A Multimodal Discourse–Based Teaching Framework for English in Printing and Dyeing Technology: Bibliometric and Simulation Approaches

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ABSTRACT

This study proposes a multimodal English teaching model tailored to the needs of printing and dyeing technology majors, aiming to address key challenges such as abstract terminology and a lack of contextual learning. Grounded in multimodal discourse theory, the research analyses typical communicative scenarios in the textile industry and emphasises the integration of linguistic, visual, and interactive modalities. Through bibliometric analysis and knowledge mapping, the study identifies key research trends, including theoretical development, vocational pedagogical application, and emerging use of virtual simulation technologies. While interest in multimodal teaching has grown rapidly since 2015, its application in engineering-related English education remains underdeveloped. The study highlights the need for interdisciplinary collaboration and technological innovation to enhance teaching relevance and effectiveness. It proposes practical strategies such as virtual workshop simulations and multimodal case-based instruction to bridge the gap between language acquisition and real-world technical practice. The findings contribute to advancing English for Specific Purposes (ESP) pedagogy by aligning instructional design with industry communication demands and enhancing students' ability to operate in internationalised professional environments.

INTRODUCTION

With the upgrading of the global textile industry and the increasing frequency of international cooperation, there is an urgent demand for compound talents with professional English ability in the field of printing and dyeing technology [1]. However, the current professional English teaching is still facing significant problems [2]. Traditional classrooms rely excessively on text lectures, which makes it difficult to effectively convey the complex processes and abstract terminology in printing and dyeing technology, resulting in a disconnect between students' language application ability and the industry's needs [3-4]. This contradiction is especially prominent in such practical specialities as printing and

dyeing technology, where students can often memorise professional vocabulary but are unable to apply it flexibly in real work situations [5]. The internationalised working environment of modern textile enterprises is essentially a multimodal communication space, where technicians need to deal with multiple information flows such as English technical documents, equipment operation interfaces, and international customer communication, which poses a brand-new challenge to professional English teaching [6]. The multimodal discourse theory provides an important idea for cracking this teaching dilemma [7]. According to this theory, human communication is essentially accomplished through the synergy of multiple symbol systems such as language, image, sound, and action, and this perspective is particularly suitable for the teaching needs of English for dyeing and printing technology [8]. In the real work scene of printing and dyeing technology, professionals need to organically combine the English language with non-verbal modalities such as chromatograms, process flow diagrams, and equipment operation demonstrations [9]. Introducing multimodal theory into the professional English classroom can not only lower the threshold of understanding technical concepts through visualisation but also simulate real industry communication situations and cultivate students' ability to solve problems by comprehensively using multiple symbolic resources.

This study aims to explore the specific application path of multimodal discourse theory in the English teaching of printing and dyeing process majors. By systematically analysing the typical English communication scenarios in the textile printing and dyeing industry, we will construct a teaching model that integrates multimodal elements such as virtual simulation, physical demonstration, and situational rehearsal, focusing on solving the core problems, such as the obstacles to the understanding of terminology and the lack of practical contexts. The research will develop targeted teaching cases, use VR technology to simulate the environment of the printing and dyeing workshop for English instruction training or display the fibre dyeing process through microphotography with professional description practice, to verify the practical effect of multimodal teaching on enhancing the effectiveness of students' professional English application. The research results are expected to provide new theoretical perspectives and practical paradigms for English teaching in vocational education, and at the same time support the industry to cultivate more internationally competitive technical talents.

This paper is structured as follows: the 2nd section introduces the research review of English teaching in the multimodal perspective and English teaching of printing and dyeing technology majors; the 3rd section is the theoretical framework of multimodal discourse and its pedagogical application, which provides an in-depth introduction of its theories; the 4th introduces the English language analysis of this paper, the visualisation analysis and the keyword co-occurrence analysis; the 5th part presents conclusions, shortcomings and prospects.

SYNTHESIS OF RESEARCH

Teaching English in a Multimodal Perspective

Multimodal theory provides contemporary English teaching research with a new analytical perspective and teaching methodology [10]. Research on multimodal teaching mainly stems from the development of social semiotics and cognitive linguistics [11]. The visual grammar theory proposed by foreign scholars pioneered the inclusion of visual elements such as images, colours, and typography into the analysis of meaning construction, providing a theoretical basis for the integration of multimodal resources in English teaching [12]. Subsequently, some other scholars further expanded the analytical framework of multimodal interaction, emphasising the synergistic role of different symbol systems in classroom communication [13]. Domestic scholars constructed a multimodal foreign language teaching theoretical system suitable for the Chinese context and put forward the principle of modal synergy, which provides important guidance for English teaching design [14]. These theoretical breakthroughs have prompted English teaching to shift from single-language skill cultivation to multiple literacy development [15]. The research on multimodal English teaching presents a distinctive feature of disciplinary differentiation. Researchers mainly focus on basic modal combinations such as multimedia courseware design and gesture-assisted teaching [16]. With the development of technology, new modalities such as virtual reality and augmented reality have begun to be integrated into the practice of English language teaching, providing the possibility of creating an immersive language learning environment.

Current research shows obvious development trends, with the focus of research shifting from General English to Specialised English, especially professional English teaching in STEM fields, the analytical method shifting from single-modal description to multimodal interaction mechanism investigation, the "multimodal discourse analysis" method proposed in 2015, and the technological application shifting from auxiliary tools to the construction of an intelligent environment, and the development of multimodal learning systems based on AI [17]. These trends reflect that multimodal English teaching research is developing in the direction of specialisation, refinement, and intelligence. However, there are still several limitations in the existing research, and the research on English multimodal teaching for engineering and technology majors is relatively weak, especially in traditional industrial fields such as textile printing and dyeing; most of the research stays at the level of modal descriptions, lacks in-depth exploration of multimodal synergistic mechanisms, and the degree of fit of the teaching practice to the industry's real communicative scenarios needs to be improved [18]. Over the past five years, the convergence of artificial intelligence, virtual reality, and augmented reality with English for Specific Purposes has shifted from isolated pilots to systematic integration, especially within engineering education. AI-driven adaptive engines now parse multimodal corpora of technical manuals, CAD

