

Scientific Research Writing Challenges among Saudi and International STEM Postgraduate Students at a Research-Intensive University in Saudi Arabia

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Abstract: *Scientific research writing presents significant challenges for postgraduate STEM students, requiring the integration of linguistic, rhetorical, analytical and disciplinary skills. However, limited research has examined the perceived scientific research-writing challenges of both Saudi and international postgraduate STEM students at research-intensive universities in Saudi Arabia. This study investigated these challenges and students' preferred forms of writing support. A questionnaire incorporating quantitative and qualitative elements was completed by 40 postgraduate STEM students, with equal numbers of Saudi and international participants and Master's and PhD students. The greatest perceived challenges were synthesising literature, identifying and articulating a research gap, writing the Discussion section and developing a coherent scientific argument. Master's students generally reported greater difficulty than PhD students in these higher-order areas, while Saudi and international students showed broadly similar patterns. Participants expressed strong demand for targeted writing support and individual consultations and 72.5% reported using generative AI tools. The findings highlight the need for developmental, research-focused provision addressing higher-order scientific-writing practices alongside linguistic support.*

Keywords: scientific research writing, postgraduate STEM students, academic writing challenges, research gap, scientific writing support, Saudi Arabia

INTRODUCTION

Scientific research writing is a fundamental component of postgraduate education in science, technology, engineering and mathematics (STEM). Postgraduate students are expected not only to develop disciplinary knowledge and conduct rigorous research, but also to communicate their work effectively through research papers, theses, conference submissions and other forms of scientific communication. The ability to present complex ideas clearly, organise information logically and position research within existing literature is therefore an important part of developing as an independent researcher. Effective scientific writing can also play an important role in thesis completion, publication and the wider dissemination of research findings (Lin & Morrison, 2021).

For many postgraduate students, however, developing scientific research-writing skills can be challenging. Scientific writing requires considerably more than grammatical accuracy or knowledge of academic vocabulary. Students must learn how to structure different sections of a research paper, synthesise information from multiple sources, establish a clear research rationale, describe methods accurately, present findings effectively and interpret those findings in relation to previous research (Chien & Li, 2022; Shahsavari & Kourepaz, 2020). They are also expected to write with clarity and precision, use sources appropriately and respond effectively to feedback from supervisors and other academic readers. While some of these difficulties may be associated with writing in an additional language, English-language proficiency alone may not account for the challenges students experience. Even students with relatively high levels of English proficiency may encounter difficulties when developing the specialised rhetorical and disciplinary practices required for scientific research writing (Lin & Morrison, 2021; Shahsavari & Kourepaz, 2020).

These challenges are particularly relevant in international research-intensive universities, where postgraduate cohorts may include students from a wide range of linguistic, educational and disciplinary backgrounds. The present study is situated within a research-intensive university in Saudi Arabia that provides an international, English-medium environment for postgraduate STEM education. Its postgraduate population includes both Saudi and international Master's and PhD students from diverse academic and linguistic backgrounds. Students engage extensively with scientific literature and are expected to communicate their research in English throughout their postgraduate studies. This diverse educational environment therefore provides a valuable context in which to examine the research-writing challenges experienced by postgraduate STEM researchers. The study is also situated within the wider context of Saudi Vision 2030, which emphasises investment in education, human capability development, future skills and innovation as part of the Kingdom's efforts to develop globally competitive capabilities and support its continuing economic and social transformation (Human Capability Development Program, 2021).

Although academic writing challenges among university students have been widely investigated, there appears to be limited research specifically examining the perceived scientific research-writing challenges of both Saudi and international postgraduate STEM students within highly international, English-medium, research-intensive universities in Saudi Arabia. Existing research has identified a range of academic and research-writing difficulties among postgraduate students, including challenges associated with language, organisation, argumentation, disciplinary conventions and research-article genres (Al Fadda, 2012; Alharbi, 2021; Al Mahmud & ur Rahman, 2023; Lin & Morrison, 2021). However, these studies have often examined academic writing more broadly or focused on particular linguistic groups, disciplines or educational contexts. Consequently, less is known about how a diverse population of Saudi and international STEM postgraduate students within the same research-intensive Saudi university perceives the specific challenges involved in producing scientific research writing. Understanding these experiences can provide context-specific evidence about the aspects of scientific writing that students find most challenging and the support they consider most useful.

The present study therefore investigates the scientific research-writing challenges experienced by Saudi and international postgraduate STEM students at a research-intensive university in Saudi Arabia. It considers a range of writing-related areas, including research-paper organisation, literature synthesis, argument development, writing individual sections of a scientific paper, academic and scientific

language, clarity and concision, source integration and responding to feedback. The study also considers the forms of support students perceive as useful for developing their scientific writing. By identifying these challenges within an international, research-intensive STEM environment, the study aims to contribute to a better understanding of postgraduate scientific writing needs and provide practical insights that may inform the design and delivery of targeted academic writing support.

The study addresses the following research questions:

1. What aspects of scientific research writing do STEM postgraduate students find most challenging?
2. How do perceived scientific research-writing challenges vary between Saudi and international students and between Master's and PhD students?
3. What types of support do students consider most useful for improving their scientific research writing?

2. Literature Review and Theoretical Underpinning

2.1 Scientific Research Writing in Postgraduate STEM Education

Scientific research writing is a central component of postgraduate STEM education, enabling researchers to communicate findings, participate in disciplinary communities and contribute to the development of knowledge. At postgraduate level, students are required to engage with increasingly specialised forms of writing, including research articles, theses, conference papers and research proposals. These forms of communication require more than general academic writing proficiency. Postgraduate researchers must learn to present complex scientific information accurately and concisely while also demonstrating an understanding of the rhetorical and organisational conventions expected within their disciplines (Hyland, 2012; Swales, 2004). More recent research has similarly emphasised that effective STEM writing involves multiple dimensions of quality and that expectations surrounding scientific communication can vary across disciplinary contexts (Grady et al., 2022).

Scientific writing can therefore be understood as a disciplinary practice rather than simply a set of transferable language skills. Different academic disciplines develop particular ways of presenting evidence, constructing arguments and communicating with specialist audiences. Research genres also contain recognisable rhetorical structures that help writers establish the significance of their work, position it in relation to previous research and communicate their contribution to a disciplinary community (Hyland, 2012; Swales, 2004). Contemporary research into STEM writing continues to highlight the importance of developing writing within disciplinary contexts rather than treating academic writing as a generic skill separate from students' research practices (Grady et al., 2022).

For postgraduate STEM students, developing an awareness of these conventions is particularly important as they move from being primarily consumers of scientific knowledge towards becoming researchers expected to produce and disseminate knowledge themselves. The transition can nevertheless be demanding. Students may enter STEM postgraduate programmes with strong technical and disciplinary knowledge while having had relatively limited formal preparation for the specialised

writing expected in research environments. Lin and Morrison (2021), for example, found that postgraduate Engineering students experienced a range of academic writing difficulties and that students' perceptions of these difficulties did not always correspond with those of their faculty. While students were more concerned with sentence-level language features, faculty placed greater emphasis on discourse-level issues such as organisation and the development of ideas. Such findings suggest that competence in scientific research writing involves both linguistic control and an understanding of broader rhetorical and disciplinary expectations.

Consequently, the development of scientific writing should be viewed as an important part of postgraduate researcher development rather than as a remedial activity intended only for students with language difficulties. Understanding how postgraduate STEM students themselves perceive the demands of scientific writing is therefore important for identifying areas in which additional guidance, instruction and institutional support may be required.

Challenges in Postgraduate Scientific Research Writing

Postgraduate students can encounter difficulties at multiple levels of scientific research writing, ranging from sentence-level language choices to the organisation and development of an entire research paper. These challenges may include using appropriate academic and technical vocabulary, constructing clear and concise sentences, organising information coherently, developing arguments, synthesising previous research and following the rhetorical conventions associated with particular research genres. The complexity of these demands means that successful research writing requires students to coordinate linguistic, rhetorical and disciplinary knowledge rather than simply demonstrate grammatical accuracy (Alharbi, 2021; Lin & Morrison, 2021).

One important challenge concerns the distinction between local, sentence-level difficulties and broader discourse-level problems. Lin and Morrison (2021), in their study of 82 postgraduate Engineering students and 24 faculty members across three English-medium universities in Hong Kong, found differences between students' and faculty members' perceptions of academic writing difficulties. Students tended to be more concerned about sentence-level language features, whereas faculty placed greater emphasis on discourse-level issues. This distinction is significant because students may devote considerable attention to grammar, vocabulary and individual sentences while experiencing less visible difficulties with organisation, coherence and the development of ideas. Such findings suggest that students' perceptions of their writing difficulties may not always correspond fully with the expectations of experienced academic readers.

