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Integrating Interprofessional Collaborative Practice Into Occupational and Environmental Health and Safety Education:

Results of a Feasibility Study

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Abstract

Objective: Although occupational health and safety programs are expected to prepare graduates to function in an interprofessional collaborative environment, research to support training in this area is far less common in this discipline than among clinical programs. We incorporated interprofessional education (IPE) competencies into an occupational health and safety course for graduate students in diverse disciplines (public health, engineering, nursing) and evaluated effectiveness.

Methods: We assessed course offerings for content learning and attitudes toward IPE and analyzed data using a mixed-methods approach.

Results: In general, students increased their understanding of the role of other disciplines, confidence in working in interprofessional teams, and valuation of IPE.

Conclusion: Introducing IPE competencies into graduate education in worker health and safety is feasible and can equip students to more effectively work in occupational health–oriented multidisciplinary teams.

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All data collection procedures were reviewed by the University of Michigan Institutional Review Board–Health Sciences/Behavioral Sciences prior to data collection (HUM 00154168) and determined to be exempt from regulation.

Keywords

education; engineering education; environmental health; epidemiology; graduate; industrial hygiene education; nursing education; occupational health

Importance of Interprofessional Education

Interprofessional education (IPE) has been highlighted as an important component of curricula offered to health care professionals in training. According to the World Health Organization, IPE "occurs when students from two or more professions learn about, from, and with each other to enable effective collaboration and improve health outcomes."[1] Recognizing the importance of IPE to prepare students to be effective members of the workforce in health care and prevention, the University of Michigan established the Center for Interprofessional Education in 2015, serving its three campuses of Ann Arbor, Dearborn, and Flint.[2] The goals of this center are to (1) "create a collaborative culture, (2) cultivate a core interprofessional curriculum, (3) develop faculty to teach in innovative learning environments, (4) create a unique body of knowledge, and (5) become a leader in IPE."[2] Among the programs offered by the Center for Interprofessional Education is "IPE Leaders," designed to give teams of faculty and staff skills in IPE and introduce IPE competencies into curricula for students, patients, and other constituents of the university.[3] These efforts come from a broader set of goals by the University of Michigan to redesign health care professional education curricula and improve the interdisciplinary capacity of health programs.[4]

The Interprofessional Education Collaborative (IPEC)—representing 21 health professional organizations—was developed to ensure that new and current health professionals are proficient in the competencies essential for patient-centered, community- and population-oriented, interprofessional, collaborative practice. The IPEC has identified four key competencies for IPE:

> "Competency 1: Work with individuals of other professions to maintain a climate of mutual respect and shared values. (Values/Ethics for Interprofessional Practice)
>
> Competency 2: Use the knowledge of one's own role and those of other professions to appropriately assess and address the health care needs of patients and to promote and advance the health of populations. (Roles/Responsibilities)
>
> Competency 3: Communicate with patients, families, communities, and professionals in health and other fields in a responsive and responsible manner that supports a team approach to the promotion and maintenance of health and the prevention and treatment of disease. (Interprofessional Communication)
>
> Competency 4: Apply relationship-building values and the principles of team dynamics to perform effectively in different team roles to plan, deliver, and evaluate patient/population-centered care and population health programs and policies that are safe, timely, efficient, effective, and equitable. (Teams and Teamwork)" (https://www.ipecollaborative.org/core-competencies.html)

Application of IPE to Occupational Health and Safety

Since 1971, the University of Michigan has received funding from the US National Institute for Occupational Safety and Health (NIOSH) to support graduate training and research. The National Institute for Occupational Safety and Health funds education and research centers, of which the University of Michigan Center for Occupational Health and Safety Engineering (COHSE) is an example. The National Institute for Occupational Safety and Health has long promoted interdisciplinary interactions among program trainees. Going beyond interdisciplinary interactions, the project described in this article focuses on IPE, which is distinct in that it involves students from two or more professions learning about, from, and with each other to enable effective collaboration and improve health outcomes.

To date, there has been little focus on IPE in NIOSH. Although not a definitive indicator, searches of NIOSH's Web site for the keywords "interprofessional education" and "interprofessional training" list only four citations, three of which are clinically related, and the fourth is limited to respiratory protection fit for nurses.

