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Cancer Prevention Interdisciplinary Education Program at Purdue University: Overview and Preliminary Results

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Abstract:

Cancer prevention is a broad field that crosses many disciplines; therefore, educational efforts to enhance cancer prevention research focused on interdisciplinary approaches to the field are greatly needed. In order to hasten progress in cancer prevention research, the Cancer Prevention Internship Program (CPIP) at Purdue University was designed to develop and test an interdisciplinary curriculum for undergraduate and graduate students. The hypothesis was that course curriculum specific to introducing interdisciplinary concepts in cancer prevention would increase student interest in and ability to pursue advanced educational opportunities (e.g., graduate school, medical school). Preliminary results from the evaluation of the first year which included 10 undergraduate and 5 graduate students suggested that participation in CPIP is a positive professional development experience, leading to a significant increase in understanding of interdisciplinary research in cancer prevention. In its first year, the CPIP project has created a successful model for interdisciplinary education in cancer prevention research.

Introduction

There is a need for innovative strategies to develop new research that can reduce cancer rates. If proven cancer prevention methods were employed in a sustainable manner, an estimated 19% decline in new cancer cases and a 29% decline in the rate of cancer deaths could be achieved by 2015 [1]. This equates to 100,000 cancer cases and 60,000 cancer deaths each year by 2015 [2]. In a report by the NCI-designated Cancer Center directors, two key strategies were identified to reduce the national cancer burden: action-oriented research and interdisciplinary research that synergizes research in informatics, human genetics, functional genomics, imaging and systems thinking, and behavioral sciences [3]. Primary prevention is the most effective approach, reducing the probability that the first tumor cell will occur. The American Cancer Society estimated that 50% of cancer deaths would be prevented through cancer prevention strategies by modifiable lifestyle factors and appropriate use of available screening for early detection of cancers [2]. For example, there is evidence that one third of cancer deaths are related to diet [4]. It is estimated that 30% or 170,000 cancer deaths in the United States in 2006 were caused by tobacco use [2]. There are other modifiable factors known to increase the risk of cancers including environmental exposures, obesity, and lack of physical activity; and these could be exploited in cancer prevention strategies [2].

Although cancer prevention research is crucial to reducing the burden of cancer, progress has been limited. One limiting factor is the lack of a critical mass of scientists who are prepared to undertake the complex and diverse work

required for cancer prevention research. Cancer prevention research is incredibly complex and requires a multidisciplinary approach. Currently, most educational efforts in cancer prevention take place within individual disciplines, which fosters a narrow program of cancer prevention research. Programs have been designed to introduce postdoctoral fellows or clinicians to cancer prevention [5,6]. However, there is a lack of interdisciplinary programs to train undergraduate and graduate students. A program that exposes students early in their academic careers to the broad field of cancer prevention, from basic science and engineering to behavioral and social sciences, is expected to enhance the students' awareness of this crucially important area of research and how the students can contribute both through their chosen career discipline and through interdisciplinary collaborations. An integrated program that exposes students to the variety of disciplines contributing to cancer prevention is needed. Students exposed to varying approaches to cancer prevention research are expected to have a stronger basis and be better equipped to participate in interdisciplinary research teams.

There is a clear need to develop educational models for interdisciplinary training, with rigorous assessment of outcomes, to create effective interdisciplinary teams in cancer prevention research. An excellent example of this is related to tobacco use and cancer risk. Tobacco use is estimated to cause 30% of cancer deaths [2]. Epidemiological studies identified the associated risk of tobacco use [7,8] prompting research into molecular, environmental and genetic mechanisms by which tobacco use lead to increased risk [9-12].

Methods to screen for cancers were improved, and health care options to financially support screening efforts explored. The subsequent battle continues to reduce smoking through behavioral modification, chemical methods, health care accessibility, legislative and policy changes including excise taxes, with city-wide bans on smoking in public places now being explored and implemented. These efforts to reduce tobacco use are slowly achieving success as the number of smokers is declining [2]. Efforts to reduce tobacco use span a variety of disciplines, including statistics, basic cell and molecular biology, nutrition, engineering, psychology, medicine, health care applications, economics and public policy. The researchers and clinicians in these disciplines traditionally find it difficult to communicate with those in disparate disciplines, slowing the pace of the progress in cancer prevention research. Individual educational programs have reported success in creating interdisciplinary research programs that assist students in working in teams [5,13]. Training researchers to communicate and create cross-discipline, synergistic teams able to effectively impact the cancer prevention field are needed with rigorous assessment on specific outcomes of interdisciplinary education.

