International Conference on Research in Education and Science
www.icres.net May 18-21, 2023 Cappadocia, Turkiye www.istes.org

An Impression that Lasts: Assessing the Impact of a Co-Curricular Service-Learning in Chemistry

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Abstract: Co-curricular service-learning has increasingly attracted participants from students as it can enrich their experience of learning chemistry, among others. An example is *Kimikamahika*, wherein chemistry students from a Catholic university in the Philippines volunteer in public schools, orphanages, daycare centers, and local organizations to promote interest in chemistry among children by demonstrating eye-catching experiments. However, studies are few on the lasting impression of co-curricular service-learning among students compared to their peers without such community engagement. Hence, this mixed-methods study assessed the long-lasting impact of *Kimikamahika* on its past volunteers vis-a-vis their peers not part of this service-learning in terms of gains in course-related skills, real-world application, career opportunities, leadership skills, and community engagement. A one-tailed Mann-Whitney U Test ($\alpha = 0.05$) of the survey responses revealed significantly higher ratings given by 54 volunteers of *Kimikamahika* in the acquisition of course-related skills ($p = 0.033$), application of classroom learning to real-world situations ($p = 0.045$), and participation in community engagement ($p = 0.013$) against the ratings of 24 peers not involved in this service-learning. A thematic analysis of interviews with thirteen past *Kimikamahika* volunteers further showed the lasting impression of a co-curricular service-learning on their academic, personal, professional, and civic life.

Keywords: Service learning, Co-curriculum, Chemistry education, Higher education, Impact assessment

Citation: Cruz, D.J., Guidote, A.V., Adarlo, G., & Yu, H.L. (2023). An Impression that Lasts: Assessing the Impact of a Co-Curricular Service-Learning in Chemistry. In M. Koc, O. T. Ozturk & M. L. Ciddi (Eds.), *Proceedings of ICRES 2023-- International Conference on Research in Education and Science* (pp. 725-736), Cappadocia, Turkiye. ISTES Organization.

Introduction

Many higher education institutions have undergone curricular reforms to respond to the demands of equipping undergraduate students for a life beyond their degrees (Sewry & Paphitis, 2018). They recognize their unique responsibility to prepare undergraduates not only with the essential knowledge related to their discipline, but also with the much-needed "skills and dispositions to be active citizens through both their personal and professional lives" (Richard et al., 2016, p. 60). For instance, students taking an undergraduate degree in chemistry, as Sewry and Paphitis (2018) point out, "need to be educated not only in the theory and practice of chemistry, but also equipped with critical skills to navigate society and the employment market" (p. 973).

However, most undergraduate students in the field of science, technology, engineering, and mathematics (STEM), such as chemistry, have been heavily trained for specialization, disciplinary knowledge, and research (Najmr et al., 2018). Their opportunities for community engagement have been limited. As a result, they are often far removed from issues that matter in society (McGowin & Teed, 2019).

A well-established academic practice in providing undergraduate students with powerful learning experiences that can transform communities is service-learning (Cooper, 2002). Bringle, Hatcher, and Hahn (2017) define service-learning as:

> a course or competency-based, credit-bearing educational experience in which students (a) participate in mutually identified service activities that benefit the community, and (b) reflect on the service activity in such a way as to gain further understanding of course content, a broader appreciation of the discipline, and an enhanced sense of personal values and civic responsibility (p. 10).

This widely used definition particularly refers to curricular service-learning, which has been commonly associated with improved cognitive goals and course-related skills, enhanced interpersonal and leadership skills, increased community engagement, better career opportunities, improved self-esteem, self-efficacy, and self-confidence, and increased ability in applying course content to real-world situations (Esson, Stevens-Truss, & Thomas, 2005). For undergraduates in chemistry, curricular service-learning has allowed them to learn about society beyond the laboratory (Sewry & Paphitis, 2018). They have also come to understand how their chosen profession would fit society (McGowin & Teed, 2019).

Notably, service-learning can take place as well in co-curricular settings (Judge et al., 2011). This form of experiential learning can exist without being based on a course subject that students would earn credits for (Griswold, 2013). Co-curricular service-learning applies to community engagements wherein students participate voluntarily outside their normal class (Bartkus et al., 2012; Farokhi et al., 2022). This community engagement seeks to enrich the students' prescribed curriculum (Bartkus et al., 2012). An example of co-curricular service-learning is community engagement by a campus organization (Judge et al., 2011). Although not formally part of the students' curriculum, co-curricular service-learning still incorporates the necessary

elements to be considered service-learning in its broadest sense (Cooper, 2002; Griswold, 2013).