The mission of COHSE is "to serve the region, nation, and world as a center of excellence for research and graduate education and in protecting the health and safety of the workforce."[5] Its graduate training programs are internationally renowned, and it has one of the largest alumni bases of health and safety programs throughout the country. The University of Michigan COHSE has long provided opportunities for students from multiple disciplines to interact, but previously, there had been no planned instruction in collaboration or opportunities to learn from each other.

The Gap in Knowledge

Calls for inclusion of IPE among health care professions—including those in public health—have appeared in the literature for over a decade.[6] However, team-based IPE activities have only recently been applied to the classroom setting and primarily in clinical practice disciplines.[7,8]

Interprofessional education has been widely accepted and incorporated into many clinical professions, but its application to public health, and particularly to occupational health and safety, appears to be emerging. The University of Iowa described efforts to include public health in an integrated curriculum that provides opportunities for IPE with clinical professions (eg, dentistry, medicine, nursing, and pharmacy).[9] In addition, the University of South Carolina added public health and social work perspectives to clinical IPE activities of students in medicine, pharmacy, and nursing.[10] While the available evidence for the effectiveness of including public health students in IPE-focused activities is limited, at least one study at Des Moines University showed that awareness of social determinants of health among clinically oriented IPE students was increased following the addition of public health students to the IPE teams.[11]

Nonetheless, there is little evidence of the application of IPE to disciplines involved in occupational health, a distinct subfield within public health. Occupational health encompasses clinical (eg, occupational health nursing, occupational medicine) and

nonclinical (eg, industrial hygiene, occupational safety engineering, and occupational epidemiology) disciplines. The need for these disciplines to interact is evident, given the multitude and complexities of occupational health and safety challenges faced by workers. In summary, information on the implementation and effectiveness of IPE activities within occupational health and additional exploration of how IPE-focused activities may enhance the competencies of both clinical and nonclinical students, including those in public health and engineering, are needed.

In collaboration with the Interprofessional Education Center at the University of Michigan, four of the authors (M.C.M., S.A.B., R.N., M.S.O.) sought to enhance the skills of occupational health and safety graduate students in interprofessional collaborative practice and evaluate the effectiveness of mechanisms used to achieve this. Within this overarching purpose, the team established three aims:

Aim 1. Revise an existing occupational health and safety course for graduate students in occupational health disciplines (ie, occupational epidemiology, industrial hygiene, industrial and occupational engineering, and occupational health nursing) to include IPE competencies, with a primary focus on competency 2.4 (“Explain the roles and responsibilities of other providers and how the team works together to provide care, promote health, and prevent disease”).[12]

Aim 2. Deliver the revised course, evaluate its effectiveness in augmenting student skills in interprofessional collaborative practice, make further revisions based on the evaluation results, and reevaluate.

Aim 3. In the process of revising and delivering the course, engage diverse professionals who complement faculty and student professional expertise, as well as associated resources, to develop strategies to meet specific occupational health and safety needs of workers, patients, and other populations.

METHODS

Subjects and Setting

For this two-group pretest/posttest study, we examined students enrolled in two sections of a graduate-level occupational health and safety course in 2019 and 2020. Students from various disciplines (ie, occupational health nursing, industrial hygiene, occupational epidemiology, and occupational safety engineering) enrolled in the course as a requirement of their funded program of study.

Instruments and Procedures

Student competencies in interprofessional collaboration and specific knowledge of roles and responsibilities of the relevant occupational safety and health disciplines were measured during the first week of the course (pretest) and the final week of the course (posttest) using instruments designed by the investigators for this purpose. Instruments were administered through an on-line learning management system.

Demographics

The six-question pretest asked students to provide their demographic information. This included their discipline (ie, occupational epidemiology, industrial hygiene, occupational health nursing, industrial and operations engineering), with "other" as an option, given that course enrollment could include students from other disciplines. Demographic information also included age, race, ethnicity, and gender.

Explain the Roles and Responsibilities of Other Providers

Assessment of student ability to explain discipline-specific roles and responsibilities was accomplished through a set of four qualitative questions.

> In two to three sentences, describe your initial understanding/impressions about (without any on-line search or reference) the expertise that an occupational epidemiologist brings to occupational health and safety, and the role that an occupational epidemiologist can play on a team addressing occupational health and safety.

