To Improve the ACADEMY
A Journal of Educational Development

The Student Teaching Fellowship Program: Providing graduate students with meaningful training in teaching through pedagogical development

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Abstract

This article describes the Student Teaching Fellowship Program (STFP), offered by the Department of Chemistry at the University of Toronto, as an opportunity for graduate students (and postdoctoral researchers) to gain meaningful training in teaching as they undertake undergraduate curriculum development and pedagogical research. Under the guidance and mentorship of faculty members, STFP projects have included the creation of innovative laboratory experiments, lectures, tutorials, workshops, and outreach activities. The structure and outcomes of the program are presented, as highlighted through three case studies. The focus of the work presented here is two-fold, in that the Student Teaching Fellowship Program: (1) offers an effective framework for curriculum revitalization that can be readily incorporated into other academic institutions and departments; *and* (2) provides participants with meaningful professional development through pedagogical training.

Keywords: higher education, curriculum renewal, pedagogical skills, professional development

https://doi.org/10.3998/tia.5821

students as partners
Student Teaching Fellowship Program
responsive curricular design

Introduction

Professional training in most higher education graduate programs is usually focused within the realms of research and academic courses, with much less emphasis on teaching activities (Austin, 2002; Brownell & Tanner, 2012; Golde & Dore, 2001). Regardless of potential career pathways (e.g., academia, industry, policymaking), graduate students are likely to engage in teaching and mentorship roles as part of their program requirements. Due to this, it is important to provide opportunities for graduate students to be trained using best practices in teaching (Austin & Wulff, 2004; Lee, 2019; Mahavongtrakul et al., 2021; Robinson & Hope, 2013). Depending on the discipline, students will typically gain some teaching experience by serving as teaching assistants (TAs) in the context of tutorial, seminar or practical instruction, as well as through the grading of assignments, quizzes, tests, and final examinations. While these TA positions provide valuable opportunities for students to begin to hone their teaching abilities, they usually do not cover the full spectrum of responsibilities required of a course instructor.

Academic institutions typically offer courses or workshops for faculty and TAs that address best teaching practices that are anchored in the theory of learning. For example, the Department of Chemistry at the University of Toronto recently launched a new graduate level professional development course, titled "Graduate Professional Development for Research and Teaching," which is required for all new chemistry graduate students (University of Toronto, 2020). This course includes a series of interactive workshops on topics including oral and written communication, ethics in teaching, research and scholarship, interpersonal skills and conflict resolution, time management, and strategies for supporting positive mental health. These workshops are designed to build upon the mandatory TA training (4 hours) that all incoming graduate students are required to complete when they join the department. In addition, the Centre for Teaching Support and Innovation (CTSI) at the University of Toronto offers a myriad of programs to support best teaching practices, such as those centered around course design, teaching dossier preparation, and creating equitable and inclusive classrooms (University of Toronto, 2024a). The School of Graduate Studies at the University of Toronto also offers a course, "Teaching in Higher Education," designed for senior PhD students and postdoctoral researchers to improve their teaching practices by learning about different pedagogical theories and styles (University of Toronto, 2024b). In this course, participants take part in a variety of teaching scenarios and are invited to reflect on their own teaching and learning experiences. However, as useful as these opportunities are, they do not provide opportunities for graduate students to actively engage in pedagogical research, curriculum development, or develop some of the necessary skills required of a university instructor.

Acting as a complement to these courses and programs, the Department of Chemistry Student Teaching Fellowship Program (STFP) was developed for graduate students and postdoctoral researchers (the STFP fellows) to hone their pedagogical skills and make a direct impact on undergraduate teaching and learning. STFP fellows are typically individuals who are strongly engaged in research programs and have a strong interest in developing their instructional skills for their future careers as educators. In the STFP, the fellows work under the guidance of a faculty supervisor within the department as they plan, implement, and evaluate new initiatives (laboratory experiments, tutorial assignments, outreach initiatives, etc.). The faculty supervisor is not required to complete formal training in effective pedagogy; however, many take advantage of training and support offered through the Centre for Teaching Support & Innovation (CTSI) at the University of Toronto. This model provides valuable teaching experience and professional development benefits to each fellow along with a financial stipend, while also allowing faculty an effective approach to implement new initiatives into their courses.

