PRIMUS, 23(10): 893–905, 2013

ISSN: 1051-1970 print / 1935-4053 online
DOI: 10.1080/10511970.2013.785734

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Service-Learning Project in a First-Year Seminar: A Social Network Analysis

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Abstract: Understanding the effects of a service-learning component on the classroom culture, socially and academically, brings a novel perspective to designing, executing, and assessing these types of active-learning projects. This paper evaluates the success of a service-learning project from a perspective of social networks by investigating the question:

How does a service-learning project affect friendship and academic collaborations in the classroom?

We believe that the benefits of service-learning involvement extend beyond helping students' academic success. Especially in a first-year seminar course, building a support system for the incoming student in order to ease the translation to a college setting is beneficial to students and to colleges. Here we use social network analysis tools to analyze relational data where relations are described as friendships or academic collaborations among classmates. Our results show that a group-based service learning project in an introductory level Statistics course has different effects on the evolution of friendship and academic collaboration networks among classmates.

Keywords: Service-learning project, collaboration networks, friendship networks, centrality measures.

1. INTRODUCTION

Social network analysis has a wide range of applications in a number of disciplines such as computer science, business, psychology, public health, and many more [7, 10, 12]. Roughly speaking, the social network methods provide tools to study interactions among objects and how these interactions evolve over time. For example, Van de Bunt et al. [14] collected friendship data along with attributes such as gender, age, residency, and smoking behavior

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for 32 freshmen using a survey method applied at seven discrete times during a semester. Then, social network analysis methods were used to develop an understanding of friendship formation among the freshmen. Palonen et al. [11], used similar methods to analyze the participation network in a computer-based collaborative learning course with 29 primary school students. They concluded that network analysis provided a deeper understanding of peer influence among students with different ability levels. A combination of qualitative methods, social network analysis, and computer data logs were explored to understand student interactions in a computer-supported collaborative learning environment in [9]. De Latt et al. [6] used social network mapping to visualize the relationship patterns and participation by each group member in a computer-supported learning environment. Calvo-Armengol et al. [3] discussed educational outcomes from a perspective of a network structure by exploring the National Longitudinal Survey of Adolescent Health dataset.

Recently, first-year students on the Statistics for Biology and the Health Sciences course had the opportunity to collaborate with the in-campus Child Development and Student Research Center (CDC) in a service-learning project called "Nutrition at the CDC." Students measured the children's snack time calorie intake and investigated their eating behavior during regular visits to the CDC. Assignments related to this project included reviewing literature on childhood obesity, attending a presentation on the ethical guidelines in observational studies, collecting and analyzing data, and presenting a poster.

In Section 1.1, we briefly discuss the structure of Rollins College's first-year seminar course program and the introductory level Statistics course, RCC: Statistics for Biology and the Health Sciences, offered in the program in Fall 2011. In Section 2, we present the details of the term-long Nutrition at the CDC service-learning component, motivation, logistics, and activities of the project, as well as the students' feedback. In Section 3, we set up the framework to apply social network analysis methods to study the social and academic outcomes of a group-based service-learning project. In Section 4, the network topology studied with the students' attributes and group affiliations help us understand the social and academic influence of a statistics-based service-learning project in a freshman seminar course.

1.1. Course Information

Rollins College is a liberal-arts institution located at Winter Park, FL. The college mission statement emphasizes the importance of "global citizenship and responsible leadership, empowering graduates to meaningful lives and productive careers." As part of helping students to become members of the Rollins community, we offer first-year seminar courses called Rollins College Conference Courses (RCC). All first-year and transfer students are required to enroll in a RCC during their first term at the college. Each year, a wide

variety of interesting topics are offered as RCC. Some of the Fall 2011 RCC titles included Art and the Brain, Fight Club, God and the Buddha, and The Landscape of Music. Students are placed in a RCC based on their preferences on the application forms. Our department offered an introductory level statistics course titled Statistics in Biology and the Health Sciences. Students who enrolled in the course declared interest in Biology, Marine Biology, Pre-Medicine, or Chemistry programs. Many had completed Pre-calculus in high school but had no significant background in statistics. Initially, the class size was 16 students. However, one student did not continue with the course; therefore, her information was not included in the final analysis performed during Week 10.

