RSC Sustainability

ROYAL SOCIETY OF CHEMISTRY

PAPER

View Article Online
View Journal

Check for updates

Cite this: DOI: 10.1039/d5su00950b

Surveying user experiences in an inclusive online green chemistry education community of practice

Nimrat K. Obhi,†*[a] Jonathon W. Moir, †*[a] Sarah Prescott, [b] Alisha Szozda,[a] Sarah Kennedy,[a] Omar Villanueva [a] and Amy S. Cannon [a]

Received 24th December 2025
Accepted 1st March 2026

DOI: 10.1039/d5su00950b

rsc.li/rscsus

The Green Chemistry Teaching and Learning Community (GCTLC)—launched in October 2023—is an online platform dedicated to fostering a global community of practice (CoP) that supports the integration and advancement of green and sustainable chemistry in chemical education systems worldwide. Consistent with the platform's mission and vision, the success of such a CoP requires an understanding of how well it can create and support a communal sense of belonging amongst users and how effectively the platform encourages and facilitates behavior change in teaching practice. To assess this, we present herein the findings from the first annual survey of GCTLC members, administered in 2024. The results demonstrate that not only has the platform helped create a strong sense of belonging among users in its first year of operation, but that it has also increased the confidence of those users to teach green chemistry. The ability to access and download curriculum materials and resources from the site was rated as one of the most useful features, and comments from respondents suggest they are actively incorporating (or plan to incorporate) those resources into existing courses they teach. The results lend strong evidence to the power of collaborative online platforms and how virtual CoPs can effect change at a global level.

Sustainability spotlight

It is critical that education systems be transformed to contextualize learning within the framework of sustainability to address the UN SDGs and train the next generation of leaders, scientists, politicians, and citizens to make informed and conscientious choices in their day-to-day lives. Community-based (bottom-up) approaches to educational reform in STEM fields have a demonstrated impact on teaching through peer-to-peer learning and accelerated adoption of new practices. The results herein demonstrate that online community platforms such as the GCTLC can support educators by providing access to resources, creating opportunities for peer-to-peer support and connection, building confidence, and supporting a sense of belonging. This has a direct impact on UN SDG #4 (Quality Education) as well as connections to many other SDGs.

Introduction

Critical to advancing sustainability goals across the global chemical enterprise is a future workforce equipped with the skills necessary to make informed decisions and invent solutions to pressing environmental, human health, and climate-related issues. Educational reform and the formal teaching of chemistry through the lens of green and sustainable chemistry provides one promising way to help prepare students to do just that. However, educational reform requires time and effort, often through grassroots efforts (bottom-up), policy-driven changes (top-down), or both.

Integrating green chemistry within a broader sustainability and systems-thinking framework is increasingly recognized as essential for preparing students to make informed decisions about chemical design. Recent work by Orgill and co-workers highlights how connecting molecular science to sustainability contexts helps students reason about life-cycle and societal impacts of chemistry.[1] Frameworks such as the IUPAC Systems Thinking in Chemistry Education (STICE/STCS 2030+) initiative provide models for embedding sustainability reasoning throughout curricula.[2] However, persistent barriers—including limited resources, training, and community support—continue to hinder widespread implementation.[3,4]

Communities of practice (CoPs) are well-known mechanisms for creating systemic change and reform in STEM education.[5–10] Specifically, participating in CoPs has been shown to help create a sense of belonging amongst educators, bolster information sharing and peer-to-peer learning, and facilitate the propagation of new teaching practices. This is especially true in situations where educators and faculty may not have access to support mechanisms at their home institutions and feel otherwise isolated in their attempts to innovate their teaching. Many chemistry education CoPs have taken root over the years, including The Process-Oriented Guided Inquiry Learning

[a]Beyond Benign, Inc., Wilmington, MA 01887, USA. E-mail: amy_cannon@beyondbenign.org
[b]The BioQUEST Curriculum Consortium, Raymond, NH, USA
† Co-first authors.

(POGIL) Project,[10,11] the Interactive Online Network of Inorganic Chemists (IONiC) and their Virtual Inorganic Pedagogical Electronic Resource (VIPEr) platform,[12,13] the Organic Chemistry Education Resources (OrganicERs) group,[14,15] the Analytical Sciences Digital Library (ASDL),[16,17] the Biochemistry Authentic Scientific Inquiry Laboratory (BASIL) Community,[18,19] and many others.[20]

