Understanding the Role of Service-Learning on Civic Engagement and Scientific Literacy

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Author Note

Dr. Joanna J. Cielocha is an associate professor of Biology. Dr. Jessica Allen is an assistant teaching professor of Biology. Collectively, they have developed and implemented a variety of service projects in their lower-level majors and non-major courses with community partners for in-person service and online citizen science platforms for virtual service. Dr. Joan Delahunt is an associate professor of occupational therapy. She primarily teaches in the entry-level occupational therapy doctorate program. One of her lab courses offered a service opportunity to participate in screening elementary age children's vision and height/weight for a local free health screening for children attending school in the urban core. Dr. Julia Vargas, director of the Center for Service Learning at Rockhurst University, supports faculty engaged in service-learning through professional development and individual coaching. The Center for Service Learning sponsors the McMeel Family Faculty Institute on Service Learning which has two programs: The McMeel Fellows program for faculty new to service learning and The McMeel Scholars program for service-learning practitioners to foster community-based research and scholarship of teaching and learning. Cielocha, Allen, and Delahunt were selected as McMeel Scholars in the summer of 2020, through which this research was conceived and supported. Correspondence to request article exemplars described in this research should be addressed to Allison Anderson, email: aanderson26@missouriwestern.edu and Alyson Hill, email: ahill6@missouriwestern.edu.

ABSTRACT

Implementation of service-learning within courses may increase students' overall attitudes towards themselves, their community, and their school and improve academic performance. The study aim was to understand students' perceptions of prior civic engagement experiences and level of scientific literacy to gauge if participation in course-based service-learning impacted continual community engagement and improved scientific literacy. Students completed a pre- and post-assessment tool measuring their level of community engagement and scientific literacy administered in six courses. Results showed that service-learning did not negatively affect student perception of civic engagement. Students enrolled in service-based courses demonstrated significant improvement in their scientific literacy. Participation in service learning facilitates growth in scientific inquiry and civic engagement.

INTRODUCTION

The term service learning was first coined in 1967 but gained popularity as a teaching methodology in the early 1990's (Giles & Eyler, 1994). Service learning seeks to pair an organized community-based service experience with course content (Bringle & Hatcher, 1996). Evidence supports that utilizing service learning in the classroom increases students' overall attitudes towards themselves, their community, and their school, while also improving academic performance (Allen et al., 2021; Bringle, 2017; Celio et al., 2011; Finley & McNair, 2013).

Civic engagement refers to the promotion of improved quality of life in the community through political and non-political processes. Additionally, participants in civic engagement develop skills, values, and motivation to make a difference in the community (Ehrlich, 2000). Service-learning is one way to foster civic learning and engagement within the curriculum (Taylor & Kridler, 2013; The National Task Force on Civic Learning and Democratic Engagement, 2010). Service-learning leads to positive effects on civic learning outcomes of efficacy, specifically, students' sense of social responsibility, ability to work with others, and the sense of being able to affect change in the community (Eyler, et al., 2001; Gallini & Moely, 2003).

Increasing scientific literacy, or the general understanding of scientific terms and how the scientific process is carried out, is a goal of science curricula in higher education (Gormally et al., 2012). Scientific literacy is not just for those being trained as career scientists (Miller, 1983). Everyday decision making is influenced by a person's understanding of science and the process of science, from the foods we eat to how we vote on policies and issues (Hobson, 2008). Although the concept of scientific literacy was first proposed in the early 1950's (see discussion in DeBoar, 2000), increasing an individual's understanding of scientific content proves difficult (Eisenhart et al., 1996).

The purpose of this study was to assess students' past experiences with civic engagement and their level of scientific literacy in courses with and without a service-learning component. We addressed two research questions. (1) How

does student participation in service-learning impact perception of civic engagement? (2) In what way does participation in service-learning impact scientific literacy for students enrolled in various courses?

METHODS

Research Design

We investigated student perceptions of civic engagement and scientific literacy by administering a survey with quantitative and qualitative methodology in a pre/post exploratory mixed methods design. A mixed methods approach is advantageous for allowing broader understanding of students' attitudes and perceptions to strengthen the interpretation of the results (Migiro & Magangi, 2011).

