Advancing Graduate Academic English Teaching: Analyzing Lexical Bundles in Photonics Research Article Abstracts

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Received: January 28, 2024 Accepted: February 23, 2024 Online Published: February 28, 2024

doi:10.5430/irhe.v9n1p1 URL: https://doi.org/10.5430/irhe.v9n1p1

Abstract

This study presents a streamlined approach to assembling a list of commonly used English phrases from abstracts in top photonics journals, aimed at enhancing academic English writing courses for graduate students. The process involved compiling a corpus of 400 recently published abstracts from leading journals in the field. Subsequently, a corpus analysis tool was employed to identify and assess lexical bundles, which are a type of formulaic language, for their educational significance and communication functions. The result is a refined list of lexical bundles, each correlated with its primary function in academic discourse. This research offers a straightforward and efficient method for developing a discipline-specific vocabulary for academic English writing instruction at the graduate level.

Keywords: lexical bundles, academic English teaching, photonics, corpus analysis, discipline-specific vocabulary, graduate education

1. Introduction

The initiation of this study finds its roots in my experience as an instructor of academic English writing for engineering students. In these classes, the challenge lies not only in teaching the nuances of academic English but also in addressing the specific linguistic needs of students from a specialized field. As English majors, we, the instructors, often lack expertise in the discipline-specific language pertinent to our students' majors. This gap is further widened by the use of textbooks that offer general content, not tailored to the unique jargon and stylistic demands of engineering or other specialized fields. Compounding this challenge is a crucial graduation requirement for these engineering students: The publication of quality papers in international journals. This requirement is not only a milestone in their academic journey but also a key motivation for their enrollment in academic English courses. However, the existing resources at our disposal are inadequate, often neglecting the specific needs of these students. The materials fail to bridge the gap between general academic English and the specialized language required for successful publication in international journals. This disconnect between available resources and the students' needs led me to explore a fast and simple method to create discipline-specific teaching and learning materials. The aim is to develop resources that are not only highly relevant to the students' field of study but also hold substantial pedagogical value. By tailoring these materials to the specific requirements of engineering students, the study seeks to enhance their ability to write and publish effectively in their domain, thereby fulfilling a critical component of their academic and professional development.

Lexical bundles, an important type of formulaic language, are recognized as an invaluable resource in the creation of such educational materials. Defined by Biber et al. (1999, p. 990) as "recurrent expressions, regardless of their idiomaticity, and regardless of their structural status," lexical bundles are distinguished by their "non-idiomaticity, structural incompleteness, and frequency-driven identification" (Bao and Liu, 2022, p. 2). This focus on frequency allows for the identification of commonly used but structurally incomplete sequences, such as *here we show that*, as evidenced in this study. This approach contrasts sharply with the treatment of idiomatic expressions like *kick the bucket*, which, due to their rarity in academic texts, are typically excluded. The study of lexical bundles reveals their varied application across different registers (Biber et al., 1999; Huang, 2018), genres (Hyland, 2008), disciplines (Cortes, 2004; Liu and Chen, 2020), and among different groups of writers (Bao and Liu, 2022, 2023; Lu and Deng, 2019). Furthermore, empirical research has underscored the significant role that formulaic language plays in

enhancing language learners' proficiency (Yu, 2022), with a robust correlation observed between high language competence and mastery of lexical bundles (Kim and Kessler, 2022). Therefore, lexical bundles are exceptionally well-suited for the development of instructional materials. Their identification, driven by frequency, relieves language instructors from the extensive task of discourse analysis in unfamiliar disciplines. The well-documented effectiveness of lexical bundles as a teaching tool further validates their use in educational settings. However, while existing research has delved into the comparative use of lexical bundles across diverse linguistic landscapes, there is a notable gap in translating these insights into practical EAP teaching strategies. The challenge for instructors lies in the specificity of lexical bundles to particular disciplines and genres, making it difficult to curate exhaustive, relevant lists for all educational needs. This challenge underscores the need for more targeted approaches in the development of EAP materials that can effectively bridge the gap between theoretical linguistic research and practical classroom application. To address this gap, this study aims to create a list of lexical bundles from top photonics journal abstracts. It embraces a method that is swift, straightforward, yet effectively tailored to compile teaching and learning resources. These resources are designed to enhance the educational experience of graduate students in specialized fields, providing them with the linguistic tools necessary for academic success. By tapping into the rich vein of lexical bundles, this study offers a novel approach to academic language instruction, one that is grounded in the latest research trends and pedagogical best practices.

