

Encouraging Scholarship: Medical School Programs to Promote Student Inquiry Beyond the Traditional Medical Curriculum

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Abstract

Many medical curricula now include programs that provide students with opportunities for scholarship beyond that provided by their traditional, core curricula. These scholarly concentration (SC) programs vary greatly in focus and structure, but they share the goal of producing physicians with improved analytic, creative, and critical-thinking skills. In this article, the authors explore models of both required and elective SC programs. They gathered information through a review of medical school Web sites and direct contact with

representatives of individual programs. Additionally, they discuss in-depth the SC programs of the Warren Alpert Medical School of Brown University; the University of South Florida College of Medicine; the University of California, San Francisco; and Stanford University School of Medicine. The authors describe each program's focus, participation, duration, centralization, capstone requirement, faculty involvement, and areas of concentration. Established to address a variety of challenges in the U.S. medical education system, these four

programs provide an array of possible models for schools that are considering the establishment of an SC program. Although data on the impact of SC programs are lacking, the authors believe that this type of program has the potential to significantly impact the education of medical students through scholarly, in-depth inquiry and longitudinal faculty mentorship.

Acad Med. 2010; 85:409–418.

Generations of physicians have been trained in the traditional medical education model, which, although comprehensive, takes a one-size-fits-all approach to medical education. Opportunities for medical students to pursue scholarly interests or independent projects are rare within standard medical education curricula. However, a growing number of U.S. medical schools have established educational programs that provide students with increased opportunities for in-depth inquiry.¹ We believe that these programs, which we will refer to as scholarly concentration (SC) programs, do more than simply augment existing medical curricula. We think they build on the knowledge and skills that students have already acquired and help students translate their multidisciplinary interests into the rigorous process of analytic, synthetic, and creative thought that constitutes scholarship. Though outcome data regarding SC program goals do not yet exist, SC programs

represent a significant trend in medical education which has received little attention in the literature.^{1–3}

SC programs have their roots in the long-standing scholarly research programs of Yale and Duke medical schools. Early U.S. medical schools were founded on the clinical apprenticeship model, which did not include formal academic medical education or theoretical teaching. One of the first schools to demand more rigorous scholarly requirements was Yale University School of Medicine (SOM), which has required a research thesis since 1839.^{4,5} All Yale students engage in mentored research and present a dissertation based on basic science, clinical research, social science, or translational research. Guidelines for the experience emphasize testing a hypothesis and developing a close relationship with a faculty mentor. This research work occurs during the four years of medical school and may include summer fellowships, elective months, and/or longitudinal experiences. Yale also encourages students to consider a fifth year of medical school for either additional research training or course work toward an additional degree.

Though relatively new in comparison with Yale, Duke University SOM initiated a required research program in 1966.^{6,7} In the Duke curriculum, preclinical courses occur in Year 1, and clinical rotations begin in Year 2. Students then devote 10 to 12 months during the third year to a scholarly experience in the biomedical or social sciences. During this scholarly year, they may also pursue courses toward an additional degree. By graduation, all students must have produced a thesis, the focus of which may range from basic science or clinical research to health policy or epidemiology.

Over the past decade, a new generation of SC programs have sprung up in a broad range of U.S. medical schools.¹ Though diverse in nature, these programs build on the idea that students should undertake mentored, in-depth inquiry during their medical training. In this article, we explore several possible SC program models. Our descriptions of programs and their structures may act as a reference for schools exploring SC program models as they design or consider an SC program that fits the needs of their particular institution.

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Methodology

We gathered information on SC programs through a two-step process. In the first step, we reviewed the Web sites of Liaison Committee on Medical Education-approved U.S. medical schools, searching for the presence or absence of SC or SC-like programs. We then contacted, by e-mail, representatives (including faculty and administrators) of those medical schools that we identified as having SC or SC-like programs, requesting additional information about the program's focus (research, cross-disciplinary study, other), participation (required versus elective; percentage of each class), duration (when students enter and exit the program), capstone requirement (any required submission of scholarly work and the forms acceptable), and concentration areas (Table 1). When necessary, we followed up by telephone and/or e-mail to clarify information or gather missing data. School representatives provided further information on program dimensions on the four SC programs described in detail below. We chose these four SC programs—at Warren Alpert Medical School of Brown University (AMS); University of South Florida (USF) College of Medicine (COM); University of California, San Francisco (UCSF); and Stanford University SOM—to represent elective and required, as well as new and long-established, programs with a variety of possible concentration areas and varied institutional histories and implementation models.

