Outcome-Based Workforce Development and Education in Public Health

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Abstract
The broad scope of the public health mission leads to an increasingly diverse workforce. Given the range of feeder disciplines and the reality that much of the workforce does not have formal training in public health science and practice, a pressing need exists for training and education throughout the workforce. Just as we in public health take a rigorous approach to our science, so too should we take a rigorous, evidence-driven approach to workforce development. In this review, we recommend a framework for workforce education in public health, integrating three critical conceptual approaches: (a) adult learning theory; (b) competency-based education; and (c) the expanded Dreyfus model in public health, an addition to the Dreyfus model of professional skills progression. We illustrate the application of this framework in practice, using the field of applied epidemiology. This framework provides a context for designing and developing high-quality, outcome-based workforce development efforts and evaluating their impact, with implications for academic and public health practice efforts to educate the public health workforce.
INTRODUCTION

Public health has been defined as “what we as a society do collectively to assure conditions in which people can be healthy” (43). This broad scope requires a diverse workforce. Public health professionals support the public health mission in multiple ways, from educating those at risk about ways to prevent disease, to inspecting restaurants, to tracking down sexual contacts of a person with a sexually transmitted disease, to identifying patterns of disease and conducting epidemiologic investigations to identify risk factors, and to working with legislators to draft policy for smoke-free work environments. This wide-ranging and evolving mission, encompassed in the 10 Essential Public Health Functions (65), relies on multiple disciplines. The term public health professional refers to many occupations, including physician, nurse, sanitarian, engineer, laboratorian, statistician, educator, communications expert, and manager. These people might enter the public health field at different stages of their career. Some enter immediately after graduation from undergraduate or graduate school, with or without academic preparation in the field of public health, whereas others enter as midcareer professionals, again with or without formal preparation in public health. Thus, public health can be considered a discovered discipline (i.e., it is not a person’s initial profession but a choice embraced later in one’s career).

Public health professionals work in varying settings not limited to academic and governmental public health. They are employed in community-based nonprofit organizations, private philanthropic foundations, accrediting and professional associations, and, increasingly, in for-profit consulting firms. Given the range of feeder disciplines and the reality that much of the workforce does not have formal training in the science and practice of public health, a pressing need exists for training throughout the public health workforce. Further, the education of this public health workforce should occur not only in academic settings, leading to a formal degree, but also in diverse on-the-job settings.

Regardless of the setting, the instruction should be of sufficient quality to elevate learners’ competence to perform the 10 essential functions within the context of their work environment.

In this review, we integrate the scientific perspective with that of education because we believe this is critical to successful public health workforce development. Just as we in public health take a rigorous approach to our science, so too should we take a rigorous, evidence-driven approach to our workforce development. To be effective, we need to integrate what is known about how adults learn and to use systematic instructional and educational design methods. Public health workforce development should be purposeful, outcome-based, strategic, and based on the contextual needs of the work environment and on sound principles of adult learning (62). Moreover, given the need for public health professionals not only to know public health and their discipline but also to know how to apply their knowledge in the public health practice context, this is an important area of partnership for the academic and practice communities. Collaborative efforts to develop the workforce, with practical problems and experiences embedded in the learning activities, will strengthen the multidirectional transfer of knowledge and skills between academic and practice communities. A closer relationship and regular interactions between academia and practice will enhance our ability to translate research into practice and to improve the practice of evidence-based public health, as seen in successful academic-practice partnerships (5, 36, 73).

We begin by reviewing the state of the art in public health workforce development and education. We provide a brief overview of adult learning theory and its role in constructing the learning environment. Competencies are critical for defining the desired outcomes of an educational activity, thus providing metrics useful for evaluating the effectiveness of skills acquisition. We describe and provide examples of the increasing acceptance of competency-based education in public health as well as the challenges...
related to the proliferation of competencies and the difficulty in selecting the appropriate ones to use in targeting a given workforce development program. We suggest that in addition to adult learning theory and competency-based education, a third construct based on the Dreyfus model of professional skills progression (the expanded Dreyfus model in public health) will provide context and guidance for determining appropriate target competencies for a given stage in the career. Using a systematic process for instructional design, the most effective workforce development and education operates within the intersection of all three of these constructs, as illustrated in Figure 1. This framework provides a context for designing and developing high-quality, outcome-based workforce development efforts and for evaluating their impact. We illustrate the application of this model in practice, using the field of applied epidemiology. We end by listing selected challenges and opportunities in this area and ideas for future directions.