Participants

Purposive and convenience sampling guided recruitment for student participants from six courses: four undergraduate biology courses of which three implemented service-learning and two graduate courses of which one implemented service-learning. Undergraduate biology service courses included General Biology II and Conservation Biology, both courses offered to biology majors and Contemporary Biology, a non-biology majors' course. The non-service undergraduate biology course was General Biology I. At the graduate level in occupational therapy, Foundation Skills Lab I was offered as a service-learning course while Foundation Skills Lab II was offered as a non-service-learning course. Inclusion criteria required participants to be enrolled in the selected undergraduate biology courses or graduate occupational therapy courses. Participants were excluded from the study if they did not provide consent for their data to be used for analysis.

Setting

This study occurred over three semesters at a small, private university located in an urban area in the midwestern United States. The continuation of the Coronavirus Pandemic into the 2021 and 2022 academic years disrupted the ability to offer students in person service-learning opportunities in the community. Therefore, service-learning opportunities were modified and limited in scope during this study. The pre/post surveys were administered electronically.

Service Learning

In the undergraduate biology service courses, students participated in a virtual service-learning experience using Zooniverse (https://www.zooniverse.org/). As pandemic restrictions lifted, some students were able to participate in in-person service-learning opportunities with the Missouri Department of Conservation Anita B. Gorman Discovery Center near the Rockhurst campus. In the graduate occupational therapy service course,

service-learning included in-person health screenings of elementary age children at local elementary schools through collaboration with Score 1 for Health (https://www.kansascity.edu/programs/clinical-experience/score-1-for-health).

Instruments and Materials

Pre/Post-Assessment of Attitudes Toward Service, Science and Level of Scientific Literacy

The pre- and post-assessment survey consisted of 23 questions in 4 categories: demographic data, previous service experience, attitude toward service, attitudes toward science, and scientific literacy. Demographic data asked participants to identify grade level, major, and enrolled course. Quantitative measures utilized electronic survey methodology to collect data on previous service and attitudes toward service section of the survey (seven Likert-scale questions); attitudes toward science section (four Likert-scale questions, one rank order question on student perception of science, and one open-ended question on defining what it means to conduct a scientific study); and six multiple choice scientific literacy questions. Two of these questions required graphical interpretation of data which targeted quantitative literacy (see Gormally et al., 2012 and citations therein). Modified assessment questions on service and attitudes towards service were from the Community-Based Learning Student Survey (Gelmon et al., 2018). Two assessment questions about scientific literacy came from the Test of Scientific Literacy Skills (TOSLS; Gormally et al., 2012); other questions were modeled after TOSLS questions but developed by the authors.

Procedure

Following approval from the University Institutional Review Board (Rockhurst University IRB 2020-22), biology and occupational therapy faculty explained the overall project to students in each class. Students who consented to participate completed the online survey during the first and last weeks of the semester. The pre- and post-assessment survey assessed the current level of civic engagement, perception of service learning, and knowledge of scientific literacy.

Data Analysis

The authors utilized paired t-tests to analyze the quantitative pre- and post-assessment data through Microsoft Excel (Microsoft Corporation, 2023). Qualitative methods of individual open coding, microanalysis, and axial coding of the responses while generating audit trails until achieving redundancy and saturation analyzed the open-ended survey question (Creswell & Creswell, 2017). Researchers compared and consolidated themes into overall combined themes. Narrative smoothing helped to derive similar themes from both the pre- and post-groups. Triangulation occurred through member checking and integration of the results with quantitative data to increase the rigor of the study.

RESULTS

Participant Demographics

A total of 333 participants completed the pre/post-assessment (Table 1). The pre-test was administered to a total of 177 students. Of these, 69% of students were enrolled in service-based courses and 31% were enrolled in a non-service-based course. Occupational therapy graduate students made up 12 of 177 responses (7%), while 116 (65%) were first-year college students. 156 students participated in the post-assessment. Of these, 79% were enrolled in service-based courses and 21% were enrolled in a non-service-based course. Occupational therapy graduate students made up 10 of the 156 responses (6%), while 92 (59%) were first-year college students.

Table 1. Demographics of student participants.

	Pre-test	*Post-test*
Total number of student respondents	177	156
Number of students enrolled in service courses	122	123
Number of students enrolled in non-service courses	55	33

Table 1. Demographics of Student Participants.

Quantitative Findings

Student responses on previous service experience, attitudes towards service, and attitudes towards science were collected using a 5-point Likert-scale.