The Green Chemistry Teaching and Learning Community (GCTLC) is a more recent addition to the list.[3,21] Launched in October 2023 by Beyond Benign and the American Chemical Society Green Chemistry Institute (ACS GCI), the GCTLC is a virtual platform whose mission is "*to create, develop, and nurture a diverse and accessible online community of practice that fosters a strong sense of belonging and supports open collaboration, networking, mentorship, and resource sharing between members of the scientific community to advance the integration of green and sustainable chemistry principles and practices across the education continuum*." Since its launch, the GCTLC has garnered over 3000 registered users from 106 countries worldwide (data as of November 1, 2025). The platform hosts a searchable, peer-reviewed library of over 400 curriculum materials and resources (including, but not limited to, greener lab experiments, lecture slides and modules, case studies, assessment questions, videos, podcasts, and links to published journal articles). It also supports a community-driven events calendar, job board, and forums and group spaces for users to connect, share ideas and information, create open dialogue, and learn from one another. Notably, the administrators of the GCTLC (composed of full-time and part-time staff employed by Beyond Benign), in collaboration with and under the guidance of community leaders and education experts, intentionally interwove the concepts of diversity, equity, belonging and respect (DEBR) throughout all aspects of the site's functional development and program planning.[22] Research in STEM education reveals that communities and networks that overlook equity often perpetuate existing exclusionary dynamics.[23–26] Brooks *et al.* provide guidelines for embedding respect and inclusion into chemistry education practice, emphasizing that equitable platforms must address institutional power structures and support all voices.[23] To address these issues, the GCTLC's moderation practices, implementation of questions and criteria to ensure equitable submission and transparent review of curriculum resources, and mentoring infrastructure are intended to operationalize DEBR as a foundation, not an afterthought. In addition, the development of a platform-wide Code of Conduct promotes a culture of safety for all users and creates a welcoming and supportive online space.

Importantly, with these foundations in place, the GCTLC aims to address the challenges and persistent barriers highlighted above in implementing green chemistry in education systems by fostering a global community of practice that shares adaptable teaching materials and promotes inclusive, systems-based approaches to advancing sustainable chemistry education. To understand how well the GCTLC is achieving its mission and to best support its community of users into the future, an annual survey was launched in September 2024 to collect user feedback and assess the impact of the platform on accelerating the adoption of green chemistry across education systems globally. While the platform is still relatively new and this is the first annual survey of its users, insights from the data are invaluable and can help support future improvements to the site. Essential questions in the survey were targeted towards understanding which functional components of the site were most used and valued, how well the platform engendered a sense of belonging, whether the GCTLC had helped users gain a better understanding of green chemistry, whether users had downloaded and used curriculum materials from the platform, whether their participation on the platform improved their confidence to teach green chemistry to their students, and how the GCTLC could be further improved. This article provides a summary of the results from this first annual survey, conducted approximately one year after the launch of the platform, to gauge how well this CoP is achieving its mission.

Methods

The survey of GCTLC users was administered from September 24th to October 21st, 2024, through the GCTLC platform (using built-in Drupal 10 webform functionality). The full survey instrument is available in the SI. A link to the survey was sent by email to 1349 users out of a total of 1502 users on the platform at the time (the difference being due to those who had opted out of email communication). A total of 94 responses were received (∼7% response rate). It is important to note that these respondents likely include some of the most engaged users on the GCTLC, which could result in biased responses, skewing the data towards more favourable results. However, while the surveys were collected and associated with user profiles on the platform (as only GCTLC users were able to complete the survey), the results are only provided in aggregate, and no identifiable data is included. Users were informed that by submitting the survey, they agreed that their responses would be used anonymously to help improve the GCTLC. They were also provided a link to the GCTLC's Terms and Conditions of Use document, which provides more details on data usage and privacy on the platform. All users must accept these terms prior to registering for the platform. As this was a survey of member and user experiences on a virtual platform and not part of a formal research study, institutional review board (IRB)/formal ethics approval was not required.

The survey was designed to include diagnostic questions to assess sense of belonging among users while also collecting self-reported engagement patterns and usage of the different site features. Careful attention was paid to the phrasing and design of the questions (closed *vs.* open, wording, format, *etc.*) to make self-reporting easier for users and to ensure self-reported data most accurately reflected users' true feelings and minimized bias, consistent with reported best practices.[27–30] The survey was divided into several sections: using the GCTLC; resources; forums; events; jobs; connection, engagement and belonging; and communication. Some of the sections (resources, forums, events, jobs) were only presented to users if they indicated in the first section that they had used that particular feature. The survey also provided an opportunity for users to update their basic user profile and demographic information, if needed, and to share any accessibility needs they may have with the site administrators to support more inclusive practices and functional design of site elements. Multiple-choice, Likert scale, and short-answer questions were the primary question formats used in the survey. Importantly, assessing sense of belonging, confidence in teaching green chemistry, and the impact of platform participation on both of these criteria requires direct self-reported user feedback and cannot be measured through engagement statistics alone. Participation in the survey was incentivized through a random draw of gift cards following the conclusion of the survey period.

Results and discussion

Respondent demographics and general usage on the GCTLC

A total of 94 responses (approximately 7% response rate) were received for the 2024 survey. Based on voluntary demographic data provided through GCTLC user profiles and analyzed in aggregate (see Fig. S1–S4), respondents hailed from at least 21 different countries worldwide, with almost half (45%) indicating they are based in the United States (Fig. S1). This is consistent with the overall geographic distribution of the GCTLC's full user base at the time (~1500 registered users), with ~49% being U.S.-based (full demographic breakdown not shown), and if anything suggests a slightly more engaged international audience that completed the survey. The high representation of U.S.-based users is not unexpected given recruitment for the GCTLC during and immediately after the platform's launch was heavily focused on existing U.S.-based networks but has since expanded to be more international. Additional efforts to expand international presence on the platform are underway (see Future work section), although it is important to note that providing information on geographic location is completely voluntary and not all users (including the survey respondents) provided this data.