Though the Student Teaching Fellowship Program is unique to the Department of Chemistry at the University of Toronto, St. George campus, a number of colleges and universities have designed similar frameworks. Some examples include:

- The University of Toronto's Mississauga and Scarborough campuses have similar programs (University of Toronto Mississauga, 2024; University of Toronto Scarborough, 2024).
- The Department of Chemistry at the University of Southern California has developed a graduate student fellowship program that provides those aspiring to become faculty in chemistry with training in undergraduate teaching (Broyer & Parr, 2019). In their training program, graduate students and postdoctoral researchers learn how to prepare and deliver lectures, develop classroom management skills, and gain practical teaching experience.
- The Department of Biology at Washington University has initiated a course-based undergraduate research experience (CURE) as a training platform for graduate students and postdoctoral researchers interested in becoming faculty at primarily undergraduate institutions (Cascella & Jex, 2018). Acting as a CURE leader allows aspiring faculty to practice a range of teaching techniques, create instructional materials, and develop a teaching philosophy based on actual practice beyond that of a standard teaching assistantship.

- The Department of Pharmacy Practice and Science at the University of Iowa has created a flexible-credit elective course with the goal of empowering student pharmacists to develop lifelong skills and provide teaching practice opportunities for graduate students (Patterson et al., 2013). In this course, four graduate students design and teach leadership development concepts to second- and third-year Doctor of Pharmacy (PharmD) students under the mentorship of two faculty members, resulting in an innovative way to offer formal leadership instruction using limited college resources.
- The Paul R. MacPherson Institute at McMaster University developed a program, named the Student Partners Program, which provides undergraduate and graduate students with opportunities to participate as partners with faculty, instructors, and staff on projects that contribute to the enhancement of teaching and learning (McMaster University, 2024). Examples of activities that students may contribute to include the design and development of new courses, creation of resources for faculty and students, and collaboration with staff and faculty partners on research projects related to teaching and learning.
- The University of Regina has a graduate teaching fellowship program that allows graduate student fellows to teach one undergraduate 3 credit hour course per semester, under the supervision of a faculty member (University of Regina, 2024). The fellowship is funded through the Faculty of Graduate Studies and Research and the Academic Unit of the graduate student.
- The Centre for Teaching and Learning at the University of Windsor has a Graduate Teaching and Learning (GTL) Fellowship program that provides graduate students a chance to develop their skills in project design, teaching and learning innovation, leadership, and public scholarship and outreach (University of Windsor, 2024). The program challenges GTL fellows to fine-tune and use creative skill sets (e.g. design thinking, prototyping, communication strategy) to disseminate what is being learned

through educational development initiatives (e.g. the scholarship of teaching and learning, peer observations, workshop design and facilitation, resource development).

Though this is not an exhaustive list, these examples highlight that there are varying initiatives across different academic disciplines in North America that have been created to contribute to the development of graduate students and postdoctoral researchers as future educators. The main difference between our program and most of the examples listed is that those programs provide graduate students with teaching and classroom management skills, whereas ours is more focused on providing graduate students with opportunities in developing and improving the content that is taught. In terms of similarities, our is most like the Student Partners Program offered at McMaster University.

The STFP model has previously been reported in the *Journal of Chemical Education* under the name "Chemistry Teaching Fellowship Program (CTFP)," though that publication only described the program broadly and with chemists in mind (Kim et al., 2017). This current work provides a significant update on the initial publication in several ways. First, it includes a description of how the program has grown and evolved since 2017. There is now more variability in team structure, project versatility and workload, while requiring a more vigorous proposal review process. Students are also given the opportunity to share their work with the Department of Chemistry at an annual "STFP Day" upon project completion. Secondly, three recent case studies are described (with supporting evidence of success) as a way to showcase the impact the STFP model can have on a variety of disciplines. Suggestions are also provided so other institutions, regardless of their program of study, will be able to adopt it to fit their needs. Finally, evidence is provided to support that the Student Teaching Fellowship Program is an effective framework for curriculum renewal *and* provides the program fellows (i.e., graduate students or postdoctoral researchers) with meaningful professional development through pedagogical training.

