Group Projects as a Method of Promoting Student Scientific Communication and Collaboration in a Public Health Microbiology Course

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Abstract: Communication of scientific and medical information and collaborative work are important skills for students pursuing careers in health professions and other biomedical sciences. In addition, group work and active learning can increase student engagement and analytical skills. Students in our public health microbiology class were required to work in instructor-assigned groups to research a human pathogen and associated disease, and to create a presentation appropriate for their classmates. Objectives of the project included building students' abilities to research and critically assess relevant scientific and medical information, increasing their scientific communication skills, and improving group collaboration skills. Another goal was for students to be the class "expert" on their chosen pathogen. Group projects were presented orally to the class, and in written formats as either posters or pamphlets. A peer evaluation was utilized to allow students the opportunity to evaluate their group's effectiveness. Students were surveyed after the projects for self-evaluation of content knowledge and confidence in scientific communication and research skills. Many students expressed enthusiasm for the project, and 96% and 65% of students reported increases in content knowledge and communication skills, respectively. We conclude that group projects are an effective means of delivering content while increasing students' confidence in science communication skills.

Keywords: group work, microbiology, science communication

Introduction

Undergraduate students majoring in fields within the allied health professions need to gain appropriate content knowledge in areas of biology including microbiology. In our curriculum, pre-nursing students and majors in other allied health programs typically take a one-semester course in medical and public health microbiology. This course focuses on basic microbiology with an emphasis on human pathogens and infectious disease, including both lecture and laboratory components. Although increasing students' content knowledge and exposure to laboratory methods in microbiology are certainly primary goals of our course, the development of other skills is also important for students planning careers in nursing and other allied health fields. For example, the ability to critically assess medical and science literature, to communicate technical information to different audiences, and to work effectively in groups are all valuable for students in these majors, and indeed are useful skills for students in many, if not all, fields in science, medicine, and technology. To address the development of these skills, we have implemented a new group project into this class. Students were assigned by the instructors to groups of three to five and were required to research and present information on a human pathogen and the associated disease. The objectives of this project included: 1) building students' abilities to research and critically assess relevant scientific and medical information, 2) increasing their scientific communication skills, and 3) improving group collaboration skills. In addition, we expected students to demonstrate in-depth knowledge about the pathogen chosen by their group.

Over the past two decades, increasing emphasis has been placed on teaching the process of science as well as content, and on exposing undergraduates to scientific research through primary literature and/or independent projects (National Research Council, 2003). Primary literature relevant to the pathogen would be the optimal source for the most current scientifically accurate information. However, students in this course had generally not been exposed to reading primary literature in the prerequisite introductory biology course, and were not expected to be familiar with

methods for searching for or reading current primary literature in microbiology and infectious disease. Our primary goal was for students to find and assess the credibility of accurate information from secondary sources and present it at a level appropriate for their classmates and the public. The internet serves as a primary source of information of science health care information for college students (Escoffery, 2005), and indeed for patients and the public as well (Wilson, 2002). Interestingly, a study suggested that students with stronger internet searching skills learned more and were more critical of information accessed through internet searching than students who were less familiar with internet searching (Tsai, 2003). We therefore allowed students to use reliable but non-primary literature sources such as textbooks and internet-accessible information, and in our view, this served as an important exercise for students in evaluating the reliability of science and health-related information on the internet.

The development of skills in communication of scientific and medical information is also important for students pursuing careers in health professions as well as in other areas of biomedical science. Students who successfully enter the nursing profession, for example, will be expected to accurately and clearly discuss science and medical information with their supervisors, colleagues, and patients, and must be able to communicate effectively with each of these groups. Evidence from several studies indicates that ineffective communication skills in nurses and other medical professionals can negatively impact patient satisfaction and compliance with recommended treatments (Chant, 2002; Fallowfield, 1999). We therefore gave students the opportunity to improve their skills in communicating technical scientific and medical information to their peers through an oral presentation and through an informational pamphlet or poster.

Substantial evidence suggests that collaborative group work and activities are effective means of learning for students (Michael, 2006; Tanner, 2003). The ability to work well as part of a team is also an important skill in many careers in current society, including the nursing and other allied health fields that students in our course are planning to enter. This project included both collaborative work and active learning elements, since students were required to work within a group to research their topic and present their findings. Because this project included several objectives that could not be directly tested with a content- and application-based quiz or exam, we used a survey to assess students' perceptions of their gains in skills from this project. We describe here our results after three semesters of using this group project assignment.