STATE OF THE ART IN PUBLIC HEALTH WORKFORCE EDUCATION

Adult Learning Theory

The diversity of professionals in public health creates broad educational needs. Given that most public health professionals have not had formal training in public health (39, 77), it is critical for the busy public health workforce to access training in settings other than full-time degree programs. Thus, designing public health educational programs that consider adult professionals’ learning needs is critical. Multiple authors consider the principles that facilitate adult learning (e.g., 13, 51, 67, 80), which include implications for public health education (15, 62, 68).

The foundations of adult learning theory arise from a synthesis of constructs garnered from social science disciplines driven by evidence and theory, such as clinical psychology, developmental psychology, philosophy, and education. To distinguish the unique characteristics of adult learning from pedagogy (educating children), Malcolm Knowles coined the term andragogy (52). Adults are active and reflective learners. They learn best when they are fully engaged in the learning process, and they bring their learning and experience into their workplace, professional practice, and community. Adults need to know why they are learning, what the goal is, and whether they can achieve the goal. Also, they expect immediate relevance to what they learn; what they learn today, they expect to use tomorrow. Furthermore, professionals, especially those in higher levels of management, often perform in uncertain situations. As such, they require varied learning experiences that allow the application of competencies in complex situations that simulate the complexities of real life, rather than classroom exercises based on rote experiences with predetermined conclusions. Finally, adults bring into the learning situation previous experiences and a level of competence that influence their interaction with the instructor, other learners, and the new content. The likelihood of learning decreases when this previous life experience is dismissed (52, 67, 80). Caffarella and other adult educators maintain that adults learn best when the educational outcomes are clear and integrated into a relevant context for their use (17, 50).

The use of adult learning principles to design the learning environment also facilitates the learners’ engagement. Adults—whether public health graduate students, participants in experiential learning fellowships in public health, or public health professionals in continuing education courses—expect to apply the competencies achieved in their program to the workplace (2, 60). If competency or the instructional experience is deemed irrelevant or inefficacious, adults will derive no professional benefit from the experience. Thus, applying adult learning theory engages the learner, which increases the likelihood that he/she will learn (13, 51, 52, 67, 80). However, given external factors in the work environment, the application of these principles does not guarantee that the
Many full-time, on-the-job training programs developed by the Centers for Disease Control and Prevention, such as the Epidemic Intelligence Service (EIS), the Prevention Effectiveness Fellowship, the Public Health Informatics Fellowship, and the co-op program to develop Public Health Advisors, were initially and intuitively based on these principles and the idea that professionals would learn on the job (53, 54, 61). Adult learning principles also implicitly or explicitly undergird the design of many continuing education courses designed for public health professionals (2, 36, 68). Although little has been formally documented regarding the use and effectiveness of adult learning principles in such programs and the impact of not using such principles, these programs have been highly successful in developing the future public health workforce (53, 54, 61, 81).

Competency-Based Education

Although adult learning theory is useful for defining how to set up the learning environment and how to engage the adult learner and identifying appropriate types of learning activities, such theory is insufficient for defining the goals for a specific class or educational activity. To quote Lewis Carroll in Alice in Wonderland, “if you don’t know where you are going, any road will get you there.” Competencies target and make explicit the expected outcomes of the educational experience. They are structural tools that facilitate adults’ engagement in the learning process. Competency in a certain skill can be defined as the ability to perform and sequence actions to attain a specific goal (33). The competencies associated with a particular curriculum or course describe the skills expected to be achieved as a result of participating in that curriculum or course, thus clarifying the educational goals. Competencies are used to develop, deliver, and evaluate instruction; identify job responsibilities; and assess individual and organizational capacity. Miner et al. (62) describe workforce competencies as complex statements that reflect different skills and that are based on the needs of the organization and a given position. Workforce competencies can be broken down into smaller, component-instructional competencies useful for targeting education. For example, as defined in Developing Competencies for Applied Epidemiology: From Process to Product (9), the complex competency, design investigations, includes component competencies such as identifying the target population, evaluating the results of power calculations, verifying individuals or groups for inclusion in a study, creating a case definition, evaluating the possible sources of bias, identifying methods to minimize potential sources of bias, and evaluating confounders.

Competency frameworks in public health.
The development of instructional and workforce competencies has a long history in the field of public health. In the early 1900s, the Flexner and Welch-Rose reports recognized public health as a discrete area of professional practice, with unique, albeit vague, requirements (35, 79). From that time to the present, researchers and practitioners have attempted to define more specifically the precise content and skills within public health (69). After the 1988 Institute of Medicine report, The Future of Public Health (43), concluded that public health preparation and public health practice were disconnected, the subsequent Public Health Faculty/Agency Forum recommended the development of universal competencies for all public health professionals and specific competencies for those practicing as content-area specialists (e.g., epidemiologists) (34, 43, 66).