Synthesising and integrating previous research represents another demanding aspect of postgraduate writing. Writing a literature review requires students to move beyond summarising individual studies and instead identify relationships between sources, evaluate previous findings and use the literature to establish a rationale for their own research. Previous research has shown that postgraduate writers may experience particular difficulty in synthesising and critically evaluating literature rather than simply summarising individual studies (Shahsavari & Kourepaz, 2020; Walter & Stouck, 2020). Similarly, developing a convincing academic argument requires writers to connect claims with evidence and position their interpretations appropriately within existing disciplinary knowledge. These higher-level writing practices can be particularly demanding for postgraduate researchers who are simultaneously

developing expertise in their subject area and learning the conventions through which knowledge is communicated within that discipline.

Challenges may also vary across different sections of a scientific research paper. Introductions require writers to establish the context and significance of a study, while Methods and Results sections demand accuracy, clarity and appropriate presentation of procedures and findings. Discussion sections can be especially demanding because writers must interpret their results, relate them to previous literature, explain their significance and acknowledge limitations without overstating their conclusions. Chien and Li (2022), examining doctoral students and their advisors across natural and applied sciences and social sciences, found that students experienced particular difficulties in writing the Discussion section and did not always fully understand its rhetorical purposes. Differences were also identified between students' and advisors' understandings of these difficulties, further demonstrating the complexity of learning discipline-specific research-writing conventions.

Evidence from Saudi Arabia indicates that postgraduate research writers experience similar multidimensional challenges. Al Mahmud and ur Rahman (2023), in a mixed-methods study involving 87 participants at the University of Jeddah, identified difficulties associated with language, argumentation and research-article genre. In particular, presenting complex information clearly and constructing strong arguments emerged as serious challenges, while students also expressed uncertainty regarding literature reviews and technical vocabulary. Their findings are important because they demonstrate that postgraduate writing difficulties within the Saudi context extend beyond grammatical competence and include broader rhetorical and genre-related demands.

Overall, existing research indicates that postgraduate scientific-writing challenges operate at interconnected linguistic, organisational, rhetorical and disciplinary levels. Identifying which of these dimensions students themselves perceive as most difficult is therefore important for understanding their writing needs and determining where targeted academic support may be most beneficial.

Scientific Writing in Multilingual and English-Medium Contexts

The increasing internationalisation of higher education has resulted in growing numbers of postgraduate researchers studying and conducting research through English, including many for whom English is an additional language. In STEM disciplines, where English is widely used for international scholarly communication, postgraduate students are frequently expected to read, write and publish research in English regardless of their linguistic background. For multilingual researchers, scientific writing may therefore involve the simultaneous development of disciplinary expertise, research competence and the ability to communicate specialised knowledge effectively in an additional language.

Research has identified a range of challenges experienced by postgraduate writers using English as an additional language. Hyland (2016), for example, found that second-language doctoral writers experienced particular difficulties in expressing complex ideas in English and in developing confidence and a convincing academic voice. Similarly, Lin and Morrison (2021) showed that L2 postgraduate Engineering students were particularly conscious of sentence-level concerns in their academic writing, including language-related difficulties. Such concerns may require students to

devote considerable attention to vocabulary, grammar and sentence construction while also managing the higher-level rhetorical demands of scientific research writing. This combination of linguistic and rhetorical demands may make the writing process particularly challenging for some multilingual postgraduate researchers.

However, it is important not to interpret postgraduate scientific-writing difficulties solely as deficiencies in English-language proficiency. Research writing involves learning how knowledge is constructed and communicated within particular disciplinary communities and these practices may be unfamiliar even to students with relatively strong general English skills (Hyland, 2012). Challenges such as synthesising literature, constructing an argument, establishing an appropriate research position, interpreting findings and responding to disciplinary expectations cannot necessarily be resolved through improvements in grammar or vocabulary alone. From an academic literacies perspective, writing is therefore understood as a socially and disciplinarily situated practice rather than simply a generic language skill (Lea & Street, 1998).

This distinction is particularly important in English-medium and highly international postgraduate environments. Students entering such universities may have diverse previous educational experiences and different levels of familiarity with English-medium academic conventions. Research on second-language doctoral writers has demonstrated that postgraduate writing development involves both linguistic challenges and the development of an appropriate academic voice, while students may draw on published academic texts, peer networks and other forms of support as they develop as research writers (Hyland, 2016). Consequently, students who appear linguistically proficient may still require support in developing the rhetorical, genre-based and disciplinary dimensions of research writing.

Research focusing specifically on Saudi postgraduate students provides further support for distinguishing research-writing challenges from general English-language proficiency. Alharbi (2021), in a mixed-methods investigation involving 275 Saudi postgraduate questionnaire respondents as well as student and supervisor interviews and analysis of written feedback, identified a range of difficulties experienced by Saudi postgraduates in English academic writing and highlighted the need for more systematic approaches to writing support. More recently, Al Mahmud and ur Rahman (2023) found that Saudi graduate students experienced difficulties not only with language but also with argumentation and research-article genre. Presenting complex information clearly and constructing strong arguments were identified as particularly serious challenges, while students also expressed uncertainty regarding literature reviews and technical vocabulary. These findings suggest that the difficulties experienced by Saudi postgraduate writers extend beyond grammar and sentence-level accuracy to include broader rhetorical, organisational and genre-related aspects of research writing.

Understanding scientific-writing challenges in multilingual environments therefore requires attention to both language-related concerns and the wider practices associated with becoming a member of a research community. Rather than viewing multilingual postgraduate students primarily through a deficit perspective, it is more useful to examine the specific writing demands they encounter and the ways in which linguistic background, previous educational experience and disciplinary expectations may interact. This perspective is particularly relevant to the present study, which examines Saudi and international postgraduate STEM students from diverse linguistic and educational backgrounds within a shared English-medium, research-intensive university environment in Saudi Arabia.

Scientific Writing Support and the Saudi Higher-Education Context

Given the complex linguistic, rhetorical and disciplinary demands of postgraduate research writing, appropriate academic support can play an important role in helping students develop as scientific writers. Such support may take different forms, including supervisor feedback, academic writing courses and workshops, individual consultations, peer review and discipline-specific writing instruction. Rather than treating writing support primarily as a means of correcting grammatical errors, effective provision should help postgraduate researchers develop an understanding of how scientific knowledge is organised, argued and communicated within their disciplines (Chugh et al., 2022; Hey-Cunningham et al., 2021).

Supervisor feedback represents an important source of writing development for postgraduate researchers. Through feedback on students' developing texts, supervisors can provide discipline-specific guidance and help students understand expectations relating to argumentation, organisation, interpretation and academic conventions (Chugh et al., 2022). However, the effectiveness of supervisory feedback can vary, and students also need to develop the ability to understand and act upon the feedback they receive. Hey-Cunningham et al. (2021) emphasise the importance of feedback literacy for both postgraduate researchers and supervisors, demonstrating that writing development involves not only receiving feedback but also learning how to use it effectively. Postgraduate writers may therefore benefit from complementary forms of support, including structured writing instruction, workshops and individual guidance, which provide explicit opportunities to examine research genres, practise writing strategies and receive targeted feedback. This may be particularly important where students enter postgraduate programmes with different levels of previous experience in scientific and academic writing.

Recent approaches to STEM graduate writing support have increasingly recognised the value of embedding writing development within disciplinary and research contexts. Structured writing courses can provide opportunities for students to analyse disciplinary texts, practise research-writing conventions and engage in peer and instructor feedback. For example, Haas & Biteen (2025) describe a professional-development academic writing course for first-year Chemistry graduate students that integrated academic reading and writing, scaffolded writing activities, peer review and structured feedback while students developed an independent research proposal. Such approaches demonstrate how writing development can be integrated into postgraduate STEM education rather than positioned as a separate remedial language activity.

The need for systematic support is also evident within the Saudi postgraduate context. Alharbi (2021) found that Saudi postgraduate students experienced a range of English academic-writing difficulties and proposed a model of support involving students, supervisors and institutions. The study emphasised that responsibility for improving postgraduate writing should not rest solely with individual students but should also involve structured institutional provision. Similarly, evidence of difficulties involving argumentation, research-article genres, technical vocabulary and the communication of complex information among Saudi graduate students (Al Mahmud & ur Rahman, 2023) suggests that targeted support should address higher-level research-writing practices alongside language-related concerns.

