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Student Scientific Inquiry in the Core Doctor of Pharmacy Curriculum: Critical Issues in Designing and Implementing a Student Research Program

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Abstract

While student-driven research has been credited with many learning benefits, few schools of pharmacy require such activities. Professional organizations repeatedly urge for incorporating research content in schools' curricula, yet no guiding principles or recommendations currently exist to guide such implementation efforts. This paper provides an overview of the critical issues, guiding principles, benefits and challenges encountered in designing and implementing a required, research program in the Pharm.D. curriculum. Several critical issues are reviewed: goals, unitary focus and expectations, structure and deliverables, time and curricular integration, monitoring and institutional oversight, outcomes measurement, resources, students and faculty response, and dissemination. These general critical issues are then discussed as implemented in the student research program at Touro College of Pharmacy-New York. Different schools can address these core issues, based on their academic milieu. This paper invites an inter-institutional dialogue for the pursuit of successful incorporation of student scientific inquiry in the core curriculum.

Introduction

Student-driven research is credited with significant learning[1–8] and professional [9,10] benefits. Professional organizations consistently encourage research content in school curricula. The reasons are two-fold: 1) as the pharmacy profession becomes more complex, research skills for pharmacists are becoming more important, especially in an increasingly competitive job market; 2) there is a critical need for pharmacy faculty with research skills to advance the scholarship agenda of the profession[11,12].The question that emerges is how to best prepare future pharmacy practitioners and the academic pharmacy workforce. Whether these two goals can be accomplished by the same approach or they require divergent solutions (e.g. dual degrees and special concentration tracks), may be the subject of a separate debate. Our focus here is strictly on ways to incorporate research skills into the regular Pharm.D. curriculum.

The American College of Clinical Pharmacy (ACCP) Task Force on Research in the Professional Curriculum[6], argues the need for a research experience for all students, and makes recommendations for "essential curricular competencies and research content in Pharm.D. programs". A recent Report of the American Association of Colleges of Pharmacy (AACP), the 2011-2012 Argus Commission Report on "Cultivating habits of mind in the scholarly pharmacy clinician"[13], emphasizes the need to nurture emerging scientists and to cultivate a spirit of "inquisitiveness and scholarly thinking" among pharmacy students. The Report explicitly highlights the importance of requiring students to engage in research projects, and makes a strong call for further explorations of efficient curricular delivery models.

Most of the current models to deliver research experiences consist of didactic courses in research methods, elective research courses, clerkships, and research seminars. For instance, research methods courses were required in 53% of Pharm.D. programs in 2006, 54% in 1997 and 50% in 1988 [7,8]. Such courses are crucial for building basic critical thinking skills and increasing research awareness, but there is no evidence that they achieve the goal of inculcating students with life-long research skills. To increase the research capability of the graduates, additional strategies to deliver research content are needed. The ACCP Task Force on Research in the Professional Curriculum[6], lists summer programs and capstone experiences as useful models to deliver research content in the Pharm.D. curriculum, yet, no recommendations on their design and implementation are available.

While examples of successful integration of large scale (school-wide) research programs into the Pharm.D. curriculum exist [1,14–16], they represent a striking minority. Surveys have shown that only 25% of schools require "some form of research"[7] and published reports indicate that school-wide student research experiences are considerably uncommon. Debate on the value of required research still exists, and institutional or faculty belief that research should be restricted to electives or special tracks, may still be a

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limiting factor. Additional barriers may include limited resources, faculty time and expertise, curricular time and logistic difficulties. Such barriers are sometimes perceived as insurmountable and have contributed in some cases to the perception that research programs may be "impossible" [7].

Moreover, in spite of a plethora of "calls to action", there is little written guidance and inter-institutional dialogue on optimum strategies to develop, implement and deliver school-wide research experiences. Furthermore, not all pharmacy schools, implementing such programs publish their experiences. Innovation in education requires considerable time and resources. Without dynamic dissemination of various schools' experiences and without an ever evolving body of guidelines, or frameworks to shape future endeavors, the implementation of evidence-based educational approaches will remain slow, if not illusory. While any program needs to be tailored to each institution (vision, culture, student and faculty characteristics vary) and a one-size-fits-all-model is untenable and counterproductive, several critical issues and guiding principles may be useful to consider when designing and implementing a required student research program.

In this paper, the focus is not on singular courses, such as biostatistics, journal clubs, specific laboratory research methods courses. It is also not on research electives. Instead, the focus is on more immersive experiences, school-wide required student research programs. In line with the American College of Clinical Pharmacology Task Force on Research in the Professional Curriculum, the focus is on hypothesis-based research[6].

The literature on school-wide required student research programs between 1999 and 2012 was reviewed. PubMed was searched, using the terms "student research", "capstone", "scholarly concentration", "required curriculum", "education", "pharmacy education", "medical education". In addition, references from retrieved publication were searched to look for additional studies. Two authors (GDV, SSV) independently evaluated the studies for inclusion, and disagreements were resolved by discussion. Article selection was based on the following criteria: 1) experience taking place in a pharmacy or medical school in the U.S.; 2) student research required for graduation; 3) original research papers, professional organization reports, position statements, or viewpoints expressing pertinent experience and/or specific recommendations were included; 4) publication between year 1999 and 2012). The aim of this review was to extract general guiding principles and "lessons learned" from various academic experiences and to qualitatively recognize emerging themes and patterns.

Medical education, with student research experience ranging from 5 to 40 and even 173 years [3,5,17,18], has generated considerable published information and exchange of ideas in the medical community. The natural history and extensive analyses of such experiences proved rich in "lessons learned". Pharmacy education, with experiences ranging from 4 years[16], to 10 years[14,15], and even more than 40 years[1], has provided invaluable information about successful design and implementation of required student research programs.

In addition, Touro College of Pharmacy recently designed and implemented a required research program. Building on this experience and lessons learned, as well as on the review of published papers and reports about research programs in pharmacy and medical education, several critical issues in the design and implementation of a required research program were identified.

Aims. The aims of this paper are: 1) to identify critical issues, guiding principles, benefits and challenges in the design and implementation emerging from the published literature of school-wide required student research programs; 2) to catalyze information dissemination and inter-institutional dialogue and collaboration between pharmacy schools implementing required student research in Pharm.D. curricula.