Program Structure and Timelines

The STFP model is composed of three components as follows: (i) proposal and review, (ii) project work, and (iii) completion (Figure 1).

(i) Proposal and Review: The Department of Chemistry issues a call for proposals (see Supporting Information: https://bit.ly/TIA_stfp) twice a year: in April (for summer projects) and during June (for fall/winter projects). Project ideas as well as graduate student/faculty partnerships can form is a variety of ways. For example, a student may approach a potential project supervisor and ask them directly if they have a project idea to work on together. Alternatively, a student may serve as a TA for a course and notice that a learning objective is not being met through existing course components. In this instance, the student may contact the course instructor(s) and propose a new idea to improve the curriculum. In some cases, faculty may approach students if they have a particular project in mind and know of a motivated student that would be a good fit for the project. Once projects and partnerships have been defined, the fellow and faculty mentor(s) work together to draft a proposal that describes the undergraduate course(s) the project will impact, the rationale for the proposed work, a detailed breakdown of how the allotted time (45–55 hours) will be spent, and an outline of how success in the project will be evaluated.

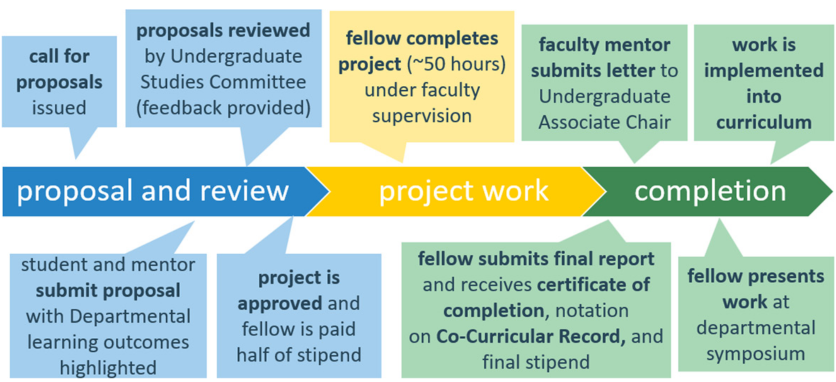

Figure 1. STFP Timeline of Events

In addition, proposals must highlight relevant departmental undergraduate learning objectives for undergraduate students (Supporting Information). Proposals are reviewed by members of the departmental Undergraduate Studies Committee (comprised of several faculty and staff in the Department of Chemistry) who are excellent educators and use the best pedagogical practices. These members provide feedback to each partnership with recommendations where necessary on how to improve the project before it begins. Once the project is approved, the fellow is paid half of their stipend (see below for funding information) and the work commences.

(ii) Project Work: The fellow then independently completes the project work under the supervision of the faculty member(s). Projects typically run between May–August (summer), September–December (fall), or January–April (winter). The guiding principle is to be as flexible and accommodating as possible with respect to timelines: it is therefore possible to spread out a fall/winter project over 8 months if needed. As a best practice, fellows have regular check-ins with their faculty supervisor(s) to update them on the progress of the project, and to discuss any issues that may have arisen. Depending on the nature of the project and the incoming skillset of the fellow, the amount of supervision the faculty needs to provide will undoubtedly vary.

(iii) Completion: Once the project is complete, the fellow submits a final report to the Department, and they receive the rest of their stipend as well as a certificate of completion and an official notation on their co-curricular record. Separately, the faculty supervisor(s) submits a letter outlining the project and their experience working with the fellow to the Undergraduate Associate Chair. The work is then implemented into the curriculum. Fellows are given the opportunity to present their projects and connect with other fellows during an annual Teaching Fellowship Day. Additionally, fellows may be invited to present their project at a department-wide Touch Base on Teaching (TBT) session. These sessions are offered virtually several times per semester and are arranged for faculty and interested graduate students/postdoctoral researchers in the Department of Chemistry to discuss teaching issues and to share ideas. Most projects are completed during the summer when both faculty and graduate students have less teaching responsibilities and are incorporated into the relevant course(s) the following academic year. Once incorporated into the curriculum, the supervisor(s) will provide informal feedback to the fellow. Depending on the success of the project, modifications may be made the following summer before the course resumes during the next academic year. In cases where significant modifications are needed, a new STFP fellow may be brought in to work on the revisions or develop an improved iteration.