However, most empirical evidence on the impact of service-learning among students is curricular in nature (Griswold, 2013; Richard et al., 2016). "The potential contribution of co-curricular service-learning to develop engaged citizens," as Keen and Hall (2009) emphasize, "is relatively unexplored" (p. 59). There are also a few studies that have assessed the enduring influence of co-curricular service-learning on graduates, who participated in this form of community engagement while they were in college (Keen & Hall, 2009; Richard et al., 2016).

Hence, this study aims to assess the long-lasting impact of co-curricular service-learning through a longitudinal follow-up. Specifically, it seeks to determine if ratings on course-related skills, real-world application, career opportunities, leadership skills, and community engagement are significantly higher among past volunteers of a co-curricular service-learning in chemistry compared to their peers not part of such undertaking. It also intends to examine closely the lasting impression of a co-curricular service-learning in chemistry on past volunteers in terms of the various areas stated above. This assessment of a co-curricular service-learning in chemistry can help higher education institutions, faculty, and campus organizations in identifying strengths and areas for improvement, which can contribute to their program planning so that service-learning will remain faithful to its purpose.

Method

In assessing the long-lasting impact of a co-curricular service-learning in chemistry, this study carried out a mixed-methods research design to gather a more comprehensive understanding from both quantitative and qualitative datasets (Leavy, 2023). Specifically, it employed an explanatory-sequential approach to follow up the quantitative results with qualitative data (Edmonds & Kennedy, 2017). This explanatory-sequential approach seeks to contextualize the quantitative results from a survey using qualitative findings from interviews (Leavy, 2023).

Setting and Participants

This mixed-methods study was set in a Catholic university in one of the highly urbanized cities in the Philippines. The Catholic university in this study seeks to form its undergraduates into leaders, who can contribute to nation-building, through the education of the whole person. Its liberal arts curriculum aims to prepare its graduates not only for excellence in their chosen professions, but also for a life of service to their community as professionals-for-and-with-others.

One of the co-curricular service-learning for undergraduate students in this Catholic university is *Kimikamahika*. Depicted as a magic show in chemistry, *Kimikamahika* strives to draw interest in chemistry within and outside

the university through eye-catching experiments performed by student volunteers from a campus organization. Instituted in 2004, *Kimikamahika* aims to address underachievement in science in the country by promoting a better appreciation of chemistry as a field that children can take part in. This co-curricular service-learning has since engaged with public schools, orphanages, daycare centers, and local organizations by showing chemistry and science as fun and simply a "magic show" to enjoy by children.

After securing ethics clearance from an accredited institutional review board, this mixed-methods study recruited participants from the list of undergraduate students and graduates belonging to the campus organization responsible for *Kimikamahika* from 2004 to 2021. For the quantitative phase, an email notification was sent to them to provide details about the study and to seek their participation in a survey. Survey respondents, who took part in *Kimikamahika*, were assigned to the volunteer group, while those who have never been involved in this co-curricular service-learning while they were in college were placed in the comparison group. For the qualitative phase, this study invited past volunteers of *Kimikamahika* for an interview until data saturation was reached or, as Saunders et al. (2018) describe, when no new data emerged.

Data Gathering

An online survey was conducted using Google Forms for its ease of collecting data as it is not bound by time and location (Levefer, Dal, & Matthíasdóttir, 2007). The survey questionnaire contained items asking for the respondents' demographic information, such as their age, gender, and employment. It also included an instrument that was adopted from Gelmon et al. (2001) and Esson et al. (2005) to measure course-related skills (e.g., *I become more knowledgeable about chemistry*), real-world application (e.g., *I can identify the chemistry behind real-world situations*), career opportunities (e.g., *The organization assisted me in clarifying my career plans*), leadership skills (e.g., *Participation in the organization helped me enhance my leadership skills*), and community engagement (e.g., *I have a responsibility to serve my community*). Each area in the instrument consisted of five items. Survey respondents were requested to rate the truthfulness and applicability of each item to them on a Likert scale of 1 (i.e., *strongly disagree*) to 7 (i.e., *strongly agree*). The developed instrument exhibited high reliability (i.e., overall $\alpha = 0.93$, course-related skills $\alpha = 0.85$, real-world application $\alpha = 0.72$, career opportunities $\alpha = 0.73$, leadership skills $\alpha = 0.85$, and community engagement $\alpha = 0.85$) and is deemed suitable for the purposes of this study.

