PROMOTING DIVERSITY THROUGH A STUDENT-STAFF COLLABORATIVE HISTORY-FOCUSED CHEMISTRY COURSE

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Abstract

This study evaluates the development, delivery, and reception of a collaboratively designed, history-focused chemistry course for first-year undergraduates at Durham University. Co-created by student interns and academic staff, the course aimed to broaden students' understanding of chemistry's global and historical development and to promote diversity and inclusivity through case studies and narratives often absent from traditional curricula that feature a Eurocentric perspective. A post-course survey conducted at the end of the module found the course particularly effective in enhancing students' understanding of the historical evolution of chemistry and the contributions of diverse chemists. Thematic analysis of qualitative feedback highlighted appreciation for the global scope and interdisciplinary perspective of the course, alongside suggestions for more applied chemistry content, a clearer chronological structure, and greater scientific depth. Challenges included condensing wide-ranging material into limited lecture time and balancing historical breadth with contemporary relevance. Ongoing improvements, guided by student feedback, have focused on clearer communication of course aims and supplementary resources to deepen engagement with chemical concepts. Findings highlight the educational value of integrating historical context, cultural diversity, and student–staff co-creation in science curricula. This approach not only fosters richer student engagement but also offers a transferable model for inclusive curriculum innovation across STEM (Science, Technology, Engineering, and Mathematics) disciplines.

Keywords: *undergraduate education, curriculum development, decolonising science, student–staff collaboration, chemistry education, student feedback, diversity*

1. INTRODUCTION

Integrating historical perspectives into undergraduate chemistry education is gaining attention as educators seek to foster not only technical proficiency but also a deeper appreciation of chemistry's development, cultural context, and societal impact [1–4]. While most undergraduate chemistry programs focus on laboratory skills and theoretical concepts, they may pay less attention to the subject's historical and human dimensions [5–8]. As a result, students may not fully appreciate how chemistry has evolved over time or its significance in various societies around the world [1,2,9–11].

Research suggests that including the history of chemistry in courses can spark students' curiosity, strengthen their scientific knowledge, and build the critical-thinking and inquiry skills that are needed for their future development as scientists [2,12,13].

Contemporary chemistry education has also been critiqued for its narrow focus on Western scientific achievements, which can inadvertently reinforce Eurocentric narratives and marginalise students who do not see their identities or heritages reflected in the curriculum [1,14–18]. Addressing these gaps is essential for fostering equity and representation. The inclusion of chemists from a variety of backgrounds and cultures challenges the implicit message that scientific progress is the domain of a select few [14,15,19].

By critically examining and revising educational content to recognise and value contributions from non-Western societies and historically marginalised groups, the curriculum aligns with broader movements in higher education aimed at creating more inclusive and socially just learning environments [1,14,20–

22]. When students see themselves and their communities represented in course material, they are more likely to feel a sense of belonging and engagement. This is linked to improved academic outcomes and persistence in STEM fields [23].

To address these needs, a new History of Chemistry lecture course was developed and introduced for first-year students as part of the 'Molecules in Action' module at Durham University. The course was co-developed by two student interns and an academic staff member, drawing on their collective interests, insights, and extensive research. This collaborative approach reflects the growing recognition of student–staff partnerships in creating engaging and relevant learning experiences, and aims to empower students as active participants in the chemistry community [24–27].

Integrating stories and case studies from across civilisations transforms the way science is taught and understood. For instance, stories about Egyptian glassmakers or Mesopotamian perfumers reveal science as a deeply human endeavour. These narratives highlight how curiosity, creativity, and collaboration have shaped scientific progress. [28–33]. This perspective counters the misconception of science as a static collection of facts and instead emphasises its dynamic, evolving nature. Stories provide context for scientific discoveries, illustrating how cultural, social, and technological factors influence the trajectory of scientific progress [28,29,34,35].

This approach helps students appreciate that scientific knowledge is provisional and subject to change, fostering critical thinking and adaptability. Storytelling also serves as a powerful pedagogical tool, making complex concepts more relatable and memorable by connecting abstract ideas to real-world experiences and historical narratives [29,30,33,36,37].

The History of Chemistry course at Durham was designed to enrich the undergraduate student experience. Foregrounding diverse voices both sparks curiosity and encourages deeper engagement beyond traditional boundaries, a strategy shown to increase participation in STEM education [14,23,38].

Presenting science as a process rather than a set of established facts encourages students to develop critical enquiry skills, understand the nature of scientific evidence, and appreciate the interplay between science and society [19,28,39,40]. This approach prepares students to be thoughtful, informed citizens and future scientists.

When students recognise the contributions of individuals from varied backgrounds, they are more likely to see themselves as part of the scientific community. This sense of belonging is crucial for retention and success, particularly among students from underrepresented groups [14,22,23,41]. By addressing these dimensions, the course not only enriches students' understanding of chemistry but also models a more inclusive, relevant, and forward-thinking approach to science education, one that is responsive to the needs of a diverse student body and the demands of a globalised world.