2. Research Design

2.1 Corpus

Table 1 illustrates the compilation of 400 abstracts from research articles published in three leading journals: *Nature Photonics* (150 abstracts), *Opto-Electronic Advances* (140 abstracts), and *PhotonIX* (110 abstracts). The selection of these journals as corpus sources is grounded in their high ranking according to the latest Journal Citation Reports, positioning them as leading publications in photonics and optics. The hypothesis underpinning this choice is that top-tier journals typically maintain stringent language standards, making their discourses ideal for teaching academic language in research paper writing. The decision to include abstracts from three journals, rather than just one, is to prevent the inclusion of journal-specific language styles. Although there is no clear evidence of journal-specific lexical bundle usage, this precautionary measure ensures a more robust and varied linguistic foundation for the study. The corpus covers publications from 2020 to 2024, with a focus on abstracts from 2020 onwards. This timeframe was chosen due to the dynamic nature of academic discourse, especially in lexical bundle usage, as noted by Hyland and Jiang (2018). Concentrating on recent discourses ensures that the study remains highly relevant to the current academic context, thereby aiding learners in effectively applying these lexical bundles in their research publications. The moderate variation in the number of abstracts from each journal reflects the differing publication outputs during this period. Consequently, the corpus comprises a total of 73,378 tokens, averaging 183.5 words per text. The moderate size of the corpus aligns with the objective of this study to propose a rapid and straightforward method for creating a teaching-oriented phrase list. The rationale behind this decision is that compiling and analyzing larger corpora can be considerably time-consuming, which might detract from the efficiency of the approach. This corpus size strikes a balance between representativeness and manageability, facilitating timely and effective analysis for educational purposes.

Table 1. Overview of the compiled corpus

	Nature Photonics	*Opto-Electronic Advances*	*PhotonIX*
Total number of analyzed texts	150	140	110
Publication year span	2020 to 2024		
Field of study for abstracts	Photonics and optics		
Average word count per text	183.5		
Aggregate token count	73,378		

2.2 Data Analysis

Wordsmith Tools 9.0 (Scott, 2024) was utilized to extract four-word lexical bundles from the corpus, applying a frequency threshold of 40 occurrences per million words (pmw) in a minimum of three different abstracts. The focus on four-word bundles is based on their prominence in lexical bundle research, as they present a broader range of

structures and functions for analysis (Hyland and Jiang, 2018). Additionally, these bundles are less numerous than two- and three-word combinations, aligning with the study's aim to identify commonly used phrases for straightforward and rapid retrieval and analysis. The chosen frequency threshold further supports this goal, as bundles falling below this threshold are more numerous and less frequent. The decision to set the dispersion criterion at three distinct abstracts is in line with Bao and Liu's (2022, 2023) observations, which highlight the significance of dispersion in lexical bundle research involving abstracts, typically very short texts. Moreover, a dispersion rate of three effectively filters out author-specific bundles, ensuring that the identified items are used by at least three different authors in these prestigious journals. This approach enhances the likelihood that the lexical bundles represent commonly accepted and utilized expressions within the discourse community, thereby underlining their pedagogical value. This methodology resulted in the identification of 171 lexical bundles.