In terms of gender identity and diversity (Fig. S2), just over half of the participants self-identified as women. Respondents self-identified across a range of race and ethnic identities (Fig. S3), with almost half self-reporting themselves as higher education educators or administrators (Fig. S4). The demographic representation of respondents closely matched the overall demographic representation of users on the GCTLC (data not shown), indicating a good representation of responses across these demographic segments.

GCTLC users self-reported having visited or used many of the different features/pages of the GCTLC (Fig. S5). Unsurprisingly, most of the features/pages that the respondents used or visited were those that require passive activity (*e.g.*, viewing a page), compared to those that require active participation and data entry (*e.g.*, submitting a new resource (learning object), event, or job posting). Fig. 1 shows the features/pages that users self-reported were most useful to them, indicating the resource library and/or resource pages and the forum and discussion spaces were the top two most useful parts of the GCTLC. This finding is also unsurprising given the interest educators have in finding useful resources to incorporate into their existing courses or to find inspiration for new labs, lecture content, case studies, or assessment questions (see later sections). This was further corroborated in the question that asks users what prompts them to visit the site most of the time. Responses are provided in Table S1 in the SI, which generally fell within the following categories: curiosity, passion, interest and/or intrinsic motivation (4 out of 60 comments); searching for resources, new materials, learning approaches or inspiration (29/60); connections, community, forums and discussions (7/60); upcoming events (3/60); jobs, opportunities, professional development or personal growth (5/60); and other/miscellaneous (12/60).

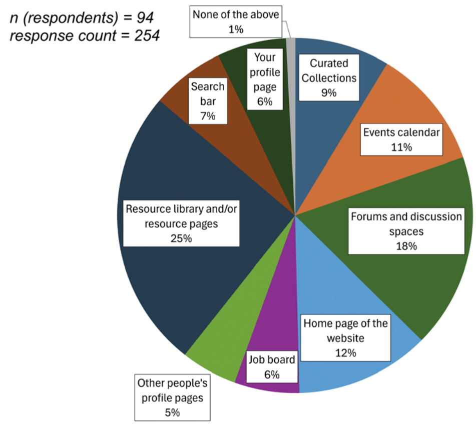

Fig. 1 Most useful features/pages on the GCTLC based on responses from surveyed community members. Respondents could select multiple options.

Fig. 2 shows the results of the Likert scale questions around the ease of use and appearance of the GCTLC (question #5 in the survey). Across all rating questions and features shown (excluding "not applicable," or "N/A" responses), at least 67% of users agreed or strongly agreed with the statements presented, indicating the GCTLC is a user-friendly and easily navigable platform. Some of the features were less commonly used than others, such as submitting resources or using the job board. A variety of factors can influence this such as the time needed to develop and submit resources to the platform, the young age of the platform at the time of the survey, and the need to search for new jobs (many of the survey respondents, being already employed as educators or teaching faculty, may not need the job board as compared to those more in need, such as graduating students).

Three of the Likert scale rating questions in question #5 were separated from those in Fig. 2 and are displayed in Fig. 3. These questions address the beliefs of GCTLC users, specifically whether they believe the GCTLC is the best place to access green chemistry resources, whether the GCTLC has strengthened their belief in the importance of students learning green chemistry, and whether the GCTLC has increased their awareness/understanding of green chemistry. Notably, all three rating questions received strong support, with at least 75% of respondents indicating agreement or strong agreement with each statement. This demonstrates that the GCTLC is on its way to achieving its mission and helping to advance the integration of green chemistry in education.