Funding for STFP projects in the Department of Chemistry is provided through the graduate office, whereby the fellow receives financial support in the form of a stipend amounting to approximately 50 hours of work completed during the duration of their project (project timelines vary due to the nature of the work as described above). In general, graduate students receive funding through a combination of research assistantships, teaching assistantships, and scholarships (from both internal and external funding sources). In terms of teaching assistantships, graduate students usually have assignments totaling 150–200 hours per academic year. Upon being selected into the STFP, fellows have the option to either accept the funding as additional compensation, or in partial lieu of their other teaching responsibilities.

Case Studies

In this section three case studies completed through the STFP are described. Each case study includes a detailed description of the project, the specific role each fellow played in project completion, and evidence to show how the STFP supported specific curriculum development efforts. The three case studies described here were carefully selected as the outcomes of the projects could be broadly applicable to other disciplines.

Case Study 1: Implementing Equity, Diversity, and Inclusion Training into the First-Year Undergraduate Curriculum

Prioritizing equity, diversity, and inclusion (EDI) in the classroom is essential to establishing an inclusive learning environment, promoting a sense of belonging, as well as improving academic performance (Bowman, 2010; Moreu et al., 2021; Nelson Laird, 2005; O'Keeffe, 2013; White et al., 2020; Williams & Karim, 2020). To address these issues, a triad partnership (consisting of a postdoctoral researcher, the departmental librarian, and a teaching faculty member) designed a project to implement EDI training into the first-year chemistry curriculum. This optional workshop introduces students to the basic principles of EDI, provides opportunities for the students to reflect on their beliefs through several hypothetical scenarios they could encounter during their undergraduate career, and introduces students to Equity Offices and other EDI-related support services available to them at the University. The training aims to raise awareness about what equity, diversity, and inclusion look like both inside and outside the classroom and laboratory, and how undergraduate students can contribute to the development of a more diverse, equitable, and inclusive department.

The STFP fellow's role in this project consisted of creating three EDI modules (understanding diversity, understanding equity, and understanding inclusion) intended to be completed by undergraduate students online and asynchronously. The fellow first conducted literature research to inform their knowledge of EDI in scholarly environments and then created content for each module. This consisted of an overview of the topic, one or two interactive presentations depicting scenarios that illustrate real-life situations that relate to the topic with different potential reactions, a few simple quizzes, links to additional resources, and a PDF file of the presentation. During the process of content creation and module development, the fellow largely worked independently and conducted the majority of the work. However, the fellow had routine discussions with their supervisors to help guide the process, and in some cases the fellow worked alongside their supervisors to complete particularly challenging tasks as a group.

To date, 1,725 students have completed the EDI training modules during their first year in the Department of Chemistry. They were given approximately one month to complete the modules for a 1% bonus on their final course grade. Preliminary analysis of student feedback indicates that the project was highly successful, including largely positive feedback regarding the format of the training as well as perceived impacts on students' own knowledge and understanding of EDI concepts after completing the modules; results of this project will be discussed in detail in a forthcoming publication. It is anticipated that the EDI training will promote equitable and inclusive behavior, academic rigor, and responsible leadership in the Department of Chemistry, as well as raise awareness about unwelcome social behaviors, their appropriate reactions, and how to access support within both the department and university.

Case Study 2: Introducing Subject Subdisciplines to First-Year Students

Many scholarly fields of study are composed of several subdisciplines that introductory students are not initially exposed to. For example, the Department of Chemistry offers a wide range of programs within diverse subdisciplines including biological, inorganic, environmental, and materials chemistry, among others. First year life science and physical science students enroll in a full year of introductory chemistry that is largely limited to select organic and physical chemistry topics. To make the department more accessible to undergraduate students, two teaching faculty members partnered with a graduate student fellow to create an informative video series that introduces the different subdisciplines of chemistry offered at the University of Toronto along with their real-world applications.

