How to Measure Success: The Impact of Scholarly Concentrations on Students—A Literature Review

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Abstract

Purpose
Scholarly concentrations (SCs) are elective or required curricular experiences that give students opportunities to study subjects in-depth beyond the conventional medical curriculum and require them to complete an independent scholarly project. This literature review explores the question, "What impact do SC programs have on medical students?"

Method
In 2008, the authors retrieved published articles using Medline, ERIC, and PsycINFO electronic databases and scanned reference lists to locate additional citations. They extracted data from selected articles using a structured form and used Kirkpatrick's evaluation model to organize learner outcomes into four categories: reactions, learning, behavior, and results.

Results
Of 1,640 citations, 82 full-text papers were considered, and 39 studies met inclusion criteria. Most articles described SC programs that offered students research opportunities. Fourteen articles provided evidence that SC experiences influenced students' choice of clinical specialty or fostered their interest in research. Eight articles reported that SCs improved students' understanding of research principles and methods. Nineteen articles reported publications and presentations to document students' ability to apply acquired knowledge and skills. Twelve studies confirmed the entry of SC graduates into academic medicine with continued engagement in research or success in obtaining grant funding. Students' criticisms focused on requiring research during clinical training and the effort needed to complete scholarly projects.

Conclusions
The diversity of articles and variable results prevent definitive conclusions about the value of SCs. Findings suggest several implications for future SC program evaluations and educational research. The authors advocate increased rigor in evaluation designs to demonstrate SCs' true impact.

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The Association of American Medical Colleges (AAMC) advocates training a diverse workforce of physicians who can make contributions to society beyond clinical medicine.[1] Medical schools have a decades-long history of exposing students to and training them in biomedical research.[2–5] Increasingly, schools provide opportunities for students to cross-train in areas beyond the conventional medical curriculum. These areas of study have included subjects as diverse as ethics, humanities, medical education, community health, and global health[6–11]; specific examples of areas of intensive, independent study and schools that offer them are described in this issue of *Academic Medicine* and elsewhere in the literature. In light of this growing trend, educators and administrators should understand the effects and consequences of scholarly concentrations (SCs) on medical students. In this report, we identify and classify the outcomes that educators, administrators, and investigators have used to evaluate the impact of these programs on students. We examine the outcomes to provide implications for future program evaluation and educational research.

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Definition of SCs

For this review, we define SCs as elective or required curricular experiences that allow medical students to study specific subjects (both medical and nonmedical) in-depth beyond the conventional medical school curriculum. SCs can vary in duration from six weeks to several years, and they often feature didactic instruction, mentorship opportunities, and hands-on experiences. Our definition also includes a required, student-generated, academic product (e.g., poster, formal presentation, written thesis) that demonstrates successful program completion. Our review includes dual-degree tracks (e.g., MD–PhD, MD–MPH), which we classify as elective SCs that award degrees on completion. As older, more established programs, dual-degree programs may provide more long-term outcomes. Thus, we believe evaluations of dual-degree programs could contribute to a literature review of SCs in medical education.

Method

Search strategy

In 2008, we used Medline, PsycINFO, and ERIC electronic databases to locate articles related to the review question, "What impact do SC programs have on medical students?" One of us (first author, SBB) used the subject MESH terms of "education, undergraduate, medical" and "medical, students" to retrieve an initial set of articles. She then conducted a series of separate searches using key words ("research activity," "research experience," "research project," "area of concentration," "scholarly," "concentration," "dual degree," "MD-PhD," "MSTP," "MPH," and "MBA") to limit citations. She searched medical education journals (*Academic Medicine*, *Medical Education*, *Medical Teacher*, *Teaching and Learning in Medicine*, and *Advances in Health Sciences Education*) electronically using the same key words. SBB read the titles and abstracts of the articles identified in key word searches and developed a master list of citations. She also scanned cited references of full-text articles to locate additional papers for consideration.

Inclusion/exclusion criteria

We included articles that (1) were written in English, (2) were published in peer-reviewed journals, and (3) reported evaluations of SCs. We did not factor in the quality of evaluation designs when selecting articles. Instead, we considered only articles that presented data to demonstrate the impact of SCs on medical students. These data include students' reactions/satisfaction, skill development/attitude change, academic products/performance, career interests, and/or employment history. We excluded articles if the SC programs did not require students to submit a scholarly project. We also excluded large-scale evaluations of either specific, cross-institutional initiatives (e.g., outcomes associated with research awards from the Howard Hughes Medical Institute) or survey research involving multiple schools (e.g., AAMC Graduation Questionnaire data) because these did not meet our definition of SCs. For instance, we did not consider an article by Gallin and colleagues[12] because it presented a large-scale evaluation of the Doris Duke Clinical Research Fellowship program, an extramural research initiative sponsored by multiple institutions rather than a single medical school. In terms of the selection process, each of us independently read approximately 50% of the full-text articles from the master list to determine whether they met inclusion/exclusion criteria. Both of us read the same article only if one or the other of us was uncertain about its eligibility for the review. We included an article in the review only if we both agreed it met the inclusion criteria.

List 1
Variables Included on Data Extraction Form

- Institutional characteristics (school name, school type, scholarly concentration [SC] sponsor)
- SC information (program type, implementation year, goals, methods)
- Evaluation design (evaluation scope, evaluation questions, institutional review board approval, data sources)
- Students' demographics (including both students within the SC and, if relevant, comparators)
- Students' perceptions (e.g., reasons for entering SC, satisfaction, change in attitudes/skills)
- Students' scholarly products/performance (e.g., publications, presentations, performance)
- Student-focused outcomes during medical school (e.g., recruitment, retention, completion)
- Student-focused outcomes after medical school (e.g., clinical specialty, leadership roles)
- Other reported outcomes (e.g., faculty recruitment/satisfaction, sustainability, cost)

Data extraction

Together, both of us developed a four-page data extraction form based on the literature and guidelines for a Best Evidence Medical Education (BEME) review.[13] In addition to bibliographic information, this extraction form recorded data about SC programs and various evaluation outcomes (List 1). Initially, we both read and discussed approximately 50% of the articles to complete the data extraction forms consistently. We then divided and independently rated the remaining articles in the review. One of us (S.B.B.) entered the data from the extraction forms into SPSS 16.0 (Chicago, Illinois) for purposes of analysis.

