

BIBLIOMETRIC ANALYSIS OF THE GLOBAL INTELLECTUAL STRUCTURE OF DUAL AND WORK-INTEGRATED HIGHER EDUCATION

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Abstract

Dual and work-integrated learning (WIL) models are important for developing a skilled workforce. This article presents a large-scale bibliometric analysis of the dual and WIL research landscape. The objective of the study was to map the core concepts, thematic clusters, and temporal trends that define the global scholarly conversation. The study analysed 1,563 unique records published between 2006 and 2025, which were extracted from Scopus and Web of Science. A hybrid methodology combining custom Python-based scripts for data integration and network analysis with VOSviewer was used to examine keyword co-occurrence, centrality, and thematic clusters. The results reveal a field centred on students, curricula, and employability. Three dominant thematic clusters emerged: graduate employability and the student experience; engineering education and pedagogical frameworks; and professional development. A temporal analysis indicates a recent shift towards wellbeing and equity. This study provides a comprehensive, evidence-based map of this important research area.

1 Introduction

In response to persistent demands for a more agile and skilled workforce, educational institutions and governments worldwide are increasingly championing dual and work-integrated learning (WIL) models. These programmes, which formally integrate rigorous academic study with substantial, accredited work experience, represent an important component of the European Union's broader strategy to encourage innovation, address pressing socio-economic challenges, and build a resilient, competitive knowledge-based economy. While “dual study” denotes formalised, employer-integrated degree programmes that are prevalent primarily in German-speaking and Central European contexts, “work-integrated learning” is used here as the internationally adopted umbrella term for cooperative education, internships, and professional placements across diverse national systems. The two models are treated jointly in this study because they share a commitment to the structured integration of academic and professional learning. Initiatives such as the European Alliance for Apprenticeships (European Commission, n.d.) aim to align educational outcomes with the dynamic needs of industry, particularly supporting the critical green and digital transitions. To produce graduates who are not only theoretically knowledgeable but also demonstrably workforce-ready, these educational models focus on cultivating tangible employability skills (Jackson, 2015)

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and career management competencies (Jackson & Wilton, 2016) through deep immersion in professional contexts.

In light of this strategic importance, a growing body of research has emerged to understand and document these educational models. However, a comprehensive review of this literature reveals a distinct and prevailing research paradigm centred on descriptive national case studies. A significant volume of recent scholarship provides deep, context-rich examinations of individual countries, which, while intrinsically valuable, collectively highlight a critical gap in the field's self-understanding. The inaugural issue of the *European Journal of Dual Higher Education* illustrates this perfectly, featuring detailed analyses of established dual education frameworks in Austria (Dragan & Hochrinner, 2024) and Hungary (Sági & Fülöp, 2024), alongside explorations of the legal and practical pathways in nations such as Belgium (Dupouy & Bakni, 2024), Slovakia and Romania (Varga, 2024a; Varga, 2024b). This country-specific lens has also been applied rigorously to countries without a formal "dual" system, such as Finland and Sweden, whose strongly work-oriented models are analysed in their own right (Laukkanen et al., 2024; Viklund & Elgundi, 2024).

This rich mosaic of national studies provides an indispensable foundation for policymakers and practitioners. The success and proliferation of this context-rich research signal a new stage in the field's maturity, one that now calls for a complementary, macro-level synthesis. Such a synthesis would not replace detailed national accounts but would build on them, allowing us to ask broader questions that naturally arise from this collective body of work: what are the dominant theoretical frameworks that unify the field, which influential concepts transcend national borders, and which less visible collaborative networks connect researchers globally? The opportunity now exists to weave these distinct and vital conversations into a cohesive international discourse, revealing the intellectual architecture that underpins the entire field.

1.1 Foundational themes in work-integrated learning research

A review of the foundational literature on work-integrated learning (WIL) reveals a scholarly discourse focused on several interconnected themes: the development of graduate employability, the formation of professional identity, the critical importance of programme design and quality assurance, and the essential role of support systems. This body of research, anchored primarily in the Australian context (as evidenced by the corpus analysed in this study), provides the empirical and theoretical bedrock upon which a broader, global understanding of the field can be built.

The primary objective identified in the literature is the cultivation of graduate employability. Researchers consistently investigate how WIL programmes equip students with the necessary attributes to succeed in the modern workforce. This extends beyond simple job attainment to include the development of sophisticated career management competencies, enabling graduates to self-manage their professional pathways effectively in an era of increased employee mobility (Jackson & Wilton, 2016). The literature argues that WIL is instrumental in developing a wide range of tangible employability skills, though scholars also caution that the mere existence of a placement is insufficient; the quality of programme design is central to overcoming barriers and ensuring effective skill development (Jackson, 2015).