The video series introduces and explains seven different subdisciplines of chemistry offered in the department: analytical, organic, inorganic, environmental, biological, physical, and polymer and materials chemistry. Each video is between 3–4 minutes and includes a definition of the subdiscipline, examples of real-world applications, active research areas, video clips of university research laboratories, and general comments and advice that would be useful to first-year students. The contributors in each video include faculty conducting research in the appropriate field, along with graduate and undergraduate students studying in the subdiscipline. The personal touch throughout each video allows students to discover the close-knit community that the Department of Chemistry offers, and concrete opportunities to get involved in departmental life.

The graduate student fellow was responsible for the majority of the project. First, the fellow drafted an interview plan that consisted of writing interview questions for each group of individuals (faculty, graduate students, undergraduate students) within each subdiscipline. Care was taken to ensure that there was a diversity of questions targeting the goals of the video series. Next, the fellow arranged online interviews with appropriate individuals and recorded them for the purposes of data collection. The final (and most time consuming) component of the project consisted of editing the raw data to assemble clips into refined videos. The first two videos were assembled with a significant amount of assistance by the faculty advisors for the purposes of learning the process. However, once the fellow was familiar with the editing process they completed the remaining videos independently.

To date, over 6,000 first year students have watched the video series (shown during class in all first-year chemistry courses since January 2022). During the first semester of implementation, students were invited to provide their insight into the impact of the videos to their perception of chemistry as a diverse discipline and the community within the department through an anonymous survey. An overwhelmingly large proportion of respondents (87%) agreed the videos gave them helpful insight into the Department of Chemistry that they were previously unaware of with 50% selecting “strongly agree” and 37% selecting “agree” on a 5-point Likert scale. In addition, 80% of respondents claimed to learn about the different areas of chemistry because of watching the video series, and 64% of students either “strongly agreed” or “agreed” that the videos were helpful before making decisions regarding undergraduate programs of study. One student commented:

> I love the way these videos are made- super informative and engaging! I really enjoyed watching them and could rewatch them many times afterwards. I also like the idea of introducing these videos in the lectures and watching them as a class. Thank you again for producing these helpful videos in the lectures and presenting them to first-year students.

While another student wrote:

> The videos were a great way of getting to know the department as people, rather than just another category on a website. The human touch really propelled me to look further in the opportunities there are in our amazing Chemistry Department.

This STFP project was successful in creating a unique video series that exposes introductory students to the diversity of topics and people in chemistry and plays an important role in their academic career path.

Case Study 3: Lecture Capture Videos to Showcase Literature Database Searching Tools

Modern learning environments require students to explore new scholarly databases and use technology in new and creative ways. Although students are often comfortable with everyday technology, using new systems effectively can be challenging to novice learners. For example, many undergraduate courses in the Department of Chemistry require students to effectively search and critically evaluate peer-reviewed articles. This important skill is necessary for students to develop chemistry information literacy to prepare them for their own independent research. It has also been found that students who are literate in chemistry information are more productive in research, are able to understand and appreciate scientific advances, and are better communicators

(Greco, 2016). There are two prominent structure-based databases which are commonly used in all chemistry disciplines, Scifinder-n Scholar (CAS, 2024) and Reaxys (Elsevier, 2023). Both databases are robust and provide access to an extensive collection of scientific literature. Even though these databases are designed to be comprehensive, novice users often find them difficult to navigate in an efficient and effective manner. If students do not know how to conduct literature searches, they tend to struggle and find certain tasks time consuming because they do not know how to efficiently find the information that they need.

To address this issue, two faculty supervisors partnered with a graduate student fellow to explore ways to take advantage of modern technology with the primary goal of furthering students' immersion and understanding of the material. In their own teaching, they found that online video streaming (e.g., lecture capture technology) was a powerful tool for delivery of course content outside of the classroom. As such, the team created a series of eight scaffolded lecture capture videos that allows students to progressively learn more complex skills within SciFinder-n and Reaxys. Each video is 2–15 minutes in length and focuses on a specific learning objective while using the database.