This project had two primary aims: first, to broaden students' understanding of chemistry's global and historical development by presenting stories, case studies, and contributions often missing from standard curricula; and second, to evaluate the course's reception and educational impact through student feedback. Accordingly, this study addresses the following research questions:

1. How does history and culture in chemistry education affect students' understanding of chemistry's development?
2. How does including diverse chemists and global cases impact students' belonging and engagement?
3. What do students think about storytelling and case studies in showing science as a human, evolving process?
4. How do students respond to a co-created, inclusive chemistry curriculum regarding literacy, thinking, and satisfaction?

2. COURSE DESIGN AND DEVELOPMENT

2.2. Rationale and Objectives

Traditional undergraduate chemistry curricula have often prioritised modern theories, laboratory techniques, and problem-solving skills, with limited attention to the origins, cultural contexts, and global evolution of chemical knowledge [1,3,9,42]. This approach can leave students with a fragmented understanding of chemistry, disconnected from its broader humanistic and societal dimensions [1,10,11]. Integrating historical perspectives helps address these gaps by encouraging students to consider how scientific ideas have developed in response to diverse cultural, technological, and societal influences [2,3,42].

The new lecture course encouraged students to reflect on the interplay between scientific discovery, culture, and technological progress, and to consider how social and cultural contexts shaped the evolution of chemical knowledge and practice. This pedagogical approach is supported by prior literature, which highlights the value of integrating historical perspectives to enrich students' understanding of chemistry's development [7,42].

In line with findings from Matthews [3] and Yaru et al. [2], the course also promoted the development of critical thinking and scientific literacy by helping students contextualise scientific advancements within their historical settings. Furthermore, by exploring scientific discoveries and technologies as responses to societal needs and prevailing cultural practices, the course followed recommendations from Knight [7] and Matthews [3] on how to connect chemistry content to its broader humanistic and societal dimensions.

Throughout the course, examples of chemists from a broad range of cultures and identities were included. This approach aligns with recent educational literature, which emphasises that representing scientists from diverse backgrounds is key to advancing the inclusivity of chemistry education [9,43,44]. By drawing on these examples, the course provided students with a more comprehensive and connected understanding of the discipline, reflecting the global and collaborative nature of scientific progress as recommended in current research.

2.3. Collaborative Development Process

A distinctive feature of this course was its collaborative development by two student interns and an academic staff member. This partnership leveraged the unique perspectives, interests, and research skills of both students and staff. The development process involved extensive research to identify underrepresented topics, select illustrative case studies, and compile a diverse range of resources, including primary texts, videos, and scholarly articles.

The team worked together to select topics and case studies such as Chinese gunpowder and Indian zinc distillation, which illustrated early chemical technologies and their societal impacts. Additionally, the curriculum highlighted the contributions of chemists from a variety of cultural backgrounds, challenging the Eurocentric narratives often found in standard textbooks and promoting a more inclusive perspective of scientific progress [45–48].

The collaborative approach also allowed for the integration of student interests and contemporary educational strategies, such as active learning and the use of real-world examples, which are known to enhance engagement and deepen understanding in science education [26,49,50]. Feedback from students during and after the course was used to iteratively refine the content and structure, ensuring that the module remained responsive to learners' needs and interests.

The course development team also collaborated closely with a member of the Department of Philosophy, a member of the Institute of Medieval and Early Modern Studies, and library staff. These interdisciplinary partnerships were instrumental in locating and selecting high-quality resources, enriching the course with philosophical, historical, and archival perspectives, and ensuring that the material was both accurate and accessible [49,50].

3. METHODOLOGY

3.1. Course Structure

History of Chemistry is a five-lecture course that is part of Molecules in Action and is an open module (meaning it is available as an elective to students from a range of degree programmes) for first-year undergraduate students. It includes a summative assessment in the form of an essay, which allows students to explore the intersectionality of chemistry, socio-politics, geography, and culture. The structure of each lecture, along with the main historical themes and ways the course broadened the cultural context of chemistry, are summarised in Table 1.

Table 1. Summary of the five History of Chemistry lectures, outlining key themes and how each session expands the historical and cultural context of chemistry. The table highlights content choices that foreground contributions from diverse cultures, recognise women and often-overlooked groups, and challenge traditional Eurocentric narratives within the discipline.

Lecture Number and Title	Key Themes Covered	Expanding Historical and Cultural Context
Lecture 1: Ancient Chemistry	Chemistry's origins in Mesopotamia, Egypt, Greece, India, and China; early practical applications; philosophical theories.	Highlights non-European contributions; features early women chemists; values practical/artisanal knowledge; social inclusivity.
Lecture 2: Middle Ages Chemistry	Impact of Arab expansion; the 'Translation movement'; contributions of Arab alchemists; synthesis of global knowledge.	Emphasises Arabic world's role in preserving and advancing knowledge; showcases cross-cultural synthesis and exchange.
Lecture 3: Middle Ages & Pre-Modern Chemistry (Part 1)	Chinese invention and spread of gunpowder; Europe's adoption of Arabic theories; exclusion of women in Europe; colonial knowledge hierarchies.	Recognises Chinese innovations and global influence; highlights Europe's adoption of non-Western knowledge; addresses exclusion of women in Europe; examines colonial knowledge hierarchies.
Lecture 4: Pre-Modern Chemistry (Part 2)	Paracelsus's Iatrochemistry; Van Helmont's experiments; Marie-Anne Lavoisier's contributions; household alchemy; knowledge exchange.	Focuses on accessibility; highlights women's central roles; values informal science; showcases cross-cultural knowledge flow.
Lecture 5: Pre-Modern Chemistry (Part 3)	Women's contributions; beliefs about metal transformation; chrysopoeia; split between alchemy and chemistry; legacy of alchemy.	Reinforces women's roles; values practical/craft knowledge; acknowledges philosophical and cultural diversity in alchemy.