Definitions. For a long time, research has been part of biomedical education without a formal appellation. It has occurred under many names, such as scholarly concentrations, research concentrations, senior projects, capstone experiences, research experiences, research programs. The term capstone is used frequently and liberally in pharmacy education, and it is applied to a wide range of activities. While some capstone experiences may be "research", not all research experiences are necessarily capstones. The use of capstone experiences in education in the United States originated from the need to provide curricular options for " in-depth knowledge" to better prepare graduates for entering the workforce[19–22]. A capstone is defined as a "culminating course or project that is discipline-based or interdisciplinary, which concludes during the final year of study"[23]. In a capstone activity, students have the opportunity to demonstrate mastery of skills and apply knowledge gained from previous course work to an academic experience meant to facilitate transition to the "real world". The focus is on synthesis and integration rather than acquiring new knowledge and skills. Capstone experiences have been implemented in undergraduate and graduate education, including pharmacy, medical, nursing and public health education. Capstone experiences take many forms, including research projects, internships, summer camps,

interdisciplinary courses, arts-based performances, or comprehensive exams in lieu of a capstone. For the purpose of this paper, a research capstone program is defined as a required, structured curricular activity that immerses students into an in-depth scientific exploration of a specific area, beyond the conventional school curriculum[2,20,24,25]. Such a program implies employing the scientific method in a hands-on experience, which generates an academic product (e.g. thesis, poster, formal presentations).

Critical Issue 1: A deliberate decision: To require or not to require

> *"If we have our own why in life, we shall get along with almost any how"*[26].

The first step in designing and implementing a program is the thoughtful, deliberate decision taken after weighing all options. The clear articulation of the motivation behind this decision will be instrumental in shaping all subsequent decisions, from design to implementation, faculty buy–in, outcomes assessment, and quality control.

While the need to introduce "some" research content in a school's curriculum is hardly debatable, reluctance, resistance, confusion or dispute may still exist about how to introduce such research. A required school-wide student research program is demanding in terms of resources, and full awareness of potential benefits and challenges is essential. While such programs have multiple potential educational benefits (short term and intermediate outcomes), the evidence that student research alone translates into improved patient care is still lacking[27]. Thus, the decision to require or not to require a research project for all students in a Pharm.D. curriculum, ultimately may rest on the institution's mission, vision and beliefs about research. If the vision is that student research aims to train *only* those students aiming a research–oriented career, then elective coursework may be the optimum choice. This option would target students with a special interest in research, those with previous research experience and those already interested in pursuing residency training, fellowships, graduate degrees or an academic career. While the elective approach has certain benefits (highly motivated students and faculty, less burden on institutional resources, faculty, curricular time, logistics) it would result in only a portion of students producing scholarly output. Such an elective program or track may result in an unintentional two-tier system with potential negative perceptions among students[3]. Additionally, student enrollment in research electives is low, less than 10% in most institutions[7].

If the school's vision is that the student-research experience aims to equip *all* students with the scientific methods skills to allow them to become team players in translating research to practice site, to have the inquiring mindset irrespective of their future workplace, and to prepare them to potentially engage in further research training, then a school-wide student research experience needs to be designed, in order to support such a mission. However, it must be realistically acknowledged that a school-wide research program embedded in the core curriculum is unlikely to be sufficient to develop an independent researcher[1]. The required and the elective options have different goals.

Required student research programs have multiple potential benefits and challenges (Table 1). Student research projects allow for the development of lifelong learning skills, such as resilience, self-confidence, self- efficacy, initiative, and creativity applicable to any workplace[28].Indeed, the 2012 National Association of Colleges and Employers Survey suggest that the skills and qualities employers of new graduates are looking for are communication and ability to work in a team structure, decision-making, problem solving, information retrieval and analysis, planning and data analysis[29]. Given that several reports estimate that the current trend in the pharmacy job market is moving toward a profession saturation[30,31], skills conferring students with increased marketability are crucially important. This is a challenge charged to all pharmacy academic institutions to evolve our curricula.

The literature to date suggests that participation in school research may stimulate interest in pursuing research–related and academic careers[2,32–35], although data are not always easy to aggregate or compare due to the considerable variability between programs, student body, funding/stipend opportunities, areas of concentration, tracks or additional postgraduate degrees. It is interesting to note that in medical education earlier experiences with required student research revealed a low level of student support [36], while more recent reports show that 80-94 %[2] consider that a research experience, if well conducted, should be a requirement for graduation. Similarly high perceptions among pharmacy students were recorded in more recent reports on research programs[15]. This is not surprising. The modern pharmacist is typically detail-oriented, increasingly involved in information retrieval, evidence-based-decision-making, and innovative problem solving. All these are attributes of scientific inquiry and intellectual curiosity itself is a crucial driving force for professional development[37]. Additionally, current evidence suggests that research programs have beneficial effects on some intermediate outcomes, such as impact on career choices and academic advancement[38,39].The experience of

some institutions suggests that required student research does not necessarily translate into a greater proportion of full time researchers, but it does translate to increased postgraduate research involvement[35].

A school-wide research program however, requires engaging institutional and faculty resources, it may be difficult to manage and may have several challenges, not always avoidable (Table 1). The decision to require or not to require such a program involves careful consideration of such factors and strong administrative and faculty commitment. Alternatively, an institution may opt for a step-wise approach: the research elective model may prove useful in pilot-testing the research program's suitability for their institution, and in allowing time to build and consolidate various elective courses before making the commitment to a full, school-wide research requirement. Several successful programs have shown that such an approach can be beneficial[3].

Critical Issue 2: Goals

> *" Goals can help shape a program's design, target faculty development initiatives and clarify performance expectations"*[2].

Research programs offer the opportunity to apply, synthesize and integrate inter-disciplinary knowledge and skills acquired during previous course work, and to gain a deeper perspective in a specific area of interest. Culminating research experiences may also prepare the ground for the transition from student to health care professional status[1,20]. Clearly articulating the program's goals is essential to its design and implementation and is instrumental in defining the success of a program[1,40]. The programs goals will translate into defining the focus, format, expectations of student output as well as program assessment. Various institutions set various goals to fit their mission and academic milieu. It is important to set realistic goals. A school-wide required research program is likely to achieve goals that are different than the goals set in an elective approach track. Required programs' goals may not be to create a researcher or to launch a research career. Required programs usually tend to develop generic skills such as critical thinking, confidence in formulating a study question, and to provide some insight into designing a study to answer it, data collection and interpretation. Thus, the program's goal may need to be broader, such as to introduce the student to first hand research experience, with an opportunity to apply the scientific method to a field of interest, and to provide a frame of reference for future potential involvement in research projects[35]. Various programs explicitly describe their goals at various levels of depth, from an introduction to scholarship broadly defined to simply exposing students to a research experience or to a rigorous in–depth scholarly experience. Many programs articulate specific knowledge and skills to be gained (formulating a study question, critically apprising the literature, collecting and analyzing data, etc.)[1, 2,14]. Other programs specify additional skills such as improving problem solving and lifelong learning skills[1].