SC Program Models

Considerable variations exist regarding the focus and structure (participation, dedicated time for SC work [i.e., duration], centralized curriculum, requirements for capstone product, and role of faculty) of recently developed SC programs (Tables 1 and 2). These variations make direct comparisons of programs difficult. Although some of the programs established earlier focused exclusively on biomedical and clinical research, more recently established programs have incorporated broader options that may include the social sciences, humanities, engineering, and even the arts. Some SC programs, such as those at Baylor COM and Cleveland Clinic Lerner COM, aim to promote the training of physician-scientists, especially those who will be qualified to carry out

translational research. Others, such as Alpert Medical School of Brown University and USF COM, emphasize advocacy, public health, and the preparation of future physicians who are able to contribute to change and improvement in the U.S. health care system. UCSF's Health and Society concentration area, for example, focuses on community health, advocacy, and health disparities; health systems and health policy; and social and behavioral sciences. Whereas traditional scholarly products typically include a presentation at a research conference, a manuscript appropriate for peer-reviewed publication, or a grant proposal, SC programs involving other areas of scholarship or interdisciplinary study may require a capstone project such as designing a new curricular element, submitting a review article for publication, developing a bioengineering tool, creating a significant original piece of literature or art relating to the health sciences, or completing a public health project.

Student participation in SC programs varies across institutions. Some SC programs are required for all students, whereas others are elective, involving just a percentage of each class (Tables 1 and 2). Another article, by Parsonnet and colleagues⁸ (also in this issue of *Academic Medicine*), outlines the philosophies associated with these choices, as well as the advantages and challenges of each of these approaches. Medical schools also vary widely in terms of the time students are expected to dedicate to their scholarly work. The structure of each school's preclinical and clinical curricula influences the amount of time available. As described above, Duke has built extended time dedicated to research training into the curriculum.⁶ The Case Western Reserve COM University Program provides a 16-week block in either Year 3 or 4 for students to work on their research, and Alpert Medical School of Brown University promotes Wednesdays during Year 2 as "self-directed learning time," which students can dedicate to concentration work. Stanford also leaves Wednesdays unscheduled during the preclinical years for concentration work. Other schools encourage students to use summer months or clinical elective periods to pursue scholarly activities.

Although some schools, such as Stanford University, require all participants to take a centralized course on the responsible conduct of research, most schools do not offer a standard curriculum for all students within the SC program. The Alpert Medical School of Brown University and the UCSF both require attendance at seminars specific to the concentration area, as well as completion of individual project work with a mentor. At each of the institutions surveyed, medical faculty serve as lecturers, mentors, and program directors; they also evaluate capstone projects and design SC-related curricula. However, the duration and intensity of faculty involvement vary widely across institutions, as do the sources of faculty funding and amounts/means of compensation.

Despite their disparate nature, the SC programs developed in the past decade feature an expanded focus on multi- and cross-disciplinary inquiry and emphasize longitudinal study and faculty mentorship. Additionally, most programs require the completion of an independent project and share the common goal of producing physicians with improved analytic, creative, and critical-thinking skills.

SC Program Case Studies

AMS

The SC program at the AMS was implemented as part of the preclinical curriculum redesign that went into effect at the beginning of the 2006–2007 academic year. The new curriculum provides dedicated time for scholarly pursuits alongside the schedule of required courses.

Program focus. The program emphasizes cross-disciplinary inquiry. School administrators at the AMS had previously noted that student projects outside of the biomedical research realm often lacked structure and rigor. They conceived the SC program as a means to promote scholarship among students who choose not to undertake basic or clinical biomedical research as part of their medical education (some students choose neither to participate in the SC program nor to undertake other research). Additionally, Brown's Program in Liberal Medical Education, and Brown University in general, have long

Table 1
Required Scholarly Concentration (SC) Programs of U.S. Medical Schools, 2008*