Analysis

We adapted Kirkpatrick's model of evaluation outcomes to organize, analyze, and synthesize the student outcomes we identified in the literature review. Kirkpatrick developed this model in the 1960s to evaluate the effectiveness of training programs at four levels: reactions, learning, behavior, and results.[14] More recently, Kirkpatrick's model has served as a common metric to organize outcomes of diverse studies reported in BEME literature reviews.[15] We categorized the outcomes of SCs as follows:

1. Impact on Satisfaction (Reactions).

   Learners' views of the SCs including their perceived value, organization, content, methods, instructional materials, and teaching effectiveness.

2a. Impact on Career Interests and Perceptions (Learning).

   Changes in learners' attitudes, interests, perceptions, or career interests during or after participation in SCs.

2b. Impact on Knowledge and Skill Development (Learning).

   Changes in learners' knowledge (e.g., acquisition of concepts, procedures, and principles), skills (e.g., acquisition of critical-thinking/problem-solving, psychomotor, and/or social skills), or confidence during or after participation in SCs.

3. Impact on Scholarly Work (Behavior).

   Learners' transfer of learning gained during SCs to the workplace.

4a. Impact on Clinical Specialty and Career (Results).

   Changes attributed to SCs at the individual, organizational, or societal level (e.g., production of additional physician–investigators).

4b. Impact on Patients (Results).

   Improvements, attributed to SCs, in the health or well-being of patients.

Results

The search produced 1,640 citations. We reduced this to 82 full-text papers after screening abstracts/titles, conducting journal-specific searches, and reviewing reference citations. Of these, 39 studies met inclusion criteria. We excluded the remaining 43 articles because they did not provide data on outcomes, were not about SCs, reported large-scale evaluations, or were about SC programs that did not require a final scholarly project (Figure 1).

We report results in two major sections. First, we present descriptive characteristics of the articles included in the review. Then, we use our adaptation

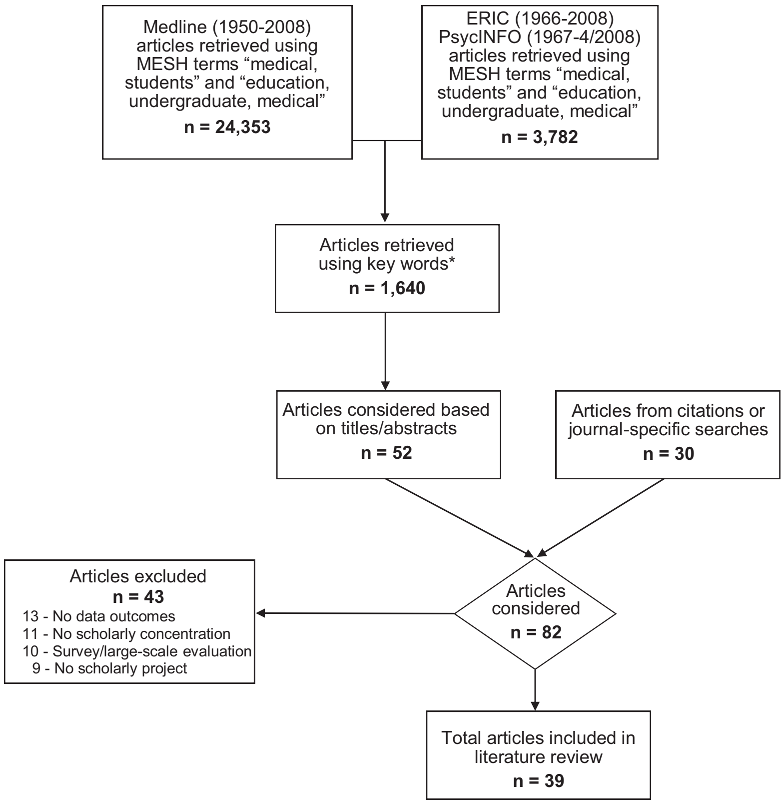

Figure 1 Selection strategy for literature review.

*The key words the authors used are as follows: "research activity," "research experience," "research product," "area of concentration," "scholarly," "concentration," "dual degree," "MD-PhD," "MSTP," "MPH," and "MBA."

of Kirkpatrick's model to organize and discuss SC outcomes.

Descriptive analysis of included studies

Setting. The majority of studies evaluated SC programs in 24 U.S. medical schools (13 private and 11 public). Six studies reported outcomes of SC programs in Canadian or European medical schools. Eight schools with long-standing SC programs or with multiple SC programs were featured in more than one of the 39 studies. Appendix 1 lists the schools included in the review.

Program type and inception. The 39 reports described required (n = 13), degree-granting (n = 11), or elective (n = 15) experiences. Thirty-two articles mentioned the year the SC was first implemented. Of the articles in our review, Ebbert[2] reports the earliest SC program, at Yale University, which implemented a thesis requirement for all medical students over 150 years ago. Four institutions created MD–PhD programs during the 1970s,[16–19] and about half of the SC programs in this review began in the early 1980s. Start dates for elective SC programs varied considerably and did not offer a discernable pattern.

Program goals. Twenty-four studies explicitly described the goals of SC programs.[3–7,9,18–35] We analyzed the content of these goals and coded them into three categories: experience/reactions, mentoring/career development, and knowledge/skill development. Table 1 presents paraphrased goals and shows that many of these SC programs focused on students' knowledge and skill development (e.g., the ability to communicate ideas/results in a well-written report). Dual-degree programs, especially MD–PhD programs, usually had career-oriented goals for graduates (e.g., the production of students who can function as independent investigators).[4,5]