2. SERVICE-LEARNING PROJECT

2.1. Motivation for the Service-Learning Project

As a faculty member who teaches introductory-level statistics courses for non-majors, I have been asked several times, "Why do I need to learn statistics?" or "How is this relevant to my major?" I encourage my students to discover applications of statistical concepts on their own. A service-learning component provides many opportunities for students to apply statistical methods to solve real-world problems. In these projects, the students' responsibility in the class evolves from learning statistics to becoming statistical consultants providing data collection and statistical analysis to a community partner. Teaching a course while concurrently mentoring a service-learning project as part of the course curriculum might be challenging for the faculty member at times. However, such projects provide an active learning and teaching environment where students, in close collaboration with the faculty member, gain hands-on experience in every phase of statistical research [1].

During this project, we collaborated with the Rollins College CDC, an on-campus facility [5]. The needs of our community partner included providing information about healthy eating behaviors to preschoolers and their parents, evaluation of calorie content of the CDC snack menu items, and understanding the eating behavior and calorie intake of each preschooler. This project fits ideally with our partner's mission statement [5]:

> Our mission is to foster growth and learning for undergraduates and children, and to support families with young children in our community. Students grow in their understanding of human development and learning. Children have innovative and creative experiences that foster growth and individual learning. Families are supported by our exceptional teaching staff through the research of faculty and students. There are opportunities for faculty to educate students in observation research skills, the design and implementation of research projects, and nurturing

relationships between students, young children, their families and community organizations.

2.2. Description of the Service-Learning Project

Our service-learning project focused on raising awareness of childhood obesity. Based on a recent research study by the Center of Disease Control and Prevention, childhood obesity has tripled for the last 30 years [4]. Although many students were aware of the problem, they were not familiar with the statistical studies on the subject. Sixteen students were randomly assigned to four groups to complete the project. Each group completed the same set of assignments.

The service-learning project included several group assignments and a final poster presentation. We devoted 2–3 lecture periods to general discussions of the project and group assignments. In addition we spent three computer-lab class periods discussing how to record, analyze, and present the data. The first group assignment was to explore www.choosemyplate.org website which offers resources such as daily calorie count charts for different age groups, nutrition facts, and the list of amount of empty calories from solid fats and added sugar. Once the students had an understanding of a healthy eating behavior for age group 2–5 years old, they needed assistance in designing an observational study. Dr. Sharon Carnahan from the Department of Psychology at Rollins College educated students about ethical guidelines to design and execute observational studies. In mid-October, students started their daily visits to collect data on what preschoolers at the CDC ate and how much of the food they ate. At the end of the observation week, each group recorded daily food and beverage choices with calorie intake calculations on an Excel spreadsheet. Students were able to plot bar charts and calculate simple statistics measures to determine how healthy were the CDC snack menu options. Their findings showed that only 4% of the preschoolers preferred to eat the snacks that classified in the vegetable food group. In fact, 18% of kids' weekly calorie intake was coming from solid fats and added sugar. As a final project, students presented a poster during a traditional pot-luck family dinner at the CDC, answered questions from the parents of preschoolers, and educated them about healthy eating behaviors in age group 2–5 years old.

2.3. Service-Learning Project Logistics

Collaborating with a community partner that has the experience and willingness to support an educational environment for a freshman class was a tremendous help during this project. From the beginning of the project, the CDC staff were involved in every step. RCC students interacted with both senior class students and CDC faculty members during their on-site visits.

We were also very fortunate to receive financial support from the Rollins College Office of Community Engagement in order to buy measurement cups and scales and to print a poster for the presentation. In addition, the on-campus location of our community partner proved to be a huge advantage for us, since students did not have to worry about transportation from school to the project site.

During this project, we encountered some scheduling difficulties. It was important for the students to be at the CDC when the children began eating, so that they would be able to record how much food each preschooler put on their plate. Initially, however, the CDC snack time varied between 10:30 and 11:30 a.m. After we consulted CDC, snack time was scheduled at 11:00 a.m. on student observation days. We also asked them to provide us with a weekly snack menu. RCC students calculated the calorie content of each item on the menu.

At the beginning of the term, students also prepared surveys to collect information about the eating behavior of the preschoolers at home. These surveys were sent to parents along with the project description letters. At the end of the term, the response rate was only 15%. Therefore, students could not include parent survey results in their analysis. This practice led to a class discussion about the response rate, missing data, and such problems with survey studies. Such discussion presented opportunities to go beyond the textbook material and started a meaningful discussion about survey research.