Setting the program's goals require a balancing act, between time, motivation, resources available and offering students a glimpse into quality research. Expectations that are too high will impact student's enthusiasm, whereas expectations that are too low will send the wrong message about scholarship and the scientific approach.

Critical Issue 3: Unitary focus and expectations

> *"A research project should focus on generating new knowledge" and should use the scientific method of analysis"* [1].

The next step is to decide how the program's goals can be met and what should be the focus of the scholarship. The design questions in this phase are:1) what qualifies as "research" or "scholarship"?, and 2) what kind of outcomes and skills are expected from the students? These are important elements, as they will directly translate into logistics, implementation and program adherence issues: would "assisting in the lab", creating a poster about promoting healthy eating behaviors, reviewing a few papers on a topic in a non-systematic way, or assisting other researchers with data entry be considered "research"? How will the vision on research and scholarship be translated into the expectations of individual research projects?

Establishing a school-wide, unitary operational definition of what "research " means, is important for several reasons: 1) students rightly expect fairness in output expectations, especially in a required course, and expect consistency in assessment , 2) the robustness of the research program at school level will be negatively affected by inconsistencies. As some experiences have shown, without a unitary goal and without programmatic consistency, the program risks to run "erratic, as an unfunded mandate without an established curriculum" [18]. Some programs in medical education, after experimenting for several years with less structured, multi-year longitudinal "exposure to research" that allowed students to select from a range of available electives to fulfill their research requirement, reverted to a more structured, goal-oriented program with a focus on hypothesis–driven research experience[40,41]. This experience suggests the need

for a more centralized curriculum. Not a centralized set of courses but rather a centralized focus, process and unitary expectations for the deliverables.

Establishing a school-wide, unitary operational definition of what "research " means, represents an important debate each school may need to entertain before reaching a decision. Traditionally, scholarship and research have been confined to the discovery of new knowledge in the form of basic sciences research and clinical research. The four types of scholarship defined by Boyer[25](i.e. scholarship of discovery, application, teaching and integration) suggest a broader definition of research that would include a diversity of inquiries. Scholarship can include many fields, such as quality improvement research, health care systems policy implementations, health care services research, education, community participatory research, interdisciplinary, translational research, and public health research. While the importance of research in such fields is beyond debate, discussion may still arise on how to measure the quality of such research and how to apply the Glassick criteria for research quality[42].

The institutional decision and consensus on what "research" means is furthermore important, given that there is an increasing concern for the broad range of interpretations and forms of scholarship conducted in schools and colleges of pharmacy nationwide, with a potentially alarming decrease in the "scholarship of discovery"[11] and the type of research that advances knowledge [25]. The ACCP Task Force on Research in the Professional Curriculum makes it clear in "The Essential Research Curriculum for Doctor of Pharmacy Degree Programs" that the curricular competencies in research revolve around hypothesis-based research[6].

Some schools incorporate into their "scholarship concentrations" or "capstone experiences" options such as a community experience in a primary care clinic, international rotations[18], journalistic, business, law, advocacy and art projects[5],creating a business plan, updating a policy or hospital protocol, distributing patient education materials[16], internships or field experiences, service learning, portfolio development, community service, and health fairs[43,44]. While such activities have the potential to nurture students' abilities of critical thinking, creativity, innovation, analysis and synthesis, such options need to be carefully examined by each institution adopting such models. Do they fit the program's goal? Are they amenable to the same level of expectations as traditional research projects? Are they perceived differently by students? For instance, allowing students to perform a critical review of medical literature as an option in a mandatory research program, was perceived as a "second class citizen" compared to the hypothesis-driven inquiry option in the same institution, an opinion held by both students and faculty[18].

Critical Issue 4: Structure and deliverables

The structure for required research typically includes a mentored research project with some institutions adding didactic components, such as courses in research methods, epidemiology, biostatistics, ethics, or other courses, depending on their core curriculum and the research program's goals.

Most research programs require individual work, although some programs allowed students to work in groups (2-5 students) [16]. Individual research projects can train the student in taking full responsibility for a project, but require more student advisers. Teamwork allows for more complex projects with a more efficient faculty to student ratio. The disadvantages are related to concerns about student's perception of equal contribution to the project[15]. Additionally, if the research requirement is embedded in the rotations schedule, student group-work would impose additional logistical and scheduling challenges.

The research deliverable takes different forms, commonly a paper/thesis on the research findings. Other formats include writing a research proposal or a publishable article. Additionally, most research programs organize a Student Research Day [16,18,40,45,46]. Students are required to present their work in poster format and in some instances as a podium presentation. The primary aim of this day is for students to practice public speaking skills[17,41] and also to facilitate an exchange of ideas among students, alumni, site preceptors and researchers from external sites. Such events have the potential to foster further research collaboration, to strengthen the relationship between the school and external sites and to increase a school's prestige.

The structure and focus of the research projects require a unitary approach. Similar to core courses, a research program requires a robust syllabus, clear objectives and assessment tools, class communication and interactivity, as well as consistent grading criteria. Unlike any other curricular activity, a research program requires the coordination of the entire student and faculty bodies to work harmoniously, with unitary academic expectations, in spite of various research topics, with various project-specific needs. This requires detailed planning and considerable faculty adherence to the program criteria. Equally important, while the goal and focus of the research program tend to have a higher stability, the delivery of the program (including format, sequence, administration) is subject to evolutionary change. For

instance, a research program in a medical education institution underwent at least 6 major curricular changes in 40 years of existence [41]. Such changes are needed in order to reflect changes in health care, practice and student needs.

Critical Issue 5: Creating the curricular time and curricular integration

> *" Step back during any curricular revision process and evaluate whether time and flexibility have been incorporated into the programs for students to pursue interesting questions or engage in scholarly activities"*[37].

One of the major challenges in implementing a required research program is creating the curricular time[37], and the temporal competition with the core curriculum[41]. The single most efficient option available seems to be greater curricular integration[41]. Integrating multidisciplinary courses based on organ systems rather than on individual disciplines and/or eliminating curricular redundancy in conjunction with the optimization of the experiential education rotations schedule can create the curricular time needed for a research program. Depending on the program's design, an additional option is freeing 1 day per week to allow students to take electives related to their research concentration/project[41]. Others promote the summer months as a self-directed time in which students can concentrate on their scholarly work[5]. Additional solutions may be found in rescheduling or reorganizing electives, giving up select basic science classroom time, and/or compensating with more efficient use of the classroom time through blended and active learning [41]. Such measures require the cooperation and support of the entire faculty.