3.2. Survey Design

To evaluate the impact and reception of the new history-focused chemistry module, a post-course survey was developed, combining both quantitative and qualitative elements. The survey included ten questions, with the quantitative section using Likert-scale questions. These allowed students to rate aspects such as course content, clarity of presentation, relevance to their studies, balance between historical periods, the value of case studies, and the representation of diverse chemists.

The qualitative section included open-ended questions designed to elicit in-depth feedback on students' experiences. These questions invited students to comment on what they enjoyed most about the course, areas they felt could be improved, and suggestions for additional topics or case studies to include in future course content.

3.3. Data Collection

The survey was administered online using Qualtrics XM at the end of the module, ensuring convenience and flexibility for students to respond at their own pace and from any device. Participation was voluntary, and responses were collected anonymously. The survey link was disseminated through the internal email system to all students enrolled in the History of Chemistry lecture course. The survey was active for four weeks, with two reminder emails sent during this period to encourage participation. Ethical approval was granted by the Ethics Committee of the Chemistry Department at Durham University (CHEM-2025-5558-5384).

No personally identifiable information was gathered, and all responses were aggregated for analysis. Anonymisation procedures were rigorously followed, with data stored securely and accessible only to the research team. There were 166 first-year students enrolled in this lecture course, with 30 (18%) students participating in the survey and 16 (10%) completing all the questions.

3.4. Data Analysis

Microsoft Excel was used for descriptive statistical analysis of the quantitative data obtained from the survey.

Qualitative data from open-ended questions were analysed thematically, following the approach described by Braun and Clarke [51]. An inductive approach was used, and responses were first organised and reviewed in their entirety to gain familiarity with the range of feedback. The data were then coded to identify recurring themes, insights, and suggestions, allowing for the grouping of similar responses and the extraction of representative quotes. This process enabled the identification of both strengths and areas for improvement in the course, as well as actionable recommendations for future development.

4. RESULTS

The results of the study, combining both quantitative survey data and qualitative thematic analysis of student feedback, provide comprehensive insights into how the History of Chemistry course met its aims and addressed the posed research questions.

4.1. Understanding of Chemistry's Development

The course demonstrated significant success in enhancing students' understanding of how chemistry has developed over time. Quantitatively, half of the respondents (50%) indicated that their understanding was enhanced "Very much," with an additional 25% reporting a "Moderate" enhancement, as shown in Figure 1. Only 13% felt their understanding was "Not at all" enhanced.

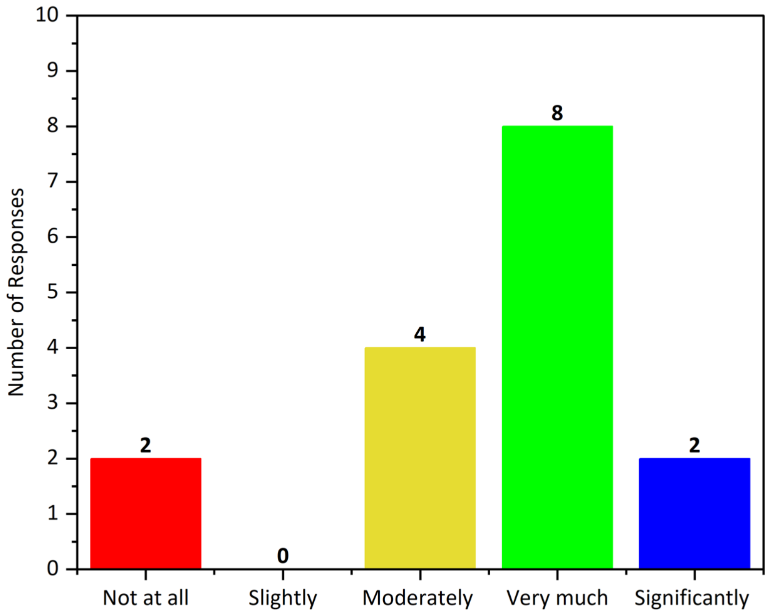

Figure 1. Distribution of student responses (n = 16) to the question, "Did the course enhance your understanding of the evolution of chemistry?" with options ranging from "Not at all" to "Significantly."

The historical progression of chemistry concepts was largely perceived as clear and logical, with 56% of students finding it "Mostly clear" and 19% rating it as "Very clear," as illustrated in Figure 2.