Materials and Methods

This project was first implemented in the Fall 2006 semester, and has subsequently been utilized in the Fall 2007 and Spring 2008 semesters as well. The Fall 2006 and Fall 2007 courses were taught by one of the authors (Walton) and the Spring 2008 course was taught by the other author (Baker). Some relatively minor changes in project format were implemented in the Fall 2007 and Spring 2008 semesters; these will be highlighted below. However, the general format of the project, grading rubric, and assessment survey were consistent among the three semesters described in this manuscript.

Students were assigned by the instructors to groups of three to five students. In the Fall 2006 semester, group assignments were completely random. In the Fall 2007 and Spring 2008 semesters, the groups were not assigned until at least one major exam grade had been recorded, and we used these exam scores to distribute students so that each group contained a mix of stronger and weaker students. Group size was largely determined by the number of students per section and the amount of time available for presentations. Each group was required to select a human pathogen from a list that we provided. The list typically contained 9-15 pathogens that were not otherwise covered extensively in the course, but were generally of high interest to students. The list of pathogens included species from four major groups of microbes (viruses, bacteria, fungi, and protozoa). Examples of popular choices included rotavirus, *Bacillus anthracis*, and *Trichomonas vaginalis*. Students were provided with a handout that contained guidelines for the project, including project objectives; requirements for content depth, format, and references; and a copy of the grading rubric. A sample grading rubric is shown in Table 1.

Groups were required to use a minimum of three reputable, peer-reviewed secondary sources for their project. Suggested sources were given in the guidelines, including the course textbook, reputable online sources such as Medline Plus (http://www.medlineplus.gov) and the Centers for Disease Control and Prevention (http://www.cdc.gov), and optionally current primary literature. On the day that the project was due, each group gave an oral presentation of no more than 10 minutes with information about their selected pathogen and the associated human disease. In

addition, groups prepared either a poster (Fall 2006 and Fall 2007 semesters) or an informational pamphlet (Spring 2008) to accompany their presentations. The target audience for the oral presentation and the poster/pamphlet were emphasized to students as an important consideration. In the Fall 2007 and Spring 2008 semesters, the posters or pamphlets were to be designed as public awareness materials that would be appropriate for any general audience, while the oral presentation was expected to include more technical information at an appropriate level for the rest of the class.

We graded each group and individual student on the day of the presentation, using the rubric shown in Table 1. As shown in the rubric, a student's grade for the project included a group component, which was the same for all members of the group, and an individual component based on how well that student presented his or her part of the group presentation and answered questions posed by the instructor and students in the audience. On the day of the presentation, all students were also required to turn in a peer evaluation that asked students to evaluate the performance of their group members. The average peer evaluation score for each student was factored into their overall grade for the project. Students' learning of the material from all of the presentations from their section was assessed by instructor-constructed quizzes or exams one to two weeks following the presentations.

Table 1. Group presentation grading rubric (Fall 2007)

	Poorly done, missing, many mistakes	**Average, some mistakes or omissions**	**Excellent, thorough. few to no mistakes**
Oral presentation			
Content (20 pts):			
Appropriate level of information	0 1	2 3	4 5
Description of microbe	0 1 2	3 4 5	6 7 7.5
Description of disease (case study, treatments)	0 1 2	3 4 5	6 7 7.5
Format (10 pts):			
Contains all required information	0	2	4
List of sources and proper citations	0	2	4
Style (well organized, easy to follow)	0	1	2
Presentation (5 pts):			
Individual able to describe presentation or poster content; answered questions	0 1	2 3	4 5
Poster			
Content (5 pts)			
Appropriate and accurate level of information	0 1	2 3	4 5
Design (5 pts)			
Poster is readable, clear, attractive	0 1	2 3	4 5
Mean peer evaluation score for group participation (0-5 pts)			_____

Total: _____ out of 50 possible points

Notes and suggestions:

Results and Discussion

Upon completion of the group infectious disease project, students were asked to provide anonymous input regarding their perception on the project's effectiveness at achieving instructor-established goals. Students were asked to rate their confidence level before and after the project in three

areas: ability to research information, ability to communicate, and depth of knowledge for their selected infectious disease. Table 2 provides the mean (+/- SD) student responses by semester. All means in a pair-wise t-test comparing before and after project responses for a given survey item showed significance at $p<0.05$. Our results support the general impression that many students lack confidence in communicating with their peers prior to this project, reporting an average which ranged from 3.2 to 3.6 on a 5-point scale among the three semesters. Survey numbers indicate the project significantly enhances their confidence in this area, increasing student average confidence by 0.8 to 1.3 beyond their initial response, with 65% of students reporting an increase when data from the three semesters were combined. Likewise, we do not expect students taking this course to come into the class with a high level of pathogen-specific knowledge. This is supported by the average response to this survey question, which ranged from 2.0 to 2.6 across the three semesters. Students clearly took responsibility for their topic as evidenced by the dramatic increase in their opinions of how well they understand the pathogen and disease following the project (a 1.9 to 2.4 increase), with 96% of total students surveyed reporting an increase. Additional support of this subject-specific knowledge increase comes from scores on quizzes over the material researched and presented. For example, students scored an average of 13.7 out of 15 pts (91.3%) on an open-note quiz over all pathogens presented, not just their own, in the Spring 2008 semester and averaged 8.6 out of 10 pts on a closed-note quiz in Fall 2007. Regardless of semester, the quiz was written by the instructor and consisted of multiple-choice questions. These scores show that, in addition to learning from their own group's research, students also learned effectively from their peers' presentations.

Interestingly, though still a significant increase, the least change in student response scores occurred in their opinions of their own confidence in researching and evaluating relevant data. We have found that most students feel capable of researching information in general, though not necessarily scientific information, prior to this course. This is likely due to the required Research and Writing course all Missouri Western State University students take as part of general studies education. Students generally take this course in their first academic year, almost always before advancing in their science curriculum to this course. Our data show an initial, confident response of 4.0 to 4.2 with only a 0.3 to 0.6 average confidence increase in adding to this skill. We feel that this relatively minimal increase in students' perceptions of their research skills may be due to our project parameters, which allowed students to use everyday resources they were already comfortable with, such as textbooks and the internet.

In the second two semesters of our project, students were also asked to evaluate their overall impression of this project as an effective way to learn about their chosen pathogen. Their high response averages of 4.4 and 4.8 indicate our project design is effective in stimulating student learning. This is an important piece of evidence showing that an active learning process is effective and well accepted by our students.

Table 2. Student response survey data. Numbers listed are response means (+/- standard deviation). Response scale used is 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree. All data comparing before and after responses for each survey statement in a given semester show $p<0.05$ in a paired-samples t-test.

	Fall 2006 (N=43)		Fall 2007 (N=50)		Spr. 2008 (N=47)	
	before	after	before	after	before	after
I am confident in my ability to research and find accurate microbiology and health information.	4.2 (0.9)	4.7 (0.5)	4.1 (1.0)	4.4 (0.7)	4.0 (1.0)	4.6 (0.5)
I am confident in my ability to communicate infectious disease-related information to my classmates and other peers.	3.6 (1.0)	4.6 (0.5)	3.5 (1.1)	4.3 (0.8)	3.2 (1.1)	4.5 (0.6)
I have an extensive understanding of the biology of the pathogen and related disease that my team selected.	2.6 (1.0)	4.5 (0.6)	2.1 (0.8)	4.3 (0.7)	2.0 (1.0)	4.4 (0.7)
Overall, this project was an effective way for me to learn about pathogens.	----	N/A	----	4.4 (0.6)	----	4.8 (0.4)

As a part of the grading rubric for assessment (table 1), students were given the opportunity to grade their group members and comment on any aspects of group interaction. Of the 140 students over three semesters who completed the project and survey only 14 received a score of less than 5, the top score, from their peers. For the peer evaluation, students were given a scale from 0 to 5 with explanations of what each score represented. A score of 5 indicated the group member "was a full participant in all aspects of the group project, and contributed his or her full share of the work, and was generally a positive influence on the group's work." Student peer evaluation numbers indicate that students are working well together despite some initial reservations in doing a group project, as seen in Table 3 which lists select student comments. In all three semesters of this evaluation students were assigned to groups of three to five students. In the Fall 2006 class, our first use of this project format, students were required to meet and coordinate efforts but were given only two 30 minute portions of lecture periods dedicated to group work time. All other interaction had to occur outside regular class times. This semester precipitated the greatest number of comments about dislike for working in groups and difficulty finding time to get everyone together. This is in agreement with other published studies using collaborative groups within the sciences, which note that negative student comments frequently relate to difficulty scheduling group meetings (Hume, 2006; Mulnix, 2003). As a result of student comments, and knowing we have many non-traditional students with extensive non-academic obligations, the next two semesters we placed students into groups that would contain stronger and weaker students based on exam scores, we provided contact information for group members, and we designated group meeting/work time within the laboratory portion of the course during a time period while students were also working independently on a bacterial unknown project. Although we cannot rule out the possibility that students were just being nice to their group members, after these changes, fewer students commented on problems with getting the group together and fewer students received a score of less than 5 from their peers. We also noted that groups worked independently, requiring very little instructor oversight, unless group dynamics were an issue or source validity was in question.