School	Program focus	Duration	Capstone requirement	Concentration areas
Baylor College of Medicine (COM)	Research-related scholarship and other areas of inquiry	Longitudinal across four years of medical school	Written report submitted in Year 4	Basic, clinical, or translational research as well as humanities, business, ethics, and health policy
Case Western Reserve University Program	Research-related scholarship	Sixteen-week research block during Years 3 or 4; Voluntary fifth-year option	Thesis manuscript due in February of Year 4; literature reviews not acceptable	No set concentration areas; pursuit of new knowledge in basic, social, or clinical sciences
Cleveland Clinic Lerner COM/ Case Western Reserve University	Research-related scholarship	Two research blocks in preclinical years; seminar series Years 1–5; one-year research thesis project completed consecutively or alternate with clinical electives in Years 3–5	Master-level thesis due by January of Year 5; the thesis is a graduation requirement	Basic science, translational research, or clinical research
Duke University School of Medicine (SOM)	Research-related scholarship	10–12 months comprising Year 3	Thesis with quantitative analysis (except in Medical Humanities track) or first-author paper submission or grant proposal—due at the end of Year 3	Anesthesiology, Surgery, and Environmental Physiology; Behavioral Neurosciences; Biomedical Engineering; Biomedical Imaging and Medical Physics; Cancer Biology; Cardiovascular Study; Clinical Research; Epidemiology and Public Health/Dual Degree; Global Health; Human Genetics and Genomics; Medical Humanities; Microbiology, Infectious Diseases, and Immunology; Molecular Medicine; Neurosciences; Ophthalmology and Visual Science
University of Pittsburgh SOM	Research-related scholarship and other areas of inquiry	Longitudinal across three years of medical school	Final report submitted Year 4	Disabilities Medicine; Geriatric Medicine; Global Health; Medical Humanities; Neuroscience; Patient Safety; Service Learning; Underserved Populations; Women's Health
Stanford University SOM	Research-related scholarship and other areas of inquiry	Multiyear program to be completed by Year 4	Presentation of scholarly project at a venue approved by the SC director due by the end of Year 4	Required "Foundation" areas: Bioengineering; Biomedical Ethics and Medical Humanities; Biomedical Informatics; Clinical Research; Community Health; Health Services and Policy Research; Medical Education; Molecular Basis of Medicine Elective "Application" areas: Cancer Biology; Cardiovascular/Pulmonary; Immunology; International Health; Neuroscience, Behavior and Cognition; Women's Health (List 4)
Vanderbilt COM	Research-related scholarship as well as other areas of inquiry	Longitudinal across Years 1 and 2	Abstract of the student's work submitted in Year 2	Laboratory-based research, patient-oriented research, health services research, medical humanities, law and medicine, global medicine, biomedical informatics, medical education, and community health initiatives
Yale SOM	Research-related scholarship	Longitudinal across four years of medical school; optional fifth year	Required thesis submitted Year 4	Basic, clinical, epidemiologic, or sociologic (including medicine and humanities) topics

* Program information was ascertained through self-report from representatives of the schools listed (via e-mail communication with the authors) and from the schools' Web sites.

Table 2
Elective Scholarly Concentration (SC) Programs of U.S. Medical Schools, 2008*

School	Program focus	Participation—approximate number (%) of students per year	Duration	Capstone requirement	Concentration areas
Albert Medical School of Brown University	Cross-disciplinary inquiry	30 (30)	Longitudinal across the four years of medical school	Final scholarly product submitted in Year 4	Advocacy and Activism; Aging; Contemplative Studies; Disaster Medicine and Response; Global Health; Informatics; Medical Education; Medical Ethics; Medical Humanities; Medical Technology and Innovation; Physician as Communicator; Women's Reproductive Health, Freedom, and Rights (List 1)
Louisiana State University School of Medicine at New Orleans	Basic science or clinical research	5 (3)	Longitudinal beginning at the end of Year 1	Publischable paper submitted in Year 4	Basic science or clinical research
Sanford Medical School of the University of South Dakota	Research-related scholarship as well as other areas of inquiry	13 (25)	Longitudinal across four years of medical school; eight-week summer externship; an additional four weeks of pathway time required in Year 4	Final scholarly product submitted in Year 4	Education, research, or service
University of California, San Francisco	Cross-disciplinary inquiry	55 (34)	Longitudinal across four years of medical school	Required submission of an abstract and presentation of results due in Year 4	Molecular Medicine, Clinical and Translational Research, Health Professions Education, Health and Society, and Global Health (List 3)
University of Cincinnati College of Medicine (COM)	Variety of areas that each have a research and clinical component	45 (30)	Longitudinal across four years of medical school; students enter concentration early Year 1	None, but most students present the results of a summer research project	Child Health, Poverty and Justice; Nutrition; Art of Family Medicine; Geriatrics; Neuroscience
University of Nebraska COM	Cross-disciplinary; focused on a specific topic in medicine	Capped at 25 (20)	Longitudinal with admission in January of Year 1 and completion before March of Year 4	Manuscript, conference presentation, or other scholarly publication due in Year 4	Aging and Integrative Medicine; Autoimmune Diseases, Care of the Underserved; HIV Medicine; Preventative Medicine; Medical Humanities and Arts
University of South Florida COM	Cross-disciplinary inquiry that includes basic science and clinical experiences	68 (57)	Longitudinal across four years of medical school	Required final scholarly "Legacy Project" submission in Year 4	Business and Entrepreneurship; Health Disparities; Health; Systems Engineering; Law and Medicine; Medical Education; Medical Humanities; Public Health/Global Medicine; Research (List 2)

* Program information was ascertained through self-report from representatives of the schools listed (via e-mail communication with the authors) and from the schools' Web sites.

List 1

Scholarly Concentration Areas for the Warren Alpert Medical School at Brown University—Scholarly Concentrations Program

1. Advocacy and Activism
2. Aging
3. Contemplative Studies
4. Disaster Medicine and Response
5. Global Health
6. Informatics
7. Medical Education
8. Medical Ethics
9. Medical Humanities
10. Medical Technology and Innovation
11. Physician as Communicator
12. Women's Reproductive Health, Freedom, and Rights

emphasized a liberal approach to and philosophy of education. Student choice and self-directed learning have long been central elements of the Brown experience. The elective nature of the SC program, and its wide range of possible concentration areas and scholarly projects, reflect this approach to education. Since the SC program's implementation, the proportion of students who have chosen to pursue biomedical research has not declined. Thus, it seems at this early stage that the program has acted only to expand the scope of scholarship within the medical school.