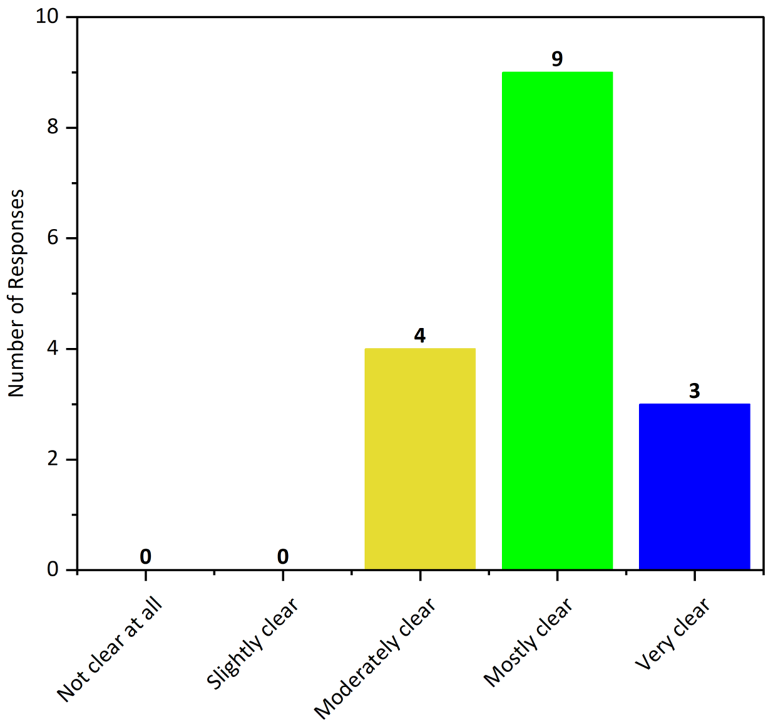

Figure 2. Distribution of student responses (n = 16) to the question, "Was the historical progression of chemistry concepts presented clearly and logically?" with response options ranging from "Not clear at all" to "Very clear."

The balance presented between ancient, medieval, and early modern chemistry was positively received, with 63% rating it as "Appropriate" and 19% as "Very appropriate," as shown in Figure 3.

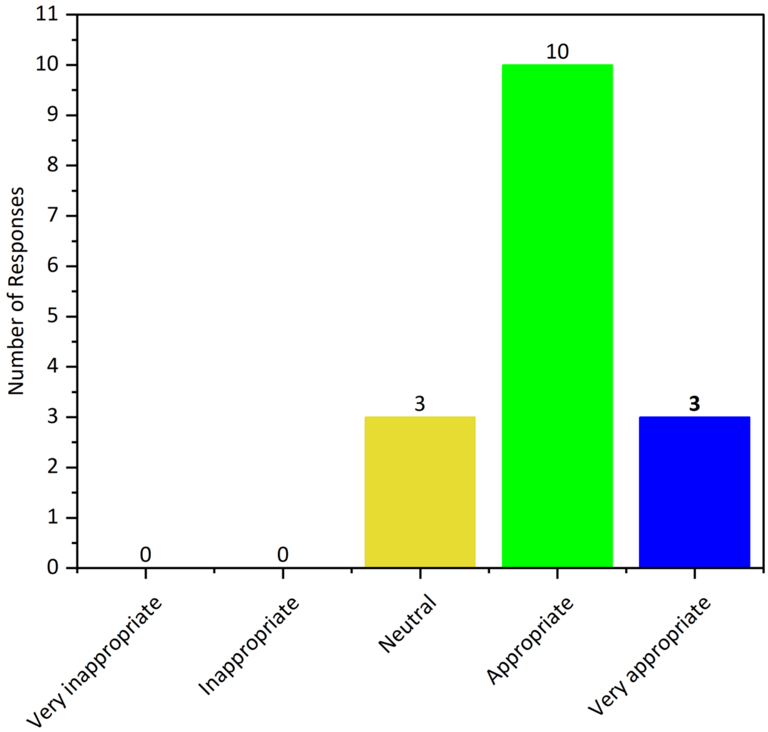

Figure 3. Distribution of student responses (n = 16) to the question, "How appropriate was the balance between ancient, medieval, and early modern chemistry?" with options ranging from "Very inappropriate" to "Very appropriate."

Qualitatively, students consistently expressed positive sentiment regarding the course's broad historical and international scope. Many valued "learning about how chemistry developed around the world and the different contributions," with specific historical periods like "the ancient chemistry and alchemy section" highlighted as particularly engaging. Students also appreciated the opportunity to understand "the development pathways of atomic theory." This feedback indicates that the course successfully met its goal of offering a culturally inclusive and wide-ranging history of chemistry, thereby deepening students' understanding of the subject's historical roots.

4.2. Impact of Diverse Chemists and Global Cases on Belonging and Engagement

The course was overwhelmingly perceived as effective in presenting diverse chemists and their contributions, with 63% rating it "Very effective" and 19% finding it "Extremely effective," as demonstrated in Figure 4. In students' written feedback, the inclusion of diverse cultures and historical practices was widely praised, particularly the global scope that explored chemistry's development across different cultures and time periods. Many valued "learning about how chemistry developed around the world and the different contributions." Specific historical periods, such as "the ancient chemistry and alchemy section," were highlighted as particularly engaging. The inclusion of diverse cultures and historical practices was also praised, as was the opportunity to understand "the development pathways of atomic theory."