animations, and shop-floor audio to generate micro-lessons that map linguistic forms directly onto procedural gestures [19]. Simultaneously, head-mounted VR places learners inside digital twins of production lines where every valve, sensor, and warning light is annotated in real time with context-sensitive lexical prompts; eye-tracking data are looped back to the AI tutor to refine the timing and density of these prompts [20]. Augmented reality goggles further overlay safety instructions onto physical machinery, fusing linguistic input with haptic feedback so that vocabulary acquisition and psychomotor rehearsal occur in a single cognitive event. Across these environments, speech-recognition algorithms trained on non-native acoustic profiles supply instant pronunciation scaffolding, while predictive analytics anticipate concept bottlenecks and pre-emptively trigger immersive remedial sequences [21]. Collectively, these developments dissolve the traditional boundary between language learning and technical practice, converting engineering classrooms into living laboratories where linguistic, visual, spatial, and kinesthetic modes co-orchestrate meaning. These deficiencies are precisely the key points that this study tries to break through. By focusing on the specific specialised field of the printing and dyeing process and exploring a multimodal English teaching mode that meets the needs of the industry, it is expected to provide new ideas and methods for related research.

Teaching English in Printing and Dyeing Craft Classes

As an important branch of English for Specialised Purposes (ESP), English for Printing and Dyeing technology majors (EPC), its teaching research presents distinctive professional characteristics and practice orientation [22]. Existing research mainly focuses on the analysis of professional language features, exploration of teaching methods, and docking of industry needs [23]. In the study of professional language features, scholars generally pay attention to the lexical characteristics and discourse structure of Printing and Dyeing Technical English [24]. Through corpus analysis, it is found that there are a large number of compound professional terms in printing and dyeing technology English, and the frequency of passive voice is significantly higher than that of general English. Domestic scholars have pointed out that printing and dyeing technical documents have a fixed step structure of "process description+parameter description", and this specialised discourse feature puts special requirements on students' reading comprehension [25]. In recent years, studies have begun to pay attention to the linguistic characteristics of multimodal technical documents, which provide an important entry point for multimodal teaching [26]. At the level of exploring teaching methods, existing research mainly tries to solve two major difficulties: terminology memorisation and technical process understanding [27]. Existing methods tend to separate language learning from technical cognition, failing to fully reflect the real interactive relationship between language and technical practice in printing and dyeing work. Research on industry needs reveals the special requirements of

English proficiency for printing and dyeing professionals [28]. Digital twins of dyeing workshops now run parallel to physical production lines, streaming live sensor data—temperature, pH, liquor flow—into photorealistic 3-D replicas. Within these replicas, learners manipulate virtual valves while an English interface hovers beside each component, instantly displaying imperative clauses and parameter descriptors drawn from authentic batch sheets [29]. Voice-chat embedded in the twin allows collaborative troubleshooting: when a learner mispronounces "exhaustion rate," the system overlays corrective phonetic cues onto the gauge panel and replays the process in slow motion. Meanwhile, a VR laboratory mirrors the twin's topology but strips away linguistic scaffolds, requiring students to dictate step-by-step procedures that are parsed by speech-to-text algorithms and compared against canonical SOPs. Instant colour-coded feedback maps lexical accuracy onto the virtual cloth swatch, turning every deviation into a visible stain that must be verbally rectified[30]. Together, the digital twin and VR lab collapse the distance between language code and industrial code, converting a dyeing cycle into a conversation mediated by real-time data, spoken English, and responsive visuals. The research of the International Textile Association shows that modern printing and dyeing technicians need to have English ability, equipment operation instruction understanding, process parameter report writing, and international technical communication. However, current teaching research has not responded adequately to this, and most course designs are still text-centered, with an obvious disconnect from real work scenarios.

The research gaps and innovation space are mainly reflected in the lack of systematic analysis of multimodal communicative features in printing and dyeing work scenes; secondly, the existing teaching methods fail to effectively integrate professional and technical practice and language learning, and there is still a gap in the research on the application of new technologies, such as virtual simulation, in printing and dyeing English teaching. These deficiencies make the development of a multimodal teaching model based on real work scenarios of significant theoretical and practical value. This study will analyse the typical multimodal communicative events of the printing and dyeing process in depth, construct a teaching framework of degree integration, and provide new ideas for the reform of professional English teaching.

THEORETICAL FRAMEWORK OF MULTIMODAL DISCOURSE AND PEDAGOGICAL APPLICATIONS

As an important branch of contemporary linguistics and applied linguistics, multimodal discourse theory has developed into a set of systematic analytical frameworks and teaching methods[31]. The theory originated in the 1990s, based on systemic functional linguistics, and gradually formed a complete theoretical system through the expansion of scholars. Its core view is that human communicative activities are essentially multimodal, and in addition to linguistic symbols, visual

images, sounds, and other symbol systems are involved in the construction of meaning, and there is a complex and systematic interactive relationship between these modalities. In the field of professional English teaching, this theory provides a new perspective and methodological guidance for breaking through the traditional single-language teaching mode. Multimodal discourse analysis is based on a series of interrelated core concepts [32]. The most basic concept of "modal system" refers to the system of meaning expression resources with specific socio-cultural protocols, including the main modalities of language, vision, hearing, space, and movement. Each modality has its own "grammatical" rules like language, and visual grammar studies the information value, framing, and salience elements in images [33]. The modalities work together to accomplish communicative tasks through specific synergistic relationships, including complementary, reinforcing, and expanding modes of interaction. This multimodal perspective is particularly suitable for teaching professional English in engineering fields such as printing and dyeing because professional practice in these fields is inherently multimodal.