The question was repeated for each of the following disciplines: industrial hygienist, occupational health nurse, and occupational safety engineer, but not for other, noncore disciplines.

Attitudes Regarding Interprofessional Teamwork

The pretest/posttest also featured two questions to assess student attitudes regarding interprofessional teamwork. Students were asked to indicate agreement in five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree) with the following statements: "I am very comfortable working on an interprofessional team" and "I see a lot of value in working on an interprofessional team." Answers were scored by faculty using a rubric prepared for this purpose. For example, the following statements were valued at 3 (out of 3) for occupational epidemiology:

> An occupational epidemiologist has experience in understanding workplace hazards and safety as it applies to large populations of people. They have a good understanding of human physiology, as well as mental and emotional strain that may result from work. Their role on occupational health and safety teams is to relay the human component of these hazards to specialists in safety engineering, chemistry, and physics. Occupational epidemiologists integrate a lot of information and must have a baseline understanding of their colleagues' fields.

Intervention

A team of faculty (M.C.M., S.A.B., R.N., M.S.O., C.D.) modified the title, content, and teaching/learning methods of an existing one-credit, cross-listed course (with approval from the participating School of Public Health and College of Engineering). The revised course, titled Interprofessional Perspectives in Occupational Health and Safety, was first delivered from January to April 2019, and the second section from January to April 2020. Details of the course are described in the Results section.

Data Analysis

For the open-ended questions about disciplinary understanding, we reviewed individual student responses and assigned a score value for each response, using a pre-established rubric (Table 1). Student descriptions of each profession were compared with definitions from agencies including the Occupational Health and Safety Administration, the State of Michigan Labor Office, and the American Association of Occupational Health Nurses. Descriptions from these agencies were treated as criterion standards, and student descriptions were assessed on how well they compared with these descriptions on a scale of 0 to 3. After rating of student responses was completed, we compared students' pretest and posttest responses by taking the overall average score of pretest and posttest questions and conducting a paired *t* test to assess difference in each course group.

For comparing student attitudes regarding interprofessional teamwork using the Likert-scale agreement questions before and after the intervention, a paired-samples *t* test was conducted in STATA 16 Statistical Software (Stata Corp, College Station, TX) to determine whether responses toward perceptions of interprofessional teamwork differed from the beginning of the semester to after course completion. This statistical method has been used to compare mean differences between treatments when observations have been obtained in pairs.[13]

RESULTS

We collected data from 100% (n = 36) of enrolled students (Table 2). Students were predominantly women (56%), White (42%), non-Hispanic (91%), and variously distributed across the four participating disciplines, with two additional students outside the four disciplines.

Aim 1: Revise an existing occupational health and safety course for graduate students in occupational health disciplines (ie, occupational epidemiology, industrial hygiene, industrial and occupational engineering, and occupational health nursing) to include IPE competencies, with a primary focus on EPEC Competencies 2.4 ("Explain the roles and responsibilities of other providers and how the team works together to provide care, promote health, and prevent disease") and 1.4 ("Respect the unique cultures, values, roles/responsibilities, and expertise of other health professions and the impact these factors can have on health outcomes").

We revised the long-standing multidisciplinary course to include a more interprofessional focus in learning objectives, activities, and evaluation as they relate to IPEC Core Competencies Domains 1 (Values and Ethics) and 2 (Roles/Responsibilities); these were chosen for focus because of the centrality of interdisciplinary education for the COHSE center, and were achievable during the academic term. However, in the interest of giving students a more complete perspective on IPE, we also included content relating to additional competencies.

Planned course content was focused on IPE core competencies. We designed learning methods to include a mix of interactive learning activities using a variety of teaching methods (eg, case studies, team-based learning), including didactic training on IPEC

competencies, informal lectures presented by extramural guest speakers, primarily used face-to-face learning, and focused on securing a level of student engagement consistent with expected outcome and level of exposure. We also included specific IPE learning activities in an occupational health and safety context. The activities were designed to be engaging, interactive, and involve peer-to-peer learning with the intent of promoting student learning about, from, and with each other. The course faculty was composed of an interprofessional team.