Strengthening postgraduate research and communication capabilities also has relevance to the broader development of Saudi higher education. Under Saudi Vision 2030, the Human Capability Development Program places emphasis on improving educational outcomes, developing human capabilities and strengthening innovation and global competitiveness (Human Capability Development Program, 2021). Within this wider national context, developing postgraduate researchers who can communicate scientific knowledge effectively in international academic environments is particularly important. Research-intensive universities can contribute to these objectives not only through scientific and technological research but also by ensuring that postgraduate researchers are equipped to communicate and disseminate their work effectively.

Consequently, understanding the types of scientific-writing support that postgraduate students themselves perceive as useful is important for the development of responsive academic provision. In highly international research environments, a combination of disciplinary guidance, explicit writing instruction, feedback and individualised support may be particularly valuable because students bring diverse linguistic, educational and research experiences. Examining these perceived support needs alongside students' reported writing challenges can therefore provide a stronger basis for designing targeted scientific-writing provision in postgraduate STEM contexts.

Synthesis of the Literature and Research Gap

The literature reviewed above demonstrates that scientific research writing is a complex component of postgraduate STEM education that requires the integration of linguistic, rhetorical, genre-based and disciplinary knowledge. Existing research has identified challenges relating to language use, organisation, argumentation, literature synthesis, disciplinary conventions and the writing of particular sections of research papers (Al Mahmud & ur Rahman, 2023; Chien & Li, 2022; Lin & Morrison, 2021; Shahsavari & Kourepaz, 2020). Research also indicates that these difficulties should not be understood solely in terms of English-language proficiency, since postgraduate researchers must learn how knowledge is constructed and communicated within their disciplinary communities (Hyland, 2012; Lin & Morrison, 2021). For multilingual students, these demands may interact with additional linguistic and educational experiences, further increasing the complexity of research writing.

Previous studies have also highlighted the importance of supervisor feedback, explicit writing instruction and structured institutional support in developing postgraduate academic and scientific writing (Alharbi, 2021; Chugh et al., 2022; Hey-Cunningham et al., 2021; Haas & Bitten, 2025). However, despite increasing attention to postgraduate academic writing internationally and some research examining the writing experiences of Saudi postgraduate students, there appears to be limited research specifically investigating the perceived scientific research-writing challenges of both Saudi and international postgraduate STEM students within an international, English-medium, research-intensive university in Saudi Arabia.

The present study addresses this gap by examining the scientific research-writing challenges reported by Saudi and international Master's and PhD STEM students at a research-intensive university in Saudi Arabia. In addition to identifying the aspects of scientific writing that students perceive as most challenging, the study considers factors associated with these difficulties and the forms of academic support students perceive as most useful. In doing so, it seeks to provide context-specific evidence that

can inform the development of targeted scientific-writing support within postgraduate STEM education.

METHODOLOGY

Research Design

This study adopted a questionnaire-based research design with quantitative and qualitative elements to investigate the scientific research-writing challenges perceived by postgraduate STEM students at a research-intensive university in Saudi Arabia. The quantitative component consisted of structured questionnaire items designed to identify and compare the aspects of scientific research writing that students perceived as most challenging. A small qualitative component was included through open-ended questions, allowing participants to describe their individual writing difficulties and the forms of support they considered most beneficial.

This design was selected because it enabled data to be collected from postgraduate students across different STEM disciplines, degree levels and linguistic backgrounds in a relatively efficient and consistent manner. The combination of closed and open-ended questions also allowed broad patterns in students' perceptions to be identified while providing additional explanatory insights into their reported experiences. The study therefore used quantitative and qualitative questionnaire data to develop a more comprehensive understanding of postgraduate scientific research-writing challenges within an international, English-medium, research-intensive university context in Saudi Arabia.

Research Context and Participants

The study was conducted at a research-intensive university in Saudi Arabia offering postgraduate education across science, technology, engineering and mathematics (STEM) disciplines. English is the primary language of academic and research communication, and the postgraduate population includes both Saudi and international students from diverse linguistic, educational and disciplinary backgrounds. This setting provided an appropriate context for investigating perceptions of scientific research writing among postgraduate STEM students.

Participants were 40 Master's and PhD students enrolled in STEM programmes at the participating university. The sample included students from a range of disciplinary areas, including biological and environmental sciences, physical sciences, engineering, computer and data science, mathematics, and related fields. Students at different stages of their postgraduate studies were represented, providing perspectives from participants with varying levels of experience in scientific research writing.

A total of 40 postgraduate students completed the questionnaire. Of these, 20 (50%) were Saudi students and 20 (50%) were international students. The sample was also equally distributed by degree level, with 20 Master's students (50%) and 20 PhD students (50%). The nationality and degree-level categories overlapped; therefore, Saudi and international participants were represented across both Master's and PhD programmes. In terms of linguistic background, 10 participants (25%) reported English as their first language, while 30 (75%) reported English as an additional language. This diversity enabled the study to examine scientific research-writing challenges across a heterogeneous

postgraduate STEM population rather than focusing on a single disciplinary, degree-level or linguistic group.

Research Instrument

Data were collected using a structured 15-question questionnaire designed specifically for this study to investigate postgraduate students' perceived challenges in scientific research writing. The questionnaire was developed in relation to the study's three research questions and informed by previous research on postgraduate academic and scientific writing challenges (Al Mahmud & ur Rahman, 2023; Chien & Li, 2022; Lin & Morrison, 2021; Shahsavar & Kourepaz, 2020). It contained a combination of multiple-choice questions, five-point Likert-scale items, multiple-response questions and two open-ended questions.

The questionnaire was organised into three main areas. The first collected background information, including participants' degree level, broad STEM disciplinary area, Saudi or international status, and whether English was their first language. These questions provided demographic information about the sample and enabled patterns in responses across different participant groups to be explored.

The second and main part of the questionnaire focused on students' experiences of scientific research writing. Participants rated their overall confidence in writing scientific research in English and indicated the level of difficulty they experienced across a range of writing tasks. These included organising and structuring a research paper, writing introductions, reviewing and synthesising literature, developing an argument, writing Methods, Results and Discussion sections, using appropriate academic and scientific vocabulary, writing clearly and concisely, grammar and sentence structure, paraphrasing, integrating sources, and referencing. Participants were also asked to identify the three aspects of scientific research writing they found most challenging and to indicate the extent to which language-related difficulties affected their writing.

The third area examined the forms of support and resources students used or considered useful for developing their scientific writing. Items included supervisor feedback, academic writing courses and workshops, individual writing support, peer feedback, published research articles, online resources, grammar and writing tools, and generative artificial intelligence tools such as ChatGPT. Participants were also asked to identify the areas in which they would most value additional support.

Most evaluative items used a five-point Likert scale, ranging from low to high levels of confidence, difficulty or challenge as appropriate to the individual question. Two open-ended questions at the end of the questionnaire invited participants to describe their greatest personal challenge when writing scientific research in English and the type of support they believed would most help them improve their scientific writing. These responses provided a small qualitative element that complemented the quantitative questionnaire data and allowed students to identify experiences or concerns that may not have been fully captured by the predetermined response categories.

Prior to the main data collection, the questionnaire was piloted with five postgraduate STEM students to assess the clarity, relevance and comprehensibility of the questionnaire items and response options. Feedback from the pilot participants was used to identify any ambiguous wording and to ensure that

the questionnaire could be completed within a reasonable period of time. Minor adjustments to wording and presentation were made where necessary before the questionnaire was distributed to the main study participants. Responses from the pilot participants were not included in the final dataset.

Data Collection

Following completion of the pilot study and finalisation of the questionnaire, data were collected electronically from postgraduate STEM students at the participating university over a three-week period. The questionnaire was administered using an online survey platform, allowing participants to complete it at a time convenient to them. An introductory statement explained the purpose of the study, the voluntary nature of participation and how the responses would be used.

The questionnaire was circulated to Master's and PhD students across a range of STEM disciplines. Recruitment sought balanced representation of Saudi and international students and of Master's and PhD students. Participation was voluntary, and no personally identifying information was requested. Students were informed that their responses would remain anonymous and would be analysed and reported only for research purposes.

A total of 40 complete and eligible responses were collected. The final sample comprised 20 Saudi students (50%) and 20 international students (50%), with 20 Master's students (50%) and 20 PhD students (50%). Only complete questionnaire responses were included in the final analysis.

Data Analysis

The questionnaire data were analysed using a combination of quantitative and qualitative procedures. Quantitative responses were first reviewed and organised according to the three research questions. Descriptive statistics, including frequencies, percentages and mean scores, were calculated to identify overall patterns in students' perceptions of scientific research-writing challenges and support needs.

Responses to the five-point Likert-scale items were assigned numerical values from 1 to 5. For items measuring the level of challenge, higher mean scores indicated greater perceived difficulty. Mean scores were calculated for each scientific research-writing area, including research-paper organisation, literature synthesis, argument development, writing individual sections of a research paper, academic and scientific language, clarity and concision, grammar, source integration and referencing. These scores were then ranked to identify the aspects of scientific research writing that participants perceived as most and least challenging.