The objective of the Cancer Prevention Internship Program (CPIP) at Purdue University is to develop and evaluate a collaborative learning model for cross-training students to address the diverse field of cancer prevention. The program was developed as a model of training to address to other interdisciplinary research training needs. Our hypothesis is that development of an undergraduate and graduate interdisciplinary program in cancer prevention will:

1) increase interest in the pursuit of graduate studies and subsequent careers in cancer prevention research, 2) provide exposure to all aspects of the field at a critical time to prepare students to better approach research problems, and 3) prepare these students for successful careers in cancer prevention research.

The program was designed to combine interdisciplinary research and service-learning experiences, seminars, and group discussions that introduce undergraduate and early graduate students or veterinary residents to the various disciplines and considerations that play a role in cancer prevention research.

Purdue University Environment for CPIP

Purdue University provides a unique environment for the development and testing of this interdisciplinary curriculum. Purdue University's Discovery Park enhances interdisciplinary research by providing a site for faculty and students within different academic disciplines to work together. Discovery Park consists of Centers of expertise from nanotechnology, cyber technology, education, healthcare and cancer (including prevention efforts). The mission of Discovery Park is to provide Purdue University with facilities, leadership and systems that transcend traditional academic boundaries, fostering an innovative interdisciplinary environment for learning, discovery and engagement. In addition, Purdue is the home of an NCI-designated Center for Cancer Research. The CPIP, funded by an NIH National Cancer Institute R25 award, is administered as a partnership among faculty from the interdisciplinary leadership team, the Oncological Sciences Center, and the Discovery Learning Research Center.

Faculty Leading CPIP

The faculty leading the CPIP are all co-PIs of the NIH funded project. The faculty are tenured or tenure track faculty with research focused on cancer prevention.

The diversity of the research of these faculty are broad, and the faculty are from the departments of Communication, Nutrition, Veterinary Medicine, Child Development and Family Sciences, Bindley Bioscience Research Center, Basic Medical Sciences, and Psychology.

The faculty mentoring students were also tenured or tenure-track faculty with research focused on cancer prevention. The faculty or graduate students in the research groups worked with the undergraduate students on a regular basis.

The faculty mentors attended the research presentations, both oral and poster, of their students. The mentoring abilities of the faculty will be monitored through student journal reflections as well as student and mentors responses to a year end survey.

Programmatic Components

The CPIP is a multi-faceted learning model that includes research experiences, coursework and seminars related to cancer prevention research, presentations and research conferences, discussion groups and networking events.

Undergraduate students also participate in a service learning experience. In its first year, the CPIP included ten undergraduate and five graduate student participants.

Selection of Participants: At the undergraduate level, focus is placed on recruitment of upper level students but exceptional sophomores were also

considered. The selection process includes submission of cancer prevention research projects from faculty, applications from students with excellent grade point averages identifying projects of interest, and subsequent matching of students and faculty through personal interviews. The criteria for selection vary by faculty, and often include interests and background of the students as well as perceived likelihood of success in the laboratory. The selected undergraduate and the mentor prepare a formal learning contract to assure that both party's expectations are met. The students were from, and had research projects in, broad interdisciplinary areas and the demographics are shown in Table 1.

At the graduate level, doctoral students in their second to final years are recruited from a variety of disciplines. We developed an application process similar to the NRSA fellowship application at NIH. Proposals were reviewed and scored by a review panel of Purdue faculty with active research in cancer prevention. Review criteria included academic and research accomplishments, research and training goals, potential for a career in cancer prevention, the quality of the research training proposed (including the training potential, and the scientific merit of the research project), and the qualifications and suitability of the proposed mentor. Applicants with the highest scores were invited to participate in final interviews. During the interview, the applicants delivered ten minute presentations on their proposed research and training plan. Fellowship awardees were selected post interview. The demographic characteristics of the graduate students were three female and two male, all third to fifth year students while in the program. They were from schools and departments of: Consumer

and Family Sciences, Nutrition; Engineering, Biomedical Engineering; Science, Chemistry and Liberal Arts, Communication.