Previous Service Experience & Attitudes Towards Service

Visual trend analyses revealed that most students, regardless of enrollment in service-learning or non-service-learning courses, responded “agree” or “strongly agree” to attitude-based questions on their previous service experience, community connections, and future service (Table 3). For students enrolled in service-learning classes, minimal change occurred in the percentage of responses for “agree” or “strongly agree” when asked about their attitudes on service on the pre-test (before service) and post-test (after service). Students enrolled in non-service-learning classes showed an increased percentage of responses for “agree” and “strongly agree” between the pre-test and post-test. The one exception for this trend is the percentage of students who responded “agree” to the question: “Shared learning with other students through service-learning will help me to understand community needs” which showed a decrease from 73% to 55%; however, that same cohort of students who marked “strongly agree” for the same question increased from 9% to 18% (Table 2).

		Strongly Agree		*Agree*		*Neutral*		*Disagree*		*Strongly Disagree*	
Pre/Post-Assessment		Service	Non-Service	Service	Non-Service	Service	Non-Service	Service	Non-Service	Service	Non-Service
Previous Service Experience Questions											
I was already participating in community service before taking this course.	Pre	21%	9%	34%	38%	17%	25%	24%	24%	4%	4%
	Post	20%	21%	50%	33%	18%	18%	27%	24%	4%	3%
Service/volunteerism allows me to see how I can be more involved in the community.	Pre	46%	27%	48%	56%	7%	15%	0%	2%	0%	0%
	Post	46%	18%	50%	70%	5%	12%	0%	0%	0%	0%
I probably will participate in community service in the future.	Pre	52%	33%	42%	55%	7%	9%	0%	2%	0%	2%
	Post	48%	27%	47%	67%	5%	6%	0%	0%	0%	0%
Attitudes Towards Service Questions											
If service activities were embedded in this course, it would help connect subject matter to everyday life.	Pre	26%	13%	52%	40%	19%	33%	2%	15%	1%	0%
	Post	31%	15%	49%	58%	15%	18%	4%	9%	2%	0%
I feel that service-learning would benefit the community.	Pre	40%	22%	55%	62%	5%	11%	0%	4%	0%	2%
	Post	46%	24%	47%	67%	6%	9%	1%	0%	0%	0%
Shared learning with other students through service-learning will help me to understand community needs.	Pre	34%	9%	55%	73%	9%	16%	2%	2%	0%	0%
	Post	31%	18%	55%	55%	11%	27%	2%	0%	0%	0%
Service-learning would allow me to communicate my ideas in a real- world context.	Pre	30%	5%	52%	64%	16%	29%	2%	2%	2%	0%
	Post	34%	18%	52%	67%	11%	15%	2%	0%	0%	0%
Attitudes Towards Science Questions											
Science and technology are making our lives healthier, easier, and more comfortable.	Pre	34%	29%	50%	49%	13%	16%	2%	4%	1%	2%
	Post	38%	6%	47%	75%	14%	18%	1%	0%	0%	0%
The benefits of science are greater than any harmful effects.	Pre	6%	0%	19%	24%	39%	40%	33%	36%	3%	0%
	Post	20%	9%	49%	46%	28%	46%	2%	0%	1%	0%
Science makes our way of life move too fast.	Pre	16%	9%	48%	49%	30%	36%	4%	6%	2%	0%
	Post	4%	33%	22%	43%	32%	18%	36%	6%	6%	0%
We depend too much on science and not enough on faith.	Pre	2%	4%	13%	9%	40%	42%	27%	32%	18%	13%
	Post	2%	3%	11%	15%	36%	40%	34%	30%	17%	12%

Table 2. Percentage of Student Responses on Pre/post-Assessment Administered to Service and Non-Service Student Participants on a 5-Point Likert Scale

Table 3. Qualitative analysis of student responses to open-ended question.

Student Prompt: Please share in your own words what it means to conduct a scientific study.

Assessment	Theme	Subtheme	Student Quote
Pre-test	"Means to an end"	Focus on following the scientific method to identify a problem and find a solution.	"Using specific methdology and controls to answer a question."
			"Defined methods and steps to answer a question/hypothesis"
Post-test	"Discovery and dissemination"	The power of the scientific method (develop question, create hypothesis, collect data, analysis, interpret findings, share with others)	"Researchers plan an experiment to gather data about something to gather the new information. This new information could lead to future experiments or new ideas passed around"
			"To study something in depth collect data and analyze something in the scientific field to obtain new knowledge"

Table 3. Qualitative Analysis of Student Responses to Open-Ended Questions.