Responses were also examined according to participant characteristics. Descriptive comparisons were made between Saudi and international students and between Master's and PhD students to explore whether noticeable differences emerged in their perceptions of scientific research-writing challenges. Given the exploratory design and relatively small sample size, these comparisons were interpreted cautiously and were used primarily to identify patterns within the sample rather than to make broader generalisations about postgraduate STEM populations.

The two open-ended questionnaire questions were analysed thematically. Responses were read repeatedly and coded according to recurring ideas relating to students' principal scientific research-writing challenges and their preferred forms of academic support. Similar codes were grouped into broader themes, and the frequency with which common themes appeared was also considered. Selected participant comments were used, where appropriate, to illustrate and provide additional context for patterns identified in the quantitative findings.

Finally, the quantitative and qualitative findings were considered together during interpretation. The open-ended responses were used primarily to explain and elaborate on patterns emerging from the numerical data, providing a more detailed understanding of the scientific research-writing challenges and support needs reported by postgraduate STEM students at the participating university.

Ethical Considerations

Ethical considerations were taken into account throughout the study. Participation was voluntary, and students were provided with information about the purpose of the research before completing the questionnaire. They were informed that they could choose whether or not to participate and that participation or non-participation would have no effect on their academic studies, assessment or access to academic support.

The questionnaire was anonymous and did not request participants' names, student identification numbers, email addresses or other directly identifying information. Responses were used solely for research purposes and reported in aggregate form. Where comments from the open-ended questions were used to illustrate findings, these were presented anonymously and without information that could reasonably identify individual participants.

Questionnaire data were stored securely and were accessible only for the purposes of the study. Before submitting their responses, participants were informed of the voluntary and anonymous nature of the research. Voluntary completion and submission of the questionnaire indicated consent to participate. These procedures were intended to protect participant anonymity and privacy and to minimise any potential risk associated with participation.

RESULTS/FINDINGS

Participant Profile

A total of 40 postgraduate STEM students participated in the study. The sample was equally divided by student status, with 20 Saudi students (50%) and 20 international students (50%). There was also equal representation across degree levels, comprising 20 Master's students (50%) and 20 PhD students (50%).

Participants represented a range of STEM disciplinary areas. Engineering constituted the largest group, with 11 participants (27.5%), followed by Biological and Environmental Sciences with 9 (22.5%), Computer and Data Science with 8 (20.0%), Physical Sciences with 7 (17.5%), and Mathematics and

Applied Mathematics with 5 (12.5%). The distribution therefore provided representation across several STEM disciplinary areas rather than concentrating the sample within a single field.

In terms of linguistic background, 10 participants (25%) reported English as their first language, while 30 participants (75%) reported English as an additional language. The sample therefore included participants from different linguistic backgrounds, with English-additional-language students representing the majority.

Table 1. Participant Characteristics

Characteristic	n	%
Student status		
Saudi	20	50.0
International	20	50.0
Degree level		
Master's	20	50.0
PhD	20	50.0
STEM disciplinary area		
Engineering	11	27.5
Biological & Environmental Sciences	9	22.5
Computer & Data Science	8	20.0
Physical Sciences	7	17.5
Mathematics & Applied Mathematics	5	12.5
English-language background		
English as a first language	10	25.0
English as an additional language	30	75.0

Scientific Research-Writing Challenges

Participants reported varying levels of difficulty across the 13 areas of scientific research writing examined in the questionnaire. The four highest-ranked areas involved synthesising literature, identifying and articulating a research gap, writing the Discussion section, and developing a clear academic or scientific argument.

As shown in Table 2, synthesising literature from multiple sources was rated as the most challenging aspect of scientific research writing ($M = 4.18$). This was followed by identifying and articulating a clear research gap ($M = 4.05$) and writing the Discussion section ($M = 3.98$). Participants also reported difficulty with developing a clear academic or scientific argument ($M = 3.83$) and writing clearly and concisely ($M = 3.70$).

These were followed by paraphrasing and integrating sources ($M = 3.58$), writing the Introduction and research rationale ($M = 3.45$), and organising and structuring a research paper ($M = 3.33$). Language-related areas were ranked somewhat lower, with academic and scientific vocabulary ($M = 3.20$) and grammar and sentence structure ($M = 3.08$).

The lowest mean scores were recorded for writing the Results section ($M = 2.93$), referencing and citation conventions ($M = 2.75$), and writing the Methods section ($M = 2.63$).

Table 2. Perceived Challenges in Scientific Research Writing

Rank	Scientific research-writing challenge	Mean
1	Synthesising literature from multiple sources	4.18
2	Identifying and articulating a clear research gap	4.05
3	Writing the Discussion section	3.98
4	Developing a clear academic/scientific argument	3.83
5	Writing clearly and concisely	3.70
6	Paraphrasing and integrating sources	3.58
7	Writing the Introduction/research rationale	3.45
8	Organising and structuring a research paper	3.33
9	Using appropriate academic/scientific vocabulary	3.20
10	Grammar and sentence structure	3.08
11	Writing the Results section	2.93
12	Referencing and citation conventions	2.75
13	Writing the Methods section	2.63

Note. Items were rated on a five-point scale, with higher scores indicating greater perceived difficulty.

Comparison of Saudi and International Students

Descriptive comparisons were conducted to explore similarities and differences in the scientific research-writing challenges reported by Saudi and international participants. Overall, the two groups demonstrated broadly similar patterns across many areas of scientific research writing, although some differences were observed in language-related areas.

For both groups, synthesising literature from multiple sources emerged as the most challenging area, with a mean score of 4.25 for Saudi students and 4.10 for international students. Both groups also reported relatively high levels of difficulty with identifying and articulating a clear research gap (Saudi $M = 4.10$; international $M = 4.00$) and writing the Discussion section (Saudi $M = 4.05$; international $M = 3.90$). Similarly, relatively little difference was observed in developing a clear academic or scientific argument (Saudi $M = 3.85$; international $M = 3.80$).

More noticeable descriptive differences emerged in language-related aspects of scientific writing. Saudi students reported greater difficulty with grammar and sentence structure ($M = 3.35$) than international students ($M = 2.80$), representing the largest difference between the two groups. Saudi students also reported greater difficulty with academic and scientific vocabulary ($M = 3.40$ compared with $M = 3.00$) and paraphrasing and integrating sources ($M = 3.70$ compared with $M = 3.45$). A smaller difference was observed for writing clearly and concisely (Saudi $M = 3.80$; international $M = 3.60$).

In contrast, only minor differences were observed in research-paper organisation, writing the Results and Methods sections, and referencing and citation conventions. Overall, Saudi and international participants reported broadly similar patterns across the highest-ranked scientific research-writing challenges, while Saudi participants reported somewhat greater difficulty in several language-related areas. As these comparisons were descriptive and based on relatively small groups of participants, they should be interpreted as patterns within the sample rather than as evidence of statistically significant differences between wider Saudi and international postgraduate populations.

Table 3. Scientific Research-Writing Challenges by Student Group

Challenge	Saudi M	International M
Synthesising literature	4.25	4.10
Identifying/articulating a research gap	4.10	4.00
Writing the Discussion section	4.05	3.90
Developing an academic/scientific argument	3.85	3.80
Writing clearly and concisely	3.80	3.60
Paraphrasing and integrating sources	3.70	3.45
Introduction/research rationale	3.50	3.40
Organising and structuring the paper	3.35	3.30
Academic/scientific vocabulary	3.40	3.00
Grammar and sentence structure	3.35	2.80
Writing the Results section	2.95	2.90
Referencing and citation conventions	2.80	2.70
Writing the Methods section	2.65	2.60

Comparison of Master's and PhD Students

Descriptive comparisons were conducted to explore differences in perceived scientific research-writing challenges between Master's and PhD students. Overall, Master's students reported greater difficulty than PhD students across most of the writing areas examined. The most noticeable differences were associated with literature synthesis, identifying a research gap and writing the Discussion section.

Master's students reported greater difficulty with synthesising literature from multiple sources ($M = 4.40$) than PhD students ($M = 3.95$). A similarly clear difference was observed for identifying and articulating a research gap, which received a mean score of 4.35 among Master's students compared with 3.75 among PhD students. The largest descriptive difference was found for writing the Discussion section, with Master's students reporting a mean difficulty score of 4.30 compared with 3.65 for PhD students.

