. In the same vein, a student from the main group stated that *"I could see the scene in 3D dimensions which help me produce much details, my confidence increased."* These claims suggest that 3D models and animations ease the speaking performance of ESP medical and makes them feel stressed and more immersive in the speaking task.

Theme 2: Improved Pronunciation, Vocabulary Retention and Motivation."

In the second theme, students admitted progress in pronunciation, vocabulary memorization, and motivation due to the 3D models tasks. Participants indicated that use of anatomical models through 3D animations encourage them to speak, one from the pilot group noting, *"I used my English when I saw the 3D model, like I was talking to a real patient, I noticed the pronunciation of certain words among my classmates too"*. As far as

vocabulary retention, students found repetition of certain words effcient to remember medical terminology. A learner from the main group claimed, *"When I saw the model and had to explain it, I used the same words again and again, so I remembered them better."* In addition, the 3D models were seen motivating and engaging. A student explained, *"It didn't feel like classic class. I have this courage to talk and describe things because I had much knowledge of the activity being presented"*. These reflections highlight the positive effect of 3D technology on ESP learners' language accuracy and motivating learning environment.

Theme 4: Challenges with 3D AR Technology

Though 3D animation was positive, the participants observed several challenges related to the use of 3D technology during speaking tasks. Some students initially struggled to navigate the 3D models, particularly when adjusting views or identifying specific anatomical parts. One participant remarked, *"I didn't know how to move or zoom in on the model, it was disturbing me."* Technical limitations, such as slow loading times of the 3D models or device compatibility issues. Additionally, a few students pointed out that access to certain high-quality 3D models required payment, limiting their ability to practice independently outside of class. Despite these hindrances, the majority expressed increased comfort with this technology after a few sessions. These challenges highlight the importance of providing user guidance and selecting accessible to ensure equitable learning experiences.

Conclusion

This research indicates that integrating 3D models into ESP education can enhance medical students speaking skills efficiency and students' satisfaction, though it does not significantly improve grammar. Additionally, ESP practitioners should be encouraged to actively engage with 3D dimensional pedagogical tools, exploring their features to create interactive ESP learning experiences. Integrating 3D models and animations into ESP aligns with the principles of context-based learning and learner centered pedagogy, focusing on authentic real-world tasks and active student engagement. This approach will help maximize the potential of virtual technologies in medical education, offering students new ways to engage with science content and learn English appropriately.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that Generative AI were used for grammar checking.

Data availability statement

Data will be made available upon request.

References

Assassi, T., & Rouaghe, F. (2024). Contemporary Trends in ESP Research within the MENA Region: A Scoping Review. *Language Teaching Research Quarterly*, *42*, 259-277.

Bekteshi, E., & Xhaferi, B. (2020). An Analysis of English for Specific Purposes among University Students. *Educational Process: International Journal*, *9*(2), 90-102. http://dx.doi.org/10.22521/edupij.2020.92.2

Bonner, E., & Reinders, H. (2018). Augmented and virtual reality in the language classroom: Practical ideas. *Teaching English with Technology*, *18*(3), 33–53

Boudersa, N. (2018). ESP education in Algeria: a description of the teaching situation scenario with focus on problems, challenges and training. *International Arab Journal of English for Specific Purposes*, *1*(1), 1-22. https://doi.org/10.34874/PRSM.iajesp-vol1iss1.14393

Bououden, F., & Rouaghe, F. (2025). English for Medical Purposes: Identifying Learning Needs of Second-Year Medical Students at the University of Bejaia, Algeria. *ALTRALANG Journal*, *7*(1), 342-353. https://asjp.cerist.dz/en/article/269883

Cai, Y., Pan, Z., & Liu, M. (2022). Augmented reality technology in language learning: A meta-analysis. *Journal of Computer Assisted Learning*, *38*(4), 929–945. https://doi.org/10.1111/jcal.12661

Chen, C.-H., Hung, S.-T., & Yeh, H.-C. (2021). Virtual reality in problem-based learning contexts: Effects on the problem-solving performance, vocabulary acquisition, and motivation of English

language learners. *Journal of Computer Assisted Learning*, *37*(3), 851–860. https://doi.org/10.1111/jcal.12528