Participation. The SC program is elective. At the time of this writing, the 29 students in the pilot class, working in 8 (of 12 possible) concentration areas (List 1) have completed their third year. During the 2007–2008 academic year, the SC program accepted 28 students, who are working in 11 concentration areas, and in the 2008–2009 academic year, the program accepted 33 students, who are working in 11 concentration areas. The participation rate for each class averages approximately 30%.

Duration. Students identify areas of scholarly interest during their first year, undertake an immersion experience during the summer between their first and second years, and expand on the experience during their second through fourth years. Interested students obtain financial support for their summer experiences, most of which derives from

an already established summer assistantship funding program.

The redesigned schedule for the second year of medical school allows students to use every Wednesday as a self-study day. This offers the possibility of regularly scheduled SC activities, including weekly seminars. In addition, the second year was shortened by six weeks, thus increasing elective time during the third and fourth years that students can devote to completing a concentration.

Centralization. AMS's SC program does not require students to take any central or core courses, although the program does sponsor events, such as an information session on institutional review board procedures, and, for first-year students, a "Summer Showcase," during which second-year students present posters of their summer work. Each concentration area sponsors general planning meetings, panel discussions of particular topics of interest, didactic sessions, and other events for its students. For example, Women's Reproductive Health has hosted discussions about topics such as vaginal rejuvenation surgery, and Informatics has sponsored a talk on health care information technology and patient safety. Contemplative Studies invited a guest lecturer to speak about contemplative approaches to pain relief, and Global Health hosts monthly meetings to discuss faculty work in international health. Additionally, faculty have been recently increasing their efforts to sponsor cross-concentration activities such as a combined Medical Ethics and Aging panel discussion.

Capstone requirement. Each student is required to submit a scholarly work in his or her fourth year. Traditional forms of scholarly work, such as a publication in a peer-reviewed journal or a presentation at a national conference, are appropriate. However, other more nontraditional products are also acceptable. The scholars in the first cohort are in their fourth year and, therefore, have not yet officially submitted any capstone products. However, student progress reports reveal plans to submit published articles, a play about HIV, several curriculum modules, portfolios of advocacy activities including the organization of an Asian health care symposium, and a National Public Radio broadcast. Regardless of its form, the

scholarly work must articulate the student's analytic/synthetic thought and creative processes. Plans are in place to create an online gallery of students' scholarly work.

Faculty involvement. The medical education administration established an infrastructure for the program, including a manager (E.G.), a steering committee, and a group of faculty members to develop SC areas. However, as the program has evolved, students have identified many additional faculty with particular interests and expertise who have also become leaders of SC areas. Each concentration area has at least one, and usually two or three, faculty directors/codirectors. Faculty directors receive small stipends as compensation.

Concentration areas. Currently, students may choose among 12 concentration areas, two more than Brown originally offered during the initial year of the program (List 1). The program accepts proposals for new concentration areas from both students and faculty. However, new concentration areas must be broad enough to attract a cohort of interested students. Additionally, faculty with expertise in that particular area must be identified to lead the concentration and provide continuity and longevity beyond the relatively brief tenure of any particular medical student.

The USF COM

To address the wide interests of its student body, USF COM has a history of developing opportunities for students to earn double degrees—both at the doctorate and master's level—in research, business, and public health. These programs have successfully addressed the needs of their few participants, but do not engage the interest of the majority of students who do not want to undertake the demands of an additional degree program. With this gap in mind, the vice dean of medical education initiated the SC program in 2007 as part of a curriculum reform initiative. The SC program aims to facilitate self-directed learning, enhance interactions among students, and foster relationships between students and faculty. Faculty and the Office of Educational Affairs saw the program as a way to individualize the curriculum and to recruit new applicants. Goals for student participants include gaining information in fields that enhance

List 2

Scholarly Concentration Areas for the University of South Florida College of Medicine's Scholarly Concentration Program

1. Business and Entrepreneurship
2. Health Disparities
3. Health Systems Engineering
4. Law and Medicine
5. Medical Education
6. Medical Humanities
7. Public Health/Global Medicine
8. Research

their understanding of medicine, undertaking experiences that contribute to their development as future physicians, and completing an independent and creative "Legacy Project." The SC program aims to strike a balance between the need for academic rigor and the desire to not detract from the time necessary to succeed in the medical school curriculum.