2.4. Service-Learning Project Learning Outcomes

The Nutrition at the CDC service-learning project assignments were designed to bridge the gap between in-class statistical knowledge and practice. Students were actively involved in the data collection, survey preparation, data analysis, and interpretation. At the beginning of the term, we had an in-class discussion about different study designs. Students decided that the observational study was a natural fit for our project. Excel was utilized to carry out the statistical computations as well as display the data visually. The quantitative and analytical structure of the service-learning project complemented the learning goal of RCC 100: Statistics for Biology and Health Sciences, namely, to develop statistical skills to understand, analyze, and interpret health or biology-related data.

One of the most valuable outcomes of the project was the final poster presentation. During the last 2 weeks of the project, students collaborated to compose a poster presentation of their results. It was displayed to the CDC parents at the annual get-together. Transforming statistical results to “simple English” required students to re-examine their findings within the context of the problem. The final poster included a detailed literature review on childhood obesity and specifics of the observational study conducted at the CDC, along with an analysis section supported by tables and graphs.

2.5. Students' Feedback and Concerns

This project allowed students to build upon basic statistical knowledge as they investigated a real-life issue. They were involved at every phase of an observational study; literature review on the research question, design of an observational study, data collection and analysis, and presentation of statistical findings. After the final presentation in week 10, students were given Likert-scale questions ranging from 1 to 5 (1: poor to 5: excellent) to evaluate the success of the service-learning projects and to pick their favorite activity related to the service-learning project. Table 1 and Table 2 summarize students' experiences with the service-learning project based on this survey. Overall results show that 86% of the students gave positive feedback about their involvement in the service-learning projects. Although many activities are included in the survey, students selected two activities as the most enjoyable parts of the project: working in groups and applying statistics to a real-life issue. It is worth noting that most of the students in the class preferred working in a group rather than working alone. Students commented that being in the same group helped them get to know their classmates better.

Student suggestions included recommending extending the time of data collection from a week to two weeks. They mentioned that, the first time they recording food consumption data, it was very difficult to remember the preschooler's name, measure how much food each child had taken on their plate before beginning to eat, and record the data at the same time. They believed that several visits would have helped them to take more accurate measurements.

Table 1. Rating of the overall experience

How would you rate your overall service-learning experience?	
14%	Excellent
72%	Good
7%	Satisfactory
7%	Not satisfactory

Table 2. Popular service-learning activities

What did you like most about the "Nutrition at the CDC" project?	
46%	Applying statistics in a real-life situation
46%	Working in groups
8%	None

3. NETWORK DATA COLLECTION AND METHODOLOGY

We used self-reporting questionnaire methods to collect relational data about the friendship and academic collaborations among the students in the Statistics in Biology and the Health Sciences course. Students were randomly assigned to four different groups, and then surveyed at three discrete time points during the term. The first survey was collected after students completed their first group assignment on writing about the childhood obesity problem in week 3; the second survey was collected after week 6 when students had completed collecting data at the CDC, and the third survey was collected at the end of week 10 when students presented their findings to the parents of preschoolers at the CDC. In these surveys, students were asked to provide answers to the following questions

1. Have you discussed a statistics homework question with a classmate during the past three weeks? (Do not include service-learning project-related questions.)
2. Have you scheduled a study session with a classmate to discuss the course material? (Do not include the meetings on the service-learning project-related issues.)
3. List the names of your friends among your classmates.

Some questions used in this study were modified from the survey samples in Appendix Box [13], in which students were limited to name at most five people. In our questionnaire, students were allowed to name any number of study partners or friends. The first and the second questions were used to map the students' academic collaboration ties, whereas, the third question provided information about the students' friendship ties. UCINET and NetDraw software packages [2] were used to display the relational data in Figures 1 and 2.

In addition to the relational data on students' networks, we collected information on students' attributes such as gender, preference for working alone versus working in a group, and residency as well as their group affiliations. They were also asked if they had a prior acquaintance with a classmate or had another course in common with a classmate. Only a very small percentage of the students were attending another class together. None of them had any prior friendship relations with their classmates. Therefore, we did not account for these in the analysis.