Chen, Y., & Lai, C. (2025). AI-Enhanced Augmented Reality for L2 Medical English Learning and Remote Surgical Collaboration. In *International Conference on Innovative Technologies and Learning* (pp. 48-57). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-98185-2_6

Chien-pang Wang, Yu-Ju Lan, Wen-Ta Tseng, Yen-Ting R. Lin & Kao ChiaLing Gupta (2019): On the effects of 3D virtual worlds in language learning – a meta-analysis, Computer Assisted Language Learning, DOI: 10.1080/09588221.2019.1598444

Dargan, S., Bansal, S., Kumar, M., Mittal, A., & Kumar, K. (2023). Augmented reality: A comprehensive review. *Archives of Computational Methods in Engineering*, *30*(2), 1057– 1080. https://doi.org/10.1007/s11831-022-09831-7

Djaileb, F. (2018). Challenges of Teaching English for specific purposes in Algeria: the case of English in medicine. *The International Journal of Social Sciences and Humanities Invention*, *5*(11), 5072-5074. https://doi.org/10.18535/ijsshi/v5i11.02

García-Ostbye, I. C., & Martínez-Sáez, A. (2023). Reading challenges in higher education: How suitable are online genres in English for medical purposes. *ESP Today*, *11*(1), 53-74.. https://doi.org/10.18485/esptoday.2023.11.1.3

Hsu, L. (2015). Examining EFL teachers' technological pedagogical content knowledge and the adoption of mobile technology in language classrooms. *Computer Assisted Language Learning*, 29(5), 1–20. https://doi.org/10.1080/09588221.2016.1278024

Ismayatim, W. F. A., Wahab, N. A., Yunus, M. M., Zamri, N. A., Nazri, N. M., & Hashimf, H. (2019). Enhancing 21st century students' listening skills via augmented reality and mobile applications. *International Journal of Innovation, Creativity and Change*, *7*(11), 314-325.

Jamrus, M. M., & Razali, A. B. (2019). Augmented reality in teaching and learning English reading: Realities, possibilities, and limitations. *International Journal of Academic Research in Progressive Education and Development*, *8*(4), 724-737. http://dx.doi.org/10.6007/IJARPED/v8-i4/6696

Küçük, S., Kapakin, S., & Göktaş, Y. (2016). Learning anatomy via mobile augmented reality: Effects on achievement and cognitive

load. *Anatomical sciences education*, *9*(5), 411-421. https://doi.org/10.1002/ase.1603

Li, M., Wang, Z., Dun, Y., & Ye, Q. (2024). The effectiveness of 3D visualization technology in human anatomy education: A meta-analysis of randomized controlled trials. *BMC Medical Education,* 24, 39**.** https://doi.org/10.1186/s12909-024-05403-4

Lin, C.-J., Hwang, G., Fu, Q.-K., & Cao, Y.-H. (2020). Facilitating EFL students' English grammar learning performance and behaviors: A contextual gaming approach. *Computers and Education*, *152*, 103876–103876. https://doi.org/10.1016/j.compedu.2020.103876

Lin, T.J., & Lan, Y.J. (2015). Language learning in virtual reality environments. *Past, Present, and Future. Educational Technology & Society*, *18*(4), 486–497.

Liu, J. E., Lo, Y. Y., & Lin, A. M. (2020). Translanguaging pedagogy in teaching English for Academic Purposes: Researcher-teacher collaboration as a professional development model. *System*, *92*, 102276. https://doi.org/10.1016/j.system.2020.102276

Nicolaidou, I., Pissas, P., & Boglou, D. (2023). Comparing immersive virtual reality to mobile applications in foreign language learning in higher education: A quasiexperiment. *Interactive Learning Environments*, *31*(4), 2001–2015. https://doi.org/10. 1080/10494820.2020.1870504

Ochoa Alpala, C. A., & Ortíz García, W. R. (2018). Creating machinima (3D) and real life videos in an ESP classroom. *Profile Issues in TeachersProfessional Development*, *20*(1), 41-56. https://doi.org/https://dx.doi.org/10.15446/profile.v20nl.59412