Moving beyond a purely skills-based definition of employability, a significant stream of research explores the role of WIL in the formation of pre-professional identity. This complex phenomenon, which encompasses a student's awareness of and connection with the values, standards, and behaviours of their chosen profession, is positioned as a critical but often underexplored aspect of graduate readiness (Jackson, 2017; Trede, 2012). Jackson's (2017) work demonstrates that work placements offer an invaluable platform for identity construction. Through observation, interaction with seasoned professionals, and structured reflection, students begin to build a professional self, a process that is as important to their future success as the application of disciplinary knowledge.

The effectiveness of these programmes depends on their structural integrity and the quality of their design. Smith (2012) addresses this directly by proposing a comprehensive framework for evaluating WIL curricula. This work highlights the key dimensions that underpin quality, including authenticity, integrated learning supports at both the university and the workplace, and the clear alignment of learning activities with outcomes. This focus on quality assurance and programme

architecture underscores a critical understanding in the field: the benefits of WIL are not automatic; rather, they result from deliberate and thoughtful pedagogical design.

Moreover, the literature illuminates the crucial role of human support systems in mediating the student experience. The academic advisor, for instance, is not a peripheral figure but plays a make-or-break role in student success (Wenham et al., 2020). This research identifies the substantial pastoral demands placed on advisors and identifies the need for robust institutional support, mentoring, and clear processes to help them manage diverse student issues, particularly concerning international students and those with mental health challenges. This focus on the support ecosystem is also echoed in the context of global pressures, where WIL is positioned as a key strategy for addressing skills shortages and preparing global citizens, with a particular focus on the unique needs and experiences of international students (Gamble et al., 2010).

1.2 Leveraging computational tools for bibliometric insight

The exponential growth in scholarly publications has rendered traditional manual review methods inadequate for capturing the full scope of research (Toaza & Esztergár-Kiss, 2024). Consequently, bibliometric analysis has become essential for mapping intellectual structures and identifying key conceptual clusters. While user-friendly software such as VOSviewer has made science mapping accessible, a powerful trend has emerged towards the use of programming languages, particularly Python and R, for more flexible, robust, and transparent analyses. This shift reflects the need to combine tools for specific analytical goals, as no single software is universally optimal (Moral-Muñoz et al., 2020).

Programmatic approaches offer several advantages. Python scripts can automate data searching, downloading, and cleaning, ensuring data quality and saving time (Toaza & Esztergár-Kiss, 2024). Furthermore, Python-based tools provide extensive and customisable analytical techniques, enabling advanced network analyses beyond basic metrics (Velasquez, 2023). Crucially, analysis via programming scripts enhances scientific rigour by ensuring transparency and reproducibility, a core principle for modern computational research (Butt et al., 2021). Building on this methodological trend, this study employs Python-based scripts in combination with VOSviewer to analyse the research landscape (Juhász, 2025). To address the fragmented nature of existing scholarship, this study proposes to construct a comprehensive mapping of the global intellectual structure of dual and work-integrated higher education.

1.3 Objectives and research questions

To provide a comprehensive, quantitative map of the scholarly conversation, this article presents a bibliometric analysis of global research output on dual and work-integrated higher education published between 2006 and 2025, drawn from the Web of Science (WoS) and Scopus databases. The analysis systematically charts the scholarly corpus, thereby moving beyond the limitations of siloed national contexts to reveal the field's underlying intellectual structure on a global scale.

To achieve this objective, the study is guided by the following research questions:

- RQ1: What are the core concepts and most influential themes that define the scholarly conversation on dual and work-integrated higher education?
- RQ2: What are the primary thematic clusters, and how do they structure the research landscape?
- RQ3: How has the field's thematic focus evolved over the last two decades?
- RQ4: What does this intellectual structure reveal about the current state and future direction of the field for both researchers and practitioners?

2 Methodology

This study employs a quantitative bibliometric analysis to systematically map the intellectual structure, evolution, and key thematic clusters within the scholarly literature on dual studies and work-integrated learning. This research design was adopted to provide a comprehensive, macro-level overview of the field, moving beyond the descriptive national case study approach to uncover the underlying patterns in the global scholarly conversation.

2.1 Data collection and scoping

To ensure comprehensive coverage and mitigate the biases of any single source, the data collection strategy utilised two of the world's leading academic databases: the Web of Science Core Collection and Scopus. The search query was constructed to maximise both relevance and recall. The final query, applied to the topic fields covering titles, abstracts, and keywords, was: ("dual study" OR "work integrated learning" OR "cooperative education") AND ("university*" OR "academic*").

The data and structure consist of two conceptual components, which were gathered on 2 July 2025. The first captures the core educational model using its varied international terminologies, while the second component acts as a filter to ensure every result is situated firmly within a higher education context. To focus on contemporary developments, the timeframe was limited to an approximately 20-year period, from 2006 to 2025. Furthermore, to ensure the analysis was based on substantive, peer-reviewed research, the author restricted the included document types to Article, Proceeding Paper, and Review, and explicitly excluded all other document formats.