In 2001, the resultant Council on Linkages Between Academia and Public Health Practice (COL) adopted a model set of core competencies for all public health professionals that were organized across eight domains of practice: analytic/assessment, policy development/program planning, communication, cultural competency, community dimensions of practice, public health sciences, financial planning and management, and leadership and systems thinking (28). For the first time, these
Competencies outlined professional practice standards that in turn described the expected skills of people within public health. In the 2006 midcourse review of the Healthy People 2010 public health infrastructure objectives, the COL determined that 91% of the respondents (accredited programs and schools of public health and nursing with public and/or community health concentrations) had integrated the competencies into their curriculum in some way (28). Edgar et al. (32) recently provided the first substantial evidence of the validity of COL competencies as a tool for determining the competence of the public health workforce. The COL’s domains and competencies have served as the framework upon which other public health-relevant competency sets have been built, such as applied epidemiology, public health preparedness, and public health informatics (9, 28, 37). In 2007–2008, the COL began a multiyear revision of the original COL competency framework (28).

Application of competencies: health education. The health education profession was the first population-based profession to develop its own competencies and to require continuing education based on them. Beginning in the 1970s, the health education profession began a process of defining the parameters of its profession. During the mid-1980s, the profession formed the National Task Force on the Preparation and Practice of Health Educators, which was charged with conducting an exacting role delineation of the generic knowledge and skills that all entry-level health educators should possess to practice in the field. This assessment defined the competencies for the profession (27). In 1988, the National Commission for Health Education Credentialing, Inc. (NCHEC) was formed to oversee the certification processes leading to a competency-based examination, which is required to become a Certified Health Education Specialist (CHES). Competency-based continuing education is required to maintain CHES certification (57). In 1998, the initial role delineation was updated after a review of entry-level competencies, and competencies were defined and validated at more advanced levels of practice (40). NCHEC revised the competency exam using the newly validated entry-level competencies. Beginning in 2010, the NCHEC will also begin credentialing health educators at an advanced level based on these advanced competencies (i.e., the Master Certified Health Education Specialist or MCHES), thus creating a competency-based career progression (63). The health education competency development experience highlights several particular points that are germane to other competency efforts: (a) competencies can define a profession, (b) competencies can be defined in tiers for different experience levels, and (c) competencies require renewal and validation periodically by the profession.

Competency-based education in public health. Competency-based education has been the primary response to the expectation of increasing relevance and accountability in academic curricula (22, 38, 39, 46, 77). To ensure that competencies guide curricula, in 2005 the Council on Education for Public Health (CEPH) amended its criteria for accreditation to require identified competencies for all areas of specialization, including core courses and content majors. The Association of Schools of Public Health (ASPH) defines competencies across the five required core areas of the master of public health curriculum (epidemiology, biostatistics, social sciences, environmental health, and health policy and management) and seven crosscutting areas (communication and informatics, diversity and culture, leadership, public health biology, professionalism, program planning, and systems thinking). These ASPH competencies served as the basis for a new certification process and examination in public health developed by the National Board of Public Health Examiners (NBPHE) (21). As with the COL and other public health practice competencies, CEPH’s requirement and the use of ASPH’s competencies by NBPHE underscore the usefulness of competencies both to make explicit the goals of educational...
activities and also to serve a quality-assurance function. Competencies are critical for public transparency and accountability because they identify the specific skills to be gained by participating in an educational program and subsequently provide the definable benchmarks for assessing the knowledge and skills gained.

Despite the utility of competencies for defining educational goals, the proliferation of competencies in public health (4; 26, pp. 30–35; 46, pp. 266–77) creates challenges for the educator attempting to select appropriate competencies to target training. To ensure that the competency-based instructional activities are at the right level of complexity to advance learners’ careers, it is helpful to add a dimension to guide curriculum development. This approach, based on the Dreyfus model of skills acquisition, which divides skills acquisition into stages, facilitates the identification of longer-term outcomes of the workforce development process by providing a larger context to consider when selecting the level of sophistication of a target competency.