Aside from an 'integrated curriculum' to create the needed time, the research experience itself requires a seamless integration with the rest of the curriculum. Curricular changes may be needed to better support students in their approach to research experience. Such changes may require commitment to present research- related concepts not only in specialized courses such as epidemiology and biostatistics, but also in other courses, through robust longitudinal curricular integration.

Didactic lectures, class discussions and activities, case-presentations and bed-side clinical decision making discussion need to move away from offering "pre-digested and summarized" facts [18], and introduce and integrate more research-related concepts. This can be accomplished through creative use of problem-based and case-based learning, better interdisciplinary integration, focus on identifying gaps in knowledge and controversies, nurturing the habit of asking questions and the ability to recognize a research question in practice situations, along with the habit of maintaining a spirit of intellectual curiosity. An ideal integration requires the sense of innovation and discovery to permeate the entire didactic and experiential curriculum.

The timing of the research experience is a critical component for its success. "When should a student start an intensive research experience?" is a question with no clear answer. Some schools opted for embedding research early in the curriculum, i.e. first[18] and/or second year[43] of study, while others allocated a research time block during [16] or toward the end of the 3rd year[14]. Other options include: multiyear, longitudinal exposure to research in a 5 year curriculum[41,46]. This approach requires a supportive research intensive institution with robust research resources. Another option is an intercalated curriculum, a 9-12 months break from the core curriculum, with an "immersive" 3rd year dedicated to intensive research and scholarship[40,41]. This option may necessitate an additional year in school if a research project is not completed in time[41]. Alternatively, the research-intercalated year may be amenable to conferring an additional certification or degree[3].

While starting early has several theoretical advantages (more research- dedicated time available, longer, more complex research projects possible, building longer adviser-student relationships), this approach has several practical disadvantages. Such disadvantages are most problematic in clinical research, which feeds on experience-driven study questions. As some schools' experiences show, requiring students to engage in clinical research before sufficient clinic exposure was met by ambivalence and frustration by some students and prompted changes in the curricular design of the research experience[40,41]. Moving the research experience later in the school's curriculum allowed reinforcing the concept that, clinical research is driven by practice and is meant to improve care. Students' knowledge base prior to engaging in the research project, motivation for research and perceived relevance all influence the likelihood of a successful research project.

Moreover, previous experiences have shown that while highly enthusiastic, only few students seem to have the confidence and the ability to choose *and maintain* a research area early in their training[27,41,40]. Other challenges include difficulties in resolving a poor faculty-student match, midway changes of interest and the challenge to manage multiple academic demands, especially during the didactic courses of the initial years.

Historically, some schools attempted to incorporate the basic research experience into basic sciences electives time[40]; however, the electives choice was haphazard and the students failed to focus their electives choices around a goal. The situation was remedied by replacing the electives option with structured multidisciplinary tracks. While appealing, such an approach is resource intensive.

Additionally, and equally important, early introduction of required research in the curriculum leads invariably to 2-4 concomitant student cohorts per faculty member, with a considerable increase in the faculty teaching load. While this approach may work for a research elective course or "individual study", it is unlikely that it is a sustainable option for a school-wide required research experience even for research intensive academic centers. However, alternative and creative solutions may exist. For instance, a two-stage process may be used, in which students may be offered an research sampling menu at various research labs with various faculty during the initial school years, followed by a last year committed phase to work in a chosen research field.

The time allocated for student research varies across institutions from 5 weeks[16] to 10-12 months[14,18,40,41] or multi-year, longitudinal experiences ranging from2 years[45] to 4 years [3,46], with or without more intensive activities during summer time. The designers of a required research program need to consider reasonable expectations for all students. Time constraints represent but one reason for a formal approval of research projects at the beginning of the process to ensure that the research projects can be realistically accomplished in the allocated time. This reinforces the need for careful institutional centralized oversight of the research program.

Critical Issue 6: Monitoring and Institutional Oversight

> *"A system of careful oversight for the research program must be in place to ensure that each student has a valuable experience"* [41]*.Tracking the progress of nearly 200 students at any one time poses a formidable administrative challenge"*[45]*.*

Since the research program is a required, graded activity, tracking student progress becomes vital. Additionally, the program needs to run consistent to its vision. Loss of adherence to an ongoing program has detrimental effects. It affects the strength of the program, the ability to assess its success and it affects students and faculty morale. Similar to any rigorous operations, a school-wide research program requires a clear, standard operations manual and consistent adherence to it. Such adherence translates into consistent expectations at the student and faculty level, and furthermore, correlates with institutional scholarship benefits, success and prestige[41].

The first level of monitoring is accomplished by mentors/advisers. The second level of monitoring is provided by a program director(s), sometimes with additional oversight from an academic affairs office or similar staff. To ensure that students receive mentoring from advisers with adequate research training, oftentimes advisers (both internal and external) have to be approved, based on faculty member's research productivity, mentorship abilities and access to research resources[3,41]. A program director (or equivalent) is often in charge of approving the planned projects at their inception, for their acceptability and feasibility[41], typically in the form of a research declaration of intent [16]. An effective and concise form is the PICO model (population-intervention-comparison-outcomes)[47–49]. For some research projects, the initial declaration of intent may need to be accompanied by an Institutional Review Board application.

Some schools employ additional interim checks, such as quarterly student and faculty reports, mandatory individual appointments or student completing self-reflecting assessments to be submitted to the mentors and also to program directors, academic affairs office or equivalent research administrative staff [41,24]. Student progress is reviewed and interventions for students who have not met expectations are formulated[45]. Sometimes interim grades are employed to attest meeting appropriate milestones and actions are taken to ensure that students are able to remediate unsatisfactory interim grades[3]. Sometimes, final, centralized approval of the final research product is in place, in addition to initial and interim approvals.

Advisers also complete summative evaluations focusing on students' communication skills, professionalism, initiative, commitment, and reliability. Excerpts of these narratives can be included in the student's school performance evaluation (e.g. dean's letter)[45]. Some schools employ student-mentor agreements[45] or other formats akin to a behavioral contract.

In order to manage this process, student research programs may have a course director, along with area heads if several tracks exist, and a full-time administrative course coordinator[45]. Some schools implement dedicated online management tools to perform student-adviser matching, to manage the online evaluation forms, and to perform queries to track the status of reports and approvals[3].

Research programs are considered "high-impact activities" but "only when they are implemented well and continually evaluated, will they realize their considerable potential" [50].

Critical Issue 7: Measuring program outcomes

> "*Complex educational interventions demand complex and appropriate evaluations*"[51].

A required research experience is institutionally demanding in terms of faculty time and resources. Therefore, assessing whether such efforts translate into benefits and whether the program is meeting its educational goals, is critically important. Moreover, information gained from assessment needs to continuously drive the quality improvement efforts and can inform needed curricular changes in the years preceding the research experience[16,52].