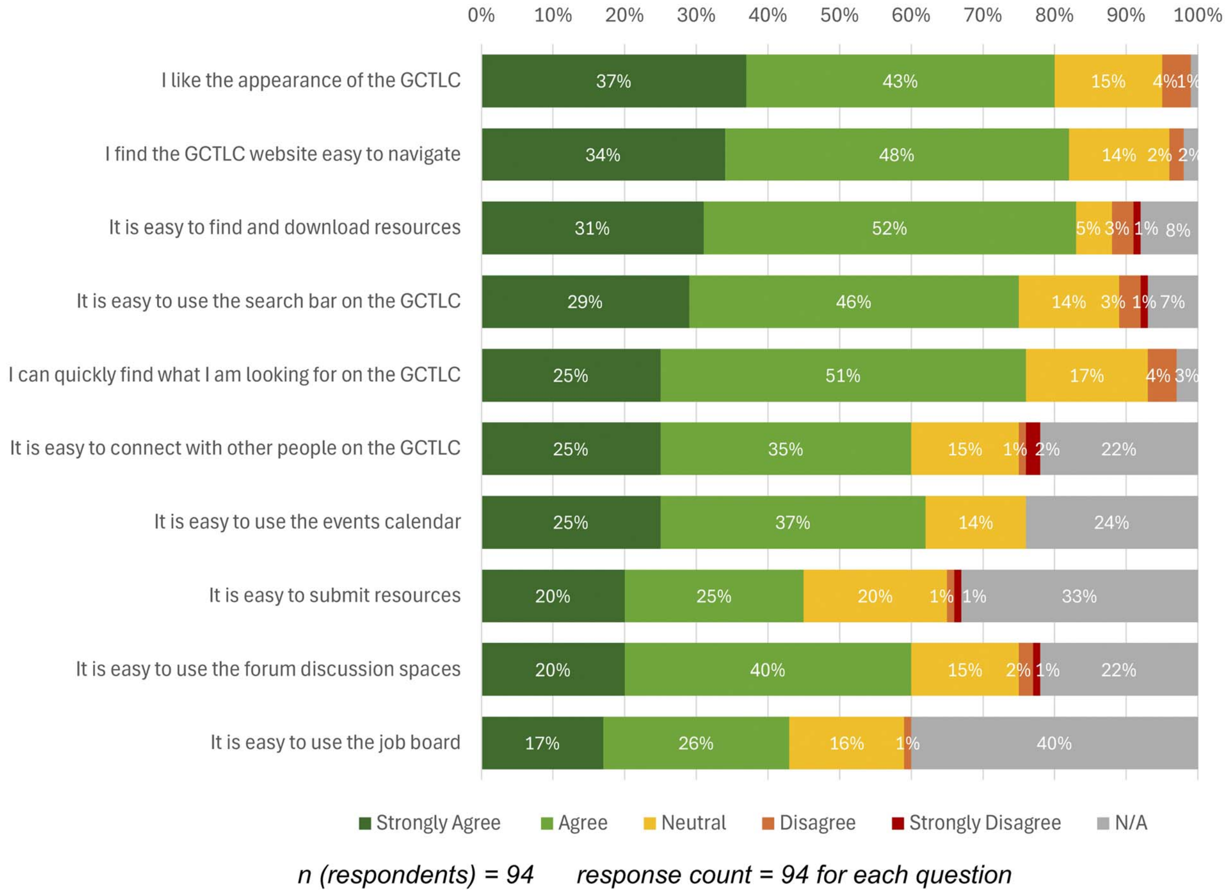

Fig. 2 Ease of use and appearance of the GCTLC across a series of Likert scale questions.

Curriculum resources and library use

To further understand the responses to question #5 (Fig. 2), users were asked if they had used any of the resources (called learning objects) from the GCTLC in their teaching (question #6). Learning objects are curriculum materials and resources available through the GCTLC's searchable library and curated collections, including both open-access downloadable content

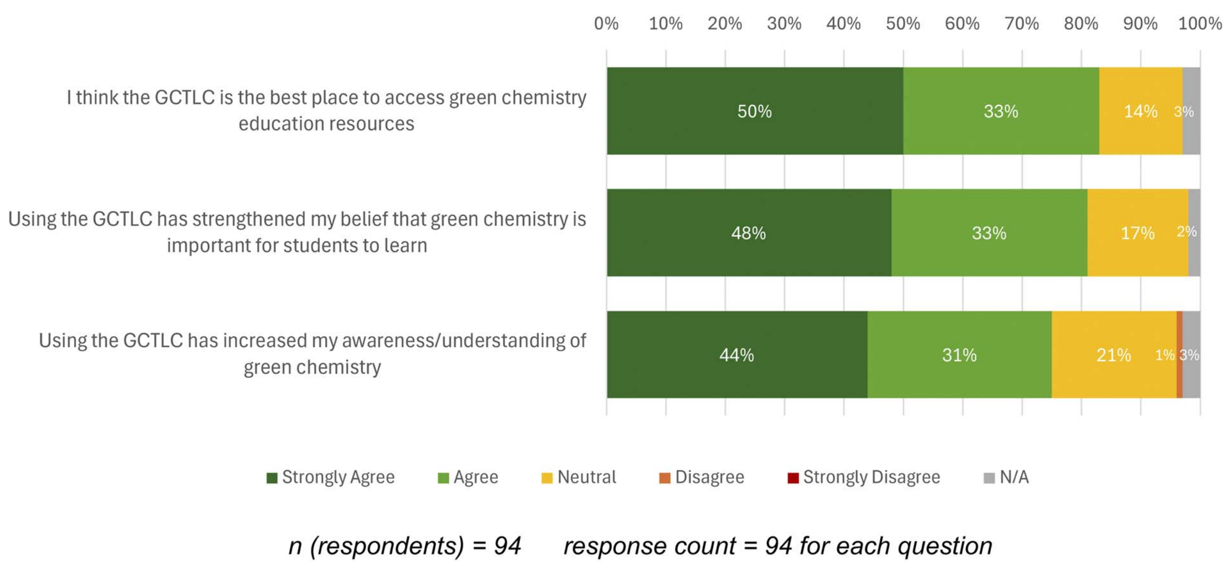

Fig. 3 Belief of respondents that the GCTLC is the best place to access green chemistry education resources, and that using the GCTLC has increased respondents' awareness/understanding of green chemistry and strengthened their belief that green chemistry is important for students to learn.