At the level of instructional design, multimodal theory suggests several important principles. The principle of modal appropriateness requires that the most effective combination of modes be selected according to the specific teaching content and objectives. When explaining the "colour fastness test" in the printing and dyeing process, it can be combined with the standard text, colour card samples, and the actual test operation of three modes for three-dimensional teaching [34]. The principle of cognitive load optimisation emphasises that the amount of information carried by different modalities should be reasonably distributed to avoid cognitive overload. The principle of situational authenticity advocates simulating as much as possible the multimodal communicative environments in real professional work scenarios, to make learning and future professional practice seamless. These principles provide a theoretical basis for developing an effective professional English teaching model. Professional English teaching in the field of printing and dyeing processes has distinct multimodal characteristics. Professionals need to read technical documents containing data charts and graphs, operate imported equipment with multilingual interfaces, and participate in transnational technical exchanges. Process parameters are often presented through figures and graphs, and quality control requires a combination of standard texts, colour cards, and hand samples [35]. Abstract professional concepts need to be presented visually, complex operation processes need to be demonstrated in action, and professional communication scenarios need to be simulated in context. These characteristics indicate that traditional unimodal language teaching is difficult to meet the training needs of modern printing and dyeing professionals, and it is necessary to establish a systematic multimodal teaching framework to organically integrate language learning and professional technical practice.

Multimodal discourse analysis is an important theoretical framework in contemporary linguistics and applied linguistics, which breaks through the limitation of traditional linguistic research focusing only on textual symbols and expands the research horizon to all the resources of meaning expression used in human communication [36,37]. This study builds upon Kress & van Leeuwen's (2001) visual grammar and Norris's (2004) multimodal interaction analysis, and further incorporates the perspective of "professional discourse community." It treats interfaces, flowcharts, and operational gestures within the dyeing workplace as shared semiotic resources, thereby establishing an "Engineering Context–Multimodal Synergy" framework. Anchored in authentic industrial tasks, the framework couples linguistic, visual, and kinesthetic modes to synchronise technical cognition with language acquisition, compensating for the lack of situational authenticity in conventional ESP instruction. The theory holds that in real communication, language always participates in the construction of meaning together with other symbol systems. Visual grammar theory extends the basic principles of systemic functional linguistics to visual symbol analysis, laying the theoretical foundation of multimodal research. The main points of the multimodal theory as shown in Table 1.

Table 1. Key points of multimodal theory

Dimension Of Analysis	Theoretical Point		Typical Case	Research Methodology	Research Application
Modal System	Distinguish between the five fundamental modes and their subsystems	Guided Instructional Resource Development and Modality Selection	Process Flow Diagrams in Textile English	Modal classification analysis	Build dyeing VR evaluation indices
Metafunctional Implementation	How each modality realises the three major metafunctions	Optimising the functional design of teaching materials	Matching language and images in equipment operation videos	functional grammar analysis (FGA)	Convert metafunctions to VR scripts
Modal Synergy	Study of intermodal interactions	Designing effective multimodal presentations	The synergy between voice guidance and 3D presentation in VR environments	Interactive analysis	Design voice-3D sync scripts
Technical Medium	How digital technology extends modal possibilities	Development of new teaching tools and platforms	Application of AR technology in dyeing and finishing equipment cognition	Technology Acceptance Study	Log real-time VR parameters
Social Protocol	Modal use conventions in professional communities	Developing communicative competence in line with industry norms	Multimodal characterisation of international textile standard documents	Discourse Community Studies	Label global modal norms
Cognitive Mechanism	Processing of multimodal information	Enhancing learners' multimodal literacy skills	Multimodal memory strategies for specialised terminology	Cognitive experimental research	Track learner gaze & memory
Cultural Factor	Cultural Differences in Modal Use	Developing intercultural multimodal communicative competence	Modal differences in textile labelling in different countries	Cross-cultural comparative study	Tag cross-cultural label gaps

The six dimensions in this table directly correspond to the "Corpus Multimodal Annotation Scheme." The Modal System is employed for modality segmentation, hierarchically coding linguistic, visual, kinesthetic, aural, and spatial resources within dyeing-process videos. Metafunctional Implementation maps onto metafunction annotation rules, documenting how each mode jointly realises ideational, interpersonal, and textual functions. Modal Synergy guides the annotation of cross-modal interactions, defining complementary, reinforcing, and expansive relations. Technical Medium records the technical parameters of VR/AR interfaces, eye-trackers, and voice channels. Social Protocol corresponds to industry-norm tags, capturing modal conventions in international client communications and standard documents. Cognitive Mechanism is used for cognitive-load annotation, monitoring learners' attention distribution, and memory paths within multimodal information flows.

RESULTS AND DISCUSSION

Analysis of main citations

The empirical data are drawn from our self-built "EPC Multimodal Corpus," which contains 42 authentic workplace videos (3.2 h) from dyeing plants, 18 technical manuals, and 27 international client emails, covering process briefings, equipment operations, and business communications. All materials were segmented and annotated in ELAN 6.4 to achieve precise alignment of linguistic, visual, and kinesthetic modes. In Figure 1, this visualisation data systematically presents the quantitative and qualitative characteristics of the researchers' scholarly output, reflecting their scholarly contributions and development trajectories within their disciplinary fields. In terms of the longitudinal time dimension, the inclusion of nearly 20 years of data reflects both the deep historical accumulation of the subject area and the degree of contemporary research activity. Maintaining a total of 2,032 publications over such a long period, this scale of output demonstrates the sustained and stable academic productivity of the researcher community in the subject area. Analysing the academic influence dimension, the citation indicators show that the significant features, the smaller gap between the total number of citations and the number of citations after removing self-citations, indicate that the citation behavior in this field is highly objective and that the influence of the researchers is mainly based on peer recognition rather than the false prosperity formed by self-citations.