Evaluation methods and scope. Most studies used questionnaires (n = 30) to collect data from SC program participants. Of these, three studies used pre/post research designs,[6,29,39] four reported student satisfaction across class cohorts,[2,3,28,36] and one study compared student outcomes across three institutions.[35] Eight articles reported outcomes obtained from school-maintained records,[7,18–20,25,26,37,38] two from structured interviews with SC program participants,[39,40] and two from content analyses of students' research projects.[23,41] Thirty-six reports mentioned the years of data included in SC program evaluations; the number of years of outcome data ranged from 1 to 30 (mean = 9.1 years, standard deviation = 8.6). Fourteen papers stated evaluation questions clearly,[2,4,7,24–26,28,29,37,39,41–44] and we could infer the evaluation questions for another 17 studies[5,6,9,16–19,21–23,27,30,32,33,35,36,45] by reading the goals and program descriptions of the SC program described. Initially, we tried to determine, using the data presented, whether reports completely or partially answered the stated or inferred evaluation questions. We struggled to make these judgments reliably, especially with inferred evaluation questions. Therefore, we do not report these data. Only four articles included statements about obtaining institutional review board (IRB) approval.[7,26,41,42]

Reported student outcomes

Level 1: Impact on satisfaction. Twenty studies reported students' opinions of SC programs.[3,6,7,9,17,20–26,28,30,36,39,42,43,45,46] Of these, 14 studies explicitly provided either questionnaire ratings or selected open-ended comments to demonstrate students' perceptions of SC experiences.[3,9,17,20–26,36,39,42,45] Five studies reported that 80% to 94% of students would undertake SCs again if given the opportunity.[25,27,36,39,45] Several studies documented student satisfaction with their SC preceptors as evidenced by students' high ratings of advising attributes such as availability,[20,22,28,45] appropriate guidance,[6,22,23,28,43] expertise,[20,28] interest in the student and/or project,[22,28] and professionalism.[6] Students' criticisms of SC programs typically involved the scholarly project, which some students thought caused unwelcome stress,[22,36,39] took too much effort,[22,28,43] lacked appropriate structure,[39] focused too much on laboratory research,[20] and/or detracted from clinical opportunities.[20,22]

Few of the studies we reviewed explored directly the question of whether SCs should become a curriculum requirement.[2,43] In a survey of Yale

Table 1
Reported Goals of Scholarly Concentrations in Literature Review

Goals of scholarly concentration programs	Reference list number
Experience/reactions	
Provide a rigorous, in-depth scholarly experience	6, 21, 23, 29, 32
Complete training leading to dual degree	18, 25
Experience satisfaction with scholastic activity/research experience	9, 20, 26, 30
Mentoring/career development	
Provide experience/environment that fosters interest in academic medicine	3, 21, 24
Foster, maintain, or increase student interest and/or participation in research	9, 26
Encourage mentoring relationships outside of the course structure	34
Produce students who can function as independent investigators	4, 5
Knowledge/skill development	
Increase understanding of the importance of research to patient care	26
Acquire an in-depth understanding of an area of medical science	7, 22, 34
Teach principles of scientific method/clinical investigation	4, 20, 31, 33
Apply principles (public health, etc.) to solve health problems	7, 27
Formulate questions/test hypotheses	3, 22, 28, 35
Conduct literature searches using medical informatics	28
Appraise scientific literature critically	3, 7, 22, 26, 28
Collect and interpret data based on observations/analyses	28, 34, 35
Learn and select appropriate research methods	22, 28, 33
Communicate ideas/results in a well-written report	7, 22, 28, 31, 34

alumni, Ebbert[2] learned that 60% of respondents thought all Yale medical students should complete a research project during their medical training. Closer examination of survey results revealed that alumni with medical school appointments (69%) held this opinion more often than those in private practice (57%). Frishman[43] identified that 50% of Albert Einstein College of Medicine graduates who completed an elective, six-month research experience during medical school (n = 49) thought research should not become a graduation requirement. Interestingly, medical students at the University of Calgary consistently assigned low satisfaction ratings to a required research experience even though many students had positive perceptions of their preceptors and scholarly projects.[22,28] Haraysm and colleagues[22] discovered that dissatisfied students viewed Calgary's research requirement as less valuable if they had previous research experience or if they wanted more time to pursue clinical training opportunities.

Level 2A: Impact on career interests and perceptions. A number of studies examined whether SC programs affected students' attitudes or career interests. Several articles reported that completing SCs during medical school influenced students' choice of clinical specialty[2,6,24,25,29,30,36,45] or interest in research.[20,24,26,29,30] One study observed that SC programs increased students' interest in rural medicine,[9] and two others reported that SC programs encouraged students to consider academic careers.[29,43] Ogunyemi and colleagues[23] reported that 20% of students at the Charles Drew School of Medicine had decreased interest in research after completing a required thesis. The authors do not speculate whether these students were generally less interested in research given Charles Drew's mission to prepare primary care physicians for careers in urban health care.

Level 2B: Impact on knowledge and skill development. Several investigations used students' self-ratings to document how completing SCs improved their abilities to evaluate the literature critically,[7,24,29,43] to write a scientific paper,[24,29,43] and/or to conduct ethically responsible research.[6,24] Other students thought undertaking SCs gave them a broader perspective of patient care,[9,17,36] improved their understanding of research principles/processes,[6,22,23,43] and enhanced their knowledge.[9,22] Another study compared the self-assessments of MD–MPH and MD-only students in appraising scientific literature.[7] Though MD–MPH graduates reported higher confidence in this area than the comparison group (80% versus 33%), the low survey response of 16% made drawing valid conclusions difficult. Interestingly, no other investigation in the literature we reviewed used group comparisons to examine the impact of SCs on students' learning. Two studies used pre/post research designs to document changes in student learning.[6,39] In one of these, students (n = 9) completed questionnaires to assess their knowledge before and after a research elective.[6] Difference scores showed that students learned the most about IRB procedures and research processes. In the other of these two studies, Shapiro et al[39] interviewed 11 students on two occasions. In post-SC experience interviews, all students said a research elective improved their confidence in designing and conducting clinical research, and nine students thought their technical skills improved during the SC.

Only one study in the review reported faculty assessments of students' scholarly products.[22] In this investigation, 276 preceptors and an evaluation committee used a 14-item checklist to rate students' written research projects using a four-point scale (1 = poor to 4 = excellent). On average, both groups rated student performance above 3 on all criteria, but preceptors consistently rated student performance higher than the evaluation committee did on all items. Because of scoring discrepancies and a potential halo effect, the authors (Harasym and colleagues) recommend using a separate evaluation committee to assign grades to students' required research projects.