(such as lecture slides, case studies, greener lab experiments, in-class activities, and video tutorials) as well as externally linked resources (such as links to journal articles, documentaries, and more). Learning objects submitted to the GCTLC undergo an initial review by the Chief Editor, who may, as appropriate, assign them to volunteer peer reviewers from the GCTLC community for evaluation against scholarly criteria established in collaboration with the GCTLC's leadership committee. Importantly, the GCTLC can accommodate both original work from community members (requiring peer review) and links to existing resources available online through other organizations and publishers. When asked about whether they had used GCTLC resources in their teaching (question #7), approximately 81% of respondents for this question (70% of all survey respondents) had done so or were planning to do so in the future, confirming that the resources available through the GCTLC are one of the biggest draws and most important features of the platform (see Fig. S6). Fig. 4 shows that, of those users who replied "Yes" or "No, but I plan to in future" in question #7, the majority had used or were planning to use between 1 to 5 resources from the GCTLC's library. In contrast, a much smaller proportion (11%) were planning to use 6 or more resources, however this non-trivial percent is not unexpected given that many of the resources on the GCTLC are organized into collections, including predesignated curriculum modules that can be used independently or as a collective set (such as to create a dedicated course on green chemistry or toxicology).

A follow-up question asked respondents to describe how they had used or planned to use the resources they downloaded (question #9). Table S2 in the SI provides a full set of responses. Many of the responses indicate an incorporation of the GCTLC's resources into existing courses, although a few responses suggested the resources were used for things beyond teaching (such as working in the pharmaceutical industry and wanting to learn about other perspectives and best practices in green chemistry). A few sample responses are provided below, which were selected based on the completeness of their responses and because they demonstrate a mix of different circumstances in which resources were implemented (*e.g.*, secondary and postsecondary levels, lectures and labs, general chemistry and analytical chemistry):

"I have used in my classroom [the] Stoichiometry challenge and the Acids, Bases, and pH resources. I have used the resources for 9th–12th chemistry and AP-Chemistry classes. Each class has between 15–20 students. I would add more research and reflection questions to the resources so that students can go further in their written reports."

"In general we use the YALE UNIDO [course] for the revision of all our chemistry [program]…although we use some of the learning materials found here in GCTLC for providing examples for waste prevention and atom economy."

"I utilized the resources from the GCTLC [for] my Green and Sustainable Chemistry seminar course, specifically integrating the Toxicology for Chemists Module 2 [as well as] 12 Green Chemistry principles."

"I use the resources to teach my students, especially during lab practicals. However, I plan to use the resources to guide my students on career opportunities and the importance of imbibing green chemistry into their daily lives in order to keep our world green."

"We are going to try the green tea iron in vitamins lab in Analytical Chem in the spring. We do the [traditional] lab, and it generates SO much waste."

"I use the Tox for Chem resources, most of the modules…and adapt them for non-science majors. These are for 20 person sections…Next semester I teach a new Tox for non-chemists course, and will further adapt the Tox for Chem resources."

"I did use the Toxicology module, as I have implemented a signature assignment to explore how PFAS exposure affects the community of color. I plan to explore ChemForward in my organic chemistry lab…if time allows."

"not in a teaching scenario but working in pharmaceuticals i like to explore other perspectives and best practices on green chemistry."

It is clear that many of the GCTLC's resources are adaptable to a range of classroom and laboratory settings, although more detailed analyses and an in-depth study are needed to fully assess this (see later section on future work).

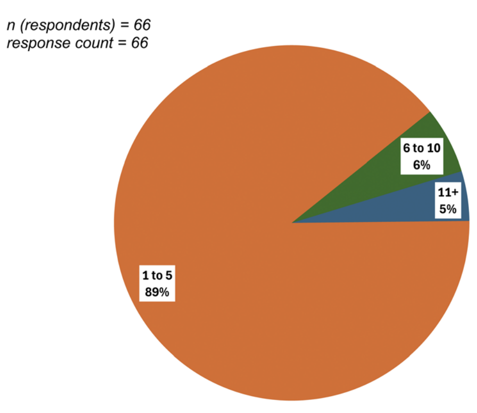

Fig. 4 For respondents who answered "Yes" or "No, but I plan to in future" in question #7 (Fig. S6), the number of resources those users have used or plan to use.

Additional site features: forums, events and job postings

Additional questions in the survey assessed user experience and feedback on other site features, including the forums, events calendar and job board (see Fig. S7–S9). Overall, fewer users made use of these additional site features compared to the resource library (54 respondents for the forums, 46 for the events calendar, and 20 for the job board). Fig. S7 shows the feedback from users regarding their experience using the discussion forums feature, which allows registered users to create new forum topic threads within any of 13 broad forum categories (such as "GCTLC General Help", "K-12", "Higher Education", "Toxicology", and "Pedagogy and Teaching Practice") and respond to comments from other users in existing threads. Overall, responses were either positive or neutral; however, more work is needed to improve the overall appearance and usability of the forums feature as well as broader engagement from the full GCTLC community.