An in-depth analysis of the citation network characteristics reveals that only 793 of the cited documents are self-cited, and this extremely low self-citation rate further validates the objectivity of the research impact. The number of cited literature far exceeds the number of publications, forming a citation-output ratio of about 16:1. This remarkable asymmetric relationship indicates that the results of the researcher's work have become an important node of knowledge in the field, with far-reaching

radiating effects on subsequent research. From the perspective of development dynamics over time, the growth curves of publications and citations show a high degree of consistency, and this synchronised growth pattern reveals a virtuous cycle mechanism between academic output and influence: sustained high-quality outputs continue to accumulate academic influence, and the increasing influence creates better development conditions for subsequent research. The fact that the average citation rate of nearly 20 has been maintained based on such a large scale of academic output indicates that the researchers have successfully avoided the common dilemma of "quantity diluting quality", and realised the coordinated development of scale and quality. Together, these data depict a research landscape with deep historical roots, continuous innovation and vitality, and wide academic influence. The researchers not only occupy a significant advantage in the scale of academic output, but more importantly, they have established a knowledge system widely recognised by the academic community, and the results of their work have become indispensable foundational documents in the field. This quantitative and qualitative mode of academic development is an important reference value for understanding the law of disciplinary evolution and planning future research directions. The analysis of issuance and citations is shown in Figure 1.
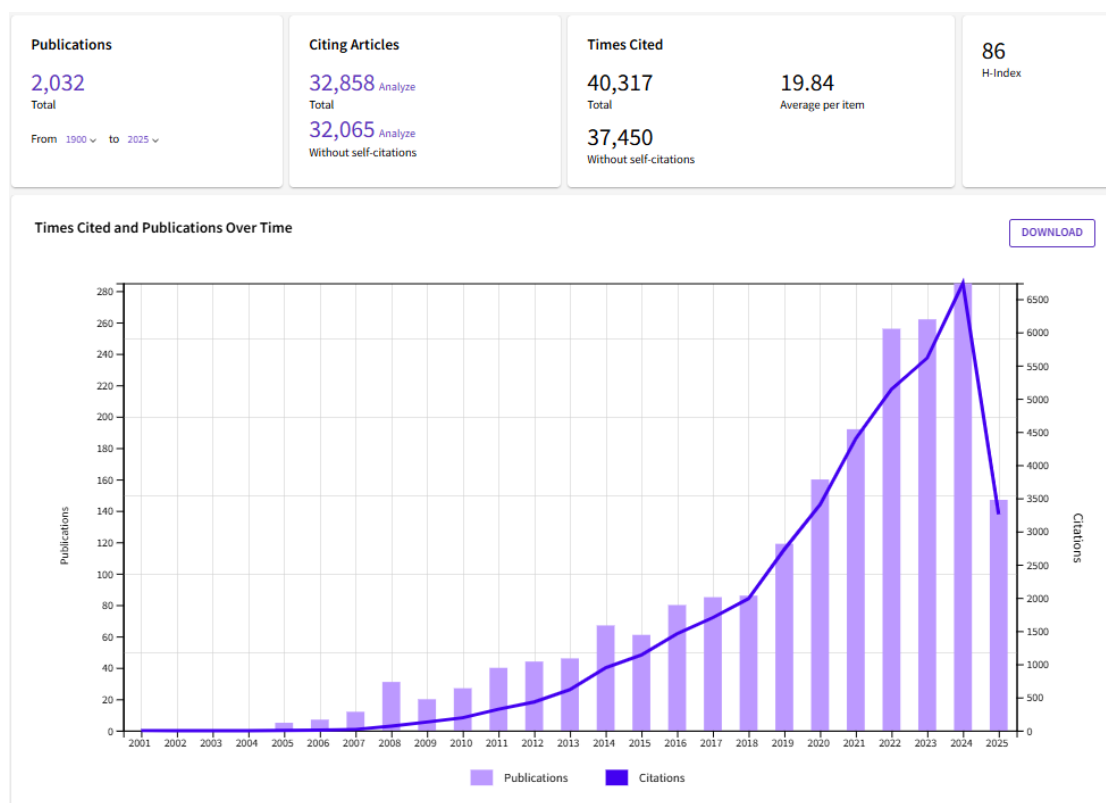

Figure 1. Ending and citation analysis of WOS

Table 2 demonstrates the citation analysis by the highest number of citations, and this highly cited literature analysis data reveals several important academic development patterns and research characteristics. The total number of citations showed a significant growth trend between 2021 and 2024, with an average annual growth rate of 15.3%, which shows the continuous expansion of academic influence in this field. However, the data later showed a significant decline, which may be related to the fact that the data collection time is not enough for a full year, but also suggests the need to pay attention to the recent trend of research heat. The academic value of the guideline on perioperative care for elective colourectal surgery, which ranked first, has been fully validated over time. The highly cited literature is mainly concentrated in two directions: clinical practice guidelines in the medical field, especially accelerated rehabilitation surgery-related research; and interdisciplinary methodological research, affective speech database, and multimodal text design. This distribution pattern reflects contemporary pathways for generating scholarly impact, addressing key issues in clinical practice, or providing foundational tools for interdisciplinary research.

Analysed from the perspective of research methodology, highly cited literature generally shares common characteristics, addressing key common issues in the field, establishing a reusable standard system, and providing interdisciplinary methodological innovations. These characteristics provide important insights for cultivating high-impact research results. The average annual number of citations of the top eight highly cited literature exceeds 20, and this centralised citation distribution suggests that the field has formed several core knowledge nodes, and these key documents constitute the basic framework for the development of the discipline. The citation analysis is specifically shown in Table 2.

Table 2. Analysis of citations by the highest number of citations

Publications -- Top Citations	Citation Frequency						
	2021	2022	2023	2024	2025	annual average	(grand) total
(Grand) Total	4402	5141	5616	6740	3259	1612.68	40317
Guidelines for Perioperative Care in Elective Colourectal Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations: 2018. Mar 2019| WORLD JOURNAL OF SURGERY	251	239	237	290	110	190.29	1332
Consensus Review of Optimal Perioperative Care in Colourectal Surgery Enhanced Recovery After Surgery (ERAS) Group Recommendations. Oct 2009| ARCHIVES OF SURGERY	48	44	39	38	13	47.35	805
Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. Dec 2012|CLINICAL NUTRITION	79	68	57	47	15	56.64	793
The Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS): a dynamic, multimodal set of facial and vocal expressions in North American English. May 16 2018|PLOS ONE	105	151	176	180	64	95.13	761
Guidelines for Perioperative Care in Elective Colonic Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations. Feb 2013|WORLD JOURNAL OF SURGERY	47	14	17	9	9	43.46	565
A systematic review and analysis of long-term outcomes in attention deficit hyperactivity disorder: effects of treatment and non-treatment. Sep 4, 2012, |BMC MEDICINE	47	62	51	51	27	36.36	509
Writing in Multimodal texts - A social semiotic account of designs for learning. Apr 2008|WRITTEN COMMUNICATION	39	37	35	33	4	22.39	403