**DREYFUS MODEL OF SKILLS ACQUISITION**

Hubert and Stuart Dreyfus conceptualized skills acquisition in 1986 in a fashion not totally dissimilar from the origins of adult learning theory. Drawing on their background in the computer sciences and the development of artificial intelligence, they observed individuals in the processes of skill development. Their initial observations led them to conclude that individuals did not just leapfrog from knowing to being able to perform but progressed through a series of five stages (31). In 2001, Hubert Dreyfus added a sixth stage (30). Despite its initial intended use for the field of technology, academic and in-service educators readily adopted this model as a logical framework for curriculum design. These educators represented professionals from backgrounds such as law, engineering, library science, pharmacy, nursing, health administration, and preparedness (8, 12, 19, 22, 70, 71, 74).

As the model is modified to accommodate the different terminology and career paths within each of the professions, the Dreyfus stages take on the nomenclature relevant to the professional classifications particular to that field of practice. Thus, the names assigned to the Dreyfus stages are idiosyncratic and vary widely and arbitrarily throughout the professional literature. Independent of the names that professional educators assign to the Dreyfus stages, there are a number of commonalities associated with their use. As individuals advance through the stages, they continue to become (a) more characteristic of a life-long learner, (b) more advanced in cognitive and affective competency domains, (c) more intuitive in their thinking and actions, (d) more sought out as a mentor, and (e) more acknowledged as a leader. Experience and increases in affective competence (emotional intelligence) play greater roles in the progression to higher levels than cognitive or technical competence alone (41, 42, 83). The Dreyfus model of skills acquisition helps to better define stages of learning and provides a roadmap for advancing from one stage to the next.

**Use of the Dreyfus Model in Medicine**

The medical field has long recognized the need for lifelong learning for medical education to engage the adult professional and to continue beyond medical school. The terms used underscore this continuum: undergraduate medical education (medical school), graduate medical education (residency), and continuing education. Beginning in the 1980s and 1990s, the medical field identified the importance of moving toward outcome-based education (18, 20, 23, 45). The Accreditation Council for Graduate Medical Education (ACGME) Outcome Project defined six crosscutting competency domains to serve as an organizing framework for all medical specialties: patient care, medical knowledge, professionalism, systems-based practice, practice-based learning and improvement, and interpersonal and communication skills (1, 7, 55), a framework accepted by major
However, the level of competence in patient care, for example, expected of the medical student, the resident, and the attending physician is obviously different. How does the educator select the appropriate target competencies for each stage of the medical career? To help frame the selection, ACGME used the Dreyfus model to identify the target for graduate medical education and to more clearly define its outcomes within the continuum of medical education (7, 55). Graduate medical education “is particularly focused on the progression of physicians through the Dreyfus competency stage, moving from well-prepared and functioning advanced beginners (medical school graduates) to fully competent physicians” (7). Although exceptions might exist, the Dreyfus stages of novice, advanced beginner, competent, proficient, expert, and master correspond generally to first-year medical student, junior and senior medical student, resident, physician recently entering practice, midcareer physician, and senior physician, respectively (47). The specific competencies used to plan training and to describe the skill level vary by career stage.

EXPANDED DREYFUS MODEL IN PUBLIC HEALTH

We have expanded the Dreyfus model for public health to include seven tiers, as displayed in Figure 2. In addition, we have added both professional (orange) and leadership (blue) competencies. These competencies appear in the form of rings around a central core. The expanded model accounts for those who enter the public health field with other professional backgrounds. These individuals may have attended medical school or been a school teacher before obtaining a degree or position in public health. Thus, we use professional competencies as a hybrid term to include not only the competencies of public health but also those from any other relevant disciplinary background the person might possess (e.g., medicine, nursing, informatics, or environmental health). As the expanded model demonstrates, people continue to develop their professional competencies as they progress in their career to the expert level. After they reach the expert level, professional competency growth stabilizes. In contrast, competencies in leadership are minimal during the early stages of a public health career. These competencies grow markedly as the career progresses, and they become the dominant characteristics of people at the advanced levels of the expanded model. The triangular outline shows that as one ascends the levels, fewer people occupy those professional ranks. Our premise is that this model applies equally to professionals in practice and academic settings.

Illustrations of the Expanded Dreyfus Model in Public Health

Below we briefly describe the different levels of the Dreyfus model and provide examples from the field of public health.

Entry-level professionals. Entry-level professionals operate through rules and regulations because they require specific guidance. They lack a sense of the overall picture of the organization. Usually, their responsibility is limited in scope, and the majority of their decisions are routine in nature. For example, the entry-level public health professional with a master’s degree often has a basic knowledge and core competencies in the field but usually has had limited opportunities to practice public health. The entry-level professional newly moving into the public health field has competencies in their source discipline (e.g., medicine, informatics, or engineering) but frequently has limited core competencies in public health. The majority of public health professionals are at this level.