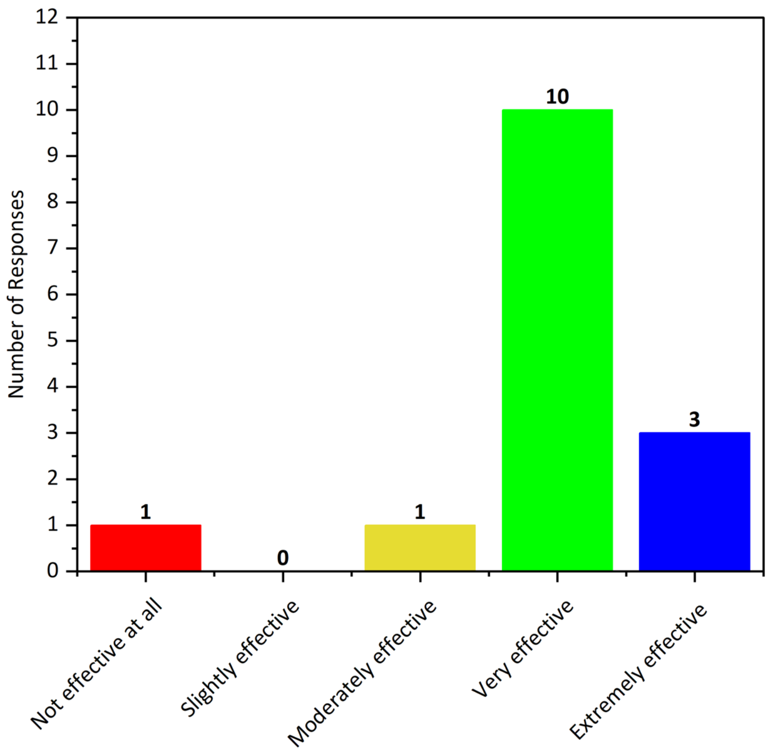

Figure 4. Distribution of student responses (n = 16) to the question, "How effective was the course in presenting diverse chemists and their contributions?" with options ranging from "Not effective at all" to "Extremely effective."

Despite this positive reception, there were some differing opinions. One student stated, "I have no interest in the diverse chemists and their contributions. I chose this module to learn about chemistry and its use/effect on the current world." This feedback suggests that while many students valued the global and historical approach, a few preferred a stronger focus on contemporary and practical aspects of chemistry. This highlights the ongoing challenge of balancing historical and cultural content with students' expectations for immediate, practical relevance.

4.3. Student Perspectives on Storytelling and Case Studies

Case studies and examples, such as Egyptian glassmaking and Mesopotamian perfumes, were largely found to be effective in illustrating historical chemistry concepts. Quantitatively, 38% of students found them "Moderately effective," 31% "Extremely effective," and 19% "Very effective," as presented in Figure 5. In total, 88% of students found these examples at least "Moderately effective," with only a small minority (6% each) rating them as "Not effective at all" or "Slightly effective."

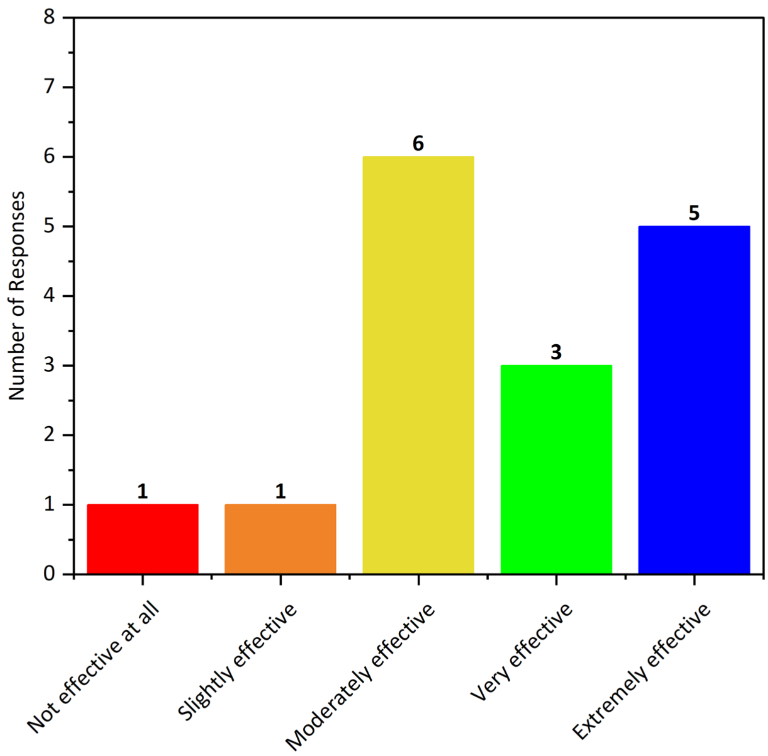

Figure 5. Distribution of student responses (n = 16) to the question, "How effective were the case studies and examples (e.g., Egyptian glass, Mesopotamian perfumes) in illustrating historical chemistry concepts?" with options ranging from "Not effective at all" to "Extremely effective."

Qualitatively, students appreciated that these narratives about the development of chemical knowledge revealed science as a "deeply human endeavour, shaped by curiosity, creativity, and collaboration." They also highlighted the engaging nature of the case studies and additional resources. However, some students requested "more depth on case studies and concepts" and a stronger focus on the scientific methods employed by historical chemists. This indicates a desire to explore the epistemological development of chemistry beyond factual history, understanding "how they made use of the tools they had to hand."

4.4. Response to a Co-created, Inclusive Chemistry Curriculum

The overall content and structure of the course were positively received, with 63% rating it as "Good," and an additional 13% each rating it "Very good" or "Excellent," as shown in Figure 6. However, a small proportion (13%) rated it "Very poor."