The 171 lexical bundles identified initially underwent meticulous manual analysis to select only those with significant pedagogical value. My first step was to exclude bundles primarily associated with specific research topics or technical terminologies, such as *complementary metal oxide semiconductor*, *organic light emitting diodes*, and *laser induced periodic surface*. The rationale behind this exclusion was their limited instructional relevance, given their minimal direct connection to general academic English usage. In addition, bundles pertaining to numerical expressions, denoted as # in Wordsmith Tools (for instance, *from # to #* and *from # nm to*), were also omitted. This exclusion stemmed from the perception that these expressions are fundamental and uncomplicated, thus unlikely to pose substantial learning challenges for graduate students. To refine the selection further, I collaborated with a linguistics MA graduate for an independent evaluation of the remaining bundles' pedagogical value. We based our assessment on a focused question: "As an instructor of a graduate-level academic English writing course, do you consider this expression to be of educational value to students?" To measure the consistency of our assessments, I applied Cohen's Kappa coefficient, achieving a score of 0.77. This score indicates a substantial level of inter-coder agreement, as categorized by Landis and Koch (1977). Following this collaborative evaluation, I finalized a list comprising 65 lexical bundles. Each of these bundles was unanimously recognized by both evaluators as possessing considerable pedagogical value, ensuring their suitability for inclusion in academic English writing courses.

Table 2. Swales and Feak's five-move model

Rhetorical move	Communicative purpose
Background	Establishing background or context
Goal	Outlining research goals or objectives
Method	Describing methodology, materials, participants, and procedures
Result	Displaying results or findings
Conclusion	Discussing conclusions and implications

I then utilized Swales and Feak's (2009) five-move model (refer to Table 2) to determine the communicative purposes of the lexical bundles. This model deconstructs a standard abstract into five rhetorical moves, each with its unique yet interconnected communicative purpose. It provides a comprehensive framework for both the creation and dissection of abstracts, enabling authors to present the essential components of their research in a concise and coherent manner, which enhances not only the readability but also the overall impact of their work. The model is particularly valuable for researchers, offering a clear guide to the genre-specific conventions they must navigate. It delineates the structure and progression of ideas, helping researchers to effectively communicate their findings and scholarly contributions. Furthermore, this model is highly beneficial for instructors of academic English, as it aligns with move-based instructional approaches commonly used in teaching abstract writing. It aids instructors in systematically guiding students through the typical language and structures used in each part of an abstract. By utilizing this model to identify communicative purposes, the study aligns academic writing instruction with practical language application. This approach ensures that students not only learn the mechanics of writing but also understand how to apply these skills in real-world academic contexts, thereby enhancing their ability to communicate effectively and persuasively in their respective academic disciplines. This integration of theory and practice in language instruction is pivotal in preparing students for the demands of academic discourse and publication.

In determining the communicative purposes of lexical bundles, my methodology was guided by Biber et al.'s (2007) bottom-up approach, which emphasizes analyzing linguistic features before considering the communicative functions

of texts. This approach was complemented by Li et al.'s (2020, p. 87) bundle-driven methodology, where "the generation of bundles came first," and the rhetorical moves in abstracts "emerged from the classification of the generated bundles." Additionally, the strategy incorporated insights from Bao and Liu's (2023) research, which, while anchored in the five-move model, extends the identification of communicative purposes beyond this framework. For example, their analysis of the background move revealed that certain bundles, such as *the importance of*, predominantly articulate research significance, thereby contributing to the overarching aim of setting the research context. This layered approach allowed for a more detailed and contextually relevant understanding of the relationship between lexical bundles and their communicative functions. It provided a deeper insight into how these bundles are employed to construct meaningful and coherent academic narratives. Consequently, this enriched perspective enables learners to utilize these lexical bundles in their writing with greater effectiveness and adaptability, fostering a more sophisticated and versatile academic writing style.

