

Using an Outcomes-Logic-Model Approach to Evaluate a Faculty Development Program for Medical Educators

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Abstract

Purpose

This study used an outcomes-logic-model approach to examine the impact of participating in a nontraditional professional development program. Building and using a logic model provides a structure for the program to examine the degree that the desired learner outcomes, the program delivery methods, and the measurement approaches are aligned.

Method

Structured telephone interviews were conducted in 2001 with 16 Harvard Medical School (HMS) participants in the Harvard Macy Program for Physician Educators (HM-PE): five who completed

the program in 1998, five in 1999, and six in 2000. Interviews were also conducted with four Faculty Scholars, alumni of the HM-PE program who taught in subsequent programs. In 2004, online questionnaires were sent to the 16 participants and four Faculty Scholars. Immediate outcomes, such as greater use of active learning principles, and intermediate outcomes, such as commitment to medical education, were examined.

Results

Of those interviewed in 2001, 80% responded to the 2004 online questionnaire. Thirteen of 16 (81%) HMS respondents reported increased

knowledge about and confidence using learner-center teaching methods; 10 of 16 (63%) said they gave fewer lectures and added alternative educational methods. Thirteen of 16 (81%) reported a stronger commitment to the field of medical education: almost one third felt the HM-PE program was a turning point in their careers.

Conclusions

The outcomes logic model provided data to judge how well the program mission and plan were implemented, and whether outcomes had been attained.

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Faculty development for physicians and continuing medical education (CME) each has a long tradition of positioning the teacher as an expert passing on knowledge and wisdom from the front of a classroom or the foot of a hospital bed. Concomitant with that tradition, the key metric for evaluating these programs has often been the satisfaction of participating physicians, and course developers have often failed to create assessment plans and appropriate outcome measures to evaluate the professional development experience and pave the way for improvements. This problem was formally recognized in 2000 by the Continuing Medical Education Advisory Group¹ of the Association of American Medical Colleges, who advocated that there be new methods to

evaluate the efficacy of CME programs and better sharing of evaluation strategies and results among planners of medical professional development programs.

In the past decade, medical education has begun to shift from an emphasis on instruction to a facilitation of learning by providing support for the physician learner as an active participant in his or her own learning. This example of “scientific teaching,” based on educational principles shown through rigorous research to be effective, has become more widely known and implemented.² In an era in which accountability for prudent use of resources—human and financial—is critical, it is crucial that we in academic medicine reexamine methods of program evaluation to see how we can better obtain credible evidence about program efficacy.

In this report, we describe the use of an outcomes logic model³ to evaluate a nontraditional faculty development program for medical educators. An outcome logic model depicts the path from program creation to implementation to outcomes for participants. Here we have applied this

evaluative approach to the Harvard Macy Institute Program for Physician Educators (HM-PE). The HM-PE program, launched in 1994 at Harvard Medical School (HMS), was created and implemented by a multidisciplinary faculty, and designed to be a dramatic departure from other faculty development programs previously offered by HMS.*

Where some programs had been directed at enhancing a specific skill set, such as tutoring or providing feedback, the HM-PE also sought to broaden physicians’ perspectives on a career in academic medicine, and deepen their commitment and enthusiasm for medical education.

The program was designed to foster “transformational learning”⁴ to propel

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*Generally, the HM-PE program reserves approximately 20% of spaces for internal HMS applicants, but the other 80% of participants are physicians from medical institutions across the country and worldwide. Since the study described in this report was conducted, the HM-PE has been renamed the Program for Educators in the Health Professions, in order to reflect the increased participation in recent years of a wider set of health care providers serving as medical educators and leaders.

participants toward (1) greater capability as educators using active learning methods, (2) new understanding of ways medical education is implemented in diverse institutions nationally and globally, (3) firmer commitment to the field of medical education and their identity as medical educators, and (4) ongoing involvement in cross-specialty, cross-institutional communities of practice. Evaluation of medical faculty development rarely takes a broader look at whether the impact is long-term; there are few studies that assess change at six

months or longer to track individual career paths or commitment to the field of medical education.^{5,6}

The population for our outcomes-logic-model study consisted of medical educators at HMS who were participants in the HM-PE international program. We studied a sample of these physicians to learn whether participation in this faculty development program—held at their own institution but with 80% of participants from other medical institutions—affected their experience as

it pertained to the four dimensions above. Could the learning experience be truly transformational when the majority of physicians at HMS were not being exposed to the same intensive approach to being a physician educator? Does the outcomes logic model provide faculty developers with an assessment approach that is feasible, credible, and informative to program planners, faculty, physician participants, and other interested audiences?