Fig. S8 shows responses to user feedback on the events calendar, which enables users to submit upcoming events for inclusion in the community-driven calendar. Users appear generally satisfied with the events calendar and find it helpful for learning about upcoming webinars, conferences and professional development opportunities. Fig. S9 shows user feedback regarding the GCTLC's job board. This is one of the less widely used features of the platform (Fig. 1), however since the demographics of the GCTLC show the majority of users (and similarly, the majority of survey respondents) are faculty or administrators in higher education (Fig. S4), there may be less interest or need for a job board given their career stages. Despite this, feedback about the job board was generally positive with respect to ease of use and appearance. More recently, group spaces were launched on the GCTLC, however this was not available at the time of the survey and will need to be assessed in future surveys.

Connection, engagement and sense of belonging

When asked about connection, engagement and belonging on the platform (Fig. 5), respondents indicated a strong interest in wanting to invite others to join the GCTLC (87% agree or strongly agree), connecting with other users through the platform (83% agree or strongly agree), and engaging with other users (82% agree or strongly agree). However, once on the GCTLC, mechanisms for connecting and establishing new collaborations (or strengthening existing collaborations) with other users could use additional support as these were rated less highly (59% and 34%, respectively, indicating agree or strongly agree).

Importantly, participation in the platform also helped users feel a strong sense of belonging, with 68% agreeing or strongly agreeing with the statement "Being on the GCTLC has helped me feel like I belong in the green chemistry education community." Respondents also agreed or strongly agreed with the statement that the GCTLC helped them feel more confident teaching green chemistry (62% agree or strongly agree) and the statement that the platform was a space for them to find support when they are in doubt about green chemistry content (69% agree or strongly agree). Overall, these results suggest the GCTLC is actively fostering a supportive online community space that creates a welcoming environment, engenders a desire to connect with others, and boosts the confidence of educators to teach green chemistry. It is clear then that the GCTLC is well on its way to achieving its mission, but more work is needed to understand next steps after joining and how community members utilize, adapt and implement resources they download from the platform and how they would like to further connect and collaborate with other users. This is consistent with and similar to trends observed in other STEM

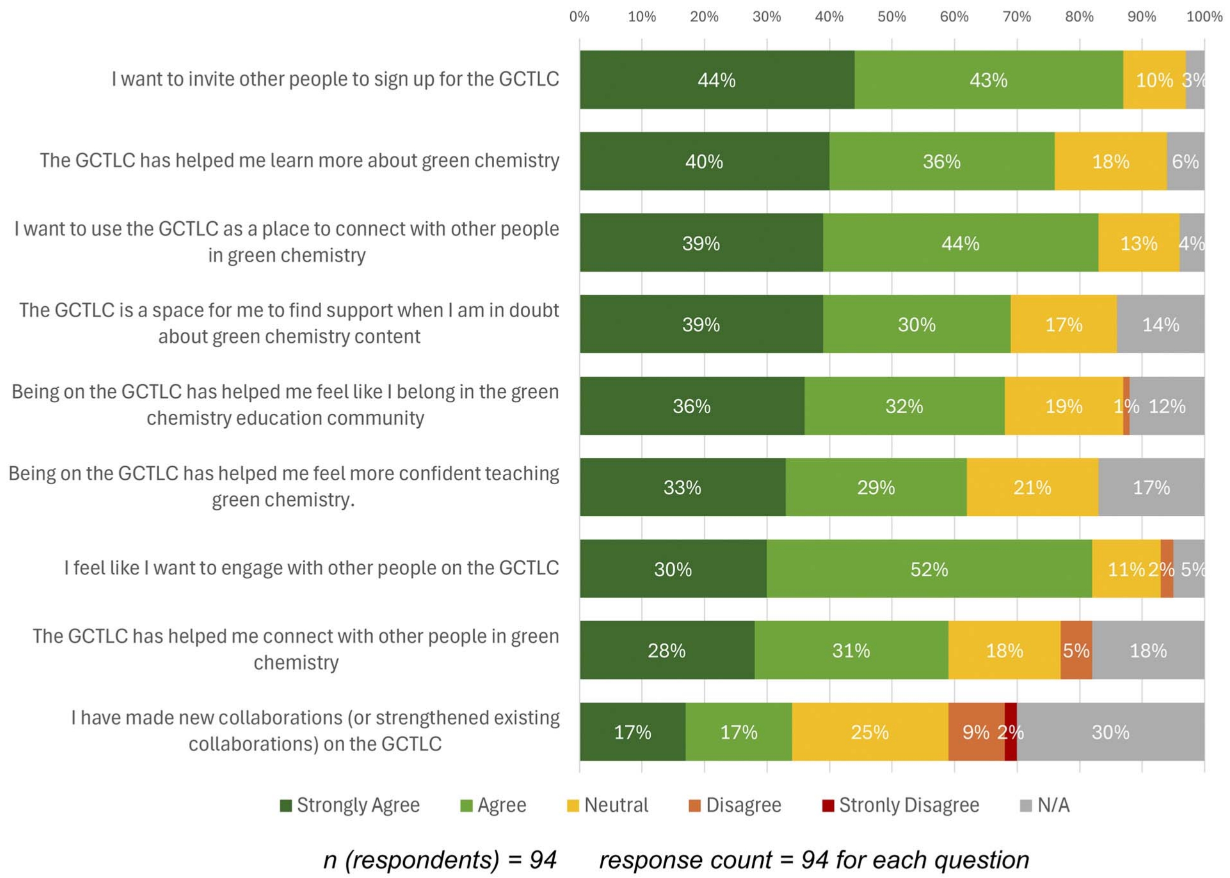

Fig. 5 Responses to questions surrounding connection, engagement and sense of belonging for users on the GCTLC.