Program focus. The SC program encourages interdisciplinary and intercollegiate inquiry. Faculty from a range of departments and specialties support each of the eight concentrations (List 2). Faculty with interest in topics across departmental lines self-identify and work together to support a given concentration. Future topics aim to cultivate interactions between the COM and other colleges/departments within the greater university. Faculty within certain concentrations are currently working with the colleges of public health, business, and engineering at USF. In the future, they may develop collaborations with the colleges of education and nursing. In addition, USF COM has established a relationship with the law school at Stetson University in DeLand, Florida.

Participation. The SC program is currently elective. Participation levels vary from 34% of the current fourth-year class (41 of 121 students) to 68% of the current first-year class (81 of 120 students), with a cross-class average of 57%. A total of 275 students are currently involved in the program, most of whom are in their second or third year of medical school.

Duration. Although the program originally allowed varying entry points,

students are encouraged to decide whether they want to join a given SC by December of their first year. During the first year, SC participants attend meetings and find mentors. Students complete much of their SC work either in monthly evening meetings or during the summer between their first and second years.

Some faculty have expressed interest in and made efforts to incorporate dedicated SC time into the curricular schedule. Some concentrations have been successful in gaining entry into the curriculum through modules or units in the required, second-year colloquium course. Colloquia are based on medical topics of current interest and significance and have included SC topics such as global health and the business of medicine. Students meet in small groups to explore the topic and interact closely with faculty who also have an interest in the field. Contact time is 10 hours for the colloquium experience. Students are encouraged to use an SC elective as well as independent study time in the fourth year to complete their final projects.

Centralization. Currently, the USF COM SC program requires no centralized courses. However, some faculty have discussed developing courses in areas of overlapping interests. Centralization exists in the method by which concentration areas receive approval. Each concentration area must submit a proposed curriculum to the curriculum committee. Also, standardized expectations exist for all SC students. These consist of completing approximately 180 hours of work that includes course elements, practical application, and scholarly presentation. To successfully complete an SC, students must gain approval for their project from both their faculty mentors and from the director of the SC program.

Capstone requirement. The capstone requirement at USF is a "legacy project" that students must complete by the end of their fourth year. This legacy project may be a paper, a presentation, or a service to the COM, and it should demonstrate the student's growth through analytic, leadership, or creative processes. At present, the format of the specific project remains flexible as long as the project supports the objectives of not only the SC program in general (self-directed learning, mentorship

participation) but also the given concentration area specifically. To date, students have published their SC research in a variety of peer-reviewed, scientific journals and have presented their abstracts at national and local meetings. Other capstone projects have included creating systems for better treatment of underserved populations, developing learning modules for students in the prematriculation program, and developing systems to ensure patient safety.

Faculty involvement. The Office of Educational Affairs appointed a director for the SC program (S.H.P.) and organized some of the initial concentration areas. The Office of Educational Affairs and the SC program director then recruited faculty leaders for most of the concentration areas. Interested individual faculty and students have initiated other concentration areas. Although concentration area leaders and faculty do not currently receive monetary compensation, the university does formally recognize teaching effort in the SC program. Further, as the SC program grows, the administration has plans to implement concrete means of recognizing faculty participation and is considering offering stipends or even part-time equivalent employment.

Concentration areas. Currently, USF offers eight concentration areas (List 2).

UCSF

When originally established in academic year 2003–2004, the UCSF Areas of Concentration (AoC) program set standards and provided institutional structure for sustained interdisciplinary projects throughout the undergraduate medical curriculum in seven thematic areas. At that time the program required students to identify a project and work with faculty advisors both to complete a thorough program of preparation (including participating in an AoC-specific core course) and to focus their inquiry. Students' experiential phase of the program involved completing the project and investigating its links to the practice of medicine.

UCSF undertook a major initiative to transform the AoC program into "Pathways of Discovery." Educational programs across UCSF all have a common goal of instilling in trainees a lifelong desire to inquire, discover, and

List 3

Scholarly Concentration Areas for the University of California, San Francisco's Areas of Concentration Program (Pathways of Discovery)

1. Molecular Medicine
2. Clinical and Translational Research
3. Health Professions Education
4. Health and Society (community health, advocacy, and health disparities; health systems and health policy; social and behavioral sciences)
5. Global Health

innovate. However, long-term follow-up studies of UCSF students and residents suggest that only a small percentage of graduates pursue careers focused on these principles. In an effort to further develop programs that will provide trainees with the skills they need to succeed in inquiry, discovery, and innovation, working groups consisting of more than 100 faculty and trainees spent two years developing the program.

Program focus. Pathways of Discovery has a focus on cross-disciplinary inquiry. The five pathways (List 3) are not mutually exclusive but, instead, are representative of different approaches to addressing related health care needs. The goal is to provide trainees with specific skills in one of several areas of academic expertise, independent of their professional training and clinical specialty.