We also designed two group work assignments, purposively assigning students to teams composed of members representing all four disciplines represented in the course. For the first group work assignment, we designed case studies of real-life occupational health issues encountered in the local university hospital, prompting students to develop recommendations to address them using multiple professional perspectives. The case studies addressed (1) increasing use of personal protective equipment to reduce workforce infection risk; (2) identifying nosocomial bloodborne pathogen exposure sources for use in creating a future intervention; and (3) development of recommendations for a comprehensive preventive maintenance program for ice machines used in the health care setting. Teams were assigned to one of the three identified topics, which were broad enough to allow teams to select unique focus areas for their project. We recruited interdisciplinary professionals from the university hospital to present background on the cases, coach students, and critique student presentations of their recommendations.

The second team project involved writing a team-informed reflection on interprofessional approaches to addressing occupational safety and health issues in the coffee industry, with the goal of improving understanding the roles and expertise of different disciplines in the delivery of an exemplary program or service in an industry setting. Here again, we recruited practicing health care professionals to provide introductory presentations; student teams were to complete a written assignment and present their reflections for interactive large group discussion.

Aim 2. Deliver the revised course, evaluate its effectiveness in augmenting student skills in interprofessional collaborative practice, make further revisions based on the evaluation results, and reevaluate.

Delivery of the Revised Course

We first offered the newly revised course in 2019 and in subsequent winter semesters through 2022. Multidisciplinary student teams collaborated to develop recommendations related to (*a*) operating room temperatures and filter standards; (*b*) HEPA (high-efficiency particulate air) filter standards for operating rooms to minimize airborne infections; (*c*) monitoring, ventilation, and cleaning guidelines for negative pressure isolation rooms; and (*d*) use of ultraviolet radiation and other best practices for operating pharmaceutical clean rooms. Continuing with the theme, student teams worked together to enhance public understanding of occupational safety and health issues by contributing to selected Wikipedia sites (eg, clean rooms, transmission-based precautions, negative pressure isolation rooms, and operating theater) and subsequently presented their contributions and learning to classmates.

Regarding the reflection assignment, students were asked (in live sessions) to share team-informed reflections on interprofessional approaches to addressing occupational safety and health issues in the coffee industry. The students shared insights on the contributions of multiple disciplines, including engineering and epidemiology, to understanding and improving occupational safety and health in this area and shared insights from personal and friends' experience in the small-scale coffee roasting and distribution business.

Evaluation of Course Effectiveness in Augmenting Student Skills in Knowledge of Discipline-Specific Roles and Responsibilities (Competency 2)

Results of analysis of student data consistently showed improvement in student understanding of occupational health and safety disciplines among students in this first offering of the revised course. Scores on disciplinary-specific knowledge ranged from 0 (no understanding of a discipline) to 3 (mastery of the subject) across all disciplines. Students enrolled in the course demonstrated an increase in scores regarding knowledge of occupational epidemiology expertise; the pretest yielded a mean of 1.36 (SD, 0.83), whereas the posttest yielded a mean of 2.03 (SD, 0.84), a statistically significant difference ($t_{35} = -3.84$, $P < 0.001$). Knowledge of industrial hygiene expertise by students also was significantly increased, with the pretest yielding a mean score of 1.25 (SD, 0.84) and the posttest having a mean score of 2.22 (SD, 0.68; $t_{35} = -6.01$, $P < 0.001$). Knowledge about the occupational safety engineering discipline was increased from the pretest (mean, 1.44 [SD, 0.69]) to the posttest (mean, 2.39 [SD, 0.69]), also statistically significant ($t_{35} = -7.93$, $P < 0.001$). Lastly, understanding of occupational health nursing expertise increased from pretest scores (mean, 1.33 [SD, 0.72]) to posttest scores (mean, 2.19 [SD, 0.75]), and these differences were again statistically significant ($t_{35} = -7.14$, $P < 0.001$).

Results from the Likert scale of items measuring student perceptions of the value of interprofessional teams appear favorable for the courses' effectiveness. When comparing means in the scale measuring student comfort in working on interprofessional teams, we found a significant difference when comparing the pretest (mean, 4.31 [SD, 0.58]) with the posttest (mean, 4.77 [SD, 0.43]; $t(34) = -4.82$, $P < 0.001$). Students enrolled in the course already saw relatively high value in IPE before the semester started (mean, 4.6 [SD, 0.60]), but a small increase was nonetheless seen in posttest student valuation of IPE (mean, 4.8 [SD, 0.41]; $t_{34} = -2.03$, $P = 0.05$).