3. Results and Discussion

Table 3 categorizes the identified lexical bundles by their communicative roles within the established five-move model, providing a clear illustration of how these bundles function in various segments of academic writing. Among the 65 lexical bundles deemed pedagogically valuable, 11 are chiefly utilized in introducing research background or context, 26 in stating research objectives, three in describing methodology, four in presenting research findings, and 21 in discussing conclusions and implications of the research. This distribution indicates a prominent trend: the language for articulating research objectives tends to be the most formulaic across the five moves, suggesting a certain level of standardization in conveying these elements. In contrast, language used for methodology descriptions is less formulaic, pointing to a more varied approach in this aspect of academic writing. Such a variation in formulaic usage across different rhetorical sections underscores the nuanced nature of academic discourse in the field of photonics. This observation is consistent with wider trends in lexical bundle research. For instance, Bao and Liu's (2023) analysis of dissertation abstracts in linguistics and Li et al.'s (2020) study in the arts and humanities both highlight a similar reliance on formulaic language, especially in stating research objectives. These patterns, evident across diverse disciplines, suggest a fundamental trait in academic writing: certain rhetorical elements, such as stating objectives, frequently follow established linguistic formulas. This trend provides a crucial insight for educators, emphasizing the importance of familiarizing students with these commonly used expressions. Such knowledge is instrumental in enhancing students' ability to navigate and communicate effectively within the academic sphere. The consistency in the use of formulaic language for specific rhetorical moves, especially in goal statements, implies a shared approach in academic writing across fields. This uniformity underscores the value of teaching these structures in academic writing courses, providing students with the tools necessary to meet the expectations of academic discourse. Conversely, the greater diversity observed in language used for describing methodologies offers an opportunity for students to explore more varied expressions, enriching their academic writing skills and flexibility. The organization of lexical bundles in Table 3 aids in understanding their specific functions within academic texts and reflects broader patterns in academic writing. These insights are invaluable for both interpreting disciplinary discourses and for informing strategies in academic writing instruction, highlighting the significance of equipping students with a repertoire of standard expressions to facilitate their effective participation in academic dialogue across various fields.

Table 3. Lexical bundles categorized by their communicative purposes

Rhetorical move	Communicative purpose	Lexical bundle
Background	Establishing background or context	has emerged as a, however due to the, due to the lack, has been made in, progress has been made, an important role in, at the core of, attention due to the, due to the limited, over the past decade, significant progress has been
Goal	Outlining research goals or objectives	here we report a, here we propose a, here we demonstrate a, here we present a, here we report the, here we develop a, here we show that, we propose and demonstrate, here we introduce a, this paper we propose, here we demonstrate that, here we propose and, here we report an, we report a new, an experimental demonstration of, here we demonstrate an, here we experimentally demonstrate, here we introduce an, here we present an, here we report on, here we review the, we demonstrate a novel, we propose a novel, we propose a simple, we propose and experimentally, we review the recent
Method	Describing methodology, materials, participants, and procedures	state of the art, with the help of, with the use of
Result	Displaying results or findings	results show that the, we find that the, as a result the, experimental results show that
Conclusion	Discussing conclusions and implications	paves the way for, can be applied to, pave the way for, this work provides a, expected to be applied, our work provides a, various applications such as, for the first time, best of our knowledge, work paves the way, be applied to other, can be extended to, demonstrate the feasibility of, demonstrate the potential of, has the potential to, paves the way to, results pave the way, up new avenues to, we are able to, work provides a new, work provides a novel, this is the first

Note: Within each category of communicative function, the lexical bundles are ordered according to their frequency in the corpus; those occurring more frequently are listed prior to those with lesser frequency.

In the background move of the abstracts, lexical bundles such as *has emerged as a*, *at the core of*, and *an important role in* are typically employed to highlight the significance of the research field (see Example 1). These lexical bundles often appear in the opening sentences of the sample abstracts, where they serve to outline the overarching technological context upon which the study is predicated. This usage effectively sets the stage for the research by underscoring its foundational relevance and situating it within a broader scientific or technological framework. Furthermore, bundles such as *significant progress has been*, *progress has been made*, and *has been made in* are utilized to convey advancements in the field. This assertion of progress often precedes the use of bundles like *however due to the*, *due to the lack*, *attention due to the*, and *due to the limited*. These latter bundles serve a critical function: They highlight existing research gaps or limitations despite acknowledged progress, thereby justifying the need for the authors' research. This rhetorical strategy not only contextualizes the study within its field but also delineates its specific contribution in addressing these identified gaps.