The semi-structured interviews of past volunteers of *Kimikamahika* were carried out through Google Meet as videoconferencing platform. Interviewing using videoconferencing offers the same features as in-person interviews aside from the flexibility and convenience it affords (Irani, 2019). To gain a better understanding of the lasting impression of *Kimikamahika* as a co-curricular service-learning in chemistry, some of the questions asked to start the interview are the following:

1) Can you describe your experience in *Kimikamahika*?
2) What did you learn through this experience?
3) Have you done anything differently as a result of your experience?

4) Has *Kimikamahika* created any new opportunities for you?
5) What did you find most challenging and rewarding? Why?

When needed, the past volunteers were probed to elaborate on their responses. The interviews were video-recorded for documentation purposes. Each video-recording was transcribed verbatim. Before data analysis, the verbatim transcripts were anonymized and each interviewed participant was assigned a pseudonym.

Data Analysis

Mean and standard deviation were utilized as descriptive statistics for continuous data, while frequency and percentage distribution were used for nominal data. Chi-square tests were performed to determine if there are significant differences in the characteristics of the volunteer and comparison groups. To determine if the ratings on course-related skills, real-world application, career opportunities, leadership skills, and community engagement among the volunteer group are significantly higher than the comparison group, one-tailed Mann-Whitney U Tests were carried out at a 95% confidence interval and 0.05 level of significance. Non-parametric statistics were employed since assumptions for normality and homogeneity of variance were not met.

Thematic analysis was carried out to make sense of the qualitative data gathered from the interviews. It involved familiarization with the data by reading the transcripts several times and writing down analytical memos when insights would occur. Codes were then assigned to selected words or phrases from the transcripts to describe the likely meanings they represented. Predetermined or a priori codes based on the study of Esson et al. (2005) were applied along with spontaneous or in vivo codes. Related codes were thereafter categorized together. Finally, patterns were looked for among the identified categories to come up with emerging themes (Bergin, 2018; Creswell & Poth, 2018; Yin, 2016).

Several steps, as suggested by Stahl and King (2020), were taken to ensure the trustworthiness of this study's findings. First, this study provided a detailed account of the research process to facilitate an audit trail. Second, data triangulation was done by following up the survey with interviews to strengthen the credibility of the findings. Third, the identified themes were reviewed against the verbatim transcripts. Fourth, reported themes were supported by relevant quotes from study participants. Lastly, the initial findings of this study were presented to a panel of experts as part of peer debriefing.

Results

A total of 78 respondents participated in the survey. 54 of them were past volunteers of *Kimihamakiha* and 24 were not involved in this co-curricular service learning while they were in college. Table 1 shows their distribution by age, gender, and employment. Chi-square tests at a 0.05 level of significance revealed there were no significant differences in the distribution of the volunteer and comparison groups by age ($\chi^2 = 1.56$, df = 2, p = 0.458), gender, ($\chi^2 = 0.01$, df = 1, p = 0.939), and employment ($\chi^2 = 5.99$, df = 4, p = 0.200). These results demonstrated that the volunteer and comparison groups were relatively similar based on their age, gender, and

employment.

Table 1. Characteristics of the Study Population

Characteristics	*Volunteer Group*	*Comparison Group*
Age		
Under 25 years old	11 (20.37%)	8 (33.33%)
25 to 34 years old	36 (66.67%)	13 (54.17%)
35 to 44 years old	7 (12.96%)	3 (12.50%)
Gender		
Female	23 (42.59%)	10 (41.67%)
Male	31 (57.41%)	14 (58.33%)
Employment		
Undergraduate Student	6 (11.11%)	3 (12.50%)
Graduate Student	4 (7.41%)	6 (25.00%)
Employed	40 (74.07%)	12 (50.00%)
Self-Employed	4 (7.41%)	2 (8.33%)
Not Employed	1 (1.85%)	1 (4.17%)

The mean average ratings for course-related skills, real-world application, career opportunities, leadership skills, and community engagement between the volunteer and comparison groups are shown in Table 2. One-tailed Mann-Whitney U Tests revealed participants from the volunteer group significantly rated themselves higher than the comparison group for course-related skills ($p = 0.033$), real-world application ($p = 0.045$), and community engagement ($p = 0.013$). However, the effect sizes or the magnitude of their differences in these areas were relatively small (less than 0.50).