Educational outcomes are traditionally conceptualized at four levels (Kirkpatrick's model) [53]: reaction (satisfaction with the educational program) , learning (knowledge, attitudes and skills gained), behavior (changes in job performance) and results (the effects of the behavior, ultimately an improved patient health status). Whether any research program can be accurately and completely evaluated by such a model may be subject to debate. The current evidence is weak in supporting the effect of educational programs on the behavior and results levels[52–56], although difficulties in assessing such outcomes may play a role. While more innovative models need to be developed, a multipronged assessment at the four levels (Table 2), has been used in evaluating research programs in medical education[2].

Immediate and short-term assessments typically rely on surveys to assess students' perceptions of skills gained and satisfaction with the research experience. Surveys distributed at the end of the research experience and/or prior to graduation are usually optional, although some may be mandatory [41]. While they provide valuable information and are relatively easy to collect, such perception surveys have limitations (low response rates, response bias, socially desirable answers, Hawthorne effect). Additionally, perceptions and satisfaction ratings are only a surrogate and an indirect measure of learning and competency[54]. Direct measures are needed to assess attaining the educational objectives set at the inception of the program. While some educational objectives are more amenable to quantification or assessment (e.g. formulating a study question, critically apprising the literature, collecting and analyzing data, presentation skills, etc.), others (e.g. innovation, creativity, critical thinking, problem solving skills) may impose assessment challenges.

The number of peer-reviewed publications during or immediately after concluding the research experience has been used as one potential measure of success. However, such a measure has limited applicability. Previous experiences show that pharmacy student research projects evolve into publications in a peer-reviewed journal at a low rate (5.3%), even when taking place in a research-intensive academic environment[14]. In medical education, while higher in some particular settings[55], consistently high publication rates are difficult to achieve even by students and trainees participating in 1-year research fellowships, such as the NIH Clinical Research Training Programs or the Doris Duke Clinical Research Fellowship[56,57]. Failure to meet a required publication expectation may lead to a sense a failure and would temper the satisfaction and the enthusiasm of the students[56].

Another measure is the student's expressed interest in pursuing a research-oriented career, before and after such an experience. In some highly successful academic centers, offering a 1-year research experience resulted in a 10% increase in the number of students who reported an interest in pursuing a research-related career[41], consistent with other reports suggesting that an intensive research experience influences the intentions to pursue academic careers[38,39,58,59]. The actual career choice and the long-term impact of research experiences on student's careers (academic or non-academic) and on their professional performance is difficult to assess. The evidence seems to suggests that a rigorous research experience(time and intensity) taking place in a research-intensive environment increases the likelihood of entering the academic and research workforce[38,39,45,60,61]. However, such an outcome, while desirable, may be unreasonable to expect in a required research program[1] embedded in regular curriculum. Surveys of the alumni have been used to obtain information on the actual choice of a career, but their costs are high, response rates are typically low and the results are threatened by considerable heterogeneity in their research program and various post-graduation confounding factors[2]. However, surveys distributed longitudinally, at the end of the research experience, prior to graduation (at some institutions mandatory surveys)[41] and serial post-graduation surveys of early career and midcareer alumni can provide useful information for strengthening the research program and for expanding its research network. Assessing the impact of research skills on professional performance in non-research settings, imposes considerable additional challenges[41]. Regardless of the type of outcome, deciding the optimum outcome measurements for any program needs to be well tailored to the goals and the design of the program.

Critical Issue 8: Resources

> *" In an era of limited resources, the added student and faculty workload associated with a required research project should be considered in tandem with the overall goals of the project"* [14].

Developing and maintaining a research experience in a resource-limited academic environment is a challenging task[41], especially when it requires equal research resources opportunities to *all* students. Adequate resources are needed not only for research infrastructure, but also for administrative support and coordination and for creating attractive research opportunities outside the school. Additionally, adequate funding can provide student rewards and recognitions and faculty support, both of which have been shown to increase student research productivity[62]. For some institutions such demands for class sizes of 100 - 200 or more students, year after year, can make the delivery of such programs unsustainable or impossible[10]. Other, more research-intensive institutions are partially supporting student research through extramural funding mechanisms such as NIH (pre-doctoral training grants), local and national foundations[45]. Some institutions have intramural or extramural scholarships to aid financing the research year[41,45]. The challenges of designing an efficient research program capable of achieving its learning objectives may be one of the reasons why too few schools and colleges have implemented required research experiences in spite of numerous and repeated recommendations from various professional organizations. Creative solutions are needed to achieve the balance between quality research and learning outcomes and the resources.

Critical Issue 9: Student and faculty response

> *"I learned that I really do not enjoy research. I realize how much I like patient interaction rather than research" (Pharm. D. student)*[63].

> *"What I learned out of this research capstone? Being inquisitive, being part of the solutions, don't wait for someone else to solve issues that sometimes you may have answers for" (Pharm.D. Student)*[63].

While research programs have multiple potential benefits, they may not be unanimously embraced by the students. For some students, a required research experience may prove career-opening, while for others it may be yet another academic exercise to be passed. Designing and implementing a required research experience requires the consideration of such possibilities and balancing the demands and expectations accordingly. Overall, the success of a research program depends on the students' enthusiasm and investment in the research experience. Students' learning styles differ[64] and research requires complex and deep learning approaches, in addition to the usual academic success qualities. The demands of a curriculum requiring research may need to be clarified during the admission process. At the same time, students who have struggled academically in previous years may have a suboptimal research experience. Steps to ameliorate this problem need to be considered by the Academic Affairs office and student advising programs[41]. Additionally, an institution implementing a rigorous required research experience needs to consider that such a school-wide research program may have an effect on student and faculty recruitment and retention[14,65].

The faculty body represents a critical element in the success of such research programs. The decision to implement a school-wide research program requires faculty commitment to mentoring and to stimulating students' enthusiasm, interests and creativity. Additionally, faculty scholarly productivity acts as a role model for a student. Thus, such a decision will require an institution-wide culture of scholarship and may call for a paradigm shift for some faculty, requiring additional faculty development and training. Moreover, developing and maintaining a culture of scholarship requires, in turn, institutional support for a robust research infrastructure and support services[6].

Critical Issue 10: Dissemination of experience and the need for dialogue

> *" Professions exist to serve society"*[9].