Similarly to the first two case studies in this work, the fellow completed the large majority of this project. The fellow first worked with the faculty members to help identify the key learning objectives they hoped to highlight in the instructional videos, with the aim of highlighting increasingly challenging learning objectives in each progressive video. Once the list of learning objectives and video themes were identified, the fellow drafted a script for each video. Once approved by the faculty supervisors, the fellows recorded themselves performing key tasks using the appropriate online database, while verbally annotating their actions using the pre-approved script. After conducting some light video editing, the video series was complete and ready for implementation.

Initially, these videos were piloted in a third-year undergraduate course (enrollment of 35 students) with the goal of teaching modern organic synthesis techniques and current chemistry research principles. Students were given an assignment that emphasized the importance of effective literature searches. The assignment consisted of five questions, specifically formatted to highlight the learning objectives of the lecture capture videos. Most students were able to conduct effective literature searches and producing correct answers (the class average for this assignment was 88%). An anonymous survey was also conducted to identify the success of the project. Of the 31 students who responded, 22 students used the instructional video to complete the course assignment. Of those, 82% agreed that the instructional videos helped them "a great deal" or "mostly" while completing the assignment on a 5-point Likert scale. In addition, 69% of respondents agreed "a great deal" or "mostly" when asked if they thought the assignment and database experience prepared them for future course work and research experiences.

One student commented "The tutorial videos were very good. They covered most questions I had." while another student stated "It was really useful going through SciFinder in class as it helped with features I was unsure of. The assignment helped, too!" Given the positive results and student feedback, the series of instructional videos were launched as a general departmental tool and the series is now available to all members of the department.

Program Outcomes

The STFP allows different departmental stakeholders (faculty members, staff, STFP fellows, and undergraduate students) to each benefit in a tangible way.

(i) Faculty and undergraduate students: curriculum development: First and foremost, faculty and undergraduate students reap rewards from the curriculum development efforts of the STFP. Instructors benefit from course renewal efforts based on best teaching practices, while undergraduates experience a responsive curriculum with courses and content tailored to their needs. The STFP proved particularly important during the COVID-19 pandemic, as it played a crucial role in the departmental ability to shift to online learning. The majority of projects in 2020 were able to be completed remotely and involved converting in-person courses and laboratories into an online format. During Summer 2020, 15 projects were completed (a record number compared to four projects completed the previous summer), which were all geared towards adapting curricula to online learning for more than ten undergraduate courses. With this program, the curriculum was adapted in a meaningful way, while also maintaining a high quality of education and assessment. Not only was a thoughtful and responsive curriculum introduced during the pandemic, but it was done in manner that was rooted in best teaching practices. Other departments may also benefit from the STFP by creating projects to aid in development of their own online resources. A range of projects have been undertaken through this program that have impacted the Department of Chemistry at the University of Toronto in a variety of ways (described above).

(ii) Graduate student fellows: pedagogical training: In addition, the STFP graduate student fellows benefit from the unique opportunity to work on meaningful pedagogical projects under the guidance of faculty mentors. They develop their pedagogical skills and gain access to the institution's teaching community where they are encouraged to continue their training through additional teaching and pedagogical opportunities within the university Centre for Teaching Support and Innovation. In addition, many of the fellows gain professional development skills and expand their professional network by disseminating their scholarly work at pedagogical conferences or have been published in the scientific literature. Recent examples include in *The Journal of Chemical Education* (Ahmadi et al., 2020; Habeeb et al., 2023; Hall & D'eon, 2023; Hoover et al., 2023; Tong et al., 2023), *Nature Reviews Chemistry* (Sebastiampillai et al., 2023), *Green Chemistry Letters and Reviews* (Nigam et al., 2023).

Since its inception more than 20 years ago, the STFP program has supported over 200 graduate students and postdoctoral fellows, with an average of 7–10 participants each year. To gain further insight into the impact of the program on their graduate school experience, four STFP fellows and three faculty supervisors were interviewed.