Capable professionals. Capable professionals begin to get a sense of the larger organization or task. Although they are still rule-based, they employ more complicated rules and procedures derived in part from experience to solve problems. They begin to use profession-specific
(i.e., public health and not just discipline-specific) competencies in daily practice. They are developing independence.

**Competent professionals.** Competent professionals, now experienced, recognize that the complexity of certain elements in their work requires nonroutine decision making, to which hard and fast rules do not clearly apply. In medicine, this might be described as developing clinical judgment. Public health professionals at this level, with foundational training in a health-related or other discipline, now rely heavily on their core public health competencies. This is demonstrated in the academic setting when junior faculty are given notice that they might not be recommended for tenure. In a public health setting, such professionals might supervise smaller groups of staff.

**Proficient professionals.** Proficient professionals make decisions by using intuition coupled with analytic thinking. They see the situation as a whole and the interconnectedness of the decisions they make in relation to systems throughout the agency. They assume leadership roles and guide others in leadership responsibilities. In the academic setting, this is the point at which a junior faculty member is recommended for tenure at the associate professor level. In a public health agency, such professionals most likely oversee multiple supervisors.

**Expert professionals.** Expert professionals zero in on the central aspects of a problem; they perform intuitively with only an occasional need for deliberation. They spend substantial time reflecting on how the system works. They assume leadership roles and assign leadership responsibilities to others. They assess the quality of the work done in their agency. They make decisions with the organization paramount. In the academic setting, the associate professor receives a recommendation for promotion to full professor. In a public health agency, such professionals have substantial authority and responsibility, with multiple direct reports who also supervise multiple tiers of staff.

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**Two Advanced Levels of the Expanded Dreyfus Model**

Although Dreyfus originally described five levels, for public health we identified two additional, albeit uncommon, levels of expertise because five levels are inadequate to differentiate the competence and skills of extraordinary leaders.

**Advanced expert professionals.** Advanced expert professionals have a higher degree of competence across all skill sets, especially leadership. They advance the field’s standards by example and by participating in agency, professional, and system-wide discussions. They develop innovative ways to solve problems. They are considered leaders by more than those in their own professional field. They span boundaries. These professionals define the competencies for the entire field. Expert professionals rarely progress to the advanced expert level.

**Luminaries.** Luminaries have the highest degree of competence in their field. Their consistent record of performance and their ability to change the course of history within a field or discipline define them. They are considered a standard bearer for professional concerns, and their name, when mentioned, lends credence to a topic. They are systems thinkers who see the interrelatedness of professions and social institutions. Although they retain their professional identities, their operational leadership competencies mirror the competencies of other luminaries in other fields. Only a select few advanced expert professionals progress to luminaries. As a result, luminaries are the rarest professionals.

The competencies associated with the higher order begin to take on a unique quality. One begins to regard the few professionals in the higher tiers less for their profession-specific competencies (e.g., medicine, laboratory science, or health education) and more for their competencies in leadership, problem solving, and systems thinking. People who reach the top become more similar in the way they think and act than their primary professional
identities indicate (Figure 2). Thus, leadership training in public health often focuses on these core leadership competencies, regardless of the professional discipline (48, 83) because the nontechnical, often affective, leadership skills differentiate effective leaders from other professionals (16, 34, 41, 42, 59, 83). The CDC Initiative for Leadership Enhancement and Development (I LEAD) uses a Dreyfus-like approach, dividing the target audience into four tiers of public health professionals (48). The Dreyfus model provides a useful framework for differentiating competence levels and for targeting workforce development activities. Adults learn best when the learning environment is matched with their experience level. Thus, a course or other educational experience should be designed for a professional at a specific Dreyfus stage, as in public health preparedness training (19). This helps in several ways: It groups organized educational activities around skill levels, it guides the selection of competencies and learning objectives at the right level of complexity, and it facilitates individuals’ choices of the right course or experiential opportunity for them. Table 1 provides concrete examples of how the expanded Dreyfus model applies to public health research, practice, and leadership.

EXAMPLE OF APPLYING THE INTEGRATED MODEL

Fellowships at the Centers for Disease Control and Prevention

The Career Development Division (CDD) at the Centers for Disease Control and Prevention (U.S. Department of Health and Human Services) manages fellowship programs often described as public health residencies in applied epidemiology, preventive medicine, public health informatics, prevention effectiveness, and management (29, 53, 54, 75, 76). The majority of participants have master’s or doctoral degrees in the disciplines that mirror the varied backgrounds of public health professionals. They provide service while they learn in the workplace. The oldest program, the EIS, was explicitly modeled after the medical residency (54, 75). The programs require some formal coursework as organized by the staff, but the majority of learning occurs through required on-the-job experiences (e.g., evaluating a surveillance system or a program, investigating an acute public health problem, completing an analytic study, or designing a community intervention). A majority (80%) of graduates of these fellowships remain employed in public health after completion of the programs.