CoPs such as POGIL[10] and VIPEr,[20] where early engagement often centers on developing and consuming shared resources (*i.e.*, the potential and coalescing phases described by Kezar and Gehrke[5]) before evolving into active collaboration and co-creation. The GCTLC appears to be following a comparable developmental trajectory—initially fostering resource-based engagement while building toward deeper collaborative exchanges.

Finally, feedback from respondents regarding communications from the GCTLC, including the GCTLC's weekly digest emailed out to all subscribed platform users, shows overall good uptake and positive reaction to weekly communications (Fig. S10), with a low unsubscribe rate (~10%). The digest also provides an opportunity to highlight work of GCTLC users from around the world, including recently published content on the GCTLC, events they may be hosting, awards they have won, and more. Users also appreciated receiving a quarterly newsletter (now discontinued) to stay informed about new information, features and updates.

Future work

Overall, initial reactions from the survey results suggest strong community member engagement and generally positive views of the GCTLC including ease of use, accessibility, feeling welcome, and feeling a strong sense of belonging on the platform. The platform also helps boost confidence in both understanding and teaching green chemistry, accessing and implementing resources in teaching, and learning about ongoing discussions and upcoming events in the community. However, more work is needed to understand the depth of use of resources from the GCTLC (*e.g.*, how they are implemented, changes needed to adapt the resources to different teaching environments, impact on student and department/school affect and motivation, *etc.*) as well as how to further support and build community engagement and collaboration across the GCTLC. An internal Community Engagement Strategy (CES) has been developed to help build further connection between users and community members from different parts of the world and focuses heavily on inclusive and equitable strategies for further growing the community. Some engagement activities piloted so far include resource hackathons (online synchronous working sessions to upload new content to the platform), conference activities linked to the GCTLC, "Ask Me Anything" sessions with expert community members, raffles, and scavenger hunts. Further studies and surveys will explore in depth the impact of the GCTLC through both qualitative studies (*e.g.*, interviews with active users) and quantitative analyses (*e.g.*, social network analysis). In addition, efforts are underway to expand the platform's presence internationally and offer opportunities, resources and tools to support educators and community members from around the world. Examples include international conference presentations and recruitment at international events, language translation tools and availability of green chemistry education resources in different languages, and availability and scheduling of webinars and information sessions in time zones outside of North America. Finally, the launch of additional features and programming through the platform, including the recently added groups feature, will also help better understand mechanisms of connection and how a sense of belonging and confidence to teach green chemistry can grow over time in an online community of practice.

Conclusions

Through the first annual survey of GCTLC users in 2024, we gathered initial data and insights regarding how the GCTLC as an online Community of Practice (CoP) is impacting and supporting users and community members from around the world. The results suggest that within the first year since its launch, the GCTLC successfully created a strong sense of belonging amongst community members and helped build their confidence in their understanding of green chemistry as well as their ability to teach it to their students. Users were most interested in the resources available through the GCTLC and, to a lesser extent, the forum discussions, events calendar, and job board, but overall had positive perceptions of these features and pages. Users were keen to invite others to participate on the GCTLC and had a desire to connect with other GCTLC community members, but so far felt less successful in actually doing so and had not yet established new collaborations or strengthened existing collaborations through the platform. Future work will explore how additional platform features, programming and community engagement activities can help foster more collaboration and connections, as well as provide more in-depth insights into how users are actively incorporating resources accessed through the GCTLC and integrating green chemistry into their courses and curricula.

Author contributions

N. K. O. and J. W. M.: conceptualization, data curation, formal analysis, investigation, methods, project administration, visualization, writing – original draft, writing – review & editing. S. P.: conceptualization, writing – review & editing. A. S.: writing – review & editing. S. K.: writing – review & editing. O. V.: writing – review & editing. A. S. C.: conceptualization, funding acquisition, supervision, writing – review & editing.

Conflicts of interest

There are no conflicts to declare.

Data availability

The data collected through the survey described in this article are stored securely on the GCTLC online platform and were analysed and graphed using standard spreadsheet software (Excel). Due to privacy reasons, the raw data is not publicly available and only the aggregated data is presented in graphical and/or tabular format both in this article and in the accompanying supplementary information (SI). Supplementary information is available and includes the survey instrument and response analysis, graphical representation of the responses to the remaining questions, and written comments from survey respondents. See DOI: https://doi.org/10.1039/d5su00950b.