2.2 Data processing and analysis

The analysis employed a hybrid methodology, combining established visualisation software with custom programming scripts, aligning with contemporary scientometric best practices for specific analytical aims (Moral-Muñoz et al., 2020). A significant challenge in multi-source bibliometric research is record merging and de-duplication; this was addressed by creating custom Python scripts. The script parsed the raw data and implemented a multi-tiered matching algorithm, utilising DOIs and title/author combinations to create a clean, consolidated database.

Following integration, the scripts facilitated critical data cleaning by standardising keyword terms (e.g., "work integrated learning" merger) and excluding generic, non-thematic keywords to ensure conceptual consistency and prevent distortion of network visualisations. The hybrid analytical workflow leveraged VOSviewer for exploratory visualisation and exported data to custom Python scripts for detailed quantitative analysis in a Jupyter Notebook file, using the Google Colab Research platform; the complete analytical scripts are openly deposited on Zenodo (Juhász, 2025), ensuring full reproducibility. Using the Pandas, NetworkX, Matplotlib libraries, and VOSviewer, the scripts enabled a series of in-depth analyses, including the construction of a keyword co-occurrence network to map the field's intellectual structure, the employment of community detection algorithms to objectively identify distinct thematic clusters, the examination of keyword usage evolution over 20 years to identify emerging and fading trends, and the calculation of four distinct centrality measures to determine the structural importance of key concepts derived from keyword analysis.

It should be noted that the visual network maps are the result of deliberate data curation to enhance analytical clarity. To prevent the visualisations from being dominated by a few overly broad terms, the core search-query keywords were excluded from the final map generation and centrality analysis. Highly frequent terms like "work-integrated learning", "cooperative education", and "higher education" were intentionally deselected. Including these "header terms" would have created a single, dense super-node at the centre of the network, obscuring the more subtle and meaningful relationships between specific thematic concepts such as employability, curriculum design, and nursing education. This exclusion is not a limitation of the data itself, but a standard and necessary step in science mapping to produce a more interpretable and meaningful intellectual map.

By contrast, terms such as "students" and "education" were deliberately retained, as these represent researcher-assigned index descriptors rather than search-query artefacts; their high centrality therefore constitutes a substantive empirical finding about the field's orientation.

3 Results and Discussion

The bibliometric analysis of the consolidated dataset reveals a complex and highly structured research landscape. The findings, presented through network visualisations and quantitative metrics, illuminate the field's core intellectual architecture, its primary thematic pillars, and its dynamic evolution over the last two decades.

3.1 Data corpus overview and processing results

The multi-stage data collection and cleaning process yielded a robust final corpus for analysis. As illustrated in the Final Processing Overview (Figure 1), the initial search retrieved 1,202 documents from the Scopus database and 1,090 from the Web of Science, resulting in a combined total of 2,292 records.

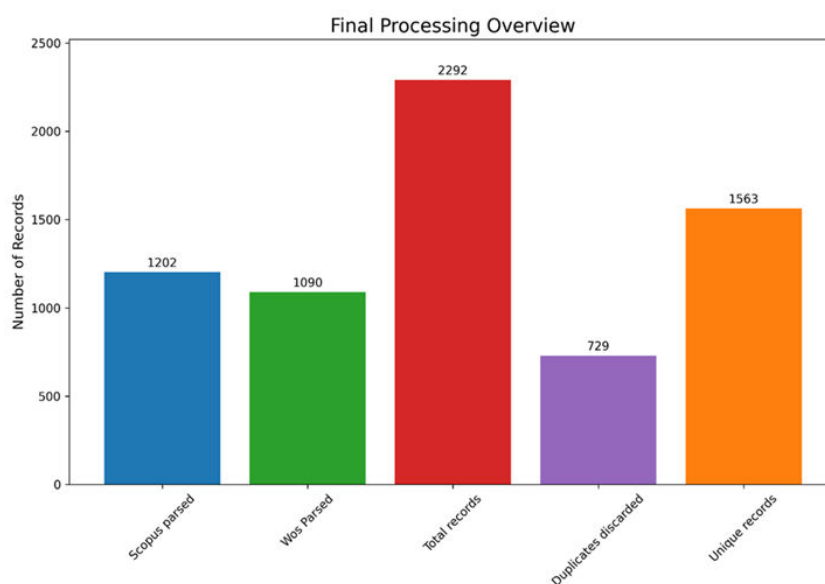


Figure 1. Final Processing Overview of Records, author's own edit

The subsequent de-duplication process, performed by the author's custom script, identified and discarded 729 duplicate entries. This procedure resulted in a final corpus of 1,563 unique scholarly records, which form the basis for all subsequent analysis. The decision to use both databases was supported by an analysis of source contributions to the final unique dataset, as shown in Figure 2.