In an evidence-based era, medical and pharmaceutical research education requires a scientific approach in itself. Teaching research and implementing a school-wide research program need to be subject to the same scientific rigor in both development and assessment, as well as in the dissemination of the results to the larger academic community. A successful research program needs to be innovative and designed on available evidence, it needs to be conducted rigorously and its outcomes need to be systematically assessed. This requires cooperation and exchange of information. Not only do very few schools and colleges of pharmacy implement research in their required curricula, but even fewer take it to a school-wide level, and fewer yet publish their results in a pharmacy education journal. As medical education has shown, successful student research programs evolve and have their own institutional natural history[18,40,41]. Learning from past challenges and

successes, and inter-institutional collaborations, are essential in maintaining progressive and successful research programs. In order to be of practical use, the results of various schools' experiences need to be easily accessible by those who need them most, i.e. other schools. Schools and colleges of pharmacy have to recognize the need for knowledge transfer and to disseminate their student research experiences and engage in a vibrant, constructive nationwide dialogue.

Experience at Touro College of Pharmacy, New York

A required student research program was designed and recently implemented as a capstone experience. The detailed design, assessment and results of the program have been reported elsewhere[66]. This student research experience was both successful and rich in lessons learned, which further shaped the views of the importance of the critical issues identified above. The underlying vision for the student research program was that scientific inquiry is an essential part of pharmacy education, valuable for both research- and non-research based careers. The goal was to develop an experience to encourage students to play an active role and to nurture their spirit of inquiry, to allow them to bring in their enthusiasm and to find a fertile ground for creativity and innovation. It was determined that the following criteria would need to be met in the program's design: 1) hypothesis–driven research; 2) accommodating a wide variety of disciplines and areas of interest; from basic sciences to clinical research and public health; 3) amenable to consistency in grading across all disciplines, since all students needed to be subjected to the same level of expectations; and 4) cost-effective and offering equal research opportunities to all students in a resource-limited environment.

Accomplishing these goals in a very new school of pharmacy, with its inaugural class, in an academic environment without a well-established research tradition imposed a considerable challenge. It was decided that these goals would be optimally achieved by a research proposal format, mirroring a competitive grant proposal, with data collection as an option. Given the potential challenges involving quality data collection by all students, we considered that accepting incomplete or inadequate data would be a disservice to the spirit and vision of the research experience, an unacceptable compromise to make, which would send the wrong message about what research is about. An additional deciding factor against the data collection requirement, especially for patient-oriented research, was the potential for delays and hurdles in obtaining Institutional Review Board approval, for a multitude of students at multiple sites. Thus, we decided that a well-written research proposal would be an optimal, cost-effective solution, offering maximal learning benefit with minimal resource investment, while preserving a consistent grading system for students across all disciplines.

In terms of curricular time, the research experience was embedded in the fourth (terminal) year, concomitant with the clinical rotations. This curricular placement was facilitated by the structure of our curriculum (2 years of didactic work plus 2 years of experiential education). However, after the first run, we moved the research experience to the third year. The reason were two-fold: 1) decongesting the terminal year with its multiple demands (e.g. NAPLEX preparation, advanced clinical rotations, residency preparation); 2) allowing more time for students who finish their research proposal in the 3rd year to optionally continue their line of research in the fourth year.

In order to ensure consistency, a 35-page Standard Operations Manual was developed to include the entire process flow, procedural details, expectations and assessment rubrics. Interim monthly student evaluations and end- of year student and faculty feedback were collected. Overall, the first offering of the research experience was very successful, mainly due to its efficient design, the enthusiasm of the students and the support of the majority of the faculty body.

Suggestions for Future Research and for Inter- institutional Dialogue

Responding to the calls for implementing more research in the pharmacy education curricula will continue to face increasing challenges. These challenges arise from increasing accreditation pressures on pharmacy education and from increasing complexities of the research. Each institution will need to identify creative solutions to a variety of challenges. The pharmacy education community is faced with intriguing questions and potential areas of future educational research:

- Which theoretical models (such as the social cognitive career theory or other theories) could be explored to further understand how research programs work and to identify programmatic success factors?
- Which design options are associated with higher productivity? For instance, how does an intercalated research curriculum compare to a longitudinal experience?
- How do various design options affect efficiency and resource use?
- What is the optimum time necessary to produce a meaningful research output?

Other challenges for dialogue and investigation include identifying:

- creative solutions to better integrate research concepts and skills throughout the core curriculum.
- innovative funding mechanisms for student research, faculty time and administrative support.
- cost-effective mechanisms to track the outcomes of research programs post-graduation.
- accurate and efficient means to measure programmatic success and student's learning benefits in areas such as creativity and critical thinking
- collaborative models for student research, inter-professional education and inter-institutional collaborative models

In solving such challenges, pharmacy schools need to engage in a national dialogue and to work collaboratively. Potential ways to establish such a dialogue may involve a variety of approaches:

- a nationwide Student Research Programs Collaborative to facilitate exchange of ideas in various formats (e.g. colloquia, virtual forums, conferences).
- nationwide or regional academic networks of inter-university collaborations to allow students to perform research at any other participating institution as part of their home school research requirement.
- increased student research awards and conference participation by students.
- a thematic issue in pharmacy education journals dedicated to student research programs.

Conclusion

Incorporation of student research programs in the Pharm.D. curriculum is a very challenging task. Our experience has identified several critical issues that need to be addressed in the design and implementation of a required research program. Different institutions will prioritize these issues based on their vision and their academic milieu. There is a need for inter-institutional dialogue for the pursuit of successful incorporation of student scientific inquiry in the core curriculum.