Table 2. Mean Average Scores on Five Areas between the Volunteer and Comparison Groups

Areas	*Volunteer Group*	*Comparison Group*	*p value*	*Effect Size*
Course-related skills	4.96 ± 0.94	4.57 ± 1.12	0.033	0.26
Real-world application	5.80 ± 0.72	5.38 ± 0.99	0.045	0.24
Career opportunities	4.19 ± 1.15	4.62 ± 1.29	0.904	0.18
Leadership skills	5.40 ± 0.90	5.10 ± 1.47	0.296	0.08
Community engagement	6.03 ± 0.76	5.42 ± 1.20	0.013	0.32

Thirteen past volunteers of *Kimikamahika* underwent semi-structured interviews. Three (23.08%) were under 25 years of age, nine (69.23%) were 25 to 34 years of age, and one (7.69%) was 35 to 44 years of age. Three (23.08%) were females, whereas ten (76.92%) were males. Two (15.38%) were undergraduate students in their senior year, ten (76.92%) were currently employed, and one (7.69%) was self-employed.

Five themes emerged from the responses of the interviewed participants about the long-lasting impact of *Kimikamahika* on them. Specifically, the past volunteers felt this co-curricular service-learning gave them opportunities to develop course-related skills, appreciate real-world application of chemistry, and deepen their community engagement. They also brought up how *Kimikamahika* helped them strengthen their leadership skills and recognize career opportunities despite survey results showing no significant differences in comparison to their peers not involved in this co-curricular service-learning.

First, their experiences in *Kimikamahika*, according to the interviewed participants, helped them to acquire further the necessary skills for their chemistry-related course subjects. For example, Participant 4 considered their involvement in this co-curricular service-learning allowed them "to deepen their knowledge about chemistry." Participants 1, 3, and 4, among others, were also challenged to apply the concepts in their chemistry-related course subjects so that they can better communicate the science behind the magical experiments. That is why Participant 1 recognized that they should not "just show the experiments," but they should "discuss them as well." Moreover, they, as Participant 4 emphasized, "must communicate the science in simpler terms for the children to understand them." The experiments demonstrated in *Kimikamahika*, as stated by Participants 1 and 4, should also be "entertaining" and "engaging" for the children. As the experiments should have a "wow factor," many of the interviewed participants narrated how this co-curricular service-learning contributed to their development of course-related skills, such as the skills needed for better science communication.

Second, this co-curricular service-learning provided the interviewed participants with opportunities for real-world application of their learning in the classroom. Participant 6, for instance, was able to use "what [they] know and what [they were] learning for the sake of others" because of *Kimikamahika*. Most of the interviewed participants, such as Participants 8 and 9, also found *Kimikamahika* as an "avenue" for them to apply chemistry to the "outside world."

Third, their involvement in *Kimikamahika* helped the interviewed participants to deepen their community engagement. In fact, all interviewed participants pointed out how community engagement is the "biggest impact" of this co-curricular service-learning on them. They, including Participant 4, considered their efforts in *Kimikamahika* have in one way or another contributed to a better appreciation of chemistry and science among less privileged children. Participant 1 also looked back on how *Kimikamahika* became a starting point for them to build lasting relationships with those in their service-learning community considering that they would still communicate with them even after they graduated from college. Because of these instances, Participant 9 and others felt "a sense of fulfillment that [they] did their best in reaching out to people… [and that they] did something to change other people's lives."

Fourth, taking part in *Kimikamahika* as a co-curricular service-learning allowed the interviewed participants to strengthen "invaluable soft skills," such as leadership skills. Since they must prepare before their demonstration of experiments to children in public schools, orphanages, daycare centers, or local organizations, Participants 1,

2, 5, and 7 learned the importance of communication and collaboration in planning projects. Until now, Participant 13 and others would tap on the leadership skills that they learned from *Kimikamahika* in "dealing with different personalities, managing timelines, and setting expectations" in their workplace. Furthermore, they, according to Participants 10 and 12, were prepared by this co-curricular service-learning on how to lead in "high-pressure situations" because of the "work ethics" that they picked up.