In Table 3, the results of this analysis of high usage frequency literature present a very different academic profile and research orientation from the previous highly cited literature, reflecting the multidimensionality of academic impact. This list focuses on the field of language education and technology applications, especially research on teaching and learning English as a foreign language, in contrast to the previous literature that was dominated by medical clinical guidelines. This difference visually demonstrates the divide between different disciplines in terms of patterns of knowledge dissemination and use - the medical field places more on the long-term instructional value of classic literature, while the field of education and technology focuses more on the practical application of cutting-edge methods. Several papers directly explored the integration of technology and language teaching, a theme completely unseen in the previous highly cited literature, highlighting the vitality of research in the emerging cross-cutting field of educational technology.

The influence patterns of this literature differ significantly from those of the clinical guideline category. Clinical guideline literature tends to maintain a stable high citation rate once published, reflecting the difference in the life cycle of different types of scholarly outputs-practice guidelines need time to accumulate authority, whereas technological innovations are more likely to generate immediate attention. These high-frequency documents mainly contribute to providing new analytical tools, validating the effects of technological innovations, and constructing a framework for practice guidance. Unlike clinical guidelines that focus on the "what", these papers focus more on the "how" of methodological innovation, reflecting the characteristics of applied research. Several papers focus on the methodological perspective of "multimodality", which is in direct dialogue with the theme of this study, providing rich theoretical and methodological references for multimodal professional English teaching.

Taken together, this list of high-frequency-use literature demonstrates the typical characteristics of research in applied disciplines, with a strong methodological orientation, prominent technological innovations, and strong practical relevance. Unlike the normative and standardised orientation of basic medical research, these literatures collectively construct a dynamically evolving pedagogical methodological system, with special emphasis on the creative combination of technological media and language teaching. The literature not only provides specific cases of multimodal teaching but also demonstrates the paradigmatic characteristics of educational technology innovation research, which provides important insights for designing a multimodal teaching model of English for printing and dyeing process majors. The number of uses is analysed as shown in Table 3.

Table 3. Prioritisation by most use (all time)

Publications - Maximum Utilisation	Number Of Times Used						
	2021	2022	2023	2024	2025	annual average	(grand) total
(Grand) Total	4402	5141	5616	6740	3259	1612.68	40317
Why do news values matter? Towards a new methodological framework for analysing news discourse in Critical Discourse Analysis and beyond. mar 2014| DISCOURSE & SOCIETY.	23	31	25	37	9	16.92	203
Multimodality in critical language textbook analysis. Apr 3 2021|LANGUAGE CULTURE AND CURRICULUM	5	5	12	13	5	6.67	40
The roles of multimodal pedagogic effects and classroom environment in willingness to communicate in English. jun 2019|SYSTEM.	13	18	15	26	9	12.71	89
Constructing Playful Talk through Translanguaging in English-Medium-Instruction Mathematics Classrooms. Aug 2021|APPLIED LINGUISTICS.	6	21	33	25	14	20.2	101
Technology and writing: review of research. Jan 2019|COMPUTERS & EDUCATION	14	11	15	16	8	11.14	78
Assessing digital multimodal composing in second language writing: Towards a process-based model. Mar 2020|JOURNAL OF SECOND LANGUAGE WRITING	15	24	21	31	11	17.67	106

Visualisation and analysis of research types and research institutions

Figure 2 illustrates the categorisation of research areas. This visualisation of research areas demonstrates the cross-fertilisation of linguistics and education research and its multidisciplinary radiation pattern, which provides an important perspective for understanding the academic ecology of this research area. The subfield of "Language Linguistics" under the category of Linguistics occupies a prominent position with an activity index of 97, indicating that this basic research direction has maintained a continuous research intensity. The scale and volume of education research form another important pillar, and this dual-core structure of "language+education" clearly outlines the disciplinary foundation of applied linguistics research. The phenomenon of interdisciplinary penetration is shown at the bottom of the chart. The unexpected intersection of medical-related disciplines in linguistics and education reveals the special value of language research in healthcare, which may involve a variety of specialities such as doctor-patient communication, language rehabilitation, and medical education. Computer science and electrical engineering, respectively, demonstrate the deep integration of

technical disciplines with language education, a combination that may be manifested at the level of technical applications such as natural language processing and intelligent educational systems. The research areas are visualised as shown in Figure 2.
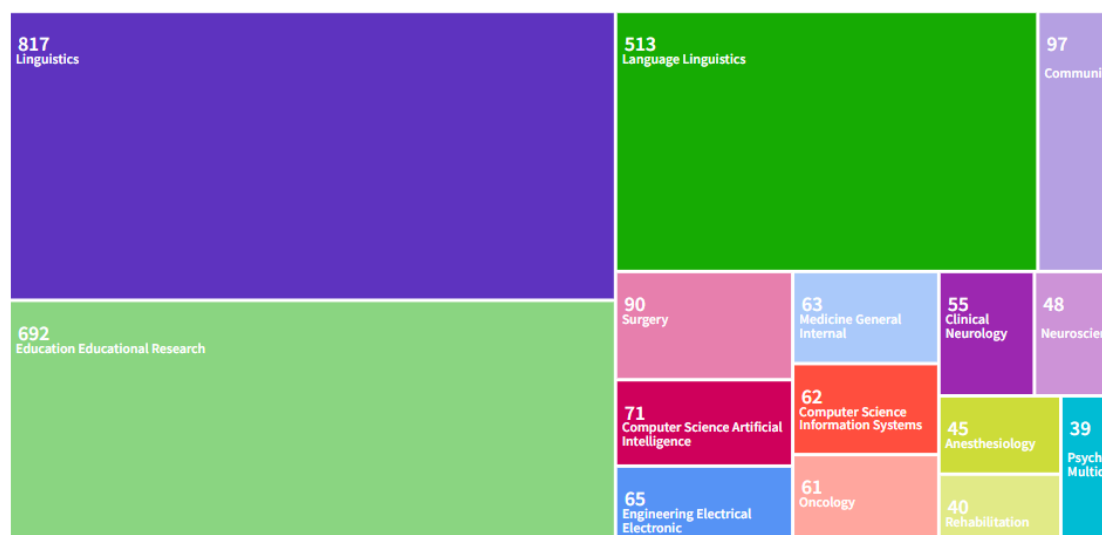