References

1. Ascione FJ. Research Requirement for PharmD Students. *Am J Pharm Educ*. 2007;71(6). Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2690922/. Accessed August 8, 2012.
2. Bierer SB, Chen HC. How to Measure Success: The Impact of Scholarly Concentrations on Students—A Literature Review. *Acad Med*. 2010;85(3):438–452.
3. Boninger M, Troen P, Green E, et al. Implementation of a Longitudinal Mentored Scholarly Project: An Approach at Two Medical Schools. *Acad Med*. 2010;85(3):429–437.
4. Brueggemeier RW, Clark AM, Das SK, et al. The path forward: the future of graduate education in the pharmaceutical sciences: the report of the 2010-2011 Research and Graduate Affairs Committee. *Am J Pharm Educ*. 2011;75(10):S13.
5. Green EP, Borkan JM, Pross SH, et al. Encouraging Scholarship: Medical School Programs to Promote Student Inquiry Beyond the Traditional Medical Curriculum. *Acad Med*. 2010;85(3):409–418.
6. Lee MW, Clay PG, Kennedy WK, et al. The essential research curriculum for doctor of pharmacy degree programs. *Pharmacotherapy*. 2010;30(9):966.
7. Murphy JE, Slack MK, Boesen KP, Kirking DM. Research-related Coursework and Research Experiences in Doctor of Pharmacy Programs. *Am J Pharm Educ*. 2007;71(6). Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2690916/. Accessed August 15, 2012.
8. Murphy JE, Peralta LS, Kirking DM. Research experiences and research-related coursework in the education of doctors of pharmacy. *Pharmacotherapy*. 1999;19(2):213–220.
9. Anon. The research agenda of the American College of Clinical Pharmacy. *Pharmacotherapy*. 2007;27(2):312–324.
10. Figg WD, Chau CH, Okita R, et al. Pharm. D. pathways to biomedical research: the National Institutes of Health special conference on pharmacy research. *Pharmacotherapy*. 2008;28(7):821–833.
11. Bauman JL, Ascione FJ, Brueggemeier RW, et al. Maintaining Pharmacy Education's Research Focus as the Academy Expands. *Am J Pharm Educ*. 2012;76(8):144.
12. Knapp DA. Pharmacy school provenance and pharmacy practice. *Pharmacotherapy*. 2012;32(2):99–102.
13. Speedie MK, Baldwin JN, Carter RA, Raehl CL, Yanchick VA, Maine LL. Cultivating "habits of mind" in the scholarly pharmacy clinician: report of the 2011-12 argus commission. *Am J Pharm Educ*. 2012;76(6):S3.
14. Kao DJ, Hudmon KS, Corelli RL. Evaluation of a required senior research project in a doctor of pharmacy curriculum. *Am J Pharm Educ*. 2011;75(1):5.

15. Kim SE, Whittington JI, Nguyen LM, Ambrose PJ, Corelli RL. Pharmacy students' perceptions of a required senior research project. *Am J Pharm Educ*. 2010;74(10):190.
16. Wuller CA. A capstone advanced pharmacy practice experience in research. *Am J Pharm Educ*. 2010;74(10):180.
17. Panter MS. Research on and in medical education. *Yale J Biol Med*. 2011;84(3):253–255.
18. Rosenblatt RA, Desnick L, Corrigan C, Keerbs A. The Evolution of a Required Research Program for Medical Students at the University of Washington School of Medicine. *Acad Med*. 2006;81(10):877–881.
19. Carlson CD, Peterson RJ. Social Problems and Policy: A capstone course. *Carlson, C. D., and Peterson, R.J. (1993). Social Problems and Policy: A capstone course. Teaching Sociology, 21(3): pp.239-241*. 1993;21(3):239–241.
20. Cuseo JB. *Objectives and Benefits of Senior Year Programs." In The Senior Year Experience: Facilitating Reflection, Integration, Closure and Transition, ed. John N. Gardner, Gretchen Van der Veer, and Associates. San Francisco: Jossey-Bass.* 1998.
21. Gardner JN, Veer GV der. *The Senior Year Experience: Facilitating Integration, Reflection, Closure, and Transition*. 1st ed. Jossey-Bass; 1997.
22. Anon. Integrity in the College Curriculum: A Report to the Academic Community. Washington, D.C.: Association of American Colleges and Universities. 1985.
23. Padgett R, Kilgo, Cindy. 2011 National Survey of Senior Capstone Experiences: Institutional-Level Data on the Culminating Experience. The National Resource Center for the First-Year Experience and Students in Transition, 2012.
24. Anon. Scholarly Concentrations at Stanford Medical School. Available at: http://med.stanford.edu/. Accessed July 25, 2013.
25. Boyer EL. *Scholarship Reconsidered: Priorities of the Professoriate*. 1st ed. Jossey-Bass; 1997.
26. Nietzsche F. *Twilight of the Idols, or How to Philosophize with a Hammer. Translated with an Introduction and Notes by Duncan Large.* 2009th ed. Oxford University Press
27. Parsonnet J, Gruppuso PA, Kanter SL, Boninger M. Required vs. Elective Research and In-Depth Scholarship Programs in the Medical Student Curriculum. *Acad Med*. 2010;85(3):405–408.
28. Bailey JM, Oliver DJ, Townsend KJ. Transition to practitioner: redesigning a third year course for undergraduate business students. 2007;13(1):65–80.
29. Anon. The Job Outlook Survey. 2012. The National Association of Colleges and Employers. http://www.naceweb.org Accessed November 15, 2012.
30. Anon. American Pharmacist Association, American Society of Health System Pharmacists. "Concerns about the accelerating expansion of pharmacy education: time for reconsideration." http://www.ashp.org/DocLibrary/News/Accelerating-Expansion-of-Pharmacy-Education.aspx (accessed 2012 November 12).
31. Anon. Pharmacy Manpower Project. Aggregate Demand Index. www.pharmacymanpower.com (accessed 2012 November 12).
32. Greenhalgh T, Wong G. Doing an intercalated BSc can make you a better doctor. *Med Educ*. 2003;37(9):760–761.
33. Nykamp D, Murphy JE, Marshall LL, Bell A. Pharmacy students' participation in a research experience culminating in journal publication. *Am J Pharm Educ*. 2010;74(3):47.
34. Rockey DC. The physician-scientist: a new generation or the last? *J. Investig. Med.* 1999;47(1):25–30.
35. Segal S, Lloyd T, Houts PS, Stillman PL, Jungas RL, Greer RB 3rd. The association between students' research involvement in medical school and their postgraduate medical activities. *Acad Med*. 1990;65(8):530–533.
36. Frishman WH. Student research projects and theses: should they be a requirement for medical school graduation? *Heart Dis*. 2001;3(3):140–144.
37. Brazeau GA. Is there time for student intellectual development and scholarly pursuits? *Am J Pharm Educ*. 2010;74(2):18.
38. Solomon SS, Tom SC, Pichert J, Wasserman D, Powers AC. Impact of medical student research in the development of physician-scientists. *J. Investig. Med.* 2003;51(3):149–156.
39. Fang D, Meyer RE. Effect of two Howard Hughes Medical Institute research training programs for medical students on the likelihood of pursuing research careers. *Acad Med*. 2003;78(12):1271–1280.
40. O'Connor Grochowski C, Halperin EC, Buckley EG. A curricular model for the training of physician scientists: the evolution of the Duke University School of Medicine curriculum. *Acad Med*. 2007;82(4):375–382.
41. Laskowitz DT, Drucker RP, Parsonnet J, Cross PC, Gesundheit N. Engaging Students in Dedicated Research and Scholarship During Medical School: The Long-Term Experiences at Duke and Stanford. *Acad Med*. 2010;85(3):419–428.
42. Glasick C, Boyer EL. Glassick CE. Boyer's expanded definitions of scholarship, the standards for assessing scholarship, and the elusiveness of the scholarship of teaching. *Acad Med*. 2000;75:8770880.