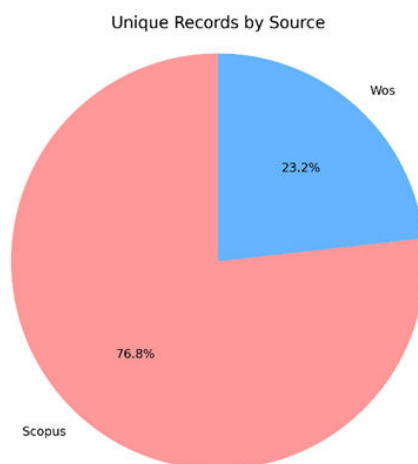


Figure 2. Unique Records by Source, author's own edit

The second figure demonstrates that Scopus was the source for 76.8% of the unique records, while Web of Science contributed the remaining 23.2%. This disparity underscores the necessity of a multi-source approach, as relying on a single database would have resulted in overlooking approximately one quarter of the relevant scholarly literature.

The temporal distribution of these 1,563 unique publications (Figure 3) reveals a clear and sustained growth in academic interest over the last two decades.

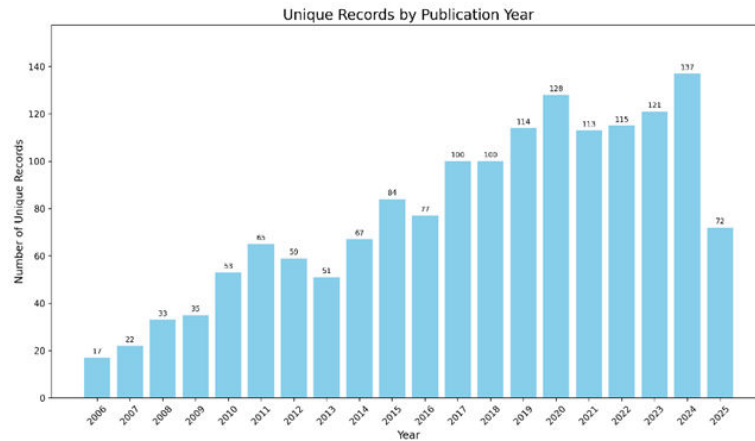


Figure 3. Unique Records by Publication Year, author's own edit

From a modest start of just 17 publications in 2006, the annual output shows a consistent upward trajectory, peaking at 137 publications in 2024. This increase in annual research output quantitatively indicates the expanding significance of, and growing scholarly attention to, dual and work-integrated higher education. It is important to note that the data for 2025 reflects a partial count for the year at the time of data collection.

To examine the geographic scope of the corpus, an analysis of author affiliations by region (Figure 4) reveals that, while the dataset draws from six major world regions, scholarly output is markedly uneven in its distribution.

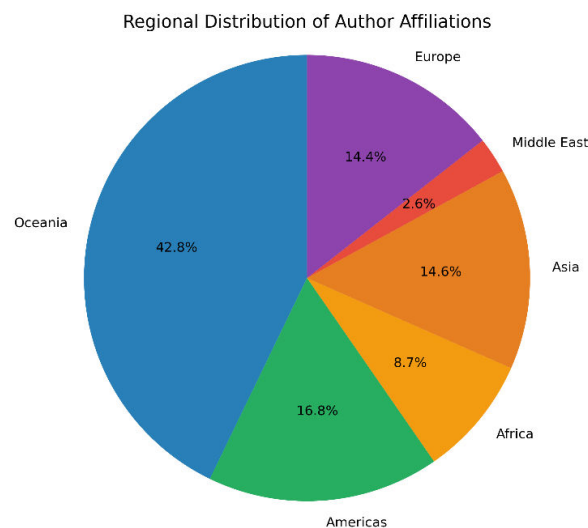


Figure 4. Regional Distribution of Author Affiliation, author's own edit

As illustrated in Figure 4, Oceania accounts for the largest regional share at 42.8%, a contribution driven almost entirely by Australian institutions, reflecting the country's disproportionate prominence in work-integrated learning research relative to its higher education system size. The Americas (16.8%), Asia (14.6%), and Europe (14.4%) follow with broadly comparable shares,

suggesting meaningful but secondary engagement across these regions. African institutions contribute 8.7% of affiliations, with South Africa as the dominant national contributor within this group. The Middle East accounts for the remaining 2.6%. Within Europe, output is distributed across numerous national contexts, with no single country holding a dominant share. This regional pattern is consistent with the established bibliometric centrality of Australia in the field and is discussed further in relation to the thematic findings below.