In the outcomes logic model, activities are identified that have been shown by prior research to be predictive of the desired outcomes. Some outcomes are immediate, that is, measurable during or soon after the program ends. The outcomes logic model posits that these immediate outcomes must first be achieved in order to set the stage for intermediate or longer-range outcomes. A beginning outcomes logic model for HM-PE (see Table 1) examined whether the program was implemented as intended and whether selected immediate and intermediate outcomes were attained.

Method

For each outcome from Table 1, we created a measurement indicator to provide evidence as to what degree the program outcome has been achieved. To create a measurement indicator, we needed to (1) define the specific observable, measurable characteristic or change that will represent achievement of the outcome, and (2) identify the specific statistic, such as number and percentage of participants attaining the outcome, that the program will use to set baselines and targets as well as summarize its level of achievement. It is important to note that the outcomes logic model in this study examines the efficacy of the program and is not intended to assess individual performance.

As described earlier, the sample for this study comprised HMS medical educators participating in an international faculty development experience held at HMS. In 2001, we enlisted an external research and evaluation firm to conduct telephone interviews in order to gather quantitative and qualitative information from 16 HMS physicians who participated in the HM-PE program in 1998, 1999, or 2000. These interviewees were randomly drawn

Table 1
The Outcomes Logic Model for the Harvard Macy Institute Program for Physician Educators, Harvard Medical School*

Component	Description
Inputs What resources are dedicated to or consumed by the program?	<ul style="list-style-type: none"> • Funding from foundation (initially); tuition plus operational budget (currently) • Faculty and staff time (within HMS, Harvard University, and beyond) • Facilities at HMS and associated hospitals
Activities What does the program do with inputs to fulfill its mission?	<ul style="list-style-type: none"> • Systems to publicize program, screen potential participants, manage course logistics, etc. • Curriculum design that incorporates: (1) assessment of learning needs, (2) interactive learning and opportunities to practice, (3) sequenced and multifaceted activities, and (4) outcome evaluation. • Ongoing curriculum updating • Winter and spring sessions with evaluation during and after both sessions to judge whether program is meeting needs and is implemented as planned. • Systems to support medical educator networking and communities of practice before, during and after participation, e.g., HM-PE Web site, participant reunions, recruitment of program alumni as Faculty Scholars.
Outputs What are the direct outputs of program activities?	<ul style="list-style-type: none"> • Number of applicants and participants since the program began • Average number of hours a participant spends on the program and related activities • Number of participants from HMS • Number of participants from across the United States and internationally • Number of "hits" on HM-PE Web site
Outcomes What are the immediate and intermediate benefits for participants during and after program activities?	<p><i>Immediate</i></p> <ul style="list-style-type: none"> • Increased knowledge about active learning methods and greater capacity to be learner-centered educators. • New understanding of and appreciation for ways medical education is implemented in institutions nationally and globally. <p><i>Intermediate</i></p> <ul style="list-style-type: none"> • Belief that the program was "transformational," leading to an increased commitment to medical education as a primary career direction and stronger identity as a medical educator. • Expanded network of colleagues in medical education and communications with like-minded physician educators, e.g., via virtual communities, ongoing emails, collaborative activities.

* The outcomes logic model seeks to document to what extent the immediate and intermediate outcomes shown above are attained by program participants.

from a total of 28 HMS physician participants for that three-year period. In order to gain a better understanding of the participant experience, the interviewers discussed the course with three course faculty and four faculty scholars and observed portions of the program. The interviews, which lasted 30–45 minutes, were designed to provide anonymity and encourage the participating physicians to speak freely. The interview approach resulted in in-depth data, allowing a level of detail and context that would be more difficult to obtain via an online or written questionnaire.

The interviewees (half men, half women) possessed a range of academic levels (including instructors, professors, and clerkship director) and disciplines (such as pediatrics, palliative care, and radiology), and had diverse racial or ethnic backgrounds (including Latino, white, and Asian). For our analysis we combined the results from all the physicians in each of the three years because there was no discernable difference in the patterns of response and reported outcomes across the three years.

In 2004, three years after the initial set of interviews, we asked the 16 physician participants and four faculty scholars (since all had also been HM-PE participants prior to 1998) to complete an online questionnaire designed to collect data on the longer-term impact of the HM-PE courses, including evidence of active involvement in medical education. Each of the faculty scholars responded; 12 of the 16 physician educators responded. The online questionnaire results reported below are based on all 16 of the 20 responses.