Interdisciplinary research experiences: A cornerstone of the program is participation of both graduate and undergraduate students in research focused on cancer prevention. Undergraduate interns devoted a minimum of 400 hours of research during the summer and received a stipend through this period. Interns continued their research on during the academic year on a part-time basis and earned a scholarship each semester. Graduate fellows were supported for one year and conducted research in cancer prevention as part of their doctoral studies.

Academic coursework and seminars related to cancer prevention research: The core of the curricular activities was a one-credit course focused on interdisciplinary approaches to cancer prevention research during the academic year. The goals of this course were to introduce students to diverse approaches to cancer prevention research and to topics related to professional development. The course familiarized students with interdisciplinary research and assisted in the development of skills to help students work within interdisciplinary research teams. Sessions included discussions with cancer survivors and oncologists that demonstrated the human face of cancer and the importance of cancer prevention. The course also covered topics such as carcinogenesis and cancer pathology, research and statistics, cancer prevention research methodologies and study design, cell and animal models and research ethics. Members of the leadership

team were the primary instructors for the course, which included experts in the fields of biology, pathology, engineering, statistics, nutrition, communication, and psychology. Instructors strongly encouraged discussion and interaction.

Undergraduate interns also participated in a summer professional development seminar with students conducting interdisciplinary research in other areas such as climate science, energy and nanotechnology. Seminar speakers covered topics such as communication of research findings, research funding sources, interpreting primary literature, and expectations of graduate school. Conversely, graduate fellows attended a set number of monthly seminars of the Purdue Cancer Prevention and Control Seminar Series as well as program retreats. In addition, graduate fellows attended meetings of the Cancer Research Clinical Partnership program sponsored by the Oncological Sciences Center. Graduate fellows also took two cancer-relevant courses approved by the CPIP leadership team in their plan of study in addition to a grant writing experience and training in ethics.

Presentations and research conferences: Fellows and interns were required to present a poster of fellowship supported cancer prevention research at the retreats of the Cancer Prevention Program at Purdue which includes broad interdisciplinary research projects. Undergraduate interns were also required to prepare research poster presentations twice to a broader research community. These experiences provided educational opportunities in interdisciplinary research. CPIP graduate fellows were required to attend a national or regional conference or scientific meeting during their fellowship. Fellows were also

required to prepare and submit an abstract to a national meeting for which the program provided travel support.

Service-learning: Undergraduate students participated in a service learning project in order to understand the burden of cancer in humans (including underserved populations), encourage continued involvement in community and service activities, enhance skills to solve real world cancer prevention problems, and provide additional opportunities for interdisciplinary teamwork. Under the guidance of a member of the CPIP leadership team, students partnered with a local non-profit program to conduct a needs assessment and engage in outreach activities to help communicate the goals and enhance the non-profit program efforts.

Discussion groups & networking events: Informal discussion groups were conducted to foster the exchange of research ideas and the development of a learning community. For example, as part of the weekly summer seminars, undergraduate interns discussed their progress and challenges in their research endeavors. These summer sessions and the monthly CPIP meetings allowed participants to become comfortable discussing their own research, re-examine their research goals and strategies, and learn about the research interests and work of participants from different disciplines. During the academic year, interns, fellows, staff, and faculty attended monthly CPIP meetings. In these meetings, students presented their research during these sessions, providing an

opportunity to develop their verbal communication and presentation skills. This venue also provided informal discussion of research with participants, which enhanced research skills, professionalism, and an understanding of interdisciplinary research efforts. Further, regular social events were also held to encourage cohesion within the cancer prevention group (community) and to enhance the professional development of CPIP participants. The program provided opportunities for social networking with faculty mentors and fostered mentor-mentee relationships between graduate and undergraduate participants. During these informal social gatherings, for example, faculty mentors discussed their career paths and the societal relevance of their cancer prevention research and graduate mentors shared with undergraduates their experiences in graduate education. CPIP students had frequent one-on-one meetings with faculty mentors. The interactions with researchers from multiple disciplines enhanced students' communication and team building skills and expanded their perspectives in cancer prevention research providing further educational opportunities in interdisciplinary research.

Program Evaluation

CPIP combined both quantitative and qualitative evaluation methods to gain a thorough understanding of the impact and effectiveness of the program; each measure is described in Table 2.