3.2 The core architecture of the field

The keyword co-occurrence network (Figure 5) demonstrates a field organised around a dense conceptual core with several distinct and specialised peripheral areas.

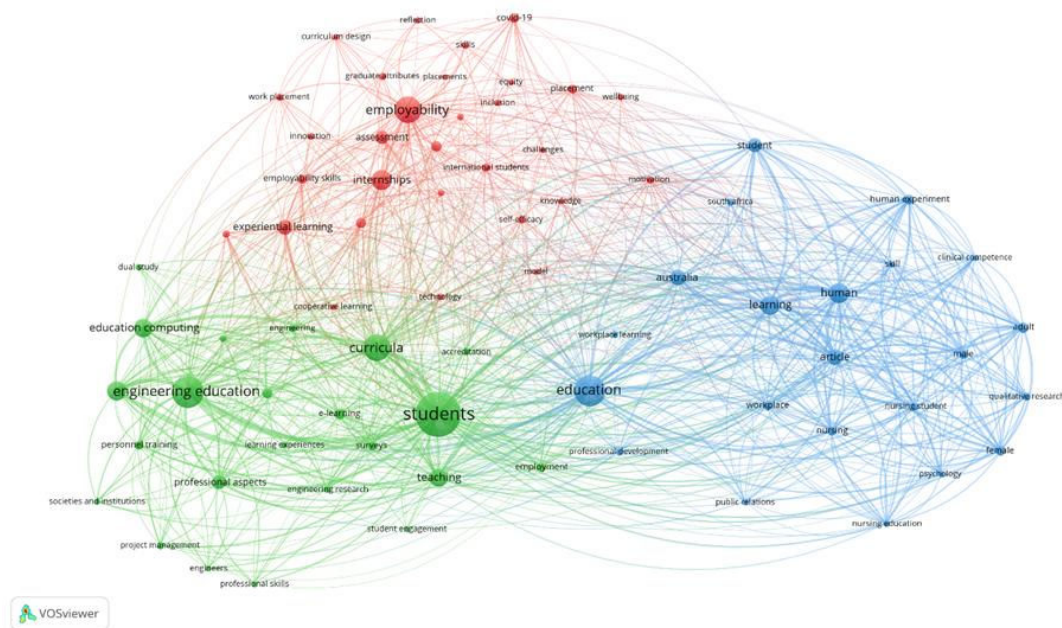


Figure 5. Keyword Co-Occurrence Network, VOSViewer

A quantitative examination of keyword centrality underscores this structure. Raw keyword occurrences (Table 1) confirm the visual centrality of key terms.

Table 1. Keyword Occurrences

Keyword	Occurrences
students	289
engineering education	171
education	167
curricula	135
employability	134
human	90
internships	87
apprentices	85
learning	85
education computing	77

The keyword students is, by a significant margin, the most frequently occurring thematic concept (289 occurrences), followed by engineering education (171) and education (167). This top tier is completed by concepts central to educational design and outcomes: curricula (135) and employability (134), affirming a strong focus on learners, specific vocational contexts, and practical goals.

This raw frequency translates directly into network influence, as measured by Total Link Strength (Table 2).

Table 2. Keyword Total Link Strength

<i>Keyword</i>	<i>Total Link Strength</i>
students	1128
education	785
human	659
engineering education	584
learning	577
article	493
curricula	489
teaching	355
adult	300
female	292

Students again dominate with a link strength of 1128, while broad concepts like education (785) and human (659) demonstrate their role as highly integrative themes by connecting to a wide and diverse array of other topics across the entire network.

The network's architecture is further illuminated by the various centrality metrics (Table 3), each telling a part of the structural story.

Table 3. Keyword Centrality Analyses

<i>Keyword</i>	<i>Degree Centrality</i>	<i>Closeness Centrality</i>	<i>Betweenness Centrality</i>	<i>Eigenvector Centrality</i>
students	0.9595	0.9610	0.0502	0.4481
curricula	0.9324	0.9367	0.0441	0.2301
education	0.9189	0.9250	0.0410	0.3548
teaching	0.8243	0.8506	0.0313	0.1780
learning	0.7703	0.8132	0.0219	0.2599
employability	0.7432	0.7957	0.0294	n/a
australia	0.7162	0.7789	0.0193	n/a
engineering education	0.6757	0.7551	0.0191	0.2864
article	0.6486	0.7400	n/a	0.2350
human	0.6351	0.7327	n/a	0.2991

As shown in the table above, the high Degree Centrality of students (0.9595), curricula (0.9324), and education (0.9189) indicates a field heavily centred on the core aspects of educational practice and design. The presence of teaching, learning, and employability among the top-ranked terms reinforces this focus on student outcomes and pedagogical effectiveness, while the inclusion

of Australia and engineering education points to a geographically anchored and discipline-specific concentration of research.