Acknowledgements

The authors would like to acknowledge the GCTLC's Advisory Committee for their support, guidance and advice on all activities related to the GCTLC throughout 2024 and 2025. The authors would also like to thank Dr Monica Soma Hensley for editorial support and suggestions. Support for this work was provided by MilliporeSigma (the U.S. and Canada Life Science business of Merck KGaA, Darmstadt, Germany), The Argosy Foundation, BASF, Hexion, Cell Signaling Technology, and Washington State Department of Ecology.

Notes and references

1 M. K. Orgill, S. York and J. Mackellar, *J. Chem. Educ.*, 2019, **96**, 2720–2729.
2 V. Talanquer and A. R. Szozda, *J. Chem. Educ.*, 2024, **101**, 1785–1792.
3 J. W. Moir, N. K. Obhi, J. MacKellar, D. A. Laviska and A. S. Cannon, *J. Chem. Educ.*, 2025, **102**(8), 3387–3398.
4 J. Andraos and A. P. Dicks, *Chem. Educ. Res. Pract.*, 2012, **13**, 69–79.
5 A. Kezar and S. Gehrke, 2015, 1–96.
6 A. Kezar, S. Gehrke and S. Bernstein-Sierra, *J. Higher Educ.*, 2018, **89**, 832–864.
7 A. Kezar, S. Gehrke and S. Bernstein-Sierra, *Rev. High. Educ.*, 2017, **40**, 217–244.
8 S. A. Barab and T. M. Duffy, in *Theoretical Foundations of Learning Environments*, Lawrence Erlbaum Associates, Mahwah, New Jersey, USA, 2000, pp. 25–55.
9 S. Ma, G. L. Herman, M. West, J. Tomkin and J. Mestre, *J. Higher Educ.*, 2019, **90**, 773–799.
10 S. E. Shadle, Y. Liu, J. E. Lewis and V. Minderhout, *Innov. High. Educ.*, 2018, **43**, 475–490.
11 POGIL, Home, https://pogil.org/, accessed 15 June 2021.
12 H. Eppley, A. Johnson, E. Benatan, M. Geselbracht, J. Stewart, B. Reisner, L. Watson and B. S. Williams, *J. Chem. Educ.*, 2009, **86**, 123.
13 Virtual Inorganic Pedagogical Electronic Resource | VIPEr, https://www.ionicviper.org/, accessed 17 June 2021.
14 A. Leontyev, J. B. Houseknecht, V. Maloney, J. L. Muzyka, R. Rossi, C. O. Welder and L. Winfield, *J. Chem. Educ.*, 2020, **97**, 106–111.
15 Welcome to OrganicERs.org! | Organic Education Resources, https://organicers.org/, accessed 15 August 2025.
16 R. S. Kelly and C. K. Larive, *J. Chem. Educ.*, 2011, **88**, 375–377.
17 Analytical Sciences Digital Library, Peer-reviewed resources for teaching analytical chemistry, https://asdlib.org/, accessed 15 August 2025.
18 A. Sikora, *FASEB J.*, 2019, **33**(S1), 456.9.
19 BASIL Biochemistry, https://www.basilbiochem.org/home, accessed 15 August 2025.
20 S. J. H. Frost, J. R. Raker, A. K. Bentley, S. Lin, J. M. Pratt, B. A. Reisner and J. L. Stewart, *J. Chem. Educ.*, 2025, **102**(9), 3807–3816.
21 Green Chemistry Teaching and Learning Community (GCTLC), https://gctlc.org/, accessed 14 September 2023.
22 N. K. Obhi, J. Moir, A. Oseolorun and A. S. Cannon, *Sustain. Chem. Pharm.*, 2025, **44**, 101944.
23 M. M. Brooks, F. A. Fullilove, A. B. Mahoney and E. A. Arriaga, *J. Chem. Educ.*, 2022, **99**, 393–401.
24 C. M. Goodwin and R. B. McKendree, *Nat. Sci. Educ.*, 2024, **53**, e20142.
25 K. T. Xia, F. D. Toste, M. B. Francis and A. M. Baranger, *Chem. Sci.*, 2025, **16**, 4412–4429.
26 S. Adams, M. Tesene, K. Gay, M. Brokos, A. McGuire, T. Rettler-Pagel, A. Swindell, Communities of Practice in Higher Education: A Playbook for Centering Equity, Digital Learning, and Continuous Improvement, *Digital Learning, and Continuous Improvement*, Every Learner Everywhere®, 2023, https://www.everylearnereverywhere.org/resources/communities-of-practice-in-higher-education/.
27 Writing Survey Questions, https://www.pewresearch.org/writing-survey-questions/, accessed 7 November 2025.
28 Best Practices for Survey Research – American Association for Public Opinion Research (AAPOR), https://aapor.org/standards-and-ethics/best-practices/, accessed 7 November 2025.
29 A. Brijmohan and Y. Tu, *Designing Surveys in SoTL: Guidelines and Considerations*, University of Toronto Center for Teaching Support & Innovation.
30 C. Wolf, D. Joye, T. Smith and Y. Fu, *The SAGE Handbook of Survey Methodology*, SAGE Publications Ltd, 1 Oliver's Yard, 55 City Road London EC1Y 1SP, 2016.