Differences were also evident in several related research-writing skills. Master's students reported greater difficulty with developing a clear academic or scientific argument ($M = 4.05$; PhD $M = 3.60$), writing the Introduction and research rationale ($M = 3.70$; PhD $M = 3.20$), and organising and structuring a research paper ($M = 3.55$; PhD $M = 3.10$). Smaller differences were observed for writing clearly and concisely, paraphrasing and integrating sources, and writing the Results and Methods sections.

In contrast, relatively small differences were observed in language-related areas. Master's and PhD students reported broadly similar levels of difficulty with academic and scientific vocabulary ($M = 3.30$ and 3.10 , respectively) and grammar and sentence structure ($M = 3.15$ and 3.00 , respectively). Referencing and citation conventions were also rated relatively low by both groups.

Overall, degree-level differences were most apparent in literature synthesis, research-gap identification, Discussion writing, argument development and writing the Introduction and research rationale. Master's students reported greater difficulty than PhD students across each of these areas, whereas the differences in language-related areas were comparatively smaller.

Table 4. Scientific Research-Writing Challenges by Degree Level

Challenge	Master's M	PhD M
Synthesising literature	4.40	3.95
Identifying/articulating a research gap	4.35	3.75
Writing the Discussion section	4.30	3.65
Developing an academic/scientific argument	4.05	3.60
Writing clearly and concisely	3.85	3.55
Paraphrasing and integrating sources	3.75	3.40
Introduction/research rationale	3.70	3.20
Organising and structuring the paper	3.55	3.10
Academic/scientific vocabulary	3.30	3.10
Grammar and sentence structure	3.15	3.00
Writing the Results section	3.10	2.75
Referencing and citation conventions	2.85	2.65
Writing the Methods section	2.80	2.45

Support and Resources for Scientific Research Writing

Participants reported using a range of resources and forms of support to assist with scientific research writing. Supervisor feedback was the most frequently reported source of support, selected by 34 participants (85%), followed by the use of published research articles as writing models ($n = 32$, 80%). Generative artificial intelligence tools, such as ChatGPT, were also widely reported, with 29 participants (72.5%) indicating that they used such tools to support aspects of their scientific writing. Grammar and writing tools were used by 27 participants (67.5%), while 24 (60%) reported using academic writing courses or workshops.

Other forms of support were used less frequently. Online writing resources were reported by 22 participants (55%), peer feedback by 18 (45%), and individual writing support or tutorials by 15 (37.5%). Overall, participants drew on both interpersonal sources of support, particularly supervisors, and a range of digital and text-based resources when undertaking scientific research writing.

When asked about areas in which they would value additional support, participants' responses closely reflected the challenges identified earlier in the questionnaire. Writing the Discussion section was the most frequently selected area, identified by 31 participants (77.5%), followed by literature synthesis and review writing ($n = 30$, 75%) and identifying and articulating a research gap ($n = 29$, 72.5%). Individual scientific-writing consultations were selected by 27 participants (67.5%), while 26 (65%) indicated that they would value additional support with developing academic or scientific arguments.

Support with writing clearly and concisely was selected by 23 participants (57.5%), followed by paraphrasing and source integration ($n = 21$, 52.5%) and academic and scientific language ($n = 18$,

45%). Fewer participants identified grammar and sentence structure ($n = 15$, 37.5%) or referencing and citation conventions ($n = 11$, 27.5%) as priority areas for additional support.

Overall, the responses show a clear correspondence between the challenges participants reported and the areas in which they requested additional support. In particular, Discussion writing, literature synthesis and research-gap identification were both among the highest-rated challenges and the most frequently requested areas for further support.

Table 5. Current Sources of Scientific-Writing Support

Support/resource	n	%
Supervisor feedback	34	85.0
Published research articles/models	32	80.0
Generative AI tools	29	72.5
Grammar/writing tools	27	67.5
Academic writing courses/workshops	24	60.0
Online writing resources	22	55.0
Peer feedback	18	45.0
Individual writing support/tutorials	15	37.5

Note. Participants could select more than one response; therefore, percentages do not total 100%.

Table 6. Areas in Which Participants Requested Additional Support

Area of support	n	%
Writing the Discussion section	31	77.5
Literature synthesis/review writing	30	75.0
Identifying and articulating a research gap	29	72.5
Individual scientific-writing consultations	27	67.5
Developing academic/scientific arguments	26	65.0
Writing clearly and concisely	23	57.5
Paraphrasing/source integration	21	52.5
Academic/scientific language	18	45.0
Grammar and sentence structure	15	37.5
Referencing/citation	11	27.5

Note. Participants could select more than one response; therefore, percentages do not total 100%.

Open-Ended Responses

Analysis of the two open-ended questionnaire questions provided additional insight into participants' scientific research-writing challenges and the forms of support they considered most useful. Four recurring themes were identified: (1) synthesising literature and establishing a research gap, (2) interpreting findings and writing the Discussion, (3) expressing complex scientific ideas clearly in English, and (4) the need for targeted and individualised scientific-writing support. These themes broadly reinforced the patterns identified in the quantitative findings.

Synthesising Literature and Establishing a Research Gap

A prominent theme concerned the difficulty of synthesising information from multiple sources. Participants described challenges in moving beyond summarising individual studies towards integrating findings from different sources into a coherent and connected review of the literature. Responses indicated that students could often understand individual research papers but found it more difficult to identify relationships between studies and organise the literature around broader themes or arguments.

Closely associated with literature synthesis was the challenge of identifying and articulating a clear research gap. Participants reported that even after reading extensively around their research topics, determining what was genuinely missing from the existing literature could remain difficult. One participant, for example, described difficulty in determining what was missing from existing research and explaining clearly why the proposed study was needed.

These responses were consistent with the quantitative findings, in which literature synthesis and research-gap identification were the two highest-rated scientific research-writing challenges.

Interpreting Findings and Writing the Discussion

Writing the Discussion section emerged as another prominent theme. Participants reported that presenting research findings was generally more straightforward than interpreting what those findings meant and explaining their wider significance. Responses indicated particular difficulty in moving beyond a description of results towards developing a convincing interpretation of those results.

Another recurring concern involved connecting findings to previous research. Participants described uncertainty about how to compare their results with existing studies and how to explain findings that differed from previously published research. Several responses indicated that participants understood what their results showed but found it more difficult to explain what those findings meant, why they were important and how they related to previous research.

The responses therefore indicated that Discussion writing involved several interconnected challenges, including interpretation, comparison with previous literature and explanation of the significance of findings. This pattern was consistent with the quantitative results, where writing the Discussion section was ranked as the third most challenging area of scientific research writing.

Expressing Complex Scientific Ideas Clearly in English

A third theme concerned the difficulty of communicating complex scientific ideas clearly, precisely and concisely in English. Participants described situations in which they understood the scientific concepts they wished to communicate but experienced difficulty expressing those ideas in an appropriately academic form.

Responses indicated a distinction between understanding scientific concepts and being able to communicate them effectively in academic English. Participants described difficulty translating complex ideas into clear and concise written explanations while maintaining the precision expected in scientific communication.

Responses also highlighted challenges associated with selecting appropriate academic and scientific vocabulary and constructing sentences that were scientifically accurate without becoming unnecessarily long or complex. The responses therefore suggested that language-related difficulties could interact with the broader challenge of communicating sophisticated disciplinary knowledge effectively.

These responses were consistent with the quantitative findings, particularly the reported difficulties associated with writing clearly and concisely, paraphrasing and integrating sources, academic and scientific vocabulary, and grammar and sentence structure.

Need for Targeted and Individualised Scientific-Writing Support

The final theme concerned the forms of support participants considered most useful for developing their scientific research writing. Responses indicated a preference for practical writing support focused on specific components of scientific research papers rather than general English-language instruction. Literature synthesis, identifying a research gap and writing the Discussion section were repeatedly identified as areas in which more focused guidance would be valuable.

Participants also indicated that individual feedback on their own scientific writing could be particularly beneficial. Responses suggested that personalised feedback would allow students to identify specific difficulties in their own texts and receive guidance on how these could be addressed within the context of their research writing.

Such support was viewed as providing an opportunity to receive guidance directly related to students' individual writing difficulties, research projects and disciplinary contexts. This preference was consistent with the quantitative findings, in which individual scientific-writing consultations were selected by 27 participants (67.5%) as a desirable form of additional support.

Overall, the open-ended responses reinforced the patterns identified in the quantitative findings and indicated that participants' scientific research-writing difficulties extended beyond grammar and vocabulary. The qualitative data highlighted interconnected challenges involving critically engaging with previous literature, establishing a research gap, interpreting research findings and communicating

complex scientific ideas effectively. The responses also indicated a preference for targeted, research-focused and individualised writing support addressing specific scientific research-writing needs.