Participants in these experiential learning programs are adult learners who desire practical skills. Recently, CDD programs have followed a rubric similar to that referenced in Figure 1 (i.e., using adult learning theory to construct the learning environment and defining appropriate-level competencies within a Dreyfus-like framework). In the late 1990s, CDD staff recognized the need to move toward outcome-based workforce development and education, using competency-based curricula and a logic model to evaluate defined short- and long-term educational outcomes. In the early 2000s, the ACGME Outcome Project and their description of the need to use scientifically valid, consensus-based measures greatly influenced the CDD (1).

As a first step, in collaboration with the Council of State and Territorial Epidemiologists, the CDD led a systematic, representative, and comprehensive effort to define competencies for applied epidemiologists in governmental public health agencies (applied epidemiology competencies or AECs) (9, 10). Using COL’s Core Competencies for Public Health Professionals (28) as a framework, the expert panel defined detailed competencies and subcompetencies specifically for four tiers of epidemiologists: Tier 1, entry-level; Tier 2, midlevel; Tier 3a, senior level supervisor/manager; Tier 3b, senior scientist. We provide an example of an applied epidemiology competency statement with selected subcompetencies above in this review. Full competency documents are available at http://www.cdc.gov/appliedepicompetencies or http://www.cste.org/competencies.asp). These levels are more...
Table 1  Expanded Dreyfus model in public health with research, practice, and leadership examples

<table>
<thead>
<tr>
<th>Level</th>
<th>Definition</th>
<th>Research application</th>
<th>Practice application</th>
<th>Leadership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry</td>
<td>Operates through rules and regulations</td>
<td>Implements data collection protocols</td>
<td>Implements programmatic activities</td>
<td>Responds to direction from leader; is unsure about the need for mentorship</td>
</tr>
<tr>
<td>Capable</td>
<td>Uses more complex procedures to solve problems</td>
<td>Oversees data-collection processes and ensures quality of data</td>
<td>Monitors programmatic activities and keeps them on track and consistent with timelines</td>
<td>Develops increasing independence and seeks opportunities for leadership in minor projects; is seeking mentorship</td>
</tr>
<tr>
<td>Competent</td>
<td>Acts with long-term goals and plans in mind</td>
<td>Designs a research protocol and implements the research agenda</td>
<td>Designs a community-based intervention and the plan for its evaluation</td>
<td>Has been a leader in projects and might supervise teams; is actively using mentorship guidance</td>
</tr>
<tr>
<td>Proficient</td>
<td>Acts by using a balance of analytic thinking and intuition</td>
<td>Designs a research agenda, ensures accuracy of the research findings, and translates the science into practice</td>
<td>Designs and implements a multipronged program to prevent and control a given condition</td>
<td>Leads major projects and often oversees multiple levels of the organization; is known to be a mentor to a limited number of others</td>
</tr>
<tr>
<td>Expert</td>
<td>Acts from intuition and uses systems thinking</td>
<td>Develops the interdisciplinary research agenda for the agency</td>
<td>Develops programmatic approaches that cross disease boundaries</td>
<td>Sets the strategic direction for an agency or major organization within it; frequently provides mentorship</td>
</tr>
<tr>
<td>Advanced</td>
<td>Develops innovative ways to solve problems</td>
<td>Promotes and obtains resources for a research agenda in a professional field of practice</td>
<td>Advocates for the fiscal and strategic direction of an agency or profession with the larger political and social systems</td>
<td>Leads strategic alliances across agency boundaries; provides mentorship on a broad scale</td>
</tr>
<tr>
<td>Luminary</td>
<td>Sets the standards for the history of professional institutions or disciplines</td>
<td>Encourages a multidisciplinary social action (including policy) response based on research findings</td>
<td>Collaborates with other professional leaders to take action to resolve major professional and social problems</td>
<td>Sets standards for the field on a national or international scale; provides mentorship to those who are mentors to others</td>
</tr>
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general than the expanded Dreyfus model levels described above, but Tier 1 epidemiologist corresponds to entry-level in the expanded Dreyfus model; Tier 2 midlevel epidemiologist spans the capable-to-competent levels; and Tier 3a senior epidemiologist (with supervisory responsibilities) and Tier 3b senior scientist correspond to the proficient and expert levels, although the scientist without supervisory responsibilities might exhibit and require such competencies in the scope and impact of their work, rather than in their supervisory span of control. As an example of how the expected competencies differ at varying levels, the Tier 1 epidemiologist supports evaluation of surveillance systems, the Tier 2 epidemiologist conducts evaluation, the Tier 3b scientist designs and conducts evaluation, and the Tier 3a leader ensures that evaluation happens. This process also underscored the importance for epidemiologists of competencies in all eight of the COL’s core competency domains, including communications, cultural competency, and leadership and systems thinking, not just data collection and analysis, which are at the core of epidemiologic practice.
After completion of the AECs, the CDD sponsored an assessment of these workforce competencies to determine which ones were considered essential for graduating EIS officers, again involving peers with experience supervising and hiring EIS officers. The participants first determined that EIS graduates functioned as Tier 2 epidemiologists, as defined here, at least by the time of graduation from the program, then selected essential Tier 2 competencies for EIS graduates. On the basis of the results of in-person meetings, interviews of EIS supervisors, and a supervisor survey, the EIS program staff narrowed the list to 19 Tier 2 competencies. Then, for each AEC competency statement, they used the knowledge and cognitive scales from Bloom’s revised taxonomy (3) and adapted the statement for the EIS program by replacing the action verb, as needed, with one that best exemplified the level of function expected of EIS graduates after completion of the two-year training program. For example, for the investigation competency, they replaced “select” with “explain” investigative processes and “create” with “interpret” hypotheses for the subcompetencies for EIS officers. The EIS staff will validate these competency statements and their implied level of complexity again with peers and use these validated competency statements to reevaluate the didactic and experiential learning components of the EIS program.