Attitude Towards Science

Results from the student responses between pre- and post-tests showed the highest percentage of change on the questions about students' attitudes towards science (Table 2). Students in both service and non-service-based courses answered more often with "strongly agree" or "agree" on both the pre- and post-test to the question "S*cience and technology are making our lives healthier, easier and more comfortable"*. Many students responded "neutral", "disagree", or "strongly disagree" on the pre- and post-tests to the question which asked, "*The benefits of science are greater than any harmful effects*" regardless of being enrolled in a service or non-service course.

Scientific Literacy

A two-tailed t-test analyzed the difference between the pre- and post-test for students in service and non-service courses as well as between the pre-tests for service and non-service and post-tests for service and non-service (Figure 1). A significant difference existed between the pre and post-test for service ($p=0.03$; a). We also found a significant difference between the post-test for service and non-service ($p=0.01$; b). No difference occurred between the pre-test for service and non-service ($p=0.5$) and no difference between the pre and post-test results for those in the non-service course ($p=0.6$). Students were asked about their perception of the term 'scientific study' and could respond with one of three options: a clear sense of understanding, a general understanding, or little understanding. Those enrolled in service-learning courses demonstrated a higher degree of confidence by responding with a clear sense of understanding of the term scientific study at 18% on the pre-test and 39% on the post-test. This level of perceived understanding was not observed in students enrolled in non-service-learning courses with 33% selecting a clear understanding of the meaning of scientific study on the pre-test and only 24% selecting this response on the post-test.

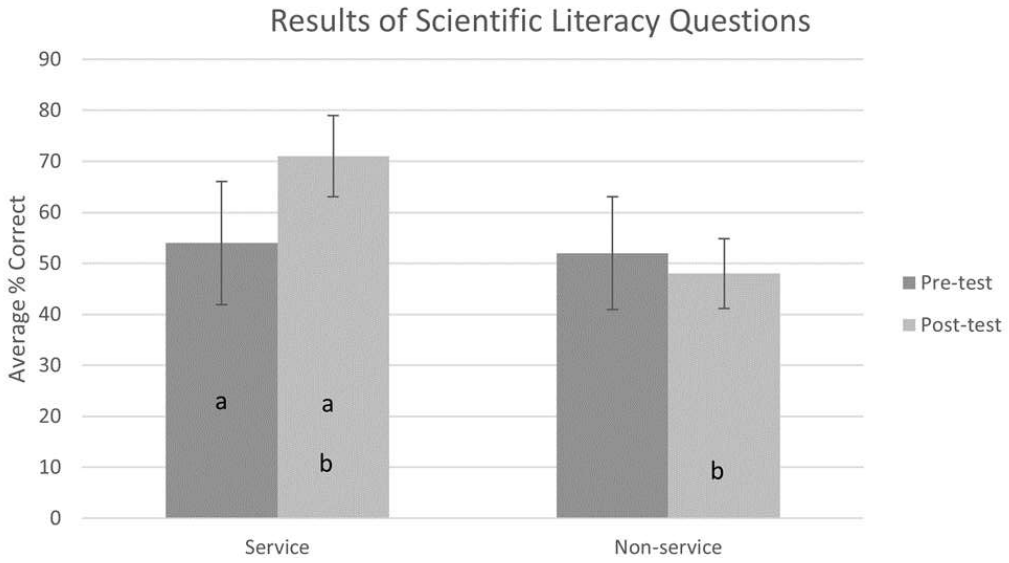

Figure 1. T-test comparing service and non-service on the pre- and post-test questions of scientific literacy.

Qualitative Findings

Results of the qualitative analyses of the open-ended question on the pre- and post-survey asking participants to describe in their "*own words what it means to conduct a scientific study*" revealed four overall themes with accompanying subthemes (Table 3). Pre-test responses tended to focus on a means to an end. While post-test responses revealed students' perception of science as a process of discovery and dissemination of data.