The last outcome in this category frequently mentioned by reviewed reports involved the number of students who completed degrees to fulfill SC requirements. Eight articles reported the total number of students who received PhDs[4,5,25,37] or MPH degrees[7,19,25,38] during their medical school training.

Level 3: Impact on scholarly work. Many of the studies cited scientific presentations and publications to document students' ability to apply acquired knowledge and skills to a career setting. Most articles reporting these data relied on students' self-reports or school records (i.e., voluntary participation in school-sponsored research symposia). No studies mentioned specific methods (electronic searches, conference proceedings, etc.) to confirm the accuracy of self-report data, and only one article used Medline searches to identify students' publications.[40]

Publication in peer-reviewed journals seemed to serve as the "gold standard" of academic success across elective, required, and dual-degree SC programs. In fact, several articles reported SC students' publication rates in peer-reviewed journals, which ranged from 8% to 85%.[3,22–24,26,31,32,36,40,43,44,46] Rates of giving presentations at regional or national meetings ranged from 10% to 41%.[3,28,33,34,44,46] Three studies presented class cohort data to show how students' publications and presentations increased over time.[23,26,36] Other articles discussed the nature of SC program students' scholarly work by listing the titles of students' projects,[6–9,23,24,32,34,39,43,46] categorizing students' projects by topic area,[22,23,26,41,43,46] or reporting the research designs that students employed.[23,43]

Level 4A: Impact on clinical specialty and career. Several studies explored whether relationships existed between students' SC activities during medical school and their choice of clinical specialty. Ebbert[2] learned that Yale graduates tended to enter clinical specialties in the departments where they completed their required research theses. He also noted that 26% of Yale graduates' current research activity was related to the topic of their student projects. Similarly, Chongsiriwatana[41] discovered that students who completed women's health projects to fulfill the University of New Mexico's research requirement matched more often into residency programs focusing on women's health than students who did research in other areas. Another study reported that those who took MPH courses during medical school tended to enter pediatrics and preventive medicine at greater rates than MD-only graduates,[19] whereas another stated that 83% of students who completed an elective honors research program in the Department of Dermatology obtained dermatology residency placements.[32] One study identified that 62% of responding graduates (n = 107) from Duke University's MD/PhD program obtained academic appointments in clinical departments (e.g., internal medicine, pathology, pediatrics) or nonclinical departments (e.g., biotechnology, basic sciences, informatics) where they could devote 48% to 65% of their time to research.[37] We could not discern from these studies whether students selected certain SC topics to enhance their standing during the residency application process or whether students explored SC opportunities that later shaped their career interests.

Other studies used students' continued engagement in research to convey the long-term impact of SC programs. For instance, several schools reported their SC program graduates' current time commitment to research,[2,4,16,18,19,27,30,35,43] involvement with research since medical school,[2,19] success in obtaining National Institutes of Health (NIH)/extramural support,[4,5,18,27,30,37] and/or record of publications after graduation.[5,27,35] To explore the impact of a required research experience on later research involvement, Segal and colleagues[35] surveyed graduates of the University of Pennsylvania who completed a research requirement and graduates of two similarly ranked medical schools with elective SC programs. Results showed that those with any research experience at all—be the experience required or elective—during medical school conducted and published more postgraduate research than those without any research experience (49% versus 32%). In another study, investigators interviewed 274 graduates of the Dutch University of Groningen to explore the relationship between completion of extracurricular research during medical school and research productivity.[40] Graduates who did research during medical school published more frequently after graduation (mean = 4 articles) than graduates without research experience (mean = 1 article). Of the graduates with research exposure in medical school, approximately 50% published during medical school, and those who had published during medical school had higher publication rates after medical school (mean = 6 articles) compared with those who had not published during medical school (mean = 2 articles).

Some evaluations of SC programs identified other career outcomes of graduates. Ten studies reported the number of graduates from elective,[30,43] required,[2,35] or dual-degree programs[4,5,16,18,27,37] who obtained academic appointments or achieved faculty rank (e.g., professor) after residency training. Three reports of MD/PhD programs presented the institutions where graduates obtained academic appointments, including their recruitment to home institutions.[4,18,37] Two reports described graduates' occupations[27,37] (clinical medicine, industry, ministry, etc.) and leadership roles[27] (journal editor, NIH section leader, etc.) to demonstrate how SC programs helped prepare physicians for careers in academic medicine as originally intended.

Level 4B: Impact on patients. No articles in the review reported outcomes to document how or whether SC programs influenced changes in health care delivery or improved patient care practices or outcomes.

Discussion

This review includes a diverse set of SC programs whose topics of study, program goals, and instructional methods varied considerably. We did choose to limit our definition of SCs to programs that require students to generate academic products to demonstrate successful program completion, and we offer this requirement as a potential standard for SCs. Speculating on what additional characteristics a gold standard SC should contain is too difficult given the range of program goals and characteristics.

Many reports used descriptive, single-group designs to examine program outcomes, or they relied heavily on self-report data. For these reasons, we cannot offer definite conclusions about the long-term impact of SCs on students. The literature only suggests that SC programs influence students' perceptions, learning, research productivity, and career decisions (Appendix 1). Even so, this review underscores the importance of using outcomes to judge the effectiveness of educational interventions in medicine. The challenge now is to identify and prioritize the best outcomes to measure to demonstrate program impact. Some believe medical educators must first determine whether educational programs actually influence learners' behaviors.[47,48] Others advocate investigations that link curricula to patient outcomes.[49,50] Alternative lines of inquiry could explore how SC programs affect organizational structures or institutional culture. Evaluating complex, difficult-to-measure outcomes of educational programs requires leadership, expertise, and resources. The current literature reveals that continuing to measure what is easy to collect (student feedback) rather than what is important to know (behavioral, institutional, or societal outcomes) will not advance research in this area.

Implications

Several lessons have emerged from this review that can help educators determine the merit and worth of SC programs. We believe the following implications for program evaluation and educational research will apply to most SC programs regardless of their topic areas or program designs.

Create program goals. Goals help shape a program's design, target faculty development initiatives, and clarify performance expectations. Goals may also help stakeholders identify the desired short- and long-term outcomes of educational programs. Most MD–PhD programs in this review had research-related goals and used publications and academic positions to demonstrate program impact. These outcomes may not apply to SC programs with different missions. Thus, if not already in place, faculty should develop goals for their SC programs and use these goals to communicate what they hope to achieve. Although goals may evolve over time, they do provide benchmarks for monitoring progress and evaluating impact.