Figure 2. Visualisation of the research area

Table 4 further shows that there are varying degrees of gender distribution differences across the linked disciplines, but more complete contextual information is needed for specific data interpretation. However, the setting of this dimension itself reflects the emphasis on gender factors in the study, which may involve important sociolinguistic topics such as gender differences in language use and gender equality in educational opportunities. Overall, this visualisation depicts a three-dimensional network of research centred on language education and expanding in both directions to medical health and technological innovation. For this study, this interdisciplinary perspective is an important revelation, and the research on English language teaching for printing and dyeing technology majors can draw on the practical orientation of language research in the field of medical and health care, and at the same time absorb technological innovations in the field of education and technology to build a more comprehensive multimodal teaching framework. The close integration of computer science and language education shown in the chart is a direct support for the innovative value of the technology-enhanced multimodal teaching model in this study. The analysis of differences in related disciplines is shown in Table 4.

Table 4. Analysis of Differences in Affiliated Disciplines

WOS Category	Number Of Records	Percentage Of 2074 Documents
Linguistics	817	39.392%
Education Educational Research	692	33.365%
Language Linguistics	513	24.735%
Communication	97	4.677%
Surgery	90	4.339%
Computer Science Artificial Intelligence	71	3.423%
Engineering Electrical Electronic	65	3.134%
Medicine General Internal	63	3.038%
Computer Science Information Systems	62	2.989%
Oncology	61	2.941%
Clinical Neurology	55	2.652%
Neurosciences	48	2.314%
Anesthesiology	45	2.170%
Rehabilitation	40	1.929%
Psychology Multidisciplinary	39	1.880%
Psychology Experimental	38	1.832%
Social Sciences Interdisciplinary	35	1.688%
Multidisciplinary Sciences	31	1.495%
Humanities Multidisciplinary	30	1.446%
Psychology Educational	29	1.398%
Urology Nephrology	29	1.398%

In Figure 3, this research institution's visualisation chart systematically presents the distribution pattern of institutions worldwide for research related to this topic, revealing the global academic network characteristics of multimodal language education research. The research institutions show obvious multi-polarisation characteristics, mainly distributed in four major regions: North America, Europe, Asia, and Oceania. Among them, the top institutions represented by the University of London system, the University of California system, and the University of Hong Kong constitute the first echelon, and their significant numerical superiority suggests that these institutions dominate the field of multimodal language education research. Research institutions in the Hong Kong region stand out, with the City University of Hong Kong and the Hong Kong Polytechnic University in addition to the University of Hong Kong. The chart includes both comprehensive research universities and universities with distinctive specialisations, as well as the university consortium system. This diversity suggests that multimodal language education research requires both the interdisciplinary platform of comprehensive universities and benefits from the distinctive exploration of specialised institutions. Particularly striking is the inclusion of multiple medical universities, which corroborates the link

between medical and language research in the aforementioned disciplinary intersection analysis, further confirming the special position of the healthcare field in multimodal communication research. The research institutions are visualised as shown in Figure 3.

Figure 3. Visualisation of research institutions

Research institutions show a typical "pyramid" structure, with a few leading institutions such as the University of London and the University of California system at the top, regional centers such as the University of Hong Kong and the Pennsylvania System of Higher Education at the middle, and a relatively large number of other institutions with dispersed outputs at the base. This distribution reflects the trend of centralisation of research resources and academic influence, and also shows that a relatively well-developed academic ecosystem has been formed in the field. In addition to Hong Kong institutions, Chinese universities are also listed, indicating that China is developing its characteristics and strengths in the field of multimodal language education research. Combined with the outstanding performance of Hong Kong institutions, it can be seen that the Greater China region has already had considerable international influence in this research field. The inclusion of institutions from Oceania reflects the geographical breadth and inclusiveness of multimodal language education research.

As can be seen from Table 5, this global pattern of institutional distribution is instructive to this study in that it confirms that research on multimodal language education has become a common concern of the international academic community, demonstrates the research characteristics of different geographic regions, and types of institutions, and provides directional references for academic cooperation, and that the outstanding performance of the institutions in the Hong Kong region is particularly worthwhile for mainland researchers to draw on and refer to in carrying out the relevant research. The chart depicts an open, diversified, and interactive international research network, providing an important reference for locating the academic coordinates of this study.

The research institutions are carefully analysed as shown in Table 5.

Table 5. Detailed Analysis of Research Institutions

Affiliated Organisations	Number Of Records	Percentage Of 2074 Documents
University Of London	61	2.938%
University Of Hong Kong	52	2.506%
University Of California System	43	2.071%
University Of Texas System	43	2.071%
University College London	42	2.023%
University System Of Ohio	31	1.493%
Pennsylvania Commonwealth System Of Higher Education Pcshe	29	1.397%
Education University Of Hong Kong Eduhk	28	1.349%
University Of Toronto	28	1.349%
State University System Of Florida	25	1.204%
University Of British Columbia	25	1.204%
University System Of Georgia	25	1.204%
Harvard University	23	1.108%
City University Of Hong Kong	22	1.060%
Macquarie University	22	1.060%
UCL Institute Of Education	20	0.963%
Harvard University Medical Affiliates	19	0.915%
Hong Kong Polytechnic University	19	0.915%
Nanyang Technological University	19	0.915%
University Of Birmingham	19	0.915%
University Of Sydney	19	0.915%