Finally, *Kimikamahika* exposed the interviewed participants to career opportunities. Their involvement in this co-curricular service-learning helped many of them to pursue careers based on their "talents" and "capabilities." For Participants 3 and 9, *Kimikamahika* made them realize career opportunities aside from the industry. Specifically, this co-curricular service-learning influenced them to take on a career in teaching as they found joy in demonstrating experiments to children and explaining the science behind them.

Discussion

Mounting evidence has shown that curricular service-learning is a high-impact educational practice that can prepare students for a life beyond their degrees (Faulconer & Kam, 2023; Kilgo, Ezell Sheets, & Pascarella, 2015). Also, research on curricular service-learning has documented its usefulness among students of chemistry (Esson et al., 2005; Faulconer & Kam, 2023; Sewry & Paphitis, 2018). However, literature is scarce on the impact of co-curricular service-learning. Studies are also few on its long-lasting influence among students involved in this type of service-learning, particularly in chemistry.

This mixed-methods study aims to fill this gap in knowledge by assessing the lasting impact of co-curricular service-learning through a longitudinal follow-up. Survey results showed past volunteers of *Kimikamahika* rated themselves higher in course-related skills, real-world application, and community engagement compared to their peers not involved in such co-curricular service-learning. These results were supported by a thematic analysis of interviews with thirteen past volunteers of *Kimikamahika*. Survey results also revealed that past volunteers and their peers did not differ in leadership skills and career opportunities. However, findings from the interviews of past volunteers identified leadership skills and career opportunities as emerging themes on the likely impact of co-curricular service-learning on them. There is a discrepancy probably because their peers could have acquired these two outcomes from other co-curricular activities of the campus organization. Furthermore, not all past volunteers took on leadership roles during their involvement in *Kimikamahika*.

Research on curricular service-learning has demonstrated the acquisition of course-related skills among chemistry students involved in such community engagement (Esson et al., 2005; Faulconer & Kam, 2023). This study offered a new perspective that course-related skills can likewise be developed in co-curricular service-learning even if it is not associated with a credit-bearing course subject. An explanation for this observation is that past volunteers of *Kimikamahika* drew from their learning in chemistry-related course subjects to come up with entertaining demonstrations of experiments. Similar to the study of Najmr et al. (2018) wherein curricular

service-learning in chemistry can offer opportunities among undergraduate students to practice science communication, this study suggests that skills necessary for science communication can likewise be fostered in co-curricular service-learning since past volunteers of *Kimikamahika* must explain to the children the science behind the "magic" in simpler terms and an understandable manner.

Based on its definition, service-learning entails applying course content in addressing the articulated needs of the community (Bringle et al., 2017). It involves rendering community service, such as the educational shows of *Kimikamhika*, as part of solving real-world problems like underachievement in science in the country. This study showed that real-world application is possible too in co-curricular service-learning as past volunteers of *Kimikamahika* used eye-catching experiments in chemistry to encourage interest in science among children in the hope of alleviating their underperformance in science.

Numerous studies have revealed the civic outcomes that come along with curricular service-learning (Kilgo et al., 2015). A growing number of studies have also documented civic identity, social responsibility, and commitment to community service, among others, as the effects of a curricular service-learning done for a chemistry class (Esson et al., 2005; McGowin & Teed, 2019). In this study, past volunteers of *Kimikamahika* expressed how their involvement in this co-curricular service-learning has largely influenced their community engagement. They learned to relate with those in the community and build lasting relationships.

The development of leadership skills is another outcome of curricular service-learning that has been demonstrated in literature (Cress et al., 2010; Esson et al., 2005; Wurr & Hamilton, 2012). Noticeably, leadership positions in campus organizations can provide formative experiences for students to learn how to lead (Wurr & Hamilton, 2012). In this study, past volunteers of *Kimikamahika* occupying leadership roles benefited most from their involvement in this co-curricular service-learning. They recalled how the leadership skills they learned in *Kimikamahika* have become handy in their workplace.