Develop logic models. After defining goals, faculty should identify which outcomes to collect systematically. To help with this process, the Kellogg Foundation developed a handbook in 1989 (and updated it in 2004) to show nonprofit agencies how to use logic models to align evaluation plans to program goals.[51] The logic model graphically depicts the inputs, activities, outputs, and outcomes of programs. *Inputs* refer to the resources needed to operate a program such as grant dollars, in-kind departmental support, or laboratory resources. *Activities* document the tasks required to implement the program (curriculum design, student recruitment, faculty development, etc.). *Outputs* identify the direct results of programs, and these are often stated numerically (e.g., the number of students enrolled in SCs or the number of students who completed research projects). *Outcomes* list the anticipated short-term (one to two years after program completion) and long-term effects (five or more years after program completion) of programs. When used as an evaluation tool, logic models can uncover program assumptions, identify needed resources, generate program outcomes, and communicate evaluation plans.[51,52] Therefore, we encourage faculty to explore how (or even if) logic models can improve the planning and evaluation of their SC programs.

Select appropriate designs. Only a few studies in this review used quasi-experimental designs to evaluate SCs. In the future, investigators should select more rigorous designs (pretest/posttest, cohort analyses of SC versus non-SC grads, etc.) if they want to explore the impact of SC programs on learners' behaviors.[47] Multiinstitutional research could also advance understanding about the effectiveness of educational interventions across sites as in Segal and colleagues' study,[35] which showed a link between undergraduate research experience and postgraduate scholarly activity.

Collect multiple sources of data. Multiple challenges (e.g., "just-in-time" planning, lack of resources) often arise that supersede evaluation activities when faculty design new educational programs. Kirkpatrick[14] recommend always collecting reaction feedback from participants because doing so (with questionnaires) is easy and the resulting data are better than no data at all. Though many view participant feedback as "soft," these data can provide information for improving program components, establishing quality benchmarks, and justifying program expansion or elimination decisions.[14] Limiting evaluation data to participant feedback, however, will not provide sufficient evidence to link educational programs to long-term outcomes. We encourage researchers to collect, when feasible, additional data from multiple sources (e.g., NIH databases, AAMC databases, faculty, alumni, patients, employers) using different methods (e.g., MEDLINE searches, interviews, questionnaires, observation, social network analysis). Doing so should allow researchers to explore other outcomes in Kirkpatrick's model and will provide opportunities to compare data across sources and methods, which will help support or refute the reliability and validity of evaluation findings.

Assess students' abilities. Although many of the SC programs in this review required students to generate and present scholarly projects, few programs reported student performance on these projects. The recent shift toward competency-based education in medicine[53–55] may encourage SC programs to develop rigorous assessment systems and tools to provide students with feedback about their performance of complex skills. Faculty, patients, or peers could provide students with diagnostic feedback about their performance in multiple domains such as professionalism, interpersonal communication, medical knowledge, and research ability. These data might help SC programs determine whether students are meeting program-specific outcomes such as formulating testable hypotheses or practicing patient-centered interviewing skills. Aggregating performance data across students could also help SCs identify areas for program improvement.

Obtain IRB approval. Ethical guidelines for human participants research in medical education have changed substantially.[56,57] Professional practice now requires investigators to submit evaluation plans of SC programs to IRBs to determine whether such plans warrant an exemption or require consent from participants.[58,59] Many IRBs may decide that the evaluation of normal educational practices meet federal exemption criteria,[60] making formal ethical review unnecessary. Other IRBs may require detailed protocols for curriculum evaluation, which may make identifying and measuring outcomes of new or evolving educational initiatives difficult. Data registries offer one approach to streamline the IRB approval process. Initially used to record and monitor patient outcomes for clinical research, a data registry is one form of IRB application with the flexibility to amend existing protocols quickly for developing programs while still protecting the rights of human participants. Data registries may also support faculty scholarship in that faculty can request registry data for academic products (posters, presentations, publications) while still maintaining ethical standards.

Identify explanatory theories. Finally, few reported studies in medical education research use theory to identify "why programs work."[61] Our review of published evaluations of SC programs corroborates this trend in that only one of the articles we reviewed used theory to explain the outcomes of a clinical research experience in family medicine.[39] Medical educators should explore the social science literature to identify theoretical models that can contribute to the academic medicine community's understanding of SC programs. For instance, Baaken and colleagues[62] used social cognitive career theory (SCCT) as a framework to explore the limitations of training programs designed to produce physician–investigators. SCCT contends that positive learning experiences (e.g., interactions between a person and his or her environment) increase confidence in career-related abilities (career self-efficacy) and shape career interests (outcome expectations). Personal attributes (gender, marital status, parental status, etc.) and other variables (clinical demands, mentor availability, conflict with dual-career, funding resources, etc.), however, may decrease self-efficacy and adversely influence outcome expectations which could discourage physicians from pursuing clinical research careers. SC programs with career-oriented goals may wish to use SCCT as one theory to identify and evaluate relationships among variables to understand how and why programs work.

Limitations

This review has several limitations. First, many of the reported outcomes in this review were related to research-oriented goals and activities. We do not know whether the outcomes of these programs (i.e., peer-reviewed publications or careers in academic medicine) generalize to SC programs with different goals (e.g., appreciate role of the humanities in medicine). Second, publication bias may exist because evaluations for some programs, especially those with elective SCs, reported favorable outcomes and offered few suggestions for improvement. Third, we may have omitted articles, given our inclusion/exclusion criteria and reliance on electronic searches. We identified 30 additional articles after scanning reference citations and searching medical education journals; nonetheless, we may have overlooked some articles. Finally, we did not calculate interrater agreement after completing data extraction forms because of the diverse outcomes in this set of articles. Ongoing discussion between raters likely reduced this problem.