In the interviews, the STFP fellows provided their perspectives on undergraduate teaching and learning, and any professional development experience they may have gained through their participation. When interviewed, all fellows noted that much more work and thought goes into curriculum development than they previously anticipated. Selected excerpts from the interviews with the fellows are highlighted below:

> My role allowed me to develop my communication and collaboration skills by providing constructive feedback on course content and participating in shared decision making with the teaching team. I was fortunate to serve as a teaching assistant for these courses after the STFP and could see the impact that these projects had in the classroom, inspiring me to think more deeply about how we design courses to make content approachable and relatable.
>
> You can experience the process of curriculum development first-hand, starting from the idea all the way to the implementation into the course. My favourite part is after the course has finished and hearing the feedback from the undergraduate students of how the project we developed helped or inspired them.
>
> My STFP experience provided me with a unique pedagogical challenge not typically encountered as a PhD student. My experience was rewarding because I was able to directly contribute to and improve the learning experience for a large cohort of future scientists. I also believe the added responsibilities associated with completing an STFP project has undoubtedly aided in my professional growth.
>
> This program enabled me to experience and appreciate all the challenges of developing a curriculum, thinking critically about what content would be beneficial to all the students, regardless of their academic goals in the future. It also allowed me to see how much work goes into making chemistry relatable, palatable, and interesting for undergraduate students, and how important the interplay is between lecture material, tutorials, practicals, and the textbook."

Additionally, three faculty who acted as STFP supervisors were interviewed to gauge their impressions and to identify any improvements they observed in their fellows from start to finish of the program. Each faculty member agreed that the program is instrumental to implementing meaningful changes into their curriculum, and that the positive impact to the fellow is undeniable. Listed below are selected quotes from interviews with the faculty.

> The STFP has been a powerful mechanism for curriculum renewal, significantly impacting my courses. It has supported and accelerated several pedagogical projects that would have been challenging to develop independently, enabling me to fully realize my vision for these courses…I appreciate the opportunity to collaborate with diverse graduate students and post-docs, learning from their discipline-based expertise while also developing my own personal mentorship approach.
>
> The great part of STFP is the positive impact not only on the undergraduate students, but also on the graduate students who participate in the program. Trainees have the opportunity to think more deeply about teaching and develop their own projects and ideas in a very different way to doing chemistry research.
>
> The STFP offered my graduate student an opportunity to think about his own teaching values, how successful past learning experiences could be integrated into a course, and which learning objectives were to be prioritized. As my graduate student held a TA position in the finalized course, they could see their work come to fruition and determine the impact of their work.

Modification and Adoption at Other Institutions

There are several strategies through which the STFP model can be adapted to fit the needs of other departments and institutions. First, although the Department of Chemistry offers monetary compensation to their fellows, other institutions may not be able to accommodate this. In this instance, providing an official certificate or transcript notation to the fellow upon project completion would be a viable option. In addition, most of the fellows at the University of Toronto are graduate students, with faculty members serving as the supervisors. Partnership structures can be varied, depending on the nature of the institution and project. For example, fellows can be undergraduate students (especially if the institution is a Primarily Undergraduate Institution), and supervisors can range from faculty to librarians, graduate students/postdoctoral fellows, and/or staff members. Each project requires ~50 hours of work, though some projects have been extended for additional time. Other institutions may not be able to accommodate this much time, in which smaller, "mini" projects (~10–20 hours of work) could be a worthwhile alternative.

Many of the STFP projects completed in the Department of Chemistry are laboratory-based, although some projects are focused on assignments (e.g., news article writing assignments, programming assignments), resources (e.g., data analysis and visualization), and outreach initiatives (e.g., undergraduate program promotional videos). Several of these projects would be relatively straightforward to adopt within other departments, such as developing undergraduate program promotional videos, data analysis resources, and assignments. In terms of the laboratory-based projects, other STEM-based departments, such as Biology or Physics, would be able to implement them, although they may pose more of a challenge for departments where practical course components, like laboratory or clinic hours, are not a part of the curriculum. In these instances, more writing-based projects may be helpful. With the insurgence of artificial intelligence (AI), it is also speculated that projects centered around effective incorporation of AI into departmental curricula will become necessary. For example, there is currently an STFP project at the University of Toronto that is investigating the development of a peer review assignment using chatbots. In this assignment, students will be given questions related to the course material and will be required to use chatbots, such as ChatGPT, to generate answers to these provided questions. They will then be required to grade the answers the chatbots provided for them, keeping in mind the validity and accuracy of the answers, the flow of the prose, and the variability in answers between different chatbots.