Results from year one: Analysis of preliminary qualitative data from focus group interviews of both the undergraduate interns and the doctoral fellows show that both groups hold positive perceptions of the program. Audio recordings of both

focus group interviews were transcribed verbatim and examined for common themes regarding the benefits of participation in CPIP. The transcripts were read thoroughly several times and students' statements were grouped into categories reflecting the specific benefit mentioned. These categories were then examined by three of the researchers independently and condensed into broad themes representing general types of perceived benefits. Five types of benefits emerged from the analysis: CPIP interns and fellows (1) learned to appreciate interdisciplinary research; (2) acquired research skills; (3) built personal and professional networks through interaction with peers and mentors; (4) developed or enhanced their motivation for a career in cancer prevention research; and (5) acquired a clearer outlook on the career opportunities in cancer prevention research. Each benefit is discussed in detail below; Table 3 provides representative quotations for each type of benefit identified.

Appreciation of Interdisciplinary Research: An important goal of CPIP is to enhance participants' interdisciplinary skills and preparation for future collaborative cancer research. Both fellows and interns stated that CPIP gave them the opportunity to learn about interdisciplinary collaboration in cancer research. Fellows described four specific benefits of interdisciplinary learning from CPIP: (1) enhanced understanding of the breadth of cancer prevention research and the contributions of fellows' doctoral research to the "big picture" of cancer prevention, for example, a CPIP fellow conducting research in cancer communication mentioned the benefit of learning the basic medical science side of cancer research and how it relates to his own research in communication; (2)

enhanced appreciation, motivation, and aspirations for research collaboration in interdisciplinary settings and understanding of the societal value and importance of interdisciplinary and collaborative cancer research; (3) development of social and professional networks of cancer prevention researchers and identification of potential collaborators for future research endeavors and (4) enhanced understanding of the technical language used in other cancer prevention research areas leading to effective interdisciplinary communication.

Undergraduate interns were less specific than the graduate student fellows in their discussions of the benefits of interdisciplinary learning from CPIP. The interns spoke generally about CPIP's role in increasing their awareness and understanding of different areas within cancer research, expanding their perspectives of the "big picture" of cancer prevention research and providing opportunities to see firsthand how interdisciplinary research is implemented in real life settings.

Enhanced Research Skills: Doctoral and undergraduate participants reported that CPIP enhanced their research and problem solving skills, and provided them with opportunities to learn about the importance of devising and considering alternative plans to their original research designs. Fellows also mentioned that the mentorship provided by CPIP faculty, especially the opportunity to work with faculty to write grant proposals helped them to develop skills that are essential to conducting research, but that are often overlooked in their academic coursework. Interns reported that the opportunities for summer-long research experiences in

cancer prevention enhanced their research skills and their understanding of published research.

Personal and Professional Networks: Participants mentioned that the CPIP seminar class allowed them to interact with and learn from their peers. For the fellows, the shared experiences and difficulties as graduate students and cancer prevention researchers helped them to create a supportive and encouraging community. Interns reported that CPIP provided them opportunities to interact with and be mentored by graduate students and faculty.

Increased motivation and aspirations for future careers in cancer research: Analysis of the data from the focus group session suggests that CPIP increased interns' aspirations and motivation for future careers in interdisciplinary cancer prevention research. For example, participants mentioned that meeting with cancer survivors in the seminar series, coupled with the opportunity to discuss the societal relevance of their research projects enhanced their motivations for future careers in cancer prevention research.

Career Clarification: In addition to enhancing their aspirations for careers in cancer prevention research, undergraduate interns also reported that their CPIP experiences helped them to clarify the career options in this research area. Some interns mentioned that the experience affirmed their initial interest in cancer prevention research, while others indicated that CPIP opened new career options in cancer prevention research. Two students, however, observing the number of working hours and dedication of professors and graduate students firsthand,

decided their aspirations were not for a research career. The students felt that observing the faculty helped them decide against a future research career which is valuable to learn at this early stage of their careers.