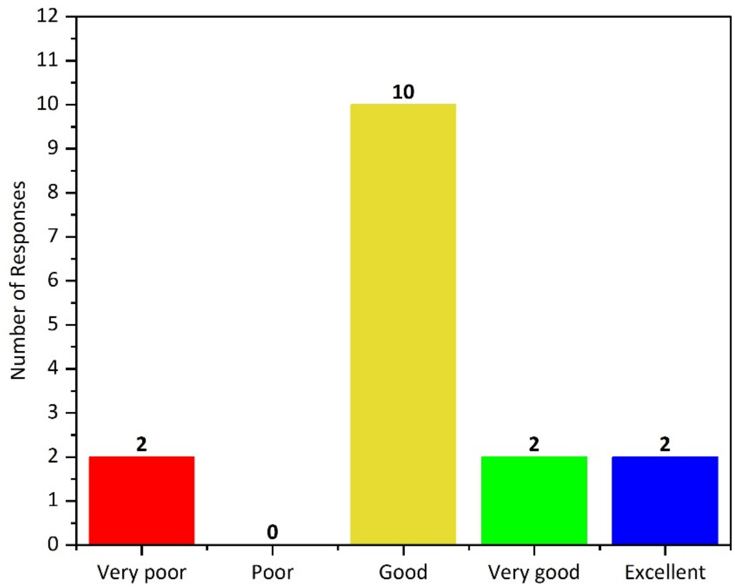

Figure 6. Distribution of student responses (n = 16) to the question, "How would you rate the overall content and structure of the History of Chemistry course?" on a scale from "Very poor" to "Excellent."

Student likelihood to recommend the course showed mixed sentiment, with half of the respondents (50%) being "Somewhat likely" to recommend it, while the remaining responses were evenly distributed across other categories. This mixed pattern may reflect the varied academic backgrounds of students (e.g., biosciences, chemistry, engineering, philosophy), leading to different expectations for a history-focused module.

Qualitatively, several students expressed strong satisfaction, with one commenting, "it is perfect." Many highlighted their appreciation for the course's global scope, the inclusion of diverse cultures and historical practices, and the engaging nature of the case studies and additional resources.

However, a prominent theme in the feedback was the perceived lack of contemporary chemistry content, with one student feeling "the course felt like a history lesson." There was interest in covering the early Industrial Revolution and Victorian periods to bridge to modern chemistry. Feedback also included comments about the course's pacing, with one student describing it as "a bit slow" and another noting that "the timeline of the medieval/early modern period was a little spontaneous." This "nonchronological structure" was a deliberate design choice to present different cultural histories separately and highlight diversity, though it sometimes made it harder for students to follow the broader development of chemistry.

5. DISCUSSION

The analysis of student feedback for the History of Chemistry course provides valuable insight into both its strengths and the diversity of student experiences. These findings set the stage for a deeper discussion of how the course met its objectives, where it fell short, and how student feedback can inform future improvements. In the following discussion, the results are interpreted in the context of current literature on chemistry education and curriculum design, with particular attention to the value of historical context, student–staff collaboration, and the ongoing challenge of balancing past with present content.

5.1. Course Reception and Structure

As shown in Section 4.4 and Figure 6, most students responded positively to the course content and structure. This supports previous research showing that learners appreciate courses that are well organised and have a clear flow and purpose [52]. However, some participants did not respond positively, which shows that even new or creative modules may not meet everyone's expectations, a pattern also seen in other studies on curriculum change [5]. Since the course is still quite new, it is understandable to see a range of opinions, and this feedback will help guide future improvements as the course develops.

5.2. Enhancing Historical Understanding

A core objective of the course was to enhance students' understanding of the evolution of chemistry. The survey results indicate significant success in this area, with half of respondents reporting their understanding was enhanced "Very much," and a further quarter reporting a "Moderately" enhanced understanding. This finding is consistent with literature on the integration of historical perspectives in science education, which demonstrates that such approaches can deepen scientific literacy and foster critical thinking [1,2]. However, as in other studies, a minority of students did not feel their understanding was improved, suggesting that historical modules may not resonate equally with all learners [45].

The clarity and logical progression of chemistry concepts were also rated positively, with most students describing the historical progression as "Mostly clear" or "Very clear." This supports the idea that careful instructional design can make complex historical content accessible [13]. The balance between ancient, medieval, and early modern chemistry was largely appreciated, echoing recommendations from curriculum experts to present a broad historical sweep to help students see the discipline's evolution [7,53].

5.3. Storytelling, Case Studies, and Engagement

As described in Section 4.3, survey feedback indicated that most respondents valued the use of stories and case studies for making historical chemistry content more engaging and understandable. Student comments particularly emphasised that learning about the origins and uses of materials made chemistry feel more real and connected to everyday life, echoing the benefits outlined in previous studies [42,54–57]. Several participants expressed interest in having more in-depth or varied case studies, suggesting that while narrative approaches were broadly effective, greater diversity and depth could further enhance critical thinking and engagement in future iterations of the course.

These findings reinforce the importance of variety in teaching methods and are consistent with research demonstrating that situating science in human contexts can promote stronger retention and motivation [42,54–56,58]. However, a small number of respondents found these approaches less helpful, highlighting the need to accommodate diverse learning preferences, consistent with observations in educational literature [59,60].