Revisions to the Initial Course Offering Based on Evaluation Results

Based on outcomes of the initial course offering, faculty made modest revisions in the subsequent (2020) course offering. Based on student evaluation of course workload, we scaled back the team activities (eg, Wikipedia development). The hospital-based professionals again presented on occupational safety and health issues of concern, this time focusing on airborne infection and the role of heating, ventilation, and air conditioning systems.

Aim 3: Engage diverse professionals to assist students to develop strategies to meet specific occupational health and safety needs of workers, patients, and other populations

The course focused on the health and safety of multiple populations, including health care workers, inpatients, ancillary personnel, and the community at large. For example, discussions included implications for proper use of personal protective equipment and infection control measures to health care worker as well as family and community health. These interdisciplinary professionals employed at the university-affiliated hospital were actively engaged in the course design and delivery. In collaboration with course faculty, they designed cases for student focus, presented background information, coached students in development of their recommendations, and participated in critique of student presentations of their recommendations for program improvement. A separate group of interdisciplinary professionals presented an exemplar case study of interprofessional collaborative practice and engaged with students in reflections on interprofessional approaches to addressing occupational safety and health issues in industry. Disciplines represented in these learning activities included industrial hygiene, nursing, and safety engineering and epidemiology.

DISCUSSION

Implications for Effective IPE Instruction

As described earlier, the importance of IPE is well recognized. In the discipline of occupational health and safety, NIOSH recognized the benefit and importance of interdisciplinary education in the 1980s with Project Minerva, an attempt to incorporate occupational health and safety education into business school curricula that was made at 25 US schools.[14] Canada followed this initiative in 1989 with support of the Canadian Society of Safety Engineering and others, providing 2-day courses to business and engineering professors on occupational health and safety topics[15]; this effort also has resulted in the development of a number of occupational health and safety training modules (https://safetymanagementeducation.com/history-and-accomplishments/). Since the 1990s, NIOSH has encouraged integration across disciplines by requiring that training programs in the NIOSH-supported education and research centers emphasize the importance of working on interdisciplinary teams and promote interdisciplinary interactions. Education and research centers such as that at the University of Michigan promote interdisciplinary activity through seminars, field trips, and research experiences that involve trainees across different programs, for example, hygiene, nursing, and epidemiology. These interdisciplinary interactions alone, however valuable, do not represent IPE. As outlined in the introduction, IPE involves students from two or more professions learning about, from, and with each other to enable effective collaboration and improve health outcomes.

This project represents a novel approach to education in at least two ways. First, whereas IPE has often included the clinical disciplines (eg, medicine, nursing, pharmacy, and dentistry), this project expands the IPE focus into a nonclinical health profession: public health. Although public health by definition is highly multidisciplinary, our observations are that the public health students included in this project shared a need for the IPE education offered by the program. Furthermore, the IPE program focused on the public health subspecialty of occupational health. Somewhat uniquely, students in this subspecialty transcended the usual categories of disciplines engaged in IPE to include students in clinical (eg, occupational health nursing) and nonclinical disciplines (eg, occupational safety

engineering, industrial hygiene, and occupational epidemiology). This unique combination of clinical and nonclinical disciplines sharing common goals for promotion of worker health and well-being was uniquely suited to gain from the approaches offered through IPE.

To achieve our mission to train effective leaders in occupational health and safety, our team incorporated activities to address IPE competencies into an occupational safety and health graduate course. We modified the activities in a second section of this course, including hospital-based case studies. Interprofessional education competencies were also emphasized in extracurricular student activities, including field trips to local sites where occupational health and safety concerns exist. This section discusses key lessons learned that can be applied in upper-level undergraduate and graduate instruction.

First, acquiring IPE competencies as emerging occupational health and safety professionals will require learning experiences beyond the identified course. In a one-credit course that also included other topics, time to IPE-related content was limited, although students spent additional time outside of class on IPE-related learning activities. For example, time spent in interprofessional activities included student interactions to better understand each other's disciplines and backgrounds, interacting with occupational safety and health professionals to understand specific issues of concern, problem definition, completion of group written reflections and other assignments, and preparing and delivering presentations. Course faculty see benefit to additional class time for informal team and client interactions, refinement of written and oral assignments, and potentially for other case studies; we plan more class sessions with these foci in future sections.