This finding is strongly corroborated by the Closeness Centrality results. The high scores for the same core keywords suggest a well-connected research network focused on how educational practices prepare students for future careers. The near-identical ranking of the top keywords across both Degree and Closeness Centrality confirms the presence of a highly cohesive and efficient intellectual core.

The Betweenness Centrality scores offer a more nuanced perspective. While the top-ranking keywords are consistent with other metrics, their actual centrality values are relatively low, with the highest score only 0.0502 for students. This important finding suggests that the research network is highly integrated and does not rely on a few critical nodes to bridge structural holes between topics. The thematic clusters are already well-connected, reflecting a field characterised by interconnected research on student-centred learning, curriculum design, and professional preparation.

Finally, Eigenvector centrality measures influence based on the importance of a node's connections. The dominance of students (0.4481) and education (0.3548) suggests a field heavily focused on pedagogical practices and the training of future professionals. The high rank of human (0.2991) alongside engineering education suggests a significant emphasis on the human aspects of education in technical disciplines, potentially encompassing areas such as human-centred design. These strong connections among influential keywords indicate the existence of well-established research clusters focused on enhancing learning experiences in engineering and education.

3.3 Thematic pillars with temporal analysis

Beyond the individual influence of key concepts, the network is organised into three distinct and highly coherent thematic regions. These keyword clusters, shown in Figure 5 and Table 4, were identified through algorithmic partitioning of the network, revealing the primary sub-fields where dual and work-integrated learning are investigated. Each cluster represents a unique community of practice within the broader scholarly conversation.

Table 4. Keyword Cluster Analysis

<i>Cluster ID</i>	<i>Coherence</i>	<i>Top Keywords</i>
Cluster 2 (green in Figure 4)	7,6684	societies and institutions, engineering education, engineering research, learning experiences, professional aspects...
Cluster 3 (blue in Figure 4)	10,6589	professional development, qualitative research, clinical competence, workplace learning, nursing education...
Cluster 1 (red in Figure 4)	1,9543	graduate employability, international students, experiential learning, professional identity, cooperative learning...

Cluster ID 1, with a coherence score of 1.9543, is intensely focused on the complex aspects of graduate employability, particularly in relation to experiential learning, internships, and the unique needs of international students. This cluster is the most diverse of the three, suggesting it acts as an intellectual hub that integrates a wide range of concepts related to the student journey from university to the workforce. It explores how approaches such as cooperative learning can support the development of a strong professional identity and ultimately improve employability outcomes, with top keywords including graduate employability, international students, experiential learning, professional identity, and cooperative learning.

Cluster ID 2 is dominated by a highly influential node and serves as the intellectual home for research on the practical design and implementation of integrated learning models. With a strong coherence score of 7.6684, this theme is well-defined and interconnected. Its core keywords, such as curricula, learning experiences, and professional aspects, highlight a central focus on preparing

future engineers by bridging the gap between academic learning and professional practice. The inclusion of societies and institutions suggests that this research also considers the broader societal context and impact of engineering education.

Finally, Cluster ID 3's thematic pillar is the most cohesive in the entire network with notably high coherence score of 10.6589. This indicates a mature, focused, and tightly interconnected area of research. The cluster is clearly delineated around the intersection of professional development and clinical competence within the specific context of nursing education and workplace learning. The prominence of qualitative research within this cluster suggests a methodological preference for in-depth exploration of the lived experiences of acquiring and demonstrating practical skills, with top keywords including professional development, qualitative research, clinical competence, workplace learning, and nursing education.

Crucially, the network overlay's temporal analysis visualisation (Figure 6) further reveals that this intellectual landscape is not static but has evolved significantly over time.