DISCUSSION

Higher-Order Scientific Writing as the Main Challenge

One of the clearest findings of the study was that participants' greatest difficulties were associated with higher-order aspects of scientific research writing rather than with language mechanics alone. Synthesising literature from multiple sources was rated as the most challenging area ($M = 4.18$), followed by identifying and articulating a clear research gap ($M = 4.05$), writing the Discussion section ($M = 3.98$), and developing a clear academic or scientific argument ($M = 3.83$). In comparison, academic and scientific vocabulary ($M = 3.20$) and grammar and sentence structure ($M = 3.08$) received lower difficulty ratings. This pattern suggests that postgraduate scientific-writing challenges extend beyond linguistic accuracy and involve the more complex rhetorical and analytical practices through which researchers construct and communicate disciplinary knowledge.

The difficulty associated with literature synthesis is consistent with previous research showing that postgraduate writers may struggle to move beyond summarising individual sources towards integrating, comparing and critically evaluating multiple studies (Al Mahmud & ur Rahman, 2023; Shahsavari & Kourepaz, 2020). Effective synthesis requires writers not only to understand individual research articles but also to identify relationships across studies and organise these relationships around a coherent argument. The open-ended responses in the present study reinforced this finding, with participants describing difficulties in combining information from multiple papers and developing a connected account of the literature. For postgraduate STEM researchers, therefore, literature-review writing represents both a reading and writing challenge, requiring critical evaluation of existing research alongside the ability to communicate relationships between studies effectively.

Closely connected to literature synthesis was the difficulty of identifying and articulating a clear research gap. This was the second highest-rated challenge and also emerged prominently in the open-ended responses. Establishing a research gap requires students to move beyond demonstrating knowledge of previous studies and to make a persuasive case for why further research is necessary. This involves evaluating the existing literature, identifying limitations, inconsistencies or underexplored areas, and positioning the proposed study in relation to this body of knowledge. Such demands reflect the rhetorical nature of research writing, in which writers must establish both the relevance and contribution of their work rather than simply describe a research topic (Swales, 2004).

Writing the Discussion section represented a further major difficulty. This finding is consistent with research indicating that Discussion sections are rhetorically demanding because writers must interpret findings, relate them to previous studies, explain unexpected results and establish the significance of their research (Chien & Li, 2022). Participants' open-ended responses similarly indicated that reporting results was often perceived as more straightforward than explaining what those results meant and why they mattered. The challenge of Discussion writing therefore appears to involve the transition from presenting scientific information to constructing an evidence-based interpretation of that information within a wider disciplinary context.

The relatively high difficulty associated with developing an academic or scientific argument further supports this interpretation. Scientific research writing requires writers to establish relationships between evidence, interpretation and claims while maintaining a coherent line of reasoning across different sections of a paper. For developing researchers, this may be particularly challenging because disciplinary argumentation is often learned gradually through engagement with published literature, supervisor feedback and repeated participation in research-writing practices. Previous research has similarly emphasised that successful postgraduate writing involves developing familiarity with disciplinary expectations and research genres rather than simply acquiring general academic-language proficiency (Alharbi, 2021; Hyland, 2012).

Taken together, these findings suggest that support for postgraduate STEM writers should extend beyond grammar correction, vocabulary development and general academic English. Although language-related difficulties remained relevant, the strongest challenges concerned the intellectual and rhetorical work involved in synthesising previous research, establishing a research gap, constructing an argument and interpreting findings. Scientific-writing provision may therefore be most effective when it explicitly addresses these research-writing practices and provides students with opportunities to apply them directly to authentic scientific texts and their own developing research, consistent with approaches that embed writing development within disciplinary postgraduate contexts (Haas & Biteen, 2025).

Saudi and International Student Perspectives

A second important finding was the broad similarity between Saudi and international students in their perceptions of the most challenging aspects of scientific research writing. Both groups identified literature synthesis, research-gap identification, Discussion writing and academic or scientific argumentation among their highest-rated difficulties. Synthesising literature, for example, received a mean difficulty score of 4.25 among Saudi students and 4.10 among international students, while identifying and articulating a research gap was rated 4.10 and 4.00, respectively. Similarly, both groups reported considerable difficulty with writing the Discussion section (Saudi $M = 4.05$; international $M = 3.90$). These relatively small descriptive differences suggest that many of the principal challenges of scientific research writing were shared across the two groups.

This finding is important because it suggests that the difficulties experienced by postgraduate STEM writers within an international English-medium research environment cannot be understood simply as challenges affecting a particular national or linguistic group. Scientific research writing requires students to synthesise complex bodies of literature, establish the contribution of their research, develop disciplinary arguments and interpret findings within existing knowledge. Previous research has similarly shown that postgraduate research writing involves challenges related not only to language but also to argumentation, research genres and disciplinary writing expectations (Alharbi, 2021; Al Mahmud & ur Rahman, 2023; Hyland, 2012). Such practices are developed through engagement with disciplinary literature, feedback and participation in research communities. The similarity between Saudi and international participants therefore reinforces the view that postgraduate research writing involves disciplinary and rhetorical development in addition to language proficiency.

Nevertheless, some differences emerged in language-related areas. Saudi students reported greater difficulty with grammar and sentence structure ($M = 3.35$) than international students ($M = 2.80$), representing the largest descriptive difference between the groups. Differences were also observed for academic and scientific vocabulary (Saudi $M = 3.40$; international $M = 3.00$), paraphrasing and integrating sources (Saudi $M = 3.70$; international $M = 3.45$), and writing clearly and concisely (Saudi $M = 3.80$; international $M = 3.60$). These findings are consistent with previous research in Saudi higher education identifying linguistic and academic-writing difficulties among postgraduate students (Al Fadda, 2012; Alharbi, 2021). More recent research by Al Mahmud and ur Rahman (2023) similarly found that Saudi graduate students experienced difficulties relating to language, argumentation and research-article genres, demonstrating that linguistic concerns can coexist with broader research-writing challenges.

However, these differences should be interpreted cautiously. Saudi or international status is not equivalent to linguistic background, and the international group itself included students from diverse first-language and educational backgrounds. Indeed, the present sample included both first-language and additional-language users of English, with 75% of the overall participants reporting English as an additional language. Postgraduate writing experiences may be shaped by an interaction of linguistic background, previous educational experience, disciplinary expectations and familiarity with academic conventions rather than by language proficiency or nationality alone (Hyland, 2012; Lea & Street, 1998). The findings therefore should not be interpreted as suggesting that Saudi postgraduate students constitute a homogeneous group or that language-related difficulties are determined primarily by nationality.

The findings also support the value of avoiding a deficit-based interpretation of multilingual postgraduate writers. Although Saudi participants reported somewhat greater difficulty in several language-related areas, their highest-rated challenges were not grammar or vocabulary but literature synthesis, research-gap identification and Discussion writing. This distinction is important because focusing predominantly on language correction could overlook the areas that students themselves perceive as most demanding. An academic-literacies perspective similarly emphasises that academic writing involves participation in socially and disciplinarily situated practices rather than simply mastery of generic language skills (Lea & Street, 1998). Support for Saudi and international postgraduate writers should therefore combine attention to clarity and linguistic accuracy, where required, with explicit development of rhetorical and disciplinary scientific-writing practices.

Overall, the similarities between Saudi and international students were more prominent than the differences. Both groups experienced substantial difficulty with the rhetorical and analytical demands of scientific research writing, while differences were more apparent in particular language-related areas. These findings suggest that postgraduate scientific-writing provision within international STEM environments should address common research-writing needs while remaining sufficiently flexible to respond to the linguistic, educational and disciplinary backgrounds of individual students.

Differences between Master's and PhD Students

A further important finding concerned differences between Master's and PhD students. Although both groups reported challenges across a range of scientific research-writing areas, Master's students

generally reported higher levels of difficulty than PhD students. The largest differences occurred in higher-order research-writing tasks, particularly writing the Discussion section, identifying and articulating a research gap, synthesising literature, developing an academic or scientific argument, and writing the Introduction and research rationale. In contrast, differences between the two groups were relatively small for grammar, academic and scientific vocabulary, and referencing.

The largest difference was observed in writing the Discussion section, which received a mean difficulty rating of 4.30 among Master's students compared with 3.65 among PhD students. This finding may reflect the demanding rhetorical and analytical nature of Discussion writing. Students are required not simply to report their findings but to interpret them, relate them to previous research, account for similarities or differences, and explain their wider significance (Chien & Li, 2022). These practices require familiarity with disciplinary expectations and experience in positioning one's own findings within an established body of research. PhD students may have had greater opportunities to develop these practices through sustained engagement with research, scientific literature, supervisor feedback and research-paper writing.