4. NETWORK DATA ANALYSIS AND FINDINGS

In this paper, the method of social network analysis [8] is used to evaluate the success of the service-learning project in building friendship and

academic relationships among students in the introductory-level Statistics course. Longitudinal network data was collected to analyze the friendship and academic collaborations among students over the term. We also investigate the "importance" of each student in the academic collaboration networks and friendship networks. In [15, 8], there is a broad discussion of the different measures that have been developed to identify the importance of each member in a network. For our purposes the degree centrality measure, the number of connections each individual has, is appropriate to identify important members. The higher the degree centrality score of a student, the more "connected" she or he is in the class.

The academic collaboration network demonstrates the study collaboration relations among students. Students are represented by nodes, and, academic collaboration ties are represented by links. In the network, a link exists between the students if they discussed a homework question or scheduled a study session within a given time frame, excluding the group meetings and discussions on the service-learning project.

Figure 1 shows the evolution of the academic collaboration network by weeks 3, 6, and 10. Different groups are displayed at the corners of each figure (each with different color). We did not distinguish between ties sent and ties received. Therefore, if student A reported studying with student B on the homework, we assumed that student B studied with student A even if student B did not name student A as a study partner in his/her survey. It is not surprising that the number of links among students had improved over the term. On average the number of study partners per student in the class increased from 2.5 to 5.7 at the end of week 10. In other words, the average degree centrality for the network increased 108% in the time period. Larger size nodes in the network are used to represent students with many study partners. An internal link in the study collaboration network represents that two group members collaborated outside the service-learning project activities to study for the course. On the other hand, an external link represents study relations between members of different groups. If α% of student A's links are internal, (100-α)% of them are

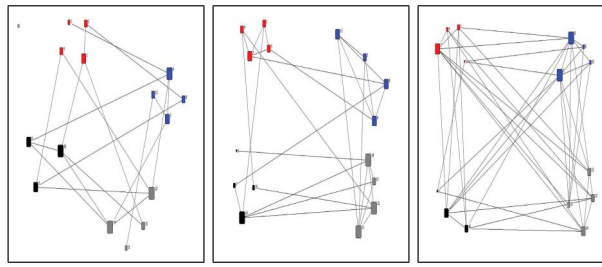

Figure 1. Evolution of the academic collaboration network (color figure available online).

Table 3. Comparison of percentage of internal links in academic collaboration networks

	Week 3	Week 6	Week 10
Group 1	18.18	55.56	25.00
Group 2	20.00	20.00	12.50
Group 3	36.36	66.67	38.46
Group 4	25.00	61.54	20.00

external. Internal link percentage of a group is calculated as the average percentage of its members' internal ties. Similarly, the percentage of external ties of a group is the average of its members' external links. We investigated the contribution by the service-learning project in building study partnerships by comparing the percentage of links within the group. Results are presented in Table 3.

Initially, many group members relied on external academic collaborations. It appears that homework-related study sessions or discussions among group members increased during week 6 when students were heavily involved in the data collection stage of the service-learning project. Students spent a lot of time outside the classroom setting during that week. However, we do not observe that high percentages of internal academic collaborations show a lasting effect on students' behavior. Although there was an increase in internal collaborations in week 6, the percentages measured in week 10 resulted in a value close to initial percentage measured in week 3 in many groups.

As we mentioned earlier, one of the main goals of a first-year seminar course is to create a support environment where an incoming student feels comfortable socializing and making new friends. Thus, we also examined the evolution of a friendship network. Based on students' answers, ties between the student and the friends among the classmates were established. We assume that this network is symmetric, with no distinction between ties sent or received. In other words, if student A reported student B to be his/her friend, we assume that student B has a link to student A even if student B did not list student A as his or her friend. This practice is common because symmetric networks is a well-studied subject.

Figure 2 shows the evolution of the friendship network in week 3, week 6, and week 10. It is important to note that on average the number of friendship ties per student declined over time. The degree centrality measures showed that initial mean value of friendship ties of 3.62 per student in week 3 decreased to 2.53 in week 10. On average, each student lost about 30% of their initial friendship ties over the time frame. An internal link for student A shows that she/he nominated a group member as a friend. Student A's external link indicates a friend nomination outside her/his own group. Similar to academic collaboration networks, the percentage of internal (external) ties of a group is calculated as the average of its members' internal (external)

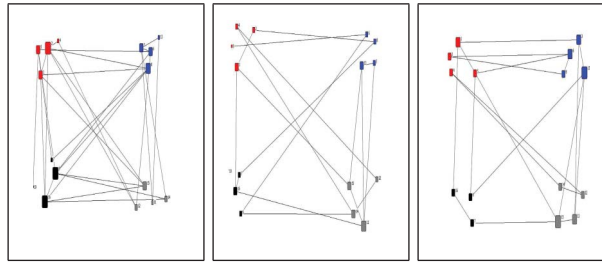

Figure 2. Evolution of the friendship network data (color figure available online).