43. Gourley DR, Vaidya VA, Hufstader MA, Ray MD, Chisholm-Burns MA. An international capstone experience for pharmacy students. *Am J Pharm Educ*. 2013;77(3):50.
44. Johnson JF. A diabetes camp as the service-learning capstone experience in a diabetes concentration. *Am J Pharm Educ*. 2007;71(6):119.
45. Gotterer GS, O'Day D, Miller BM. The Emphasis Program: a scholarly concentrations program at Vanderbilt University School of Medicine. *Acad Med*. 2010;85(11):1717–1724.
46. Schor NF, Troen P, Kanter SL, Levine AS. The Scholarly Project Initiative: introducing scholarship in medicine through a longitudinal, mentored curricular program. *Acad Med*. 2005;80(9):824–831.
47. Richardson WS, Wilson MC, Nishikawa J, Hayward RS. The well-built clinical question: a key to evidence-based decisions. *ACP J. Club*. 1995;123(3):A12–13.
48. Anon. Centre for Evidence Based Medicine. Oxford. UK. Available at: http://www.cebm.net/. Accessed July 16, 2013.
49. Anon. National Network of Libraries of Medicine (NN/LM) Home Page. Available at: http://nnlm.gov/. Accessed July 16, 2013.
50. Kuh GD. *High-impact educational practices : what they are, who has access to them, and why they matter.* Washington, DC: Association of American Colleges and Universities,; c2008.
51. Schuwirth L, Cantillon P. The need for outcome measures in medical education. *BMJ*. 2005;331(7523):977–978.
52. Kirking D. The role of research in PharmD education. *Am J Pharm Educ*. 1988;52(2):131–134.
53. Kirkpatrick D, Kirkpatrick J. *Evaluating Training Programs: The Four Levels. San Francisco, Calif: Berrett-Koehler Publishers Inc.; 2006*.
54. Dipiro JT. Student learning: perception versus reality. *Am J Pharm Educ*. 2010;74(4):63.
55. Dyrbye LN, Davidson LW, Cook DA. Publications and Presentations Resulting From Required Research by Students at Mayo Medical School, 1976???2003. *Acad Med*. 2008;83(6):604–610.
56. Cohen BL, Friedman E, Zier K. Publications by students doing a year of full-time research: what are realistic expectations? *Am. J. Med.* 2008;121(6):545–548.
57. Smith MA, Barry HC, Williamson J, Keefe CW, Anderson WA. Factors related to publication success among faculty development fellowship graduates. *Fam Med*. 2009;41(2):120–125.
58. Jacobs CD, Cross PC. The value of medical student research: the experience at Stanford University School of Medicine. *Med Educ*. 1995;29(5):342–346.
59. O'Sullivan PS, Niehaus B, Lockspeiser TM, Irby DM. Becoming an academic doctor: perceptions of scholarly careers. *Med Educ*. 2009;43(4):335–341.
60. Brancati FL, Mead LA, Levine DM, Martin D, Margolis S, Klag MJ. Early predictors of career achievement in academic medicine. *JAMA*. 1992;267(10):1372–1376.
61. Straus SE, Straus C, Tzanetos K, International Campaign to Revitalise Academic Medicine. Career choice in academic medicine: systematic review. *J Gen Intern Med*. 2006;21(12):1222–1229.
62. Zier K, Friedman E, Smith L. Supportive programs increase medical students' research interest and productivity. *J. Investig. Med.* 2006;54(4):201–207.
63. Vaidean G. *Touro College of Pharmacy Research Capstone. Report to the Dean, 2012. Unpublished, raw data*. New York, NY; 2012.
64. Newble DI, Entwistle NJ. Learning styles and approaches: implications for medical education. *Med Educ*. 1986;20(3):162–175.
65. Boninger M. Foreword: Scholarly Concentrations in the Medical Student Curriculum. *Acad Med*. 2010;85(3):403–404.
66. Vaidean GD, Vansal SS, Moore RJ, Feldman S. Student scientific inquiry in the core curriculum. *Am J Pharm Educ*. 2013 Oct 14;77(8):176.

Table 1. Benefits and challenges of a required research program

Required student research experience	
Potential benefits	**Potential challenges**
• Problem –based learning activity • Information retrieval and analysis skills • Critical thinking and creativity • Decision-making and problem solving skills • Organization and planning skills • Leadership skills • Lifelong learning skills • Boosts an investigative state of mind and the confidence to probe deeper into solving clinical /practice-based questions • Expands the areas of interest of the students and increase confidence in approaching non-traditional aspects of the profession (e.g. public health, prevention, health policy) • Awareness about career options • Potentially increase marketability • Potentially increase likelihood for matching for residency programs • Potentially prepare for research-and non-research -based careers	• Student work overload • Faculty teaching overload • Lack of valid outcome measurement, lack of definition of long-term "success" • Resources allocation for administering the research program • Curricular time pressure • Advisors training • Institutional paradigm shift • Faculty development needs • Unmotivated students may have problems, may affect their enthusiasm and the adviser's enthusiasm • Authorship • Not sufficient to prepare a well- rounded independent researcher

Table 2. Outcome measures for student research programs[1]

Program outcome measure	Caveats and challenges
Short –term	
Reactions: Satisfaction • Perceptions Surveys- students, faculty	• Subject to response bias • Surrogate measure of impact
Learning • Career interests and attitudes change - Perceptions Surveys • Research knowledge and skills - Evaluation of knowledge and skills - Surveys of perceived confidence in skills - Surveys at the end of the research experience prior to graduation (mandatory or optional)	• Subject to response bias • Surrogate measure of impact
Long-term	
Behavior • Scholarship related to the research experience • Scholarship as a consequence of the research experience • Tracking the number of peer-reviewed publications, invited presentations, abstracts, awards • Post-graduation surveys of the alumni • Surveys of employers on research attitudes, skills and productivity	• May not capture the full impact • May be subject to other, less quantifiable factors
Results: Career tracking, Career choices, and Career success • Securing residency placements, academic research positions, • Grants funded • Surveys of early and midcareer alumni on actual choice of a research–oriented career	• Longitudinal studies are costly • Response rates are low • Subject to various post-graduation confounding factors

[1]- based on the Kirkpatrick's model[53] and adapted to a student research program

Table 3. Critical issues in the design and implementation of school-wide required research programs

Critical issue
1. A deliberate decision: To require or not to require
2. Goals
3. Unitary focus and expectations.
4. Structure and deliverables
5. Creating the curricular time and curricular integration
6. Monitoring and Institutional Oversight
7. Measuring program outcomes
8. Resources
9. Student and Faculty Response
10. Dissemination of experience and the need for dialogue