Conclusion

The Student Teaching Fellowship Program stands as a robust program structure that provides an efficient method to advance curriculum development efforts while equipping graduate student fellows with valuable pedagogical training. Since its inception in 2002, 129 projects have been completed, with 72 of those projects completed in the last five years alone as the department transitioned to online learning. In this paper, we describe the two main goals of the Student Teaching Fellowship Program: (1) to offer an effective framework for curriculum revitalization that can be readily incorporated into other academic institutions and departments; and (2) to provide participants with meaningful professional development through pedagogical training. The STFP program structure was discussed, and suggestions were provided on how to adopt and adapt the program to other departments. Three different case studies centered on EDI training, promotional videos, and literature database searching were highlighted as examples of projects that are widely applicable to all fields of study. Program outcomes were described through interviews with students and faculty that participated in the program. Many fellows commented that the STFP experience improved their leadership, creativity, and communication skills, widened their professional network, and ultimately enriched their teaching abilities. Faculty noted that the program allowed them to improve aspects of their courses that they otherwise would not have been able to accomplish on their own, as well as honing their mentorship abilities. When developing and implementing this program, we encountered two main challenges. From an administrative perspective, completing the project in a timely manner can be difficult, which can delay its subsequent implementation into the course. From a student perspective, effectively promoting the program to graduate students is a challenge, as they are exceptionally busy with research, teaching assistant responsibilities, and coursework. Convincing them to participate can be difficult if they feel it will negatively impact their other duties. Ultimately, the model presented here can serve as a platform for other departments and institutions to implement a similar Student Teaching Fellowship Program into their own department as a method of improving the pedagogical training of graduate students and resulting in revitalized curricula.

Biographies

Alicia Battaglia is a postdoctoral fellow in the Department of Mechanical and Industrial Engineering at the University of Toronto. She previously completed her PhD in Polymer and Materials Chemistry in the Department of Chemistry at the University of Toronto (St. George campus). During her doctoral studies, Dr. Battaglia contributed to several curriculum development initiatives with various faculty members to enhance undergraduate chemistry education.

Barb Morra is an Associate Professor (Teaching Stream) in the Department of Chemistry at the University of Toronto (St. George campus). Dr. Morra engages in pedagogical research and curriculum development initiatives which have resulted in a suite of research-based laboratory experiments, activities, and technological tools that help undergraduate students connect chemistry with research and applications. To further these efforts, Barb actively collaborates with undergraduate and graduate students in a variety of pedagogical projects.

Andrew Dicks is a Professor (Teaching Stream) in the Department of Chemistry at the University of Toronto (St. George campus). Dr. Dicks is currently the Associate Chair (Undergraduate) of Chemistry and has been teaching undergraduates at all academic levels since 2001. He is particularly involved in the teaching of green chemistry and sustainability concepts to his students and has an ongoing interest in improving the laboratory experience to make practical work more insightful and meaningful.

Acknowledgments

The authors would like to thank the Department of Chemistry Graduate Office for providing funding for the Student Teaching Fellowship projects. Soha Ahmadi, John De Backere, and Madeline Gerbig are acknowledged for developing the EDI training module case study. Karolina Rabeda and Kristine Quinlan are acknowledged for developing the departmental video series case study, while Mark Taylor, Sophie Rousseaux, Rachel Baker, and Anji Zhang are acknowledged for their contributions to the video sample provided in the Supporting Information. Sophie Rousseaux and Anika Tarasewicz are acknowledged for developing the literature database searching case study.

Conflict of Interest Statement

The authors have no conflict of interest.

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