To conclude, educational programs, especially resource-intensive ones, require evaluations to inform decision making. The outcomes reported in Appendix 1 suggest that SCs influence students in several ways (i.e., fostering in-depth study, encouraging scholarly activity, increasing research productivity, and influencing career decisions). This review also identifies several lessons that may improve the evaluation of SCs. At this point in time, the literature does not provide sufficient evidence to allow definitive statements about the value of SC programs. Future research should employ more rigorous evaluation designs to show the direct impact of SC programs on both learners and, ideally, patient outcomes. Until then, medical school leaders will have to rely on the available literature and their own experiences to decide if—given the resources expended—SC programs achieve their desired goals.

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Appendix 1

Summary of 39 Articles Included in Review, Organized by Program Type

Reference number	First author (year published)	Institution (public/ private status); name of scholarly concentrations (SCs)	Year SC initiated	Evaluation participants; method	Evaluation scope (years)	Select evaluation outcomes
Required SC programs						
20	Blazer D (2001)	Duke University School of Medicine (SOM) (Private); Third Year Study Program	1966	Medical student graduates; questionnaire (n = 124, 67% response)	2	• Over 65% of graduates reported that research experience increased appreciation of biomedical research and understanding of scientific methods. • Approximately 5–10 students receive Howard Hughes Medical Institute awards each year.
41	Chongsiriwatana KM (2005)	University of New Mexico SOM (Public); Approved Research Project	1993	Medical students' projects; document analysis (n = 456 projects; 85% selected)	7	• Students who completed women's health project (18%) were twice as likely to enter residency focusing on women's health than students who did research in other areas (1.8, 9% CI, 1.4–2.3).
2	Ebbert A (1960)	Yale University SOM (Private); Thesis	1839	Medical students; alumni questionnaire (n = 1,034, 85% response)	25	• Many graduates entered specialties in departments where they did their student research projects. • 22% of all graduates and 43% of graduates with full-time faculty appointments said their research projects had moderate/great impact on their career choice. • Those who did summer research or devoted extra year to research were more likely to conduct research after graduation. • 26% of graduates' current research activities were related to topics of their student research projects.
36	Elwood JM (1986)	Nottingham Medical School (Other); Honours Year Programme in Community Health	1973	Medical students; alumni questionnaire (n = 98, 80% response)	12	• 67% of graduates said research program influenced choice of medical school. • 32% thought research experience influenced career choice. • Over 80% thought research made difference in personal/practical skills and improved understanding of community health. • 53% presented or published project, and 78% maintained interest in project topic. • 67% perceived experience as very valuable. • 92% were glad they did program.
21	Grochowski C (2007)	Duke University SOM (Private); Foundation for Excellence Curriculum Third Year	1980	Medical students; questionnaire (n and response rate not given)	2	• 91% of students reported scholarly experience as good/excellent.
22	Harasym PH (1992)	University of Calgary Faculty of Medicine (Other); Research Elective Program	1989	Analysis of faculty ratings of students' projects (n = 276); medical student questionnaire (n = 46, 69% response)	4	• Research topics were as follows: clinical (35%), experimental (22%), administrative (2%), and theoretical (42%). • Research preceptors rated students' projects higher than central evaluation committee. • 72% of students thought project was useful; 65% said they enjoyed doing project; 35% reported improved informatics skills; 22% reported improved knowledge; 13% thought project provided career opportunities; 11% published their project.

(*Appendix continues*)

Appendix 1, continued

Reference number	First author (year published)	Institution (public/private status); name of scholarly concentrations (SCs)	Year SC initiated	Evaluation participants; method	Evaluation scope (years)	Select evaluation outcomes
29	Houlden RL (2004)	Queen's University SOM (Other); Critical Enquiry Elective	Not stated	Medical students; pre/post questionnaire (n = 60; 85% response)	1	• 75% of students reported making contacts that would help them with postgraduate training. • 62% indicated elective helped them decide on clinical specialty. • 40% had increased interest in research career. • 68% reported improved confidence in manuscript preparation skills, 53% in literature review, and 43% in problem formulation. • 67% expected a publication, and 46% expected presentation after elective.
46	McPherson JR (1984)	Mayo Clinic College of Medicine (COM) (Private); Science Minor	1974	Third-year medical students; school-collected data (n = 244)	6	• 234 students completed written project. • 58% either published or presented research. • 47% of students (versus 28% nationally on AAMC Graduation Questionnaire) planned to do research during graduate training.
23	Ogunyemi D (2005)	Charles R. Drew University of Medicine (Private); Primary Care Medical Student Research Thesis	1995	Fourth-year medical students; questionnaire (no n or response given)	9	• 168 students completed 112 projects completed by one (48%), two (28%), or three (27%) students. • Projects coded by topic/theme in article. • 50% of students reported that thesis experience increased their interest in research. • 20% thought thesis decreased their interest in research. • 73% reported improved knowledge about research process.
31	Rhyne RL (2000)	University of New Mexico SOM (Public); Longitudinal Scholarly Research Project	1993	Medical student graduates; school-collected data (n = 201; response rate not given)	3	• All students completed research project. • 8% published work in peer-reviewed journals. • 36%–44% of students graduated with commendation in research (presented or published work and received 2 faculty recommendations).
34	Rosenblatt RA (2006)	University of Washington SOM (Public); Independent Study in Medical Science	1981	Multiple classes of medical students (≥170 per class); school-collected data	9	• Presents examples of student research projects. • 27%–41% of students (by class) presented research at regional meeting.
35	Segal S (1990)	University of Pennsylvania SOM (Private); Required Research Project	1970	Medical student alumni from 3 schools 1980–1982; questionnaire (n = 567, 76% response)	3	• Those with research experience during medical school were more likely to do postgraduate research (37% versus 21%), to do postgraduate basic science research (12% versus 5%), and to publish postgraduate research (49% versus 32%) than those without research experience. • Those from schools with research requirement were more likely to read specialty medical journals than those without research requirement. • No differences detected in clinical specialty or career satisfaction.