A similarly clear difference emerged in identifying and articulating a research gap (Master's $M = 4.35$; PhD $M = 3.75$). Identifying a convincing gap requires extensive familiarity with the relevant literature as well as the ability to critically evaluate what has already been investigated and determine where a new study can make a meaningful contribution. Previous research involving Master's students has identified research-gap identification as a particular difficulty alongside synthesis, paraphrasing and other aspects of literature-review writing. These challenges have been associated with students' status as developing researchers and limited opportunities to practise the complex processes involved in constructing a literature review (Benbellal & Khaldi, 2021).

Literature synthesis showed a similar pattern, with Master's students reporting greater difficulty ($M = 4.40$) than PhD students ($M = 3.95$). This finding corresponds with previous postgraduate-writing research demonstrating that students frequently find it difficult to move beyond summarising individual studies towards synthesising, critiquing and explaining relationships within the literature (Shahsavari & Kourepaz, 2020). Walter and Stouck (2020) similarly highlight the complexity of literature-review writing for graduate students and the importance of appropriate institutional and supervisory support. Literature synthesis therefore appears to be a developmental research-writing skill rather than a straightforward matter of locating and summarising relevant sources.

Master's students also reported greater difficulty with developing an academic or scientific argument ($M = 4.05$; PhD $M = 3.60$), writing the Introduction and research rationale ($M = 3.70$; PhD $M = 3.20$), and organising and structuring a research paper ($M = 3.55$; PhD $M = 3.10$). Taken together, these differences suggest that research-writing experience may contribute to students' developing ability to recognise disciplinary conventions and construct scientific arguments. Scholarly writing develops through engagement with disciplinary texts, feedback and participation in academic research practices, rather than through the acquisition of generic language skills alone (Hyland, 2012).

In contrast, differences between Master's and PhD students were considerably smaller for language-related areas. Grammar and sentence structure received mean scores of 3.15 and 3.00, respectively, while academic and scientific vocabulary received scores of 3.30 and 3.10. This pattern is noteworthy

because the main degree-level differences were associated less with linguistic accuracy than with the more rhetorical and analytical dimensions of scientific research writing. Degree level alone does not necessarily determine English-language proficiency, whereas progression through postgraduate research may provide increased exposure to disciplinary literature, scientific writing, supervisor feedback and opportunities to develop research-related rhetorical practices.

These findings have implications for the timing and targeting of postgraduate writing support. Master's students may particularly benefit from early and explicit instruction in literature synthesis, identifying research gaps, developing scientific arguments and interpreting findings within Discussion sections. PhD students may still require support in these areas, as their mean scores demonstrate that such tasks remained challenging, but support could be differentiated according to students' research-writing experience rather than being delivered uniformly across postgraduate degree levels.

Overall, the findings suggest that scientific research-writing development is associated not only with linguistic competence but also with increasing participation in research and disciplinary writing practices. The lower difficulty ratings reported by PhD students in several higher-order areas may reflect greater accumulated research-writing experience; however, given the descriptive nature and relatively small sample of the present study, this interpretation should be treated cautiously. Longitudinal research would be needed to determine more directly how scientific research-writing abilities develop as students progress through postgraduate study.

Scientific-Writing Support Needs

The findings also provide important insights into the forms of support postgraduate STEM students use and the areas in which they would value further assistance. Supervisor feedback was the most frequently reported source of scientific-writing support, identified by 85% of participants, followed by published research articles used as writing models (80%). Academic writing courses and workshops were also used by 60% of participants. These findings highlight the importance of both disciplinary guidance and explicit writing support in the development of postgraduate scientific writing. Previous research has similarly emphasised the important role of supervisor feedback, feedback literacy and structured institutional support in developing postgraduate writers (Chugh et al., 2022; Hey-Cunningham et al., 2021).

The areas in which participants requested additional support were particularly revealing because they closely corresponded with the challenges identified elsewhere in the study. Writing the Discussion section was the most frequently selected area for additional support (77.5%), followed by literature synthesis and review writing (75%), identifying and articulating a research gap (72.5%), individual scientific-writing consultations (67.5%), and developing academic or scientific arguments (65%). In comparison, considerably fewer participants identified grammar and sentence structure (37.5%) or referencing and citation conventions (27.5%) as priority areas for further support.

This close correspondence between perceived difficulty and requested support strengthens the argument that postgraduate scientific-writing provision should extend beyond general academic-English instruction. Students appear to require explicit guidance in the rhetorical and analytical processes involved in constructing scientific knowledge through writing. Rather than focusing

predominantly on sentence-level accuracy, scientific-writing provision could therefore include targeted instruction in synthesising literature, establishing research gaps, constructing scientific arguments and interpreting findings within Discussion sections. Such support may be particularly valuable when students are able to apply these practices to authentic published research and to their own developing research texts.

The strong interest in individual scientific-writing consultations is also noteworthy. While workshops and courses can address common writing challenges, individual consultations provide opportunities to respond to the particular needs of a student, research project or disciplinary context. This may be especially valuable in STEM environments, where conventions and expectations can vary across disciplines and research genres. Individual writing support should not necessarily replace supervisor feedback; rather, it can complement disciplinary supervision by focusing explicitly on rhetorical organisation, clarity, argument development and other aspects of scientific communication.

Another notable finding was the widespread use of digital writing support. Generative artificial intelligence tools such as ChatGPT were reported by 72.5% of participants, while grammar and writing tools were used by 67.5%. The substantial use of generative AI in the present study suggests that such tools have become part of the writing practices of many participants. Recent research has similarly demonstrated growing use of ChatGPT and other digital tools in higher-education writing and has explored their potential for feedback, revision and other forms of writing support (Mahapatra, 2024; Zhao et al., 2024). Research in the Saudi higher-education context has also identified frequent student use of tools including ChatGPT and Grammarly, together with positive perceptions of their usefulness for activities such as idea generation, outlining and language-related support (Ozfidan et al., 2024).

The use of generative AI nevertheless raises important pedagogical questions. Although AI-supported tools can provide rapid and accessible assistance during the writing process, students need to evaluate generated content critically and remain responsible for the intellectual content, interpretation and argumentation of their research. Research has demonstrated the potential of ChatGPT to provide formative writing feedback while also highlighting the changing role of digital tools within academic writing practices (Mahapatra, 2024; Zhao et al., 2024). Scientific-writing provision should therefore help students develop informed and critical approaches to AI-supported writing rather than treating such tools either as replacements for disciplinary expertise or simply as technologies to be avoided.

The use of digital tools also does not appear to remove the perceived need for human and disciplinary feedback. Supervisor feedback remained the most widely used source of support despite the high reported use of generative AI, while more than two-thirds of participants expressed interest in individual scientific-writing consultations. This combination suggests that participants may value different forms of support for different purposes. Digital tools can provide accessible and immediate assistance, whereas supervisors, writing instructors and individual consultations can provide contextualised feedback that takes account of disciplinary expectations, research aims and the intended scientific contribution.

Overall, the findings support a multi-layered approach to postgraduate scientific-writing development. Such an approach could combine supervisor feedback, targeted workshops on higher-order research-writing skills, individual scientific-writing consultations, analysis of published disciplinary models

and informed use of digital and generative AI tools. Importantly, support should be aligned with the areas students themselves identify as most challenging, particularly literature synthesis, research-gap identification, Discussion writing and scientific argumentation. This would enable scientific-writing provision to respond more directly to the rhetorical, analytical and linguistic demands encountered by postgraduate STEM researchers.

Implications to Research and Practice

The findings of this study have several implications for the provision of scientific research-writing support for postgraduate STEM students. Most importantly, the results suggest that writing support should extend beyond a primary focus on grammar, vocabulary and sentence-level accuracy. Although these areas remained challenging for some participants, the greatest difficulties concerned higher-order research-writing practices, particularly literature synthesis, identifying and articulating a research gap, writing the Discussion section and developing a coherent scientific argument. Postgraduate writing provision should therefore address the rhetorical and analytical processes involved in constructing and communicating scientific knowledge.

One practical implication is the value of targeted scientific-writing workshops organised around specific research-writing tasks. Rather than offering only broad academic-writing courses, institutions could provide focused sessions on synthesising literature, establishing a research gap, developing a research rationale, constructing scientific arguments and interpreting findings within the Discussion section. Such workshops could use published research articles from different STEM disciplines as models, enabling students to examine how experienced researchers perform these functions in authentic scientific texts. Students could then apply the same principles directly to their own developing research papers or theses.