Table 3. Select student comments from the student survey. Comments presented here are representative of the types of comments for each semester of this project.

Select student comments	
Fall 2006	It was alright, overall I think we worked together well as a group and we all did our part of the project & it was actually pretty informative.
	The project would not have taken as long to complete if all of the members in the group had participated instead of just two of us.
	I think a presentation (power point) might be better. Very crowded looking at the posters. Pamphlets I think is a good assignment.
	I enjoyed the poster assignment, it gave me a chance to get to know my classmates and it was a nice break from every day class routine.
Fall 2007	I thought the project was a good assignment. It helped me get to know some of my classmates better, and we actually had fun working together. The biggest thing that worried me was presenting the pathogen because I am scared of public speaking! All in all, I thought it was good.
	Enjoyed it, enjoyed getting to know & work with new classmates in research.
	The only thing I could suggest for you to change is to hand out an information sheet for the team members to contact each other. I found my teammates helpful & willing but the first few days nobody thought to trade emails & phone numbers.
	I really enjoyed the research with the group but the project and the unknown at the same time was time consuming for me.
Spr. 2008	I think this was a good idea, to make people work together as a group. I know this was one of the most challenging parts of the entire project for some groups
	It was a good way to learn about other important pathogens that are not as popular as like the AIDS or the Ebola virus. I really liked that each of these pathogens is very important to the health related fields.
	I thought the project was a great way to cover certain pathogens in more detail. The Power Point and pamphlet made the presentation more interesting and educational. A good end-of-the-year project!
	Group projects can be fun. It was hard to get together as a whole group.

This project was designed to engage students in active learning through researching a pathogen, improve group collaboration skills, and increase both written and oral communication skills even though the specific delivery of this project was slightly different each semester. In Fall 2006 the project involved the preparation of a technical poster on the chosen infectious disease and the presentation of that poster to peers during a designated lecture period. Some groups chose of their own initiative to also prepare a pamphlet to provide to all classmates, which proved to be very popular with the other students. Each team submitted exam questions based on their material and the specific information researched and presented by each group was tested on the course's final exam. In Fall 2007 the project was adjusted to include the presentation of the material in an oral PowerPoint during laboratory sessions and the preparation of a poster for use as a public awareness tool. Groups therefore had to prepare materials appropriate for two different audiences, and were graded on the appropriateness of the oral presentation for their classmates and of the poster or pamphlet for the general public. We considered the general public a particularly appropriate audience to focus on because the student population in this course is primarily interested in allied health careers. A recent study in a nonmajors chemistry course also described the value of requiring students to communicate scientific information to nonspecialist or lay audiences, and students in this course generally agreed that communicating scientific information to this audience was a valuable learning experience (Shane, 2008). Students were allowed access to the posters for several days followed by a closed-note quiz. In Spring 2008 the project included an oral PowerPoint presentation in laboratory sessions and the preparation of a single sheet public awareness pamphlet provided to each classmate that could be used during a quiz. Regardless of the format used to fulfill our objectives we saw similar student survey response increases as shown in table 2, and similar class quiz scores ranging from 86.0% to 91.3%. In addition, the overall quality of work accomplished by the students across the three semesters of our project was very high and met our expectations with students averaging 93.4%, 92.6%, and 91.9% on instructor-determined grading. These data show that minor alterations to this project to suit the logistical needs of a class or the preference of an instructor still result in high student achievement of the stated objectives.

In conclusion, our project requiring students in a public health microbiology course to work in groups to research and present an infectious disease and demonstrate content knowledge was very successful. Our data support that, regardless of minor adjustments in project format, the students self-assessed an increase in comfort with researching relevant information, communicating with others, and understanding their pathogen. In addition, we observed that students worked well together in their groups and required very little instructor guidance. Our data demonstrate that allied health students can actively learn science, communicate science information, and learn science from their peers. This type of project has given us the opportunity to play a role in helping students to develop essential skills needed by future health care providers.

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