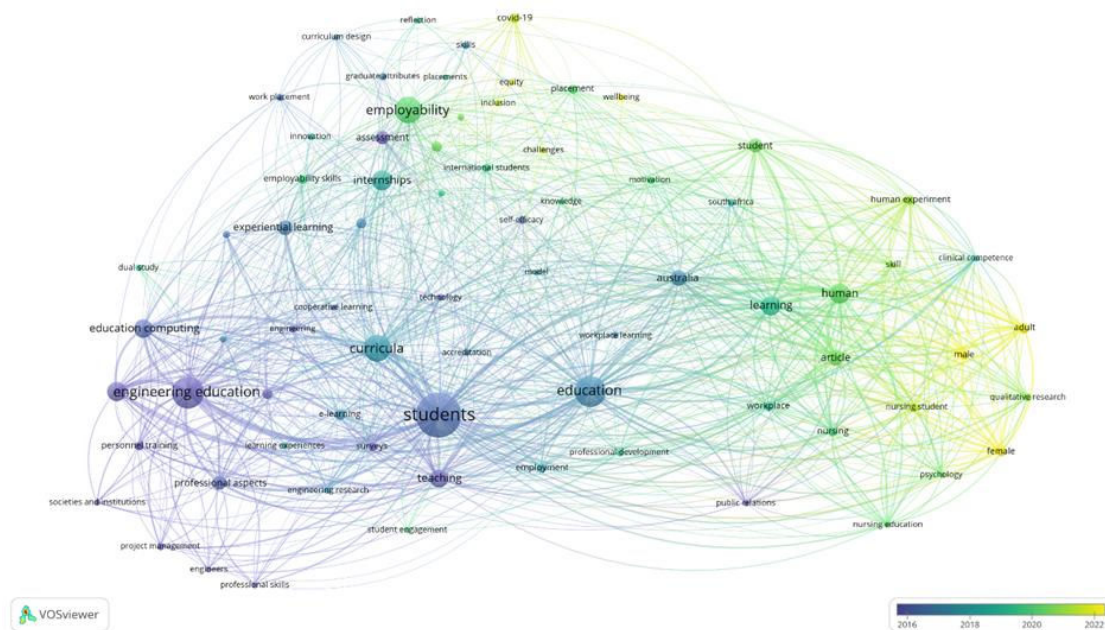


Figure 6. Temporal Overlay of Keyword Co-Occurrence Network, VOSViewer

The overlay map illustrates this dynamic by colour-coding keywords based on their average publication year, with older terms in blue and more recent terms in yellow. Foundational concepts in the field, such as students, education, and teaching, appear in darker blue, indicating their established presence since the earlier years of the analysis period. The most recent research fronts, however, are concentrated in bright yellow nodes that have emerged prominently since 2021. This recent shift is most pronounced in Cluster 1, where a suite of new concepts has appeared.

Table 5. Keywords Average Publication Year

<i>Keywords</i>	<i>Avg. Pub. Year</i>
wellbeing	2022,7222
male	2022,0345
female	2021,8667
adult	2021,6667
equity	2021,6667
covid-19	2021,3226
challenges	2021,3125
nursing student	2021,2381
inclusion	2021,1176
human experiment	2020,9667

Here, the most recent keywords across the entire network appear, including wellbeing (2022.7), equity (2021.7), and COVID-19 (2021.3). This indicates a distinct evolution in the conversation around employability, incorporating a more holistic and socially aware perspective.

This indicates that the research conversation in this domain is evolving significantly, expanding from a traditional focus on skills and preparedness to a more holistic understanding of the graduate experience, one that now incorporates broader concerns for student wellbeing, equity, and the effects of external global factors.

Similarly, Cluster 3 demonstrates a recent evolution, with the keywords male (2022.0) and female (2021.9) emerging as contemporary topics. This points to a growing scholarly interest in understanding and addressing gender-specific factors within nursing education and professional development. The term human experiment (2021.0) also appears as a recent node, suggesting a rising focus on simulation-based training, evidence-based pedagogical interventions, and the ethical considerations surrounding clinical education, particularly in the post-pandemic era. These temporal shifts indicate the field's responsiveness to contemporary societal issues and its continuous adaptation to new challenges and research methodologies.

3.4 Discussion

The volume of literature confirms that dual and work-integrated higher education is a specialised, nascent, and growing area of academic inquiry, rather than a long-established discipline. This analysis thus provides a comprehensive map of this focused scholarly domain.

In relation to RQ1, the scholarly conversation is defined by the strong centrality of students, curricula, and employability, forming the intellectual bedrock of the field with an overarching focus on the learner's journey, pedagogical design, and practical outcomes. This focus is anchored in key vocational domains (engineering and nursing) where theory-practice integration is both methodologically expected and professionally mandated. Influential themes like engineering education and human factors highlight the field's vocational orientation and its concern for the human element in technically demanding disciplines. Australia also emerges as a highly central node across all four centrality metrics, indicating its substantial influence in shaping the foundational literature of the field. The dominance of Australia as a central node reflects the country's early institutionalisation of WIL frameworks and its sustained contribution to the empirical and theoretical foundations of this research area.

In response to RQ2, the network is structured into three primary thematic pillars, each representing a distinct community of practice. Cluster 3 (nursing education) and Cluster 2 (engineering education) represent mature, highly focused research areas with strong coherence scores of 10.66 and 7.67 respectively, emphasising professional development and the integration of technical knowledge with workplace practice. Notably, "dual study" is firmly associated with the engineering cluster in the literature, suggesting that the formalised, employer-integrated model has

found its primary scholarly articulation within technical education discourse. In contrast, Cluster 1, centred on graduate employability and international students, is more diverse with a coherence score of 1.95, serving as a dynamic hub that synthesises concepts from experiential learning, professional identity, and cooperative education to prepare graduates for the job market across multiple disciplines.