The differences observed between Master's and PhD students also suggest that scientific-writing support may benefit from being differentiated according to students' research experience and stage of study. Master's students reported particularly high levels of difficulty with literature synthesis, research-gap identification and Discussion writing. Early and explicit support in these areas may therefore be especially valuable for students beginning postgraduate research. PhD students may require more advanced or discipline-specific support, particularly as they move towards publication and increasingly specialised forms of scientific communication. A developmental approach to writing support may consequently be more appropriate than providing identical provision to all postgraduate researchers.

The findings also highlight the potential value of individual scientific-writing consultations. More than two-thirds of participants (67.5%) indicated that they would value this form of support. Individual consultations can complement workshops and supervisor feedback by allowing students to discuss difficulties arising from their own texts and receive focused guidance on organisation, argumentation, clarity, literature synthesis and other aspects of scientific communication. Importantly, such provision should complement rather than replace disciplinary supervision, since supervisors remain essential sources of expertise regarding scientific content and disciplinary expectations.

A further implication concerns the role of generative artificial intelligence in postgraduate scientific writing. With 72.5% of participants reporting the use of generative AI tools, such technologies appear to form part of the contemporary writing environment for many postgraduate researchers. Rather than treating AI use solely as something to prohibit or ignore, scientific-writing programmes could incorporate explicit guidance on its appropriate, critical and responsible use. Research with postgraduate students has highlighted the importance of AI literacy encompassing not only the ability to use AI tools but also cognitive, behavioural and ethical dimensions of their use (Sangadji et al., 2025). Research into higher-education writing practices also indicates that generative AI is influencing how students approach writing, strengthening the case for developing AI literacy alongside established academic-writing competencies (Zhao et al., 2024).

Such guidance should emphasise that generative AI can function as a support for the writing process rather than a substitute for the researcher's intellectual contribution. Students need to remain responsible for evaluating evidence, interpreting findings, developing arguments and determining the scientific contribution of their research. This is particularly important in relation to the challenges identified in the present study. While AI tools may assist with aspects of language, brainstorming, revision or feedback, determining whether a research gap is meaningful, critically synthesising literature and interpreting scientific findings requires disciplinary judgement and critical engagement. Research involving postgraduate students has similarly identified substantial use of AI tools in academic writing and generally positive perceptions of their usefulness, reinforcing the need for educational approaches that encourage informed and responsible use of these technologies (Anani et al., 2025).

Finally, the findings support a multi-layered model of postgraduate scientific-writing provision. Such a model could combine disciplinary supervisor feedback, targeted scientific-writing workshops, individual consultations, analysis of published research articles, peer interaction and responsible use of digital and generative AI tools. Support should also recognise the linguistic diversity of international postgraduate populations. While some students may require additional assistance with grammar, vocabulary or clarity, the findings of this study indicate that higher-order research-writing challenges were evident across the diverse sample.

Overall, postgraduate scientific-writing support should be closely aligned with the authentic demands of research practice. Helping students to become effective scientific writers involves more than improving their English; it requires supporting them in learning how to synthesise knowledge, identify meaningful research gaps, construct evidence-based arguments, interpret findings and communicate their scientific contribution effectively. A more targeted, developmental and research-focused approach to writing support may therefore better prepare postgraduate STEM students for thesis writing, publication and participation in international scientific communities.

7. Conclusion

This study investigated the scientific research-writing challenges perceived by Saudi and international postgraduate STEM students within an international, English-medium, research-intensive university in Saudi Arabia. By examining the experiences of both Master's and PhD students from a range of STEM disciplines, the study sought to identify the aspects of scientific writing students found most

challenging, explore differences between participant groups, and determine the forms of support students considered most useful.

The findings indicate that the most prominent challenges were associated with higher-order scientific research-writing skills rather than language mechanics alone. Synthesising literature from multiple sources emerged as the greatest challenge, followed by identifying and articulating a clear research gap, writing the Discussion section, and developing a coherent academic or scientific argument. Although participants also reported difficulties with vocabulary, grammar and sentence structure, these areas were generally rated as less challenging. Scientific research-writing development should therefore not be viewed primarily as a matter of improving linguistic accuracy; it also involves developing the analytical, rhetorical and disciplinary practices required to construct and communicate scientific knowledge effectively.

The comparison between Saudi and international students revealed more similarities than differences. Both groups identified broadly the same higher-order research-writing challenges, although Saudi participants reported somewhat greater difficulty in several language-related areas, particularly grammar and sentence structure and academic and scientific vocabulary. Similarly, differences between Master's and PhD students were most apparent in higher-order research-writing tasks. Master's students reported greater difficulty with literature synthesis, identifying a research gap and writing the Discussion section. These descriptive differences may be associated with differences in research-writing experience or stage of study, although the present study cannot establish the reasons for these patterns.

The findings concerning students' support needs further reinforce these conclusions. Participants expressed particularly strong demand for support with Discussion writing, literature synthesis, research-gap identification and scientific argumentation, while individual scientific-writing consultations were also highly valued. Supervisor feedback remained an important source of support, but participants reported drawing on a wider range of resources, including published research articles, writing tools and generative artificial intelligence. The widespread reported use of generative AI further highlights the importance of helping postgraduate researchers develop critical and responsible approaches to emerging writing technologies alongside more established forms of academic and disciplinary support.

Overall, the study highlights the value of a targeted, developmental and research-focused approach to postgraduate scientific-writing support. Effective provision should combine attention to linguistic clarity with explicit development of literature synthesis, research-gap identification, scientific argumentation and interpretation of findings. It should also recognise differences in students' research experience and provide opportunities for both structured instruction and individualised feedback. By aligning scientific-writing support more closely with the authentic rhetorical and analytical demands of postgraduate STEM research, universities may be better positioned to support students in developing the writing practices required for thesis completion, research publication and effective participation in international scientific communities.

8. Future Research

Several limitations should be considered when interpreting the findings of this study. First, the study involved a relatively small sample of 40 postgraduate STEM students from a single research-intensive university in Saudi Arabia. Although the sample included equal representation of Saudi and international students and of Master's and PhD students, the findings are context-specific and should not be generalised to all postgraduate STEM students in Saudi Arabia or other educational settings. The purpose of the study was primarily to identify patterns within this particular postgraduate research environment rather than to make population-level claims. Future research could therefore include larger samples drawn from multiple universities in Saudi Arabia and other international research contexts to examine whether similar patterns emerge across institutions and student populations.

Second, the study relied primarily on self-reported perceptions of writing difficulty. Participants' ratings provide valuable insight into the aspects of scientific research writing they personally experience as challenging, but perceived difficulty does not necessarily correspond directly to demonstrated writing performance. For example, a student may perceive Discussion writing as particularly difficult even though an analysis of their written work might reveal greater difficulties in another area. Future studies could therefore combine questionnaire data with analysis of students' actual scientific writing, such as research papers, thesis chapters or manuscript drafts. This would enable researchers to compare perceived challenges with observable features of students' writing.

Third, the study used a questionnaire-based design with a relatively small qualitative component consisting of two open-ended questions. While these responses provided useful explanatory insights and broadly reinforced the quantitative findings, they did not allow the same depth of exploration that could be achieved through interviews or focus groups. Future research could use semi-structured interviews to explore in greater detail why students experience particular aspects of scientific writing as challenging and how previous educational, linguistic and research experiences influence their writing development.

A further limitation concerns the descriptive comparisons between Saudi and international students and between Master's and PhD students. Given the relatively small number of participants in each group, the study did not seek to establish statistically significant differences or causal relationships. The observed differences should therefore be interpreted as patterns within the present sample. The sample size also did not permit meaningful comparisons across individual STEM disciplinary areas. Future studies involving larger samples could employ inferential statistical analyses to determine whether differences between student groups are statistically significant and to explore the possible influence of additional variables such as English-language background, disciplinary field, previous publication experience and stage of postgraduate study.

The categorisation of participants as Saudi or international should also be interpreted cautiously. Nationality does not provide a direct measure of linguistic background, educational experience or English-language proficiency. International students themselves represent a highly heterogeneous population, and both Saudi and international participants may use English as an additional language. Future research could therefore examine linguistic and educational background more directly rather than relying primarily on broad nationality categories.

Finally, the study captured participants' perceptions at one point in their postgraduate studies. Scientific research-writing abilities may develop as students gain research experience, engage more extensively with disciplinary literature, receive supervisor feedback and participate in publication activities. Longitudinal research following students from the beginning of their postgraduate studies through later stages of Master's or PhD research could provide a clearer understanding of how particular scientific-writing challenges change over time and how different forms of writing support contribute to this development.

Despite these limitations, the study provides useful context-specific evidence concerning the scientific research-writing challenges reported by a diverse group of postgraduate STEM students. In particular, it identifies several areas—literature synthesis, research-gap identification, Discussion writing and scientific argumentation—that warrant further investigation and may provide productive targets for future postgraduate scientific-writing support.

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