5.4. Diversity, Representation, and Student Expectations

A particularly strong area of the course was its effectiveness in presenting diverse chemists and their contributions. This was overwhelmingly rated as effective, reflecting the growing emphasis on equality, diversity, and inclusion (EDI) in science education [46]. However, one student expressed a preference for a more contemporary or applied focus, highlighting a tension noted in the literature between historical or cultural content and student expectations for practical relevance [1,45]. This feedback suggests that, while representation is important, clear links to modern chemistry and its applications may further enhance student engagement.

The likelihood to recommend the course showed mixed sentiment, with half of respondents "Somewhat likely" to recommend it and the rest spread across other categories. This pattern may reflect the varied academic backgrounds of respondents, as students from biosciences, chemistry, engineering, natural sciences, mathematics, biochemistry, computer science, biological sciences, and philosophy may have different expectations for a history-focused module. Similar findings are reported in broader studies of interdisciplinary and history-infused STEM curricula [49].

5.5. Addressing Modern Content, Pacing, and Structure

A recurring point in the qualitative feedback was the request for more content on modern or "real" chemistry. One student perceived the module more as a history lesson, lacking sufficient connection to current chemical practice. There was particular interest in developments from the Industrial Revolution and early Victorian periods. This highlights a gap between the course's historical focus and expectations for material directly related to present-day studies.

Adding examples from modern chemistry or including clearer explanations of equipment and techniques could help make the course feel more relevant and engaging. However, given the limited number of lectures, introducing more modern content would require reducing coverage of other topics, which is a trade off that requires careful consideration. Revising the course synopsis to clearly outline its aims and the type of content covered would help students make more informed choices and align their expectations with the course's focus on historical rather than contemporary chemistry.

Feedback also addressed the pacing and structure of the course. One student noted that lectures sometimes moved slow and suggested progressing through the material more quickly. Another observed that the timeline occasionally jumped around, especially during the Medieval and early modern periods. This reflects a deliberate design choice: the course team chose to teach the history of different cultures separately, providing a clear narrative within each cultural context and avoiding a Eurocentric perspective. While this structure enabled deeper exploration and highlighted diverse contributions, it also meant that the overall timeline was not strictly chronological. Topics from different cultures that occurred concurrently were presented in separate blocks, which sometimes made it harder to follow the broader development of chemistry. A more linear or clearly signposted timeline could improve students' ability to track the progression of ideas and discoveries.

Although one student said they wanted to see more Euro-American developments like the Industrial Revolution, the course intentionally focused on examples often underrepresented in traditional curricula. This approach aimed to centre contributions from diverse cultures and expand students' understanding of chemistry's global roots [1]. However, the course layout could be improved by altering the first lecture so that it includes a slide that asks students to question their current understanding on modern chemistry and consider challenging any stereotypes that they may hold regarding chemical education. This could result in the course being more well-received by students who were not as receptive or interested in the historical aspect nor the cultural impact on discoveries.

5.6. Collaborative Development and Multidisciplinary Perspectives

A key strength of the course was its collaborative, student–staff co-creation approach. The interns, drawing on their own experiences as undergraduate students, played a central role in shaping the course to reflect student learning preferences, such as developing a course handbook with detailed explanations and recommended readings to make the material more accessible and clear [25]. The academic staff member contributed their expertise to ensure the lecture slides were coherent and could be delivered effectively within the available time. This partnership between students and staff meant the course was both comprehensive and engaging [25,60]. The team was united by a shared goal of diversifying and decolonising the curriculum at Durham University, and each collaborator brought their own perspective and motivation that enriched the course. This creative freedom allowed the interns to build a module that reflected the kind of representation they wanted to see in the chemistry department. This collaborative, student–staff co-design model aligns with research showing that involving students as partners in curriculum design can increase engagement, foster a sense of belonging, and improve the relevance of course content [25–27]. The positive reception of the course's inclusive content and structure further supports the effectiveness of such partnerships in higher education.

History is a multidisciplinary subject, bringing together ideas from sociology, philosophy, geography, and science [1]. The History of Chemistry course gave students a chance to explore these themes and look at chemistry from a different angle, while also working towards decolonising the curriculum. Research suggests that including historical context in science education helps students better understand the nature of science and improves their overall scientific thinking [1,13,42,57,61,62]. Studying the history of chemistry can lay the groundwork for understanding contemporary topics and gives students a sense of the cultural significance of scientific achievements, which can help develop their lateral thinking and problem-solving skills [1,42,61].

5.7. Alignment with Research Questions

In response to Research Question 1 (How does history and culture in chemistry education affect students' understanding of chemistry's development?), the course effectively broadened students' perspectives on the evolution of the discipline. As demonstrated in Section 4.1, survey data indicated that students gained a clearer appreciation of chemistry's global roots and the complex interplay of cultures and societies in shaping scientific progress.

Regarding Research Question 2 (How does including diverse chemists and global cases impact students' belonging and engagement?), findings presented in Section 4.2 showed that the representation of diverse chemists and international case studies contributed positively to students' sense of belonging and engagement. The approach was widely valued by respondents.