(*Appendix continues*)

Appendix 1, continued

Reference number	First author (year published)	Institution (public/ private status); name of scholarly concentrations (SCs)	Year SC initiated	Evaluation participants; method	Evaluation scope (years)	Select evaluation outcomes
28	Smith FG (2001)	University of Calgary Faculty of Medicine (Other); Research Project Program	1989	Medical students; school and questionnaire data (n = 63, 91% response) compared with data collected 10 years earlier	2	• 44% of students presented at school-sponsored symposium. • 22% presented at regional/national meeting. • 11% submitted work for publication. • 48% planned to submit work for publication. • More students completed 2-year projects than 10 years earlier when SCs were first implemented. • 48% reported improved skills in data presentation, 38% in data interpretation, and 19% in hypothesis testing.
Dual-degree SC programs						
16	Abelmann WH (1997)	Harvard Medical School (Private); Health Sciences and Technology–MD Program	1970	Medical student alumni; questionnaire (n = 270, 92% response)	14	• 71% of MDs and 84% of MD–PhDs obtained academic appointments. • 73% of alumni reported being active in research. • 52% devote more than half their time to research. • 75% of graduates reported active teaching roles.
38	Boyer MH (1997)	Tufts University SOM (Private); Combined MD–MPH Program	1987	Medical students; comparison of MD–MPH (n = 122) and MD-only (n = 1,466) students; school data	9	• Of graduates, 62% chose primary care specialty (medicine, family practice, pediatrics), 11% obstetrics–gynecology, and 8% general surgery. • No difference in age or scores (MCAT scores and USMLE Step I and II) between MD–MPH and MD-only students. • MD–MPH students more likely to have bachelor of arts degree and lower basic science GPA than MD-only students.
37	Bradford WD (1996)	Duke University SOM (Private); Medical Scientist Training Program	Not stated	Medical students; alumni questionnaire (n = 107, 73% response). Also data from NIH and recent graduates	30	• 74% of graduates in academic medicine or research, with others in private practice. • Of those in academic positions, 82% had full-time appointments, spent 50%–65% of time devoted to research, and devoted 23%–30% time to clinical medicine. • 68% of graduates with full-time academic appointments were PIs of current NIH grants.
17	Chauvin SW (2000)	Tulane University SOM (Private); MD–MPH Dual Degree Program	1971	Enrolled medical students; questionnaire (n = 69, 62% response)	1	• 72% of students agreed that program gave them broader perspective of patient care than MD degree alone. • 61% agreed they learned how to interact with a variety of health care professionals. • 55% planned to practice in urban setting. • 52% planned to practice in an international setting for a period of time. • Over 80% agreed they were glad they enrolled in program.

(*Appendix continues*)

Appendix 1, continued

Reference number	First author (year published)	Institution (public/ private status); name of scholarly concentrations (SCs)	Year SC initiated	Evaluation participants; method	Evaluation scope (years)	Select evaluation outcomes
4	Frieden C (1991)	University of Washington SOM (Public); Medical Scientist Training Program	1969	Medical student graduates; alumni questionnaire and school-collected data (n = 148; no response rate reported)	16	• 90% of graduates accepted into "first choice" residency programs. • 86% employed at academic institutions. • 69% receive National Institutes of Health support. • 11 received investigator awards (HHMI, Pfizer, etc.), and 60 devoted >75% of their time to research.
18	McClellan DA (1992)	Johns Hopkins University SOM (Private); Medical Scientist Training Program	1975	Medical student graduates; school-collected data, annual alumni questionnaire. Most results for graduates since 1980 (n = 109; no response rate reported)	30	Of 42 graduates who have entered professional careers at time of study . . . • 81% completed house staff training and hold full-time faculty appointments in clinical (68%), basic science (18%), or joint clinical/basic science departments (14%). • 9% pursued postdoctoral training instead. • 14% are research scientists at NIH/elsewhere. • 5% work in industry. • None are in private practice.
19	Rosenberg SN (1998)	Columbia University College of Physicians and Surgeons (Private); MD–MPH Program	1976	Medical students; questionnaire (n = 137, 49% response)	15	• 84% of students enrolled in MPH said public health training was of value to clinical work. • Those who took public health courses more likely to enter pediatrics and preventive medicine than MD-only graduates.
5	Schwartz P (1999)	University of Pennsylvania SOM (Private); Medical Scientist Training Program	1969	MD–PhD graduates; alumni questionnaire (n = 216, 85% response) and CV analysis	29	Of 140 graduates who had completed their training at time of study . . . • 83% in academic medicine. • 92% said current position involved significant research. • 67% reported >50% time commitment to research. • Within past 3 years, 98% published in peer-reviewed journals. • 92% are PIs on projects, and 87% are PIs on externally funded projects.
25	Stellman JM (2008)	Columbia University College of Physicians and Surgeons (Private); Macy Scholars Program for MPH Degree	1999	Graduating medical students; questionnaire (n = 58; 79% response)	7	• 74% of students thought training helped them "very much" in meeting personal goals. • 75% reported substantial influence on their career choice. • 50% reported substantial influence on residency choice. • 41% said training enhanced ability to meet patients' needs. • 26% reported attaining skills in epidemiology/biostatistics and 21% in general research skills. • 88% very satisfied with program.
42	Watt CD (2005)	University of Pennsylvania SOM (Private); Combined MD/PhD Degree Program	Not stated	All enrolled medical students; questionnaire (n = 96, 57% response)		• 61% of students thought project improved ability to recognize clinical problems that can be solved scientifically. • 60% agreed that they plan to pursue careers as physician–scientists. • 58% rated research interest as extremely important factor in choosing specialty. • 90% were satisfied with the program but wanted more career advising.

(*Appendix continues*)