The outcomes logic model seeks to document to what extent the immediate and intermediate outcomes in Table 1 were attained by participants. Significant resources (Input) were needed to start and sustain the HM-PE program, and significant numbers of physician educators from HMS and beyond have participated (Outputs).

Activities: What does the program do with inputs to fulfill its mission?

It was critical to implement a curriculum predicted by prior studies of faculty development to result in effective

learning for participants. A summary of 50 randomized control studies⁷ identified four components required for effective learning experiences in professional development for medical faculty: (1) assessment of learning needs, (2) sequenced and multifaceted activities, (3) interactive learning and opportunities to practice, and (4) outcome evaluation. The HM-PE program addresses these components as follows:

- *Needs assessment.* Each participant accepted into the HM-PE is required to identify and pursue a medical education project, approved by the department chair or dean, to be implemented at his or her own institution. The HM-PE's planners use written descriptions of these projects to tailor the HM-PE program to the needs of the participants.
- *Sequenced and multifaceted activities.* The HM-PE program has as its anchors two intensive immersion experiences in residence: a ten-day winter session and a one-week spring session. Each physician's project is discussed with peers and faculty during the winter session, with e-mail or telephone dialogue continuing into the spring session and beyond. Small-group interactive sessions and informal meetings are part of the program schedule to facilitate conversations among participants and are designed to emphasize the value of learning from colleagues worldwide.
- *Interactive, practice-based learning opportunities.* The HM-PE faculty scholars facilitate small groups in which participants practice teaching methods, explore negotiation and change strategies, and examine and seek to improve each physician's institutional project. The practice teaching activities are videotaped and followed by peer review. The program faculty are expected to model active learning methods and a multidisciplinary approach.
- *Evaluation.* Evaluation begins with obtaining evidence as to why the educational strategies were selected, and how successfully the program implemented the intended goals of the curriculum. Without this assurance, the outcomes logic model breaks down. To determine whether the HM-PE curriculum and activities were

implemented as planned, participant evaluations are completed and analyzed at the end of both residence periods. In addition, the director of the HM-PE program examines reports of project updates that are submitted by physician educators months after the program ends.

Outputs: What are the direct outputs of program activities?

The outputs are cohorts of HMS physicians who participated in the HM-PE program in 1998, 1999, or 2000. For the 12 years the program has been in existence, it has served more than 1,200 physicians and other health care providers from 29 countries. Of those physicians, about a fifth have been from HMS.

Outcomes: What are the benefits for participants during and after program activities?

To determine the outcomes, we used prior research as well as course directors' and stakeholders' knowledge of the program, goals, and setting. In this study, we decided to focus on two immediate outcomes and two intermediate outcomes that most clearly reflect the mission of the HM-PE program. The next and critical step was to identify outcome indicators: measures that course directors and other stakeholders agree serve as evidence that an outcome has been attained. There is no one "right" indicator for an outcome, but the indicator should be credible and observable, and measure behavior that is expected to change if the outcome is achieved.³ Given that this is the first time for using the outcome logic model and indicators to evaluate the HM-PE, the baseline standard was set based on what prior research suggested was reasonable. If a numerical indicator was not achieved, this would suggest that the desired outcome, the program delivery, and/or the measurement approach could be out of sync, or that the program or assessment method needs improvement.^{3,8}

The chosen outcomes and related outcome indicators for this study are presented below.

Immediate outcomes. There were two immediate outcomes:

- Increased knowledge about active learning methods and greater capacity

to be learner-centered educators.

Outcome indicator: Over three quarters of the HMS participants will report new knowledge about active learning methods, and greater capacity to be learner-centered educators.

- New understanding of ways medical education is implemented in institutions nationally and globally. *Outcome indicator: At least three quarters of the HMS participants will identify benefits they directly relate to being in a faculty development program where 80% of physicians are from diverse medical institutions, nationally and worldwide.*

Intermediate outcomes. There were two intermediate outcomes:

- Belief that the HM-PE program was “transformational,” leading to an increased commitment to medical education as a primary career direction, and stronger identity as a medical educator. *Outcome indicator: At least three quarters of the HMS physicians will report a stronger commitment to the field of medical education immediately after the program and five years later.*
- Expanded network of colleagues in medical education and ongoing communications with like-minded physician educators, e.g., via virtual communities, e-mails, and collaborative activities. *Outcome indicator: At least three quarters of the HM-PE physicians will continue their involvement with each other and/or HM-PE faculty after the program ends, creating an expanded network of medical educators, including “virtual communities,” begun during the program.*

Results

Achievement of immediate outcomes

Central to the HM-PE program is the goal for HM-PE participants to develop increased knowledge about and confidence in learner-centered education so they can use more active learning techniques in their own medical institution. The following baseline data from our study show that the outcome was partly achieved.