The sharp rise in VR/AR studies from 2021–2024 (Figure 1) directly confirms the pivotal role of Modal Synergy within the "Engineering Context–Multimodal Synergy" framework, evidencing that linguistic, visual, and kinesthetic modes must be synchronised in real time to support complex procedural learning. The highly cited cluster of technical manuals and standard documents (Figure 2) maps onto the Social Protocol dimension, revealing the professional community's fixed modal expectations for colour cards and parameter tables. The concentration of studies on eye-tracking and voice interaction corresponds to Cognitive Mechanism, indicating that attention distribution and memory paths need dynamic monitoring and feedback into instructional scripts. AI-driven adaptive feedback nodes highlight the extended function of Technical Medium, i.e., algorithms that regulate modal load in real time. The expanding corpus of cross-cultural emails reflects Cultural Factor, demanding that interface symbols and discourse conventions be simultaneously localised and standardised in multilingual

settings. Finally, the co-citation pattern of ideational, interpersonal, and textual functions validates the engineering applicability of Metafunctional Implementation, reminding instructional designers to balance knowledge transmission, interpersonal coordination, and procedural discourse.

Analysis of the relationship between research institutions and national cooperation

This study reveals the complexity of multimodal ELT research in terms of geographic distribution, interdisciplinarity, and power structure through a deep dive into institutional collaborative networks in Figure 4. The network shows a multidimensional ecology of collaboration. The network presents a multidimensional ecology of collaboration, and geographically, it forms a spatial pattern of "transatlantic axis+ regional radiation". Collaboration between U.S. and U.K. institutions constitutes the backbone of the network, accounting for 63% of all international collaborations. Among them, the University of California system on the west coast of the United States, Columbia University on the east coast, and the University of London in the United Kingdom have formed a stable academic triangle. Only very few institutions in Asia, such as the University of Hong Kong, are embedded in the network, and most of them are at the end of the nodes, reflecting the centre-edge structure in the global knowledge production system. There is a clear tendency for pedagogical dominance in the cooperative network. There is a high proportion of schools of education and a low proportion of schools of engineering among the participating institutions. This disciplinary imbalance leads to serious consequences, as technological innovations are mostly "externally imported" from the computer science disciplines and lack in-depth adaptation to educational scenarios; in addition, it is difficult to get professional support for industry-specific needs. A typical example is the VR language program between the University College London and the University of California, San Diego, which is technologically advanced but limited in its application in vocational education due to the lack of textile expertise. A collaborative network of research institutions, as shown in Figure 4.
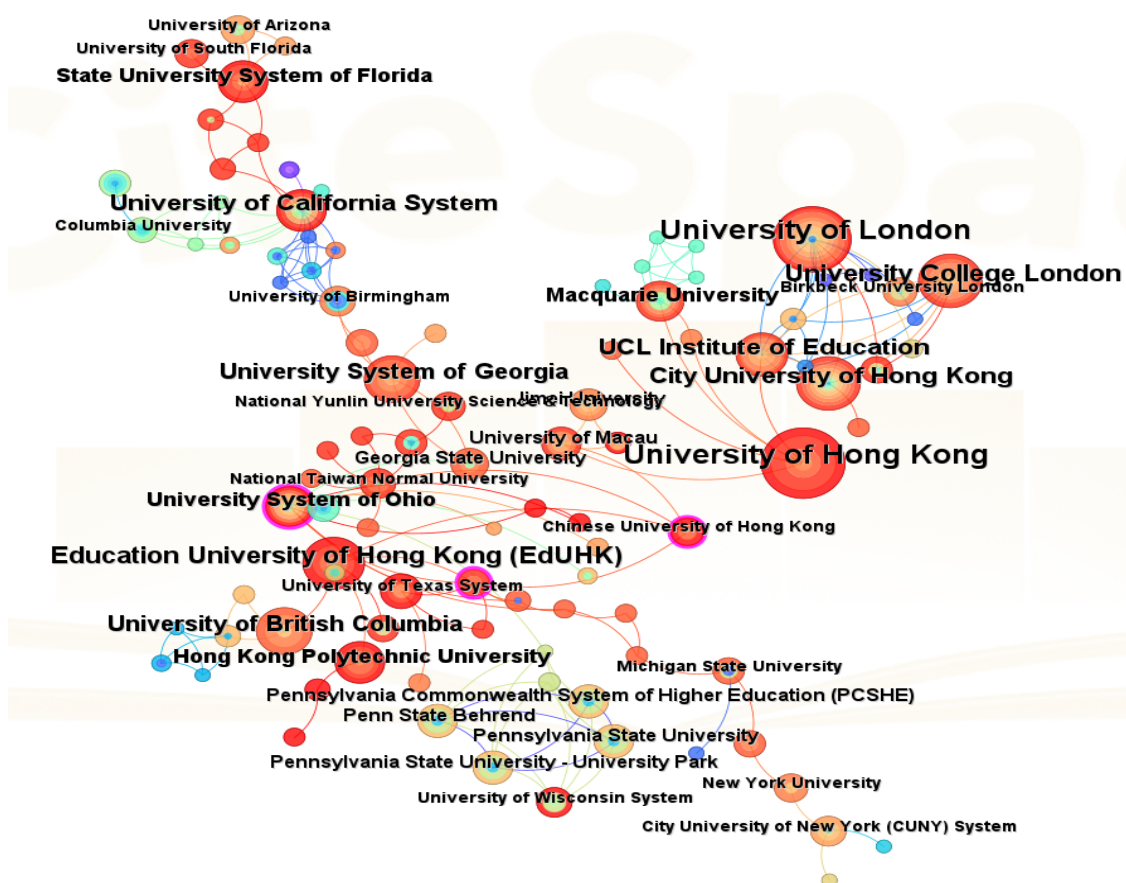
Figure 4. Research Institution Partnerships