Appendix 1, continued

Reference number	First author (year published)	Institution (public/private status); name of scholarly concentrations (SCs)	Year SC initiated	Evaluation participants; method	Evaluation scope (years)	Select evaluation outcomes
27	Wilkerson L (1993)	Harvard Medical School (Private); Harvard–MIT Program in Health Sciences and Technology	1971	Medical students; alumni questionnaire (n = 270, 90% response)	10	• 94% of students held full-time faculty appointments. • Respondents reported time as 44% patient care, 38% research, 9% teaching, and 8% administration. • 73% reported current involvement with research. • 50% reported local leadership positions. • 14% reported state/professional leadership positions. • 18% reported national leadership positions (i.e., editor). • 172 published in peer-reviewed journals with article type (i.e., basic science) cited in article. • 85% would choose the program again, with a frequent reason being the quantitative approach to medicine/basic science.
Elective scholarly concentration programs						
6	DeHaven MJ (2005)	University of Texas SW Medical Center (Public); Community Health Fellowship Program	2002	First-year medical students; pre/post questionnaire (n = 9; no response rate reported)	3	• Presents topics of students' projects. • Mean change from pre/post ratings showed students had increased familiarity with IRB (+2.9), research processes (+2.1), and ability to design project (+2.0).
3	Fisher WR (1981)	University of Florida COM (Public); Research Experience	1969	Medical students who participated in research; questionnaire (n = 166; 75% response)	10	• 66% of students published student research project. • 10% presented student research at regional/national meeting. • 41% had continued research involvement after graduating from medical school. • 74%–96% had a positive research experience.
43	Frishman WH (2001)	Albert Einstein COM (Public); Medical Student Research Project	1981	Medical students; alumni questionnaire (n = 49, 71% response)	13	• 42% of alumni graduated from medical school with distinction in research. • 85% submitted student projects for publication; of these, 90% published in peer-reviewed journals. • 85% reported impact on their careers. • 25% said it encouraged their pursuit of academic careers. • 33% had academic appointments. • For time committed to research, 4% reported exclusive involvement, 25% significant commitment, 35% some commitment, 22% limited involvement, and 14% no involvement. • Over 70% reported improved ability to collect data, to conduct literature reviews, and to identify resources.

(*Appendix continues*)

Appendix 1, continued

Reference number	First author (year published)	Institution (public/ private status); name of scholarly concentrations (SCs)	Year SC initiated	Evaluation participants; method	Evaluation scope (years)	Select evaluation outcomes
33	Gonzales AO (1998)	University of Colorado SOM (Public); Family Medicine Scholars Program	1990	First-year medical students (n = 161 students); school-collected data	7	• Of 161 who did research, 17 presented work (of 19 submissions) and 2 published research (of 6 submissions). • Article presents examples of students' research topics.
7	Harris R (2008)	University of North Carolina SOM (Public); Health Care and Prevention Program	1997	Medical students; alumni questionnaire (n = 95, 16% response)	4	• MD–MPH graduates rated their ability to appraise literature critically more highly than non-MPH graduates (80% versus 33%). • Descriptive titles of projects cited.
24	Jacobs CD (1995)	Stanford University SOM (Private); Medical Scholars Program	Not stated	Medical students; alumni questionnaire (n = 73, 73% response)	1	• 75% of students published at least one article based on research in medical school. • 52% presented at national/international conference. • Over 80% of students agreed that project improved ability to ask questions, analyze data, use new techniques, develop methodologies, and critically review literature. • 79% were satisfied with the experience and thought it motivated them to pursue further research. • 61% thought the experience helped them make career decisions.
45	Legardeur B (1993)	Louisiana State University SOM (Public); Cancer Education Program	1989	First-year medical students; questionnaire (n = 42, 93% response)	3	• 98% of students agreed that experience was beneficial to career goals. • 36% agreed that they were interested in a clinical oncology career. • 12% agreed they were interested in a cancer research career. • 83% would repeat the program.
40	Reinders JJ (2005)	Dutch University of Groningen Medical School (Other); Extracurricular Research	Not stated	Medical school graduates; interviews (n = 274, 86% response)		• Medical students who did research published more after graduation (mean = 4) than students without research experience (mean = 1). • Those who did research during medical school published more before and after medical school than others.
44	Remes V (2000)	University of Helsinki Faculty of Medicine (Other); Extracurricular Research	Not stated	Enrolled medical students; questionnaire (n = 289, 55% response)	1	• Of the 31% of students who did research, 38% published and 27% presented work. • Men published more than women (49% versus 29%). • 84% of all who did research received scholarship/salary.
8	Shafer A (2003)	Stanford University SOM (Private); Medical Scholars Program	2000	Medical students; school-collected data	4	• Students generated several products (i.e., published poems/articles, published illustrations, online children's book, etc.) from 29 completed projects.
39	Shapiro J (1994)	University of California SOM, Irvine (Public); Research Assistantship Program	Not stated	First-year medical students; pre/post structured interviews (n = 11)	2	• 100% of students agreed that research project increased confidence in ability to conduct clinical research. • 90% agreed that project increased technical competence. • Article presents examples of student projects.

(*Appendix continues*)

Appendix 1, continued

Reference number	First author (year published)	Institution (public/ private status); name of scholarly concentrations (SCs)	Year SC initiated	Evaluation participants; method	Evaluation scope (years)	Select evaluation outcomes
30	Solomon SS (2003)	University of Tennessee COM (Public); Medical Student Research Fellowship	1977	Medical students; alumni questionnaire (n = 118, 29% response)	5	• 45% of graduates published student research project. • 25% presented student research project. • 62% thought research experience influenced overall career. • 42% thought research influenced career choice.
		Vanderbilt University SOM (Private); Medical Student Training Program	1975	Medical students; alumni questionnaire (n = 88, 33% response)	5	• 97% of graduates agreed that research is valuable to their career development. • 83% said they were more likely to do research after experience. • Students' publications, presentations, and prizes presented in article.
32	Wagner RF (2006)	University of Texas Medical Branch SOM (Public); Honors Research Program	2001	13 medical students who completed dermatology research thesis; school-collected data	5	• All students completed project, resulting in 7 first-authored publications and several research awards. • 10/12 students successfully obtained dermatology residencies.
26	Zier K (2006)	Mount Sinai SOM (Private); Medical Student Research Program	1996	First-year medical students; questionnaire (n = 110, 99% response)		• 80% of students thought experience increased application of research to medicine. • 70% reported increased interest in research. • 54%–65% participated in research day. • Peer-reviewed manuscripts increased between 1998 (11%) and 2004 (25%). • More students served as first authors (5% to 13%) in same time frame. • 90% reported learning from the experience. • 75% rated experience as excellent/outstanding.
9	Zorzi A (2005)	University of Western Ontario SOM (Other); Rural Summer Studentship Program	1999	First-year medical students; pre/post questionnaire (n = 23, 52% response)	4	• Mean change in pre/post ratings showed students had improved knowledge of rural medicine and patient care (+2.6), improved knowledge of research topic (+1.6), and increased interest (+1.3) in rural/ regional medicine. • Students rated experience as valuable to their medical education. Article presents examples of student projects.