Table 4. Comparison of percentage of internal links in friendship networks

	Week 3	Week 6	Week 10
Group 1	0.00	26.67	36.36
Group 2	13.33	28.57	33.33
Group 3	26.66	22.22	33.33
Group 4	25.00	25.00	0.00

ties. To explore the effects of the service-learning project, we compared the evolution of the internal and external friendships links. The results in Table 4 demonstrate that the friendship links between groups grew stronger over time.

In order to investigate the relation between the academic collaboration network and the friendship network, we performed a correlation analysis on week 3, week 6, and week 10 datasets. In week 6, the centrality scores in both networks became moderately correlated (0.53 with $p = 0.03$). However, we did not find any significant correlation between degree centrality scores in week 3 and week 10. We also performed a regression analysis on the week 10 dataset to explore whether the high connectedness in academic collaboration networks contributes to the overall experience ratings of the service-learning project. A regression analysis was also performed for the friendship networks. Our analysis did not determine significant mean differences in the overall service-learning experiences of "connected" versus "not-so-connected" members in the academic collaboration network as well as the friendship network.

5. CONCLUSIONS

Nutrition at the CDC service-learning project enriched students' perspectives about applying mathematics to real-life issues. Early in their college career,

students learned that mathematics can make a difference in resolving social problems. Based on students' recommendation, the CDC improved their menu options by adding a variety of vegetable-based snacks.

It is an interesting problem to evaluate the effectiveness of a service-learning component on stimulating friendship and academic collaboration relations among first-year students. From the results of week 6, projects that require students to collect data as a group outside the classroom environment appear to be helpful in building strong social and academic collaboration skills. Although friendship ties improved within groups over the term, strong in-group academic collaboration ties did not last until the end of the term. There might be several possible explanations why individuals choose their friends and study partners differently. Friendship might build voluntarily; however, student achievement level might play an important role in building academic collaborations. Since Statistics in Biology and the Health Sciences course was offered as a first-year seminar course during the Fall term, we did not have any information about students' GPAs to investigate this claim further.

In a future study, we plan to examine the role of service-learning projects on a classroom culture with a larger student population. Another interesting extension of this study could be the comparison of the structure of friendship and academic collaboration networks and their evolutions over an academic term in courses with and without such service-learning requirements. We plan to include students' attributes such as frequency of involvement in voluntary work or community events, GPAs, hobbies, and favorite academic subjects, along with the relational data for future studies.

5.1. Limitations of the Study

Although some of the current findings could apply to designing quantitative-based service-learning projects to promote close social and study relations among first-year students, there were several limitations to our study. The first was the small sample size of 16 students. Therefore, instead of statistical analysis, the topology of friendship and study evolution networks was displayed visually in Figure 1 and Figure 2. A larger sample size is needed to statistically confirm the visual findings.

The second limitation of our study was the lack of a control group. This course was offered for the first time in Fall 2011. In addition, there was no other course offering based on quantitative data analysis. Therefore, even though there were many first-year seminar courses with and without the service-learning component, we did not have any course offerings to which we could compare the technical aspects of the service-learning component in the Statistics for Biology and the Health Science course. In presence of a control group, we anticipate that the final network structure in the academic collaboration networks will not be significantly different in courses with or without

group-based service-learning requirements. On the other hand, friendship networks might end up with many members that are "not-so-connected" in the absence of group-based service-learning requirement. However, both of these claims need to be further investigated.

ACKNOWLEDGEMENTS

I am grateful for many helpful discussions with Dr. Skvoretz, Dr. Carnahan, and the staff members at the Rollins College CDC, and the Community Engagement Office during this project. The Associated Colleges of South Andrew W. Mellon Faculty Grant supported my research on social network analysis.

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BIOGRAPHICAL SKETCH

Zeynep Teymuroglu received her Ph.D. in Applied Mathematics at the University of Cincinnati. She has been an Assistant Professor at Rollins College since 2010. Her research interests are in mathematical modeling, biostatistics, and mathematics education. She uses service-learning projects part of her teaching in the introductory-level Statistics courses.