Lastly, research has shown career development as an outcome of curricular service-learning (Bowen, 2007; Esson et al., 2005). Experiences in curricular service-learning that are concretely aligned with their chosen discipline can aid students make informed decisions about their careers (Bowen, 2007). Most importantly, these experiences of community engagement can influence students to choose careers inclined toward civic commitment (Mitchell & Rost-Banik, 2019). This study documented how past volunteers of *Kimikamahika* realized there are career opportunities for them aside from working in the industry. Several of them, for example, became involved in science education.

Limitations and Future Directions for Research

This mixed-methods study encountered several limitations, which can affect how its findings can be generalizable. First, there is selection bias given that purposive sampling was used in recruiting study

participants. Future studies should employ probability sampling and consider multiple settings to address this bias. Second, the study participants could have given socially desirable responses when answering the survey and responding to the interviews. Later studies should ensure anonymity and data confidentiality during the informed consent process to minimize socially desirable responses. Third, recall bias is likely as study participants were asked to recollect their experiences of co-curricular service-learning while they were in college and relate them to their current circumstances. Future research should consider carrying out prospective studies to manage recall bias. Fourth, baseline data on course-related skills, real-world application, career opportunities, leadership skills, and community engagement are not available. Some of the study participants might have scored higher in these areas at the onset. This constraint can be addressed in future research by conducting prospective studies to measure baseline information so that a better understanding of the lasting influence of co-curricular service-learning can be arrived at. Lastly, other factors may have contributed to the long-lasting impact of co-curricular service-learning among study participants. The Catholic university in this study, for instance, has a strong tradition of community service, which can inspire its students to be oriented toward community engagement. Further research is warranted to explore how other factors interplay.

Conclusion

Despite not being tied to a credit-bearing course subject, co-curricular service-learning can offer the same benefits as curricular service-learning. The impact of co-curricular service-learning among students, as shown in this study, includes far-reaching effects on areas, such as their course-related skills, real-world application, and community engagement. Co-curricular service-learning can also bring about leadership skills when students are given the occasions to lead in their campus organizations. Furthermore, it can provide them with career opportunities particularly when community engagement is asked for. In sum, co-curricular service-learning can leave an impression that lasts on a student's academic, personal, professional, and civic life. It does so by complementing and enriching the curriculum of students, such as those in chemistry.

Declaration of Funding and Competing Interest

This research received funding from the Office of Admission and Aid where the study was set and from the local government of Marikina City. The authors do not have competing interests to declare.

References

Bartkus, K.R., Nemelka, B., Nemelka, M., & Gardner, P. (2012). Clarifying the meaning of extracurricular activity: A literature review of definitions. *American Journal of Business Education, 5*(6), 693-704. https://doi.org/10.19030/ajbe.v5i6.7391

Bergin, T. (2018). *An Introduction to Data Analysis: Quantitative, Qualitative, and Mixed Methods.* SAGE Publications, Inc.

Bowen, G. (2007). How service learning fosters synthesis and prepares students for careers. *Career Journal, 5*(2), 4-5.

Bringle, R.G., Hatcher, J.A., & Hahn, T.W. (2017). Introduction to research on service learning and student civic outcomes. In J.A. Hatcher, R.G. Bringle, & T.W. Hahn (Eds.), *Research on Student Civic Outcomes in Service Learning* (pp. 3-24). Stylus Publishing, LLC.

Cooper, J.R. (2002). *Social Responsibility and Types of Service Learning: A Comparison of Curricular Service Learning, Co-Curricular Service Learning, and Traditional Community Service*. (Doctoral dissertation). Retrieved from ProQuest. (3057842)

Cress, C. M., Yamashita, M., Duarte, R., & Burns, H. (2010). A transnational comparison of service-learning as a tool for leadership development. *International Journal of Organizational Analysis, 18*(2), 228-244. https://doi.org/10.1108/19348831011046281

Creswell, J.W., & Poth, C.N. (2018). *Qualitative Inquiry and Research Design: Choosing among Five Approaches*. SAGE Publications, Inc.

Edmonds, W.A., & Kennedy, T.D. (2017). *An Applied Guide to Research Designs: Quantitative, Qualitative, and Mixed Methods*. SAGE Publications, Inc.