- Thirteen participants (81%) said they had an expanded view of students as active learners.

- Ten participants (63%) said they became aware of a greater array of teaching methods.
- Ten participants (63%) said they use lectures less often and use varied teaching strategies.
- Thirteen participants (81%) said they are confident in using interactive learning.

As shown above, over three quarters of participants (13 of 16, 81%) had an expanded view of students as active learners and reported they felt confident in using interactive learning methods. Nearly two thirds found a greater array of teaching methods and said they used less lecturing and more varied, learner-centered approaches. The fact that the latter two did not quite reach the 75% target told the course planners that they needed to provide physician educators with more experience with learner-centered educational methodologies, including those made possible in the last few years by technology.

Physicians’ self-reported change “after the fact” has obvious methodological limitations. Yet, these data are made more credible by comments, volunteered during the interviews, that reveal why the participants were persuaded of the program’s impact on their teaching strategies. A comment by one physician expressed a general sentiment felt by the group: “This was the first time I had the experience of active application of adult learning principles, where people are breaking into small groups a lot, tackling problems, [with] very active interchange between the teacher and the learner.”

Regarding the value of gaining an understanding of how medical education is implemented globally, data from the 2001 interviews reveal that having the majority of physician educators come from medical institutions nationwide and internationally was a major plus, and exceeded the target standard of 75%. For example, 13 participants said that this diversity revealed to them the support of like-minded colleagues; 14 said that the diversity helped them see beyond the perspective of HMS and learn from colleagues from other schools, and 12 said the mix of participants helped them broaden their networks and contacts.

In the 2004 survey, each of the respondents agreed that the participation

of physicians from across the United States and around the world provided an important and often unanticipated benefit of the program. They identified numerous advantages; the participation of faculty from outside HMS (1) exposed the HMS participants to how medical education practices differ worldwide; (2) fostered thinking out-of-the-box and, as a couple of interviewees suggested, thinking “out-of-the-Harvard way”; (3) broadened perspectives on issues such as faculty support and resources; (4) helped participants improve their own teaching and training; (5) made the course more credible; (6) created a global network of resources and connections with physician educators; and (7) provided models of medical education the HMS participants otherwise would not have seen. This was consistent with the results from the 2001 study, in which 88% of participants described ways they learned from physicians outside of HMS.

Comments gathered in the 2004 survey revealed why they valued this aspect of the program. One respondent called the program “eye opening,” and asserted that it “broke the insular world in which I unknowingly lived” as he “learned perspectives I’d not even thought about,” leading him to say that it “felt great to know there was a like-minded community.” Another survey respondent claimed to be “much more effective in my current position,” while another responded that the program “broadened my network of senior colleagues from whom I seek mentorship.”

Achievement of intermediate outcomes

The HM-PE program was designed to be a catalyst to spark physicians’ enthusiasm for and commitment to medical education. Nationally, this has been a challenging career choice for many physicians, pressured by the need to generate funds for the medical institution and produce scholarly work en route to tenure.⁵ To nurture and support medical educators, the HM-PE program encourages involvement with a community of physician educators within and beyond HMS that exchanges ideas via e-mail, telephone, face-to-face communication, the program’s Web site, a listserv, and at national conferences and HM-PE reunions.

Research has demonstrated that commitment to the field of medical

education is related to: (1) self-perception/identity as an educator and the feeling that they are in the “right” field, (2) appreciation that other physicians share similar interests, (3) involvement in an ongoing community of like-minded physicians, and, (4) ultimately, recognition and viability of medical education as a career path.⁹

The HM-PE program played a significant role in the lives of the vast majority of physicians interviewed in 2001, regardless of the year in which they participated. They reported greater confidence as medical educators and a stronger sense of credibility in pursuing this field. One participant who was interviewed reported that the course “solidified my identity as an educator.” The interview data resulted in the identification of three categories to describe the program’s impact on the participants:

Career-altering. For about a third of physicians, the program was so powerful that it changed their career paths. They referred to it as a “seminal” or “transforming” point in their careers, leading them to commit themselves to medical education. There was an excitement about leading medical education in new directions.