Future Directions

In the first year, the program was designed and implemented by the faculty and staff to optimize engagement in cancer prevention research efforts, to provide the students with skills in working in interdisciplinary teams and professional development, and to devise a rigorous evaluation of the impact of the curriculum. We have identified a number of areas to improve. We have modified the admissions process for the graduate students to an online system to facilitate the review of the applications. We have broadened the solicitation of projects and graduate applications to continue to engage new mentors and a broad range of disciplines. Because the number of projects submitted was greater than the number of undergraduate students that can be funded in the program, specific criteria for selection of the projects, and the faculty on the leadership team will contribute to this selection process. The professional development series over the summer for the undergraduates was changed so that only the CPIP students were in their sessions to better tailor the sessions and create a community amongst the students. The service learning component began as a partnership with a well established service learning course designed for engineering students. It was determined that the goals of the CPIP were not consistent with the goals of the engineering service learning program, and a separate program was administered for the CPIP students led by one of the leading faculty of the CPIP

program. It was also recognized that an alumni program needed to be developed due to the overwhelming enthusiasm of the students in the first year of the CPIP. Overall, the modifications to the program were minor, but likely to improve the program through increasing group cohesion and enhancing the learning community composed of graduate fellows and undergraduate interns.

Conclusion

The complex problem of cancer prevention and control requires an interdisciplinary approach involving disciplines such as informatics, human genetics, imaging, systems thinking and behavioral sciences [3]. CPIP aims to attract talented researchers at the undergraduate and graduate level to cancer prevention research and to train them to be better equipped to apply interdisciplinary strategies in their future careers. The program has trained ten undergraduate and five graduate researchers in the CPIP inaugural year by engaging them in seminars, presentations, research experiences, service learning activities, and networking events. The project uses a mixed-methods evaluation strategy that combines qualitative techniques with survey instruments to measure the effect of participation on students' understanding of interdisciplinary research and plans to pursue collaborative interdisciplinary research in the future. Preliminary results suggest that participation in CPIP is a positive professional development experience for both undergraduate and graduate students. Students reported an increase in understanding of interdisciplinary research in cancer prevention. Importantly, they reported that through interactions with colleagues in many disciplines, they understood the

need for interdisciplinary collaboration and training that can help them see the “big picture” and motivate them to ask new questions and find new opportunities for cutting-edge research. Their interactions with each other and with mentor faculty created a support network that allowed students to share in each other’s successes. Inclusion of graduate and undergraduate students allowed for significant mentoring opportunities that were beneficial to both groups. In its first year, the CPIP project has created a successful model for interdisciplinary education in cancer prevention and control research. Future evaluation results will examine the impact of participation on students’ educational and career pathways.

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Table 1 CPIP Academic Majors and Research Project Disciplines for each Undergraduate Student.

Student Majors	Gender	Year	Research Project Discipline
Chemical Engineering	M	Soph	Biomedical Engineering
Comp and IT	M	Soph	Communication
Pharm Sciences	M	Senior	Biological Sciences
Applied Mathematics	M	Soph	Biomedical Engineering
Electrical Engineering	F	Senior	Biological Engineering
History	M	Senior	Marriage and Family Therapy
Biomedical Engineering	F	Soph	Communication
Pharm Sciences	M	Junior	Medicinal Chemistry and Molecular Pharmacology
Biology	M	Senior	Basic Medical Sciences
Biology	F	Junior	Medicinal Chemistry and Molecular Pharmacology

Table 2: Description of CPIP Evaluation Protocol

Instrument	Description
Pre-post Surveys	These are multi-section instruments consisting of Likert type rating scales, multiple choice and open-ended questions. The pre-participation survey solicits information on participants' academic and demographic characteristics and collects baseline data on participants' research skills and self-efficacy, interdisciplinary skills, and expectations of the program to which post-participation measures are compared. The post-participation instrument also solicits for information on students' perceptions of the various components of the program.
Doctoral fellow pre-participation interview	Graduate CPIP fellows are individually interviewed about their expectations of the program and understanding of interdisciplinary research in cancer prevention.
Research scenario activity	Pre-post assessment participants' interdisciplinary skills, understanding of interdisciplinary cancer prevention research and relationship or connectedness among various cancer prevention fields
Cancer knowledge test	This is a pre -post test of students' knowledge of cancer issues based on the CPIP seminar course
Reflective journal	Participants are required to electronically submit three guided journal entries each semester to in which they reflect on their experiences and academic and professional development in the program.
Mid-term and post-participation focus group interviews	Focus group interviews are conducted at the end of the fall and spring semesters separately with undergraduate and graduate participants at the end of the fall semester assess their views and perceptions of the program and formative information to improve the CPIP
Faculty mentor survey	These are administered to faculty mentors to solicit data regarding faculty perceptions of the program, its impact on the interns and faculty's ratings of interns' research skills and efficacy.
Post Program Survey	The purpose of the post-graduation survey is to longitudinally follow CPIP alumni.

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