The CDD sponsored a similar process to define competencies for public health informaticians (25) and is following a similar process to reevaluate the didactic and experiential learning components of the EIS program.

CHALLENGES AND OPPORTUNITIES

We have proposed an integrated model for outcome-based workforce development built on adult learning theory, competency-based education, and the expanded Dreyfus model. We recognize, however, that challenges exist in fully implementing and evaluating this model. Most of the evidence base for use of these constructs or other rigorous evaluation of methods in workforce education comes from other disciplines, especially other health-related disciplines. Public health needs a stronger evidence base and more research in educational methods. This model provides a framework for a potential research agenda, answers to which will strengthen public health workforce education.

For example, this integrated model, with its explicit inclusion of adult learning theory, reinforces the importance of the outcome of educational activities on the learning of the learner to possess practical reasoning (72). Practical reasoning is more likely when educational activities involve a "direct encounter with the phenomena being studied rather than merely thinking about the encounter, or only considering the possibility of doing something about it" (11). Academia should embed practical experiences with realistic conditions of ambiguity, benefits, and consequences, as well as opportunities for reflecting on these experiences in its educational programs. The CEPH requirement for practicum underscores this point, as do those who have discussed similar concerns in public health and other health professional workforce development (18, 34, 35, 38, 39, 43, 44, 46, 56, 62, 77, 79). Public health needs to assess the relative educational benefits of different methods for providing practical experiences.

The practice community, in contrast, should take a more academic approach to education of the workforce, balancing this with the need to provide service while learning (11, 24). The public health practice community needs to improve the ability of public health professionals to practice evidence-based public health (i.e., to use scientific reasoning in the real-world environment to translate science into practice) (6, 14, 49, 64, 82). However, critical questions remain unanswered. For example, public health educators need to evaluate whether academic or practice programs using adult learning principles are more effective than those
that do not. In public health we should investigate which instructional methods are most effective in engaging the adult learner in optimized learning for a given discipline or even within a given discipline (e.g., infectious versus chronic disease epidemiology). We must evaluate under what circumstances an individually based or team-based design of learning is more effective. Further, public health needs to develop the science base for assessing the use of technology-based, just-in-time instruction that is becoming the cornerstone of contemporary communication.