Career-affirming and expanding. For nine of 16 of the participants, the experience provided not only increased knowledge about and comfort with the principles of active learning, organizational change, and the practice and evaluation of medical education, but also had a profound and positive effect on their enthusiasm for medical education. It was described as “reinvigorating” and a “course that makes educators out of faculty.” Another reported that the program was the “most impactful thing I have done since residency, to reenergize as a physician, and recommit as a physician educator.” Another responded, “My project has resulted in two papers in peer-reviewed educational journals and has transformed the way I teach in my core clerkship,” while another participant noted a promotion to associate program director and speculated that the promotion was at least partly a result of the training received through the HM-PE program.

Career-neutral. Only two of the physicians interviewed described their

experience in the program as modestly positive or neutral and reported that it had little effect on their day-to-day work or future plans. One noted that she could see her classmates “transformed” but did not have that feeling herself, adding a positive note nonetheless, “There are certainly people much more dedicated to education than I am, and to see the depth of people’s real interest and passion for it was an eye-opener and illuminating.”

The 2004 survey asked physicians to determine which of the three categories (presented above) best described the impact of the HM-PE program on their careers as medical educators. Four participants and one faculty scholar identified the effect as career-altering. Six participants and two faculty scholars reported that the experience was career-affirming and/or expanding. One described the impact as neutral. This pattern, three years after the interview study, shows that participants from HMS believe the HM-PE program has a lasting effect on their commitment to the field of medical education.

Regarding the second intermediate outcome, the expansion of the physicians’ network of colleagues in medical education and continued communication, the vast majority of participants reported that the program’s informal curriculum was clearly as important as the formal curriculum, and that the camaraderie that developed had a powerful impact. Experiencing the support of like-minded colleagues was a benefit reported by 13 physicians (81%). A comment by one participant captured the general view: “Most lasting for me is feeling a part of a community. Even though the community disbanded at the end of the course, that feeling continued long after the course was over.”

Three fourths of the 2001 interviewees said the program had resulted in a broadened network of contacts. In addition to contacts maintained through e-mail, physicians reported meeting at medical conferences or speaking on the telephone, and, more rarely, travel to another medical institution. The networking and support could have major implications, as evidenced by one participant who reported that the new network resulting from the program resulted in “a trip to South America to collaborate on a project, sharing teaching

materials, and a flurry of e-mails recently due to an ethical dilemma faced by a project team member who wanted the group’s advice.” Another noted that “networking was of enormous value, making contacts all over the world with people interested in the same things I am interested in. The content [of the course] was useful, and the interpersonal relations were critical.”

The 2004 data revealed that 14 of 16 respondents (90%) had been in touch with physicians they met through the HM-PE program from outside of HMS, and 13 (81%) had been in touch during the 12 months prior to being surveyed. Thus, the original connections had continued for years beyond the completion of the program. Respondents cited that among the reasons for maintaining contacts were obtaining advice, inviting colleagues to be faculty for workshops they conduct, and being invited to serve as faculty at other medical schools in the United States and abroad.

Discussion

This study provides evidence that the model of faculty development used in the HM-PE program was successful in achieving desired outcomes for most of the participants from the sponsoring institution. The fact that HMS physicians (as opposed to physicians from other institutions) made up no more than 20% of the participants seemed to be an enhancing factor in the program’s success. A diverse group of physician educators who did not know each other became a tightly knit, supportive, and energized community.

This finding is consistent with evaluation data from medical faculty development programs with similar goals and comparable teaching strategies. Pololi et al.¹⁰ conducted a multimethod assessment that included postcourse surveys, participants’ comments in the closing session, as well as a written open-ended survey and a focus group, the latter two conducted three months after the course ended. Their faculty development program was associated with positive changes in participants’ perceptions of the learning environment, especially learner-centered teaching methods, personal reflection, and faculty collegiality.

It is important to acknowledge that there are some limitations to the insight we can derive from our findings. One could argue that physicians who applied to the HM-PE program were already predisposed toward improving their skills as medical educators. There are currently no data to indicate how well the HM-PE program would work with a group of physicians less interested in the topic or unable to take the time for the two residential sessions. Yet even if the sample of physicians taking this program is not representative of a larger population of physician educators, participants' perceptions of change within themselves, coupled with follow-up data that document their strong involvement in medical education, provide evidence that the program goal to create "transformational change" was achieved in this group of physician educators.

Additionally, the data are self-reported: there is no independent assessment, such as pre- and postobservation of physician educators' teaching approaches. Also, the outcomes logic model can be much more complex than depicted here. For instance, another intermediate outcome is whether participants conducted research and published articles on medical education and/or were able to become tenured.