(1) *Recently, ultrafast laser-induced self-organization engineering* ***has emerged as a*** *promising rapid prototyping platform that opens up facile and universal approaches for constructing various advanced nanophotonic elements and attracted tremendous attention all over the world.*

In the goal move, bundles like *here we report a*, *we report a new*, *here we propose a*, and *here we demonstrate a* are commonly used to introduce the primary aim or innovative aspect of the research (Example 2). These expressions typically appear at the beginning of the abstract, quickly orienting the reader to the study's intent. Similarly, *here we present a* and *here we develop a* indicate the introduction of new methodologies or findings. Expressions such as *here we show that* and *we propose and demonstrate* emphasize the study's objective and the subsequent validation of

proposed theories or methods (Example 3). Bundles such as *here we introduce a* and *this paper we propose* often herald new perspectives or approaches within the research. Further, *an experimental demonstration of* underscore significant discoveries, particularly emphasizing their practical or experimental nature, and *here we experimentally demonstrate* and *here we introduce an* highlight the hands-on, empirical approach of the research (Example 4). Overall, these lexical bundles are crucial in clearly and concisely delineating the research objectives, guiding the reader through the intended goals, and underscoring the study's contribution to the field. Their strategic placement and consistent usage across various abstracts reflect the standardized nature of communicating research aims in academic discourse.

(2) ***Here we report a*** *multifunctional, non-volatile additive that can be used to modulate the kinetics of perovskite film growth through a hydrogen-bond-bridged intermediate phase.*

(3) *In this work,* ***we propose and demonstrate*** *a fully connected QKD network without trusted node for a large number of users.*

(4) ***Here we experimentally demonstrate*** *a spatial-temporal-multiplexed ONN system that simultaneously overcomes all these challenges.*

In the presentation of results or findings, certain lexical bundles are consistently used to effectively convey the outcomes of the study. Bundles like *results show that the* and *we find that the* are pivotal in directly presenting key findings. These bundles serve to transition the reader from the theoretical or methodological aspects of the paper to its empirical outcomes, clearly stating the significant results uncovered by the research. Similarly, *as a result the* is another commonly used expression that links the research methods or approaches directly to their outcomes. It acts as a connector, seamlessly integrating the cause-and-effect relationship between the research process and its findings. *Experimental results show that* is particularly used in studies with a strong empirical component (Example 6). This phrase underscores the evidence-based nature of the findings, highlighting that the results are not merely theoretical but are backed by experimental data. These lexical bundles play a critical role in structuring the abstract and ensuring clarity in the communication of research findings. By consistently employing these specific phrases, authors effectively guide readers through their research narrative, from objectives and methodology to conclusive evidence and results. This standardized approach in presenting results enhances the comprehensibility and impact of academic writing, particularly in conveying complex scientific or technical information succinctly.

(5) ***We find that the*** *disordered beginning of the perovskite film growth deteriorates the buried interface.*

(6) ***Experimental results show that*** *the sensitivity and the figure of merit of the tip hot spot enhanced fiber NMF-CPR sensor can achieve up to 2995.70 nm/RIU and 25.04 RIU−1, respectively, which are 1.68 times and 1.29 times higher than those of the conventional fiber plasmonic resonance sensor.*

When discussing conclusions and implications, various lexical bundles are employed to articulate the significance and future applications of the research findings. Expressions such as *paves the way for*, *pave the way for*, and *results pave the way* are often used to suggest that the study opens up new possibilities or directions for future research (Example 7). They indicate that the research has laid a foundation upon which further advancements can be built. Bundles like *can be applied to* and *expected to be applied* highlight the practical applicability of the research findings in various fields or scenarios. This usage emphasizes the versatility and potential real-world impact of the study. Bundles such as *this work provides a*, *our work provides a*, and *work provides a new* underscore the contribution of the research in offering fresh perspectives or solutions (Example 8). When authors use *various applications such as*, they specifically point out the diverse areas where the research can be beneficial. *For the first time* and *best of our knowledge* are used to denote groundbreaking or novel aspects of the research, suggesting that the study has ventured into previously unexplored or little-understood territories. *Can be extended to* and *demonstrate the feasibility of* imply that the findings have broader implications or can be adapted for use in other contexts. Bundles like *has the potential to* convey the future promise of the research, indicating its capacity to influence subsequent studies or applications. *(Open) up new avenues to*, *we are able to*, and *work provides a novel* also suggest new opportunities or methodologies introduced by the research. Finally, *this is the first* typically prefaces a claim about the study's unique contribution to its field, establishing its novelty and significance (Example 9). Overall, these lexical bundles serve as key tools for authors to effectively communicate the broader impact, potential applications, and innovative nature of their research, thereby framing their work within the larger context of ongoing scholarly discourse.