Esson, J.M., Stevens-Truss, R., & Thomas, A. (2005). Service-learning in introductory chemistry: Supplementing chemistry curriculum in elementary schools. *Journal of Chemical Education, 82*(8), 1168-1173. https://doi.org/10.1021/ed082p1168

Farokhi, M.R., Lacy, J., Chapa, I., Garcia, S., Geelhoed, M., Lesser, J., Stone, M., Worabo, H., & Zorek, J.A. (2022). Defining and classifying co-curricular interprofessional education in the health professions: A scoping review protocol. *JBI Evidence Synthesis, 20*(7), 1842-1851. https://doi.org/10.11124/JBIES-21-00206

Faulconer, E., & Kam, C.J.Y. (2023). Service-learning in undergraduate general chemistry: A review. *Journal of Experiential Education, 46*(1), 32-51.

Gelmon, S.B., Holland, B.A., Driscoll, A., Spring, A., & Kerrigan, S.M. (2001). *Assessing Service-Learning and Civic Engagement: Principles and Techniques*. Campus Compact.

Griswold, R. M. (2013). *A Mixed Method Study to Measure Outcomes from Co-Curricular Service-Learning Experiences* (Unpublished doctoral dissertation). University of Houston, Texas.

Judge, L.W., Pierce, D., Petersen, J., Bellar, D., Wanless, E., Gilreath, E., & Simon, L. (2011). Engaging experiential service learning through a co-curricular club: The Chase Charlie Races. *ICHPER-SD Journal of Research, 6*(2), 30-38.

Irani, E. (2019). The use of videoconferencing for qualitative interviewing: Opportunities, challenges, and considerations. *Clinical Nursing Research, 28*(1), 3-8. https://doi.org/10.1177/1054773818803170

Keen, C., & Hall, K. (2009). Engaging with difference matters: Longitudinal student outcomes of co-curricular service-learning programs. *The Journal of Higher Education, 80*(1), 59-79. https://doi.org/10.1080/00221546.2009.11772130

Kilgo, C.A., Ezell Sheets, J.K., & Pascarella, E.T. (2015). The link between high-impact practices and student learning: Some longitudinal evidence. *Higher Education, 69*(4), 509-525. https://doi.org/10.1007/s10734-014-9788-z

Leavy, P. (2023). *Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches*. The Guilford Press.

Lefever, S., Dal, M., & Matthíasdóttir, Á. (2007). Online data collection in academic research: Advantages and limitations. *British Journal of Educational Technology, 38*(4), 574-582. https://doi.org/ :10.1111/ j.1467-8535.2006.00638.x

McGowin, A.E., & Teed, R. (2019). Increasing expression of civic-engagement values by students in a service-learning chemistry course. *Journal of Chemical Education, 96*(10), 2158-2166. https://doi.org/10.1021 /acs.jchemed.9b00221

Mitchell, T.D., & Rost-Banik, C. (2019). How sustained service-learning experiences inform career pathways. *Michigan Journal of Community Service Learning, 25*(1), 18-29.

Najmr, S., Chae, J., Greenberg, M.L., Bowman, C., Harkavy, I., & Maeyer, J.R. (2018). A service-learning chemistry course as a model to improve undergraduate scientific communication skills. *Journal of Chemical Education, 95*(4), 528-534. https://doi.org/10.1021/acs.jchemed.7b00679

Richard, D., Keen, C., Hatcher, J.A., & Pease, H.A. (2016). Pathways to adult civic engagement: Benefits of reflection and dialogue across difference in higher education service-learning programs. *Michigan Journal of Community Service Learning, 23*(1), 60-74. https://doi.org/10.3998/mjcsloa. u3239521.0023.105

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H., & Jinks, C. (2018). Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & Quantity, 52*(4), 1893-1907. https://doi.org/10.1007/s11135-017-0574-8

Sewry, J.D., & Paphitis, S.A. (2018). Meeting important educational goals for chemistry through service-learning. *Chemistry Education Research and Practice, 19*, 973-982. https://doi.org/10.1039/ c8rp00103k

Stahl, N.A., & King, J.R. (2020). Expanding approaches for research: Understanding and using trustworthiness in qualitative research. *Journal of Developmental Education, 44*(1), 26-28. https://www.jstor.org/ stable/45381095

Wurr, A.J., & Hamilton, C.H. (2012). Leadership development in service-learning: An exploratory investigation. *Journal of Higher Education Outreach and Engagement, 16*(2), 213-240.

Yin, R.K. (2016). *Qualitative Research from Start to Finish*. The Guildford Press.