For Research Question 3 (What do students think about storytelling and case studies in showing science as a human, evolving process?), as detailed in Section 4.3, students found that storytelling and case studies made scientific ideas more relatable and helped them view chemistry as a dynamic, human-centred discipline. The effectiveness of these pedagogical approaches was evident from both the quantitative ratings and open-ended feedback.

In answer to Research Question 4 (How do students respond to a co-created, inclusive chemistry curriculum regarding literacy, thinking, and satisfaction?), results discussed in Section 4.4 indicate that the collaborative development process increased the perceived relevance and accessibility of the module. Students responded positively to the inclusive curriculum, although some suggested including more content on modern chemistry and providing clearer chronological signposting.

5.8. Recommendations and Future Directions

The History of Chemistry course successfully met its main aims of enhancing students' historical understanding and promoting diversity. These findings provide further evidence for the value of integrating historical context and student partnership in science education, as highlighted in recent literature [1,2,25]. However, feedback also points to ongoing challenges, such as balancing historical content with contemporary relevance and meeting varied student expectations. Future iterations could address these by incorporating more explicit links to modern chemistry and offering opportunities to explore applied aspects alongside historical themes.

One key challenge in developing the History of Chemistry course was deciding on the content and condensing it into five lectures. The breadth and depth of topics, along with the complexity of each historical period, made this a complex task. Consequently, the team collectively prioritised certain topics for focus. Nonetheless, regular review of student feedback allows for updates, including potential changes to the examples used for each time period. The student survey also indicated interest in having a stronger focus on the chemistry underlying each example, which is difficult to achieve within the time constraints. To address this, additional supplementary materials can be added to the course handbook for those wanting to explore topics in more depth, with links to other first-year chemistry modules where relevant.

6. CONCLUSIONS

The History of Chemistry course largely succeeded in enhancing students' understanding of the discipline's evolution, with half of respondents reporting their understanding was enhanced "very much." Students valued the course's broad historical and global scope, especially its emphasis on diverse chemists and the exploration of chemistry's development across different cultures and time periods. This reflects ongoing efforts to promote inclusivity and representation within science education [1,46]. Sections on ancient chemistry and alchemy stood out as particularly engaging, likely due to their story-based approach and emphasis on chemistry's global origins. Case studies and practical examples also supported learning effectively, with 88% of respondents rating them at least "moderately effective."

Some areas for improvement were identified in the feedback. There was interest in placing greater emphasis on contemporary and applied aspects of chemistry, as the module was seen by some as focusing more on historical topics and not as closely connected to current chemical practice [45]. Comments also referenced the pacing of lectures and the nonchronological structure, which reflected a deliberate choice to present different cultural histories separately and to highlight diversity and avoid Eurocentrism. Additional suggestions included providing greater depth in case studies and placing more emphasis on the scientific methods used by historical chemists [2].

A key strength of the course was its collaborative development, which brought together students, staff, and colleagues from other disciplines. By drawing on these interdisciplinary partnerships, the team created a more engaging and relevant course for a diverse student body. This approach also ensured that the curriculum incorporated multiple perspectives, supporting a more holistic understanding of chemistry within its broader cultural and historical context [24–27,63].

For future iterations, the course could benefit from clarifying the course synopsis to manage student expectations and incorporating more explicit links to modern chemistry, potentially by providing additional resources in the course handbook for those seeking to explore applied chemistry in greater depth [45]. While maintaining its culturally diverse focus, adjusting the pacing and providing clearer chronological signposting may further support student understanding.

The History of Chemistry course offers a valuable model for integrating historical context, cultural diversity, and student–staff partnership into science education [1,2,25]. Ongoing refinement, informed by feedback, can help balance historical depth with contemporary relevance, offering a replicable strategy for other science departments seeking to innovate and diversify their curricula [64]. Future research could explore whether historical perspectives have a lasting influence on students' scientific literacy and critical thinking, for example through longitudinal studies. It could also investigate how similar modules might be adapted and implemented in different academic contexts [3].

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APPENDIX

The following questions were included in the survey administered to students at the end of the History of Chemistry course.

1. How would you rate the overall content and structure of the course?

(Likert scale: 1-5, from Poor to Excellent)

2. Did the course enhance your understanding of the evolution of chemistry?

(Likert scale: 1-5, from Not at all to Significantly)

3. Was the historical progression of chemistry concepts presented clearly and logically?

(Likert scale: 1-5, from Not clear at all to Very clear)

4. How appropriate was the balance between ancient, medieval, and early modern chemistry?

(Likert scale: 1-5, from Very inappropriate to Very appropriate)

5. How effective were the case studies and examples (e.g., Egyptian glass, Mesopotamian perfumes) in illustrating historical chemistry concepts?

(Likert scale: 1-5, from Not effective to Very effective)

6. How effective was the course in presenting diverse chemists and their contributions?

(Likert scale: 1-5, from Not effective at all to Very effective)

7. How likely are you to recommend this course to others?

(Likert scale: 1-5, from Very unlikely to Very likely)

8. What aspects of the course did you enjoy the most?

(Open-text field)

9. What areas of the course do you think could be improved, and how?

(Open-text field)

10. Are there any specific topics you would like to see added or expanded in future iterations of the course? Please provide any additional comments or suggestions for improving the History of Chemistry course.

(Open-text field)