Participation. The working group originally envisioned the elective Pathways of Discovery as an SOM program for matriculating medical students or newly entering fellows and junior faculty. Rates of participation have increased over the years from 29 students (19% of the graduating class) in 2005 to 55 students (34%) in 2009. During the past two years, the Pathways leadership has made a strong commitment to expand Pathways to include learners from all of the UCSF professional schools (comprising nursing, dentistry, and pharmacy) and the graduate division (including biochemistry and molecular biology as well as global health sciences).

Duration. Pathways offers multiple entry points across undergraduate and graduate education. Students can declare a concentration as late as the spring of their third year, but they must complete

their projects by April of the year they graduate. Students can typically complete the Pathways Core Program (required course work, experiential/research component, and legacy development) during the four years of medical school. Students willing to undertake an additional year are considered part of the Advanced Program (plans to develop the Advanced Program into a master's degree program are in place). The competence of student-investigators in the Advanced Program is marked by their ability to conceptualize and articulate an agenda that requires substantial independence and follow-through. They complete at least a portion of this agenda during their tenure in the pathway, and many will undertake additional training via, for example, postdoctoral studies, to be equipped to continue their work. Residents who had entered Pathways as medical students design a course of research that furthers and builds on their previous work. Pathways provides for different levels of participation and rigor; however, the program requires both undergraduate and graduate medical students to take core courses such as a foundational/overview course, a research methods course, a works-in-progress seminar, and a final reflections seminar, all of which are tailored to their individual schedules and levels of expertise. Presently, both core and advanced programs award certificates.

Centralization. Learners in each of the five Pathways concentrations will participate in formal courses and, with a faculty researcher, in guided (i.e., mentored) experiential learning that consists of a self-selected project in partnership with, for example, an existing health care organization, government agency, advocacy organization, community group, community clinic, health department, or academic unit. The length of the experiential component is at least three to six months for learners in the Core Program and at least nine months for learners in the Advanced Program. This mentored, experiential project forms the central aspect of learners' participation in the pathway. Each concentration area determines its own required course work and experiential curricula; however, the legacy projects are centrally reviewed by project mentors and pathway directors, and student evaluations of each pathway are also centrally administered.

Capstone requirement. Before graduation, students produce and present a tangible legacy, which is often in the form of traditional scholarship, such as a scientific paper, but it can also be more innovative, such as an exhibit, patient registry, policy brief, or Web-based curriculum module. All students must submit an abstract and present their project either as a poster or oral presentation at a program symposium. For highly motivated trainees, some pathways also provide a prescribed curriculum leading to a master's degree.

Faculty involvement. Each concentration area has two paid codirectors. Faculty who teach in the required courses or mentor projects do so on a volunteer basis.

Concentration areas. The five pathways were built on the foundation of the successful AoCs (List 3).

Stanford University

Throughout its history, Stanford has upheld the philosophy that "the best doctors are those who are medical researchers."⁹ Stanford's five-year curriculum, instituted in 1959, was designed to create a "climate of graduate education."⁹ In the 1990s and early 2000s, 90% of graduates dedicated at least one quarter (Stanford uses a quarter—rather than a semester—system) of their medical education to conducting research, and 70% of students remained longer than four years to complete the curriculum. Despite this high level of participation, faculty observed that the research students produced often lacked rigor and that faculty oversight of projects was inadequate, whereas students felt that mentorship was variable and research opportunities were hard to identify. As a result, in 2003, during a comprehensive curricular reform effort, a required SC program was initiated to support and promote the long-standing tradition of in-depth research and to foster close mentorship by faculty.

Program focus. The program focuses on learning methods for in-depth inquiry. Students select one of eight scholarly foundations, or methodological areas (List 4). Students may also choose one of six scholarly applications (content areas) in which to apply their methodological expertise (List 4). Selection of an application area is not required but is

List 4

Scholarly Concentration Areas for the Stanford University School of Medicine's Scholarly Concentrations Program*Required "Foundation" Areas*

1. Bioengineering
2. Bioethical Ethics and Medical Humanities
3. Biomedical Informatics
4. Clinical Research
5. Community Health
6. Health Services and Policy Research
7. Medical Education
8. Molecular Basis of Medicine

Elective "Application" Areas

1. Cancer Biology
2. Cardiovascular/Pulmonary
3. Immunology
4. International Health
5. Neuroscience, Behavior, and Cognition
6. Women's Health

available to students with interests that align with one of the content areas.

Foundations and applications differ in that the foundations focus on research methods whereas the applications constitute domains in which methods can be applied. If students would like to learn more about a specific application area, they can choose that application area and apply to it what they have learned in the concentration. For example, a student interested in applied malaria research might learn methodologies of study from the Clinical Research foundation and approaches to working in international settings from the International Health application. If an application is selected, the foundation requirements are cut back so that the academic requirements for all students are the same (a minimum of 12 units, either 12 in a foundation or 6 in a foundation and 6 in an application). The foundation and application must be intertwined under the supervision of the SC directors.