Second, we recommend that learning about IPE competencies not be limited to a single course but be included in other activities program-wide. For example, we encouraged interprofessional collaboration during extracurricular field trips with multidisciplinary peers. For example, during transit to field sites, we paired students from different disciplines, directing them to interview peers of other disciplines about their concerns regarding health and safety issues at the facility to be toured and the types of measures that might address these concerns. After the visit, we asked them how their perspectives have changed and any surprises and/or lessons learned.

Third, the success of in-class learning activities (eg, case studies) was greatly enhanced by the participation and dedication of the occupational health and safety professional partners recruited for this purpose. Specifically, we invited selected staff from the university hospital to present case studies of actual occupational health problems in their institution. In this learning activity, the hospital staff described a different problem to each team of students, challenging them to collaboratively generate possible approaches to the problem. The agency partners continued engagement for several weeks during the semester, returning for student presentations. In additional examples, an occupational health professional working in industry presented a case study of an occupational health problem in the coffee industry; a second occupational health professional provided guidance in development of student contributions to selected Wikipedia pages.

Evaluation of the Second Iteration of the Revised Course

Second-year results were somewhat less consistent than first-year results but also showed improvement in student understanding of roles and responsibilities of occupational health and safety disciplines. Students in taking the second section of the course improved their perceptions of the value of interprofessional team, but showed a nonstatistically significant increase in tests of comfort in their interprofessional roles. Differences between cohorts in terms of the course effectiveness, particularly on the goal of understanding of the roles of the various occupational health disciplines, might be attributed to various factors in the second section that were out of the instructors' control, including the composition of students enrolled in the class, the manner in which data were collected, and, last but not least, the COVID-19 pandemic disrupting the semester and requiring changes in course delivery formats (ie, videoconference instead of face-to-face).

CONCLUSIONS

This report described the revision and effectiveness of a course for students in occupational health and safety focused on development of interprofessional practice competencies. We found a scarcity of published work on introducing IPE competencies in a classroom setting focused on training students in fields relevant to occupational health and safety. Although much of the work in IPE education has been in clinical disciplines, the focus of this course on development of interprofessional skills in public health education (particularly occupational health education) was unique. This project extends the work of the University of Michigan NIOSH Education and Research Center, which is focused on the goal of improving health and safety of the workforce.

Overall, results demonstrated the feasibility, effectiveness, and sustainability of the new course and will be used as the foundation for future curriculum development. Enhanced interdisciplinary competency of students is expected to improve occupational health and safety, as well as public health.

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TABLE 1.

Grading Rubric: Student Understanding of Roles of Other Disciplines

Score	Description
0 points	Student left response field blank or responded “I don’t know,” or their response did not reflect the profession at all.
1 point	Student response demonstrated basic understanding of the expertise brought by professionals in the field they were asked to describe but not necessarily in the occupational health specialization. An example of this would be a student who correctly describes the role of an epidemiologist, but did not identify the specific roles of occupational epidemiologist.
2 points	Student demonstrated intermediate understanding of the expertise brought by professionals in the field they were asked to describe and in the appropriate occupational health specialization.
3 points	Student demonstrated advanced understanding of the expertise brought by professionals in the field they were asked to describe and in the appropriate occupational health specialization. Generally, responses of students who demonstrated advanced understanding closely reflect the descriptions of disciplines developed by professional organizations.

TABLE 2.

Student Demographics (n = 36)

Characteristic	
Mean age, y	24.7 (SD, 3.0)
Distribution by gender	
Woman	56%
Man	42%
No response	2%
Prefer not to answer	0%
Distribution by race	
White	42%
Asian	42%
Black or African American	3%
White and Asian	3%
Other	8%
No response	2%
Distribution by ethnicity	
Not Hispanic or Latino	91%
Hispanic or Latino	6%
No response	3%
Distribution by discipline	
Industrial hygiene	52%
Industrial and operations engineering	17%
Occupational health nursing	11%
Occupational epidemiology	8%
Other public health majors	6%
Other engineering majors	6%