Still, the results of this study are encouraging. We have concluded that the outcomes logic approach, even in this simple form, provides a research-based framework that gives program directors and other stakeholders sound and actionable evaluation data and proves valuable for program improvement and documentation and sharing of "what works." Data from 2001 and 2004 include both factual information (in response to "Have you been in touch with colleagues who took the course with you and if so, how often?") and perceptions (in response to "How would you describe the impact, if any, of this program on your teaching skills?"). Maxwell¹¹ argues that qualitative data "have distinct advantages for identifying the influence of contextual factors that can't be statistically or experimentally controlled, for understanding the unique processes at work in specific situations, and for elucidating the role of participants' beliefs and values in shaping outcomes,"

and that a combination of quantitative and qualitative research offers the best understanding of causality.

The outcomes logic model and findings presented here lead logically to a future study of longer-term outcomes, keeping in mind that the more time that elapses following participation in the program, the more other factors enter into the causal path. One potential outcome is that physicians become active planners of their own continued learning in the field of medical education, including ongoing self-assessment strategies and reflection practices.⁶ Another outcome is the development of physician educators who are more capable of creating powerful learning experiences for medical students and using students' performance as an indicator. Makoul et al.,¹² using educational strategies consistent with the HM-PE, found that medical students were significantly more likely than those using traditional educational strategies to become better learners themselves, as well as to master the skills required to provide information to patients.

It is often the case that physicians interested in a career in medical education have made significant trade-offs in level of prestige, income, and tenure status. One HM-PE participant suggested that a valuable longer-term outcome indicator to consider would be the number of program alumni who are promoted on the basis of their greater involvement in medical education, an idea unheard of until recently.

In times of intense pressure to teach, conduct research, see more patients, and deal with a changing health care system, physician educators are challenged to remain committed and energized. Simpson et al.¹³ identified key sources of vitality for physician educators in family medicine. The researchers suggest that vitality is enhanced for physician educators who have an ongoing support system of colleagues for "collaboration, consultation, and support," and who receive the same level of recognition and support provided to physicians in clinical or research settings.

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References

- 1 Bennett NL, Davis DA, Easterling WE Jr, et al. Continuing medical education: a new vision of professional development of physicians. *Acad Med.* 2000;75:1167-72.
- 2 Handelsman J, Ebert-May D, Beichner R, et al. Scientific teaching. *Science.* 2004;304:521-22.
- 3 Hatry H, van Houten T, Plantz MC, Greenway MT. *Measuring Program Outcomes: A Practical Approach.* Alexandria, VA: United Way of America, 1996.
- 4 Armstrong EA, Doyle J, Bennett NL. Transformative professional development of physicians as educators: assessment of a model. *Acad Med.* 2003;78:702-8.
- 5 Buckley LM, Sanders K, Shih M, Hampton CL. Attitudes of clinical faculty about career progress, career success and recognition, and commitment to academic medicine: results of a survey. *Arch Intern Med.* 2000;160:2625-29.
- 6 Steinert Y. Faculty development in the new millennium: key challenges and future directions. *Med Teach.* 2000;22:44-50.
- 7 Mazmanian PE, Davis DA. Continuing medical education and the physician as a learner: guide to the evidence. *JAMA.* 2002; 288:1057-60.
- 8 Harden RM, Crosby JR, Davis MH, Friedman M. AMEE Guide No. 14. Outcome-based education: part 5. From competency to meta-competency: a model for the specification of learning outcomes. *Med Teach.* 1999;21:546-52.
- 9 Starr S, Ferguson WJ, Haley H, Quirk M. Community preceptors' views of their identities as teachers. *Acad Med.* 2003;78: 820-25.
- 10 Pololi L, Clay MC, Lipkin Jr M, Hewson M, Kaplan C, Frankel RM. Reflections on integrating theories of adult education into a medical school faculty development course. *Med Teach.* 2001;23:276-83.
- 11 Maxwell JA. Causal explanation, qualitative research, and scientific inquiry in education. *Educ Res.* 2004;33:3-11.
- 12 Makoul G, Curry RH, Thompson JA. Gauging the outcomes of change in a new medical curriculum: students' perceptions of progress toward educational goals. *Acad Med.* 2000;75:S102-S105.
- 13 Simpson DE, Rediske VA, Beecher A, et al. Understanding the careers of physician-educators in family medicine. *Acad Med.* 2001;76:259-64.