The learning methods within the SC program are largely mentored, hypothesis-driven research activities conducted with the guidance of a Stanford or Stanford-affiliated faculty member. Thus, the learning methods are individually supervised, hands-on approaches that include reading literature in a given field, developing protocols for conducting research, managing all

regulatory requirements (i.e., internal/institutional review board or biosafety protocols), conducting experiments and documenting results. In a few cases, the in-depth inquiry is a mentored literature review of a given problem.

Participation. The SC program is required. With the exception of MD/PhD students, all students (approximately 80 per class) must participate.

Duration. Stanford University SOM requires all applicants to write an essay about how they might benefit from the SC program; this essay is a central factor in acceptance to the medical school. During Admit Week, before matriculation, students learn about concentration areas through concentration fairs, at which faculty and student representatives of the various concentrations present information about the course work and research opportunities each concentration provides. During the first quarter of the first year, each concentration hosts a lunch for students in order to provide more details about the concentration opportunities, and, on four afternoons per year, concentrations hold breakout sessions with their faculty and students. Undeclared students can attend whichever concentration breakout they find interesting. Additionally, a Medical Scholars program conducts a large forum in the spring at which students present their work, and several concentrations host their own forums throughout the year. At these forums, first-year students can learn of ongoing projects and see the kind of work other students have accomplished in various concentration areas. Students must select a concentration by the beginning of the second year. Students then work with the concentration director to select course work (a minimum of 12 units), identify a research mentor, and delineate a project that conforms to student interest and time constraints.

Students can meet course work and research requirements at any time throughout the curriculum. Stanford University as a whole has four 11-week quarters per academic year. Unlike the remainder of students at the university, however, medical students start their preclinical years early so that the fall quarters of Years 1 and 2 are each 15 weeks long. Students may replace any

quarter or series of quarters with full-time research, although, with the longitudinal, organ-based system curriculum, stepping out of some quarters is easier than stepping out of others. To remain on track with the curriculum, students may (1) take a three- to four-quarter, full-time research block to conduct research and then reenter the curriculum where they exited, (2) do part-time research quarters (i.e., take only half of the standard curriculum for each of two years, leaving afternoons or mornings available for research), (3) conduct their research during the summer quarter after their first or second year, which in the latter case delays the beginning of the clerkship year, or (4) conduct their research during the clinical years when scheduling is often more flexible.

Students may apply for research funding from Stanford's Medical Scholars endowment; they are permitted up to six quarters of full-time research funding. Students are also encouraged to apply for external funding. In the academic years 2004–2007, the mean number of funded research quarters per student was three.

In the preclerkship years, every Wednesday is free from required classes, permitting time for students to do course work and conduct research for their concentrations. Starting in the spring quarter of the first preclerkship year, two additional afternoons are free for concentration research and study. During clerkships, students attend bimonthly afternoon concentration area break-out sessions during which they present ongoing and completed research, meet with visiting scholars, and discuss careers in the scholarly area with faculty. Students are encouraged to pursue second degrees, through Stanford's master's programs in epidemiology, business administration, public policy, bioinformatics, or health services research, or through the master's of public health program at Berkeley. Completion of a Stanford PhD program is also possible.

Centralization. Since the addition of the SC program to the curriculum, all students have been required to take a course in the responsible conduct of research. Additionally, Stanford SOM organizes the aforementioned yearly concentration fair.

Capstone requirement. Each student must submit a scholarly work before graduation. Although this is typically a scientific paper, other creative work is acceptable. Students have completed a wide variety of mentored work in the humanities. They have published novels and works of creative nonfiction that involve medicine. They have produced films; for example, one group of three students created a film about the experience of anatomy class in the first year of medical school. Another student created an online history of medicine course that has been an elective in the medical school curriculum. Other students have presented artwork or have created art programs for patients. Students are required to present their scholarship—in whatever form it takes—at an academic forum. The SC director must attest to each student's successful completion of these requirements.

Faculty involvement. Each concentration area includes a panel of faculty who are actively involved in student mentorship and in reviewing research proposals. The SC program committee comprises the faculty directors of each of the foundations and applications. The chair of this committee is a concentration area director who holds a leadership role for the program more generally. All faculty at the university are eligible to mentor students in research projects; their departments receive tuition support for this activity.

Concentration areas. Students must choose from among eight “Foundations,” and they may add one of six “Application” areas (List 4). Students may also create their own concentration with close faculty mentorship, although few choose this option.

Discussion

The four medical schools profiled here created their SC programs as a means of addressing a variety of challenges inherent in modern medical education: the breadth of required curricular content that often comes at the expense of in-depth knowledge; the lack of rigor and structure in student-conducted projects; the need for less time-intensive alternatives to dual-degree programs; and the small number of graduates pursuing careers involving lifelong inquiry. The programs use innovative structures

involving faculty and resources in both undergraduate departments and graduate programs to fully implement cross-disciplinary educational experiences for students. Additionally, each program recognizes the importance of longitudinal inquiry—both for increasing in-depth learning and for fostering the essential mentoring relationships on which students and faculty can build over time. These four programs are implemented longitudinally, across the span of the undergraduate medical education curriculum.