Outemzabet, B., & Sarnou, H. (2023). Exploring the significance of English-based communication for a community of medical academics in a public university teaching hospital in Algeria. *English for Specific Purposes*, *70*, 116-130. https://doi.org/10.1016/j.esp.2022.12.001

Porchescu, G. V., Shchedrina, E. V., Rubleva, O. S, & Tyutyunnik, I. A. (2023). The use of three-dimensional visualization when teaching a foreign language as an important condition for improving the quality of foreign language training of future specialists in the socio-cultural sphere. Perspektivy nauki i obrazovania – Perspectives of Science and Education, 63 (3), 219-235. doi: 10.32744/pse.2023.3.14

Rothinam,N., Maniam, M, (2025). Perceptions of English for Medical purposes (EMP) Module: insights from students and lecturers.

Quantum Journal of Social Sciences and Humanities, *6*(3), 292-299. https://doi.org/10.55197/qjssh.v6i3.686

Saraa, N. (2020). Teachers' Challenges while Designing an ESP Syllabus. *International Arab Journal of English for Specific Purposes*, *3*(1), 83–92. https://doi.org/10.34874/PRSM.iajesp-vol3iss1.23558

Soboleva, E. V., Suvorova, T. N., Zenkina, S. V., Bocharov, M. I. Professional Self-Determination Support for Students in the Digital Educational Space. European Journal of Contemporary Education, 2020, vol. 9, no. 3, pp. 603-620. DOI: https://doi.org/10.13187/ejced.2020.3.603

Solak, E., & Cakir, R. (2015). Exploring the Effect of Materials Designed with Augmented Reality on Language Learners' Vocabulary Learning. Journal of Educators Online, 12(2), 50-72. https://doi.org/10.9743/JEO.2015.2.5

Spivachuk, V., Chaikovska, O., Niskhodovska, O., & Kruk, A. (2023). Enhancing EFL profession-based vocabulary acquisition through 3D engineering animation for engineering students,*Virtual Reality* vol.26, pp.:963–978. https://doi.org/10.1007/s10055-021-00606-2

Teplá, M., Teplý, P., & Šmejkal, P. (2022). Influence of 3D models and animations on students in natural subjects. *International Journal of STEM Education*, *9*(1), 65. https://doi.org/10.1186/s40594-022-00382-8

Tsai, C. C. (2020). The effects of augmented reality to motivation and performance in EFL vocabulary learning. International Journal of Instruction, 13(4), 987-1000. https://doi.org/10.29333/iji.2020.13460a

Ustun, A. B., Simsek, E., Karaoglan-Yilmaz, F. G., & Yilmaz, R. (2022). The effects of AR-enhanced English language learning experience on students' attitudes, self-efficacy and motivation. *TechTrends*, *66*(5), 798-809. https://doi.org/10.1007/s11528-022-00757-2

Vygotsky, L. S. (1978). *Mind in society: the development of higher psychological processes*. Harvard University Press.

Wang, J., Li, W., Dun, A., Zhong, N., & Ye, Z. (2024). 3D visualization technology for Learning human anatomy among medical students and residents: a meta-and regression analysis. *BMC Medical Education*, *24*(1), 461. https://doi.org/10.1186/s12909-024-05403-4

Wedyan, M., Falah, J., Elshaweesh, O., Alfalah, S. F., & Alazab, M. (2022). Augmented reality-based English language learning: importance and state of the art. *Electronics*, *11*(17), 2692. https://doi.org/10.3390/electronics11172692

Yoke, S. K., Ahmad, T. A., & Hasan, N. H. (2019). Exploring the potential of augmented reality in English for report writing: A perceptive overview. *Int J Educ*, *4*(33), 13-21.

Youn, J. K., Park, H. S., Ko, D., Yang, H. B., Kim, H. Y., & Yoon, H. B. (2023). Application of additional three-dimensional materials for education in pediatric anatomy. *Scientific Reports*, *13*(1), 9973. https://doi.org/10.1038/s41598-023-36912-9

Zolfaghari, Z., Karimian, Z., Zarifsanaiey, N., & Farahmandi, A. Y. (2025). Navigating challenges in medical english learning: leveraging technology and gamification for interactive education–a qualitative study. *BMC Medical Education*, *25*(1), 1045. https://doi.org/10.1186/s12909-025-07511-1