(7) *Our work* ***paves the way for*** *experimentally exploring the fundamental problems of quantum theory in the formulation of path integrals.*

(8) ***This work provides a*** *novel insight into the SERS substrate design based on CM and is expected to be applied to other two-dimensional materials.*

(9) *To our knowledge,* ***this is the first*** *reported practical dynamic interactive metasurface holographic system.*

4. Conclusion and Implications

In conclusion, this study has successfully formulated a specialized list of lexical bundles, derived from the most recent and impactful publications in the field of photonics. This list stands out for several reasons, each contributing to its high pedagogical value in academic English writing courses, particularly at the graduate level.

Firstly, the simplicity and rapidity of the list's development process are noteworthy. By employing efficient corpus analysis tools and a targeted selection methodology, the study has streamlined the traditionally time-consuming process of compiling lexical bundles. This efficiency makes the approach highly practical for educators looking to quickly adapt their teaching materials to the latest academic trends. Secondly, the list's utility in teaching and learning is significantly enhanced by the clear connection it draws between lexical bundles and their communicative purposes. By categorizing these bundles according to their function within the established five-move model, the study provides instructors and learners with a clear and structured approach to understanding how specific phrases contribute to the coherence and persuasiveness of academic writing. Thirdly, the discipline-specific nature of the list, which focuses exclusively on top-tier journals in photonics and optics, ensures that the lexical bundles are directly relevant and applicable to students in this field. This specificity ensures that students are learning language that is not only academically rigorous but also directly pertinent to their area of study. Furthermore, the study's approach in selecting recent articles for corpus compilation means that the resulting list is up-to-date with current academic discourse. This relevance is crucial in a field that is rapidly evolving, ensuring that students are equipped with the latest linguistic tools to effectively communicate their research. Additionally, the study addresses the challenge of teaching academic writing by providing a resource that is not only academically sound but also practical in application. The list can serve as a foundation for various instructional activities, from guided writing exercises to more advanced tasks like editing and revising academic texts.

These findings underscore the necessity of acquainting students with these commonly used expressions, which is crucial for enhancing their proficiency in academic communication. By understanding and employing these formulaic structures, students can better navigate the conventions of academic writing across various fields. This approach not only aids in their immediate academic success but also equips them with the skills to effectively engage in scholarly discourse, fostering a deeper connection with the academic community and enhancing their ability to communicate complex ideas more clearly and effectively.

This study has certain limitations that must be acknowledged. Firstly, its focus is exclusively on the field of photonics, which might limit its applicability in academic English classes that cater to a diverse range of majors. Students from other disciplines may not find the lexical bundles derived from photonics research articles as directly relevant to their specific academic needs. As a result, the utility of the study could be enhanced by expanding its scope to include lexical bundles from a broader range of disciplines, thereby catering to a more diverse student body. Secondly, the study's concentration on research article abstracts, while valuable, overlooks the lexical nuances present in dissertation abstracts. Empirical evidence suggests considerable differences between the language used in research articles and that in dissertations (El-Dakhs, 2018). This oversight might limit the study's applicability for students who are primarily engaged in writing dissertations, which often have distinct stylistic and structural requirements.

In light of these limitations, future research should consider extending the analysis to encompass a wider array of disciplines, thereby increasing the relevance and applicability of the findings for a broader range of academic fields. Additionally, comparative studies involving both research article abstracts and dissertation abstracts would provide a more comprehensive understanding of lexical bundle usage across different types of academic writing. This expansion would not only address the noted limitations but also enrich the pedagogical tools available for teaching academic English writing across various contexts.

Acknowledgements

I sincerely thank the editor and anonymous reviewer for their constructive feedback.

Authors' contributions

As the sole author of this study, I, Kai Bao, was responsible for all aspects of the research paper, including the conception and design of the study, data collection, analysis, and interpretation, drafting the manuscript, and critically revising it for important intellectual content. I also read and approved the final manuscript to be published.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interests

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of Sciedu Press.

The journal and publisher adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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