As mentioned above, an abundance of competency sets have broad applicability for public health professionals [e.g., COL competencies, and competencies in public health law, emergency preparedness, and informatics (4, 9, 25, 26, 28, 37, 46, 77)], making the selection of relevant competencies for a given discipline difficult. In contrast, certain critical disciplines lack specific competencies in public health to guide their training (e.g., health economists, statisticians, or laboratorians). Competencies are demanding to define; competency development is resource-intensive when done well. We in public health need to determine the best methods for developing competencies, how a professional group determines which competencies are the right ones—in terms of specificity and target level,—and the best practices for designing training to achieve competencies. In addition, although we have underscored the importance of competencies for accountability and for defining professional standards, assessment of the achievement of a complex mix of competencies is challenging, and assessing the contribution of the educational intervention to the accomplishment even more so. ACGME assesses competencies for physicians, as increasingly are medical boards in maintenance of board certification for physicians, using four types of tools: cognitive tests, direct focused observation of performance, 360-degree assessments, and portfolios of learning (1, 55). Although such methods are presumably adaptable to public health as well, we need to evaluate and develop useful public health equivalents. It would be challenging to develop a standardized community, similar to the standardized patient in clinical medicine for direct observation of performance, but disaster and table-top exercises and other simulations mimic the public health practice environment. We should identify the most cost-effective methods of measuring competence for the public health workforce. With its explicit recognition that workforce development is career-focused and, thus, outcome-based in a larger sense, the expanded Dreyfus model in public health complements the other two conceptual approaches of the integrated model. Quality professional education attends to the needs of the adult learner and is competency-based. By adding insights from the Dreyfus model into the systematic design of instruction, the curriculum can be enhanced to include challenging and thought-provoking exercises, as well as experiential learning activities that encourage more sophisticated skills acquisition and career progression. We need to determine how to identify and assess best practices in workforce education that facilitate career progression through the Dreyfus stages. Do competencies and use of this integrated model make a difference? We must improve methods to evaluate whether we move from the Dreyfus model and competencies to improved competence of the workforce.

Workforce development is a critical area for collaboration between academia and practice; however, both sides often feel that they do not have enough time, and academics often deem public health practice not rigorous enough, and practitioners often view academic education as not relevant enough. Thus, collaboration can be stifled by this perceived disconnect. Nevertheless, we believe that the integrated model of outcome-based workforce development described here is both rigorous and relevant and that it frames critical research questions worthy of collaborative investigation by academia and practice. We should assess whether this integrated model, with competencies defining rigorous and relevant outcomes and metrics, provides the common
language to facilitate dialog among academia and practice and increases workforce development expertise on both sides. A closer partnership between academia and practice using an integrated model for outcome-based workforce development and education will enhance the multidirectional transfer of skills and knowledge and improve our ability to translate research into practice, ultimately improving the public’s health.

**FUTURE DIRECTIONS**

Development and education of the public health workforce, whether in academia or practice, should be rigorous and outcome-based. Workforce development programs should be designed to fill a specific need and have clear, relevant, and measurable program goals and outcomes. Programs should be able to justify their instructional approach and use sound instructional design principles. Educational programs should monitor measurable quantitative and qualitative outcomes and seek external peer review of their curricula, and use these results to improve the program. In this review, we proposed an integrated model for outcome-based workforce development in public health that provides a context based in adult learning theory and directed toward professional career development. We believe that this integrated model provides a framework for a research agenda in the area of public health workforce education, as highlighted in the Challenges and Opportunities section above.

To use this integrated model most effectively and to answer the research questions posed, a new discipline with expertise in educational methods and public health, one devoted to quality assurance in public health workforce development, is needed, along with a journal dedicated to education within the public health profession. This discipline will develop and evaluate best practices in the scholarship of teaching and learning in public health education, similar to educators in the medical field, and publish its work to disseminate knowledge about effective methods of workforce education. The development of such a discipline requires partnership between academia and practice; ultimately, this partnership will improve the quality of education in academic and practice settings and, through workforce education, speed the translation of science into practice. We in public health education should link theory and practice because it ties the science of knowing with the art of knowing how. Or, as underscored by David Leach, former CEO of ACGME, when he suggested that public health and ASPH consider use of the Dreyfus model (55), we should ensure that the qualified are also competent.

**SUMMARY POINTS**

1. Workforce education and design of the learning environment should incorporate principles of adult learning.
2. Competencies are important for defining educational goals, targeting instruction, and defining and evaluating educational outcomes.
3. The Dreyfus model of skills acquisition provides key context and guidance for selecting skill level (i.e., which specific competencies to use as a target) and focuses on longer-term career outcomes.
4. The systematic design of instruction integrates all three concepts for high-quality, effective outcome-based workforce education.
5. Academia and public health practice should work together in a continuum for public health workforce education. Academia should include more practice-based experiences in their educational programs, and practice should take a more academic, rigorous approach to workforce development.

6. Public health needs a discipline focused on public health workforce education.

DISCLOSURE STATEMENT

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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LITERATURE CITED

Figure 1
Integrated model for outcome-based workforce development.

Figure 2
Expanded Dreyfus model in public health.
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