In relation to RQ3, the temporal analysis indicates a significant and accelerating evolution in the field's focus over two decades. The most compelling finding is the clear temporal shift evidenced by the recent emergence of keywords such as "wellbeing" (avg. publication year 2022.7), "equity" (2021.7), "male" and "female" (2022.0 and 2021.9), and "COVID-19" (2021.3). This suggests a substantial shift, likely accelerated by the pandemic, indicating a move beyond purely economic or skills-based justifications toward a more humanistic and socially responsible model that actively addresses gender disparity, student mental health, and inclusive educational practices. The appearance of "human experiment" further signals rising interest in the ethical dimensions of educational research and complex adult learning, particularly through simulation-based and technologically mediated approaches.

Finally, in relation to RQ4, this intellectual map reveals both a mature, vocationally focused core and clear frontiers for future inquiry. The field emphasises practical outcomes, particularly in engineering and nursing, yet its emerging research fronts point in a more expansive direction. First, the field should move beyond general employability to examine its contemporary components and investigate how dual study curricula can integrate training for green and digital transitions. Second, the recent shift towards wellbeing and equity requires empirical testing of specific interventions that promote mental health and inclusive learning environments within WIL contexts. Third, interdisciplinary inquiry is needed to explore how structured pedagogical models from engineering could enhance training in other fields, and how the patient-centred care ethos of nursing education could enrich technical workforce formation. Finally, the emergence of the keyword "human experiment" as a recent node points to an emerging discussion on ethics and technology, requiring focused studies on the responsibilities of universities and industry partners in ensuring student safety, data privacy, and psychological wellbeing within technologically mediated learning environments.

Beyond future research directions, these findings carry direct implications for curriculum design and policy. Programme designers should treat the emerging centrality of wellbeing and equity not as peripheral concerns but as core design criteria to be addressed in the structural design of WIL programmes, alongside the established emphases on employability skills and disciplinary competence. At the policy level, the identified gap around green and digital transition competencies represents a strategic priority: supranational frameworks such as the European Alliance for Apprenticeships are well-positioned to incentivise employer partnerships that explicitly embed these competencies within dual and work-integrated degree structures, translating bibliometric signals into actionable curricular priorities.

Viewed against the national studies discussed in the introduction, these global cluster patterns have both confirmatory and complementary significance. The strong coherence of the engineering cluster aligns with the structured, employer-partnered dual models documented in Central European contexts, where the formalised integration of academic study and professional practice is a defining institutional feature (Dragan & Hochrinner, 2024; Sági & Fülöp, 2024). Conversely, the diversity and breadth of Cluster 1 mirrors the broader, less institutionally prescribed WIL traditions of Scandinavian and Anglo-Saxon systems, where work-oriented education takes multiple forms without a singular structural mandate (Laukkanen et al., 2024; Viklund & Elgundi, 2024). This correspondence between the macro-level bibliometric structure and micro-level national accounts suggests that the global intellectual architecture of the field is not arbitrary but reflects genuinely distinct educational and institutional traditions.

4 Conclusions

This study mapped the intellectual structure of the global research landscape on dual and work-integrated higher education through a comprehensive bibliometric analysis of 1,563 unique

records drawn from Scopus and Web of Science. Taken together, the findings establish a coherent and evolving field anchored in student-centred, vocationally oriented scholarship across engineering and nursing education, with a clear recent trajectory towards broader humanistic and socially conscious concerns, most visibly in the rising centrality of wellbeing, equity, and inclusion.

This bibliometric map provides both researchers and practitioners with an evidence-based orientation to a field that is simultaneously mature in its vocational core and dynamic in relation to its emerging frontiers. It confirms the global intellectual coherence of what national case studies tend to examine in isolation, demonstrating that European, Anglo-Saxon, and Australasian traditions are not isolated silos but interconnected threads within a shared scholarly architecture. Future work should build on this structural overview through targeted qualitative inquiry and interventional research, particularly in the areas of student wellbeing, equity, and competency development for green and digital transitions.

4.1 Limitations

While this bibliometric analysis provides a broad macro-level overview, its conclusions should be interpreted in light of several methodological limitations. Although the dataset is sourced globally, the study's theoretical framework heavily draws on European educational policy discussions. Therefore, researchers applying these findings in non-European contexts should consider this conceptual bias. First, because the analysis is based on metadata, it offers a high-level structural perspective but does not capture the detailed richness or argumentative subtleties of full texts. Second, relying on Scopus and Web of Science excludes publications not indexed there, such as some books, regional journals, or highly specialised articles. Nevertheless, the transparent methodology adheres to established scientometric standards, offering a reliable, data-driven overview of the key themes and intellectual structures shaping the international discourse on dual and work-integrated higher education.

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