Over the years, medical schools and other institutions of higher learning have established many types of programs to address problems in the U.S. system of higher education. SC programs share some characteristics with undergraduate majors in their emphasis on longitudinal inquiry into a particular area. SC programs also have similarities to medical school elective/selective programs in their inclusion of medical content that is often absent from required courses. However, unlike undergraduate majors, medical concentrations exist in parallel with traditionally required biomedical course work, and SC students conduct projects involving in-depth study above and beyond mastering core content. And, unlike medical school electives/selective programs, SC programs focus on the creation and sharing of new knowledge.

When they are implemented well, SC programs focus on the cognitive aspects of scholarship, and this focus is what makes these programs unique. To simply train students in the processes of basic science, or in clinical or translational research, or to have them simply complete a service project without any accompanying analysis of the work, is not enough. To be truly transformative, SC programs must go beyond process and actually improve students' ability to think creatively, critically, analytically, and synthetically. Only rigorous program evaluation will tell schools whether their SC programs are having the desired impact.

One of the other articles (by Bierer and Chen³) in this issue of *Academic Medicine* reviews in-depth the findings thus far on the impact that SC programs have on medical students. We know that although SC programs have clearly caught the

imagination of faculty and students, data on program outcomes are lacking. What is the impact on students' cognitive skills, and how might this be measured? Do these programs meet the needs of students and fulfill the goals of the institutions that implement them? Do students who participate in SC programs develop different career pathways because of them? Investigators clearly need to conduct more research on the impact of such programs on students, on the careers of practicing physicians who complete such programs, and on the medical schools that offer them. Other issues to be addressed concern the need for faculty training in mentorship, the “ideal” number and variety of concentration areas, the evaluation of scholarly work, and how institutions can make time within the curriculum for this type of program.

Although data on program impact are lacking, the four programs highlighted here report anecdotal evidence of program strengths, the foremost of which is faculty mentorship of students. Because scholarship requires a collaborative model in which faculty members mentor students over a sustained period of time, these relationships become an important aspect of participating students' medical school experience. Mentoring relationships within SC programs provide role models and guidance for students interested in careers that integrate research, teaching, and advocacy with clinical service. Thus, we believe SC programs have the potential to increase the number of students who pursue academic careers and who may ultimately seek leadership positions. Longitudinal evaluation of program impact on student careers would be useful to determine whether SC programs realize this potential. Another article in this issue (Parsonnet and colleagues⁸) describes Stanford's efforts in this area. Other strengths of SC programs include both recognizing academic excellence and providing administrative structures for activities such as volunteer work or advocacy that encourage scholarship.

Though not yet a full-fledged movement in U.S. medical education, the flurry of newly established SC programs will likely continue over the next several years. The recently created SC Program Collaborative, a group comprising representatives from institutions that

offer SC programs across the country, is one mechanism by which medical educators can share information, collect and analyze data, and learn from one another regarding these issues.

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Acknowledgments: The authors extend their thanks to the members of the Scholarly Concentration Program Collaborative and representatives from other medical schools for their willingness to share their insights and experiences.

Funding/Support: None.

Other disclosures: None.

Ethical approval: Not applicable.

References

- Schor NF, Troen P, Kanter SL, Levine AS. The Scholarly Project Initiative: Introducing scholarship in medicine through a longitudinal, mentored curriculum program. *Acad Med.* 2005;80:824–831.
- Kanter SL, Wimmers PF, Levine AS. In-depth learning: One school's initiatives to foster integration of ethics, values, and the human dimensions of medicine. *Acad Med.* 2007;82:405–409.
- Bierer SB, Chen HC. How to measure success: The impact of scholarly concentrations on students—A literature review. *Acad Med.* 2009;85:438–452.
- Yale School of Medicine. Office of Student Research. Available at: <http://www.med.yale.edu/facres/index.shtml>. Accessed November 2, 2009.
- Ebbert A Jr. A retrospective evaluation of research in the medical curriculum. *J Med Educ.* 1960;35:637–643.
- Blazer D, Bradford W, Reilly C. Duke's 3rd year: A 35-year retrospective. *Teach Learn Med.* 2001;13:192–198.
- Duke University School of Medicine. Third Year. Available at: <http://thirdyear.mc.duke.edu>. Accessed November 2, 2009.
- Parsonnet J, Gruppuso PA, Kanter SL, Boninger M. Required vs. elective research and in-depth scholarship programs in the medical student curriculum. *Acad Med.* 2009;85:405–408.
- Cuban L. Change without reform: The case of Stanford University School of Medicine, 1908–1990. *Am Educ Res J.* 1997;34:83–122.