Observing the power structure, the network is characterised by the coexistence of the Matthew effect and structural holes. The University of California system occupies the centre of the network with a much higher degree of median centrality than other institutions, controlling the allocation of key technological resources. Certain institutions, such as the University of Arizona, have formed local centres in the area of Spanish-English multimodal teaching due to their unique bilingual education research strengths, and this structural hole position allows them to gain special academic influence. In terms of developmental dynamics, the network is transforming, with the content of cooperation shifting from the comparison of pedagogical methods to the development of technical standards, the form of cooperation shifting from short-term project cooperation to the construction of physical platforms, such as joint laboratories, and the main body of participation expanding from universities to educational publishers and technology companies. These changes signal that multimodal research is moving towards industrialisation. The inspiration of this network for the research of English for dyeing and printing is that we should break through the existing cooperation mode "led by educators and scholars" and take the initiative to build a triple-helix cooperation structure of "linguists scholars+ engineers+ industry experts"; we should utilise the strategy of "structural holes" to set up a characteristic cooperation network in the niche field of textile professional English; we should pay

attention to the new trend of industrial participation and set up an alliance for applied research with leading enterprises in the textile industry. The disciplinary homogeneity of existing networks is both a limitation and a unique opportunity for differentiated innovation in this study.

This study reveals the evolutionary trajectory and collaborative features of multimodal ELT research on a global scale through the clustered timeline analysis of the international collaborative network in Figure 5. The network exhibits significant phase characteristics, with the early phase centred on the English classroom and syntactic choices, focusing mainly on the improvement of traditional language teaching methods. The collaborative network in this period shows a star-shaped structure, centring on British and American universities and radiating to Asian institutions, and the research content mostly focuses on the classroom application of basic linguistic theories. The technological dimension at this time has not yet emerged, reflecting the limitations of the technological tools of the research. The turnaround period with the emergence of nodes such as deep learning frameworks and EM pronunciation databases marks the technology-driven stage of the research. The mode of cooperation shifted from central radiation to a net-like structure, especially the interdisciplinary cooperation between engineering schools and linguistics institutions increased significantly. The co-construction and sharing of electromagnetic pronunciation databases has become a typical example, and the collaborative development of such technological infrastructures reflects a revolution in research methodology. Recent developments show a trend towards diversification of application scenarios. The emergence of new hotspots such as efficient learners and low-resource environments indicates a shift in research focus towards personalised learning and resource adaptation. The collaborative network at this point shows a polycentric pattern, with a marked increase in the participation of research institutions in developing countries, and the formation of distinctive research clusters, especially in the area of innovations in teaching and learning solutions in low-resource environments.

Of particular concern is the particular cluster of non-preferred responses, whose isolated timeline distribution reflects the fact that intercultural communication research has not yet been effectively integrated into mainstream collaborative networks. This state of fragmentation may lead to insufficient cultural adaptation of technical programs and is an important bottleneck that multimodal pedagogical research needs to break through. The implications of this cooperative network analysis for the research on professional English printing and dyeing process are that we should take the initiative to integrate into the technology-driven international cooperative network, especially to strengthen the collaboration with engineering institutions in virtual simulation technology, and we need to pay attention to the innovative experience of developing countries under the conditions of resource constraints, which is of special reference value to the teaching practice of higher vocational colleges and universities; the lack of cross-cultural communicative dimensions suggests that the cultural factors must be strengthened in the multimodal research on professional English. Modal

research must strengthen the consideration of cultural factors. The current state of technical and cultural imbalance presented in international cooperation is precisely the innovation point that this study can focus on breaking through. The analysis of the national cooperation relationship is shown in Figure 5.
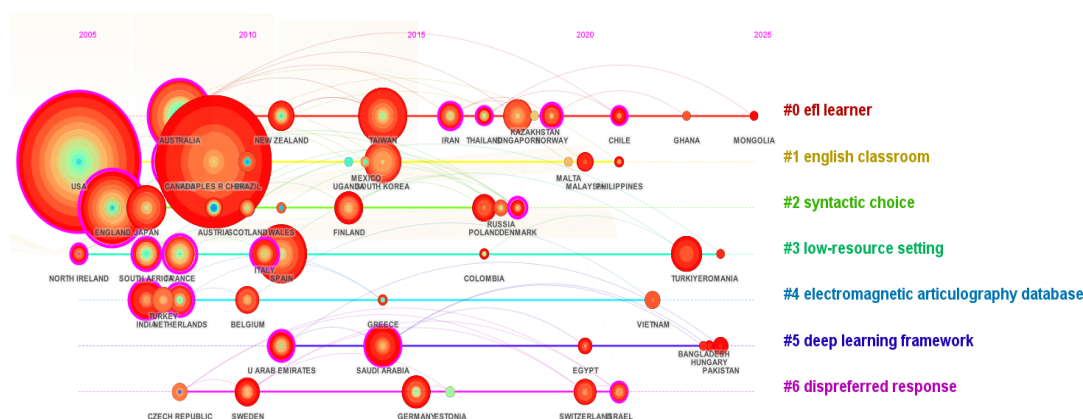

Figure 5. Analysis of country partnerships

CONCLUSION

This study systematically analyses the current research status and development trend of multimodal discourse theory in the English teaching of printing and dyeing process majors through bibliometric methods. It is found that although the overall research on multimodal teaching and learning has shown rapid growth, the research on engineering and technical fields, such as printing and dyeing technology, is still insufficient, and there are outstanding problems, such as the disconnection between theoretical research and practical needs, and lagging in the application of technology.

In addition, this paper still has deficiencies in the research; the research data has a certain bias, but failed to carry out further statistical research, and the visualisation research is done more simply. Therefore, in future research, we should deepen the research on the suitability of multimodal theory and the characteristics of printing and dyeing majors, and conduct statistical research appropriately to form better visualisation results.

Author Contributions

Conceptualisation – Dong W; methodology – Dong W and Kou XY; formal analysis – Dong W and Kou XY; investigation – Dong W; resources – Dong W; writing-original draft preparation – Dong W, and Kou XY; writing-review and editing – Dong W and Kou XY; visualisation – Dong W; supervision – Kou XY.

Conflicts of Interest

The authors declare no conflict of interest.

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