DISCUSSION

Civic Engagement and Service-Learning

Based on the comparative analysis of pre- and post-survey results, there was very little difference of previous civic engagement for all student participants, regardless of being in a service or non-service course. This may be due to the nature of the students attending the university. Further, students who were enrolled in non-service courses indicated that if service activities were embedded in their course, it would help connect the subject matter to everyday life and understand the community needs. Our results (Table 2) are consistent with these findings with over 85% of students enrolled in service courses responding Agree or Strongly Agree on the post-tests to both of the following questions "Service allows me to see how I can be more involved in the community." and "Shared learning with other students through service-learning will help me to understand community needs." Regardless of the service setting, virtual or in-person, student perception of civic engagement remained positive. Ahmad and Gul (2023) found that online service-learning was a useful approach for promoting social justice and civic attitudes for students working in a laboratory setting. Furthermore, other studies support the finding that students desire to be part of something bigger and utilize their education for good (Cielocha, 2022; Owusu-Agyeman & Fourie-Malherbe, 2021) whether service-learning occurs in-person or online.

Scientific Literacy

Qualitative analyses of the pre- and post-survey open-ended questions revealed that student participants grew in their understanding of how to conduct a scientific study, consistent with improved scientific literacy through service-learning (Reynolds & Ahern-Dodson, 2010). In the pre-experience survey, the focus was on the scientific method as a "means to an end" where the focus was on finding the solution to the original problem. Many students described the steps of the scientific method including identifying a question, creating a hypothesis, applying quantitative or qualitative procedures all in the hopes of answering the question. For example, one student shared that conducting a scientific study meant, "using specific methodology and controls to answer a question." Similarly, another student said, "A study to gather information to answer a bigger question." Conversely, in the post-experience

survey, students described conducting a scientific study with an emphasis on the actual process versus focusing on the end game. This theme wove throughout all student descriptions. One student's definition of a scientific study was, "Coming up with a question you wish to answer, hypothesizing about what the answer may be, developing a method in which to collect appropriate data that will help to answer or shed insight into that question, performing the study using the derived methods, compiling results in an organized way and making conclusions/discussing these results." Another student shared, "researchers plan an experiment to gather data about something to gather the new information. This new information could lead to future experiments or new ideas passed around." Therefore, students in the post-experience survey described not only the steps of the scientific process, but who they might work with and how they might disseminate their findings. Students in the post-experience survey demonstrated the broader benefits of participation in a scientific research project including collaboration, new learning, and contribution to the community (Adebisi, 2022).

Further, evidence of scientific literacy improvement existed in the multiple-choice question set. While students in both the service and non-service courses scored the same on the pre-test, students in service-learning courses showed significant improvement in their scientific literacy. This is consistent with current literature which implemented service-learning and tests of scientific literacy (Hayford et al., 2014, 2015) while those not involved in service showed no improvement on their scores on the post-test.

LIMITATIONS

A study limitation included a sampling bias as the participants were from incongruent student populations. For example, General Biology I is the non-service-learning undergraduate biology course in which the survey was administered. This course is generally taken by first semester first-year students and covers introductory topics of cellular and molecular biology. Whereas, General Biology II, the main undergraduate service-learning based course for which the survey was administered, focused more on ecology and organismal diversity. Additionally, participants consisted of mainly undergraduate students with a small sample of graduate students who completed the pre- and/or post-survey.

Measurement bias occurred within the survey design. The administered survey consisted of six multiple choice questions on scientific literacy. Two of these came directly from the TOSLS (Gormally et al., 2012). The remaining four were written by the authors, of which three covered topics relating to population growth, predator-prey interactions, and climate change—all topics which are covered in General Biology II. These ecologically based questions on the scientific literacy assessment covered topics which are aligned with the General Biology II curriculum, and are not presented in the General Biology I curriculum.

CONCLUSION

All students, regardless of the opportunity to participate in service, demonstrated growth in their understanding of the scientific method. Students enrolled in a service-learning course showed significant improvement in their scientific literacy over the semester. Many Americans express positive attitudes towards science and technology (National Science Board, 2020). The pace by which we receive this knowledge has increased in the internet age (Miller et al., 2021). Education is the most important variable for peoples' positive perception of science (National Science Board, 2020) further illustrating the need to provide students with innovative ways to learn scientific methodology through service-learning within their community.

Based on our survey data, students expressed a desire to continue to be civically engaged. Our research demonstrates that service-learning plays a role in students' perception of connection with their community. Incorporation of service-learning in coursework facilitates growth in scientific inquiry and civic engagement to prepare more civic-minded and compassionate individuals upon graduation.

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