Competency Mapping and Analysis for Public Health Preparedness Training Initiatives

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SYNOPSIS

"Every health department fully prepared; every community better prepared."

J.M Henderson, Associate Director
Terrorism, Preparedness, and Response
Centers for Disease Control and Prevention
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Competency-based education and assessment initiatives have been completed in a number of health care and health management professions during the past decade. In addition, several competency specification endeavors have been similarly undertaken in relation to the field of public health, including the development of the Council on Linkages between Academia and Public Health Practice competency model and the initial competency modeling Delphi survey completed by the Association of Schools of Public Health. All of these organizations have subsequently had to address the many challenges and barriers to the dissemination and integration of their models into specific educational and professional development practices. As previously addressed by many researchers in the field of competency modeling and deployment, understanding and acceptance of competency-based systems are formidable goals, often rife with controversy. This article describes the processes undertaken by The University of Michigan Center for Public Health Preparedness to integrate competency-based learning and assessment in educational and training initiatives with its many community partners.

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COMPETENCY-BASED LEARNING AND ASSESSMENT

During the past decade, there has been a growing interest in learning and competency-based systems in various areas of education, training, and professional development, especially in higher education.[1–3] Competency-based education and assessment initiatives have been completed in a number of health care and health management professions, including the Accreditation Council for Graduate Medical Education (ACGME), the American College of Healthcare Executives (ACHE), the American Hospital Association (AHA), the American Nurses Association (ANA), the National Association of Boards of Pharmacy (NABP), and the National Center for Healthcare Leadership (NCHL). In addition, several competency specification endeavors have been undertaken in relation to the field of public health. The Council on Linkages between Academia and Public Health Practice completed development of a competency model in 2001, and the Association of Schools of Public Health (ASPH) initiated competency modeling activities in 2003. The specific core competency domains and related sub-competencies that have been disseminated to date by many of these organizations and other authors have been summarized in previous work by research teams working in collaboration with the NCHL.[4] Also included in the NCHL-sponsored work are a summary of recent progress in competency identification for health management; an historical overview on competency-based education and assessment; a glossary of terms frequently used in discussions surrounding competency-based education, training, and professional development; and an outline of key challenges and benefits associated with competency modeling.[4]

With support from the Centers for Disease Control and Prevention (CDC) and the Association of Teachers of Preventive Medicine through a 2002 cooperative agreement, the Columbia University School of Nursing's Center for Health Policy also developed a competency model to provide a foundation from which to build locally relevant training, exercises, and drills for eight types of CDC-targeted public health workers. The resulting work, entitled *Bioterrorism and Emergency Readiness: Core Competencies for All Public Health Workers*, includes nine domains of competencies.[5] Model developers defined "competency" as a complex combination of knowledge, skills, and abilities—frequently referred to as KSAs in the educational and instructional development and measurement literature—demonstrated by organization members that are critical to the effective and efficient functioning of the organization.[5]

All of the organizations engaged in competency specification and modeling for their members have subsequently had to address the many challenges and barriers to the dissemination and integration of their models into specific educational and professional development practices. As previously addressed by many researchers in the field of competency modeling and deployment, understanding and acceptance of competency-based systems are formidable goals, often rife with controversy.[3] Hence, competency-based education and training has long been avoided by educators for a number of reasons,[4] including fear of change, lack of understanding of competency-based pedagogy practices and deployment methodologies, confusing terminology, development costs and time constraints, inadequate consensus building, and questionable assessment techniques.[4]

The purpose of this article is to describe the processes undertaken by the Michigan Center for Public Health Preparedness (MI-CPHP) to integrate competency-based learning and assessment in all its educational and training initiatives. In partnership with the Michigan Department of Community Health, the Michigan Association for Local Public Health, and the Michigan Public Health Training Center, the MI-CPHP strives to ensure that frontline public health workers are well prepared to respond to bioterrorism and other public health crises.

CURRICULUM DEVELOPMENT AND THE ROLE OF BLOOM'S TAXONOMY AND DREYFUS' MODEL OF SKILL DEVELOPMENT

Seminal work in educational competency identification and measurement by Benjamin S. Bloom and his colleagues at the University of Chicago in the early 1950s led to a theoretical framework to facilitate communication about curriculum development and assessment among educators.[6] Bloom's *Taxonomy of Educational Objectives* provided a set of standard classifications to facilitate definition of the many nebulous terms often encountered in curriculum development and evaluation initiatives.[6] The framework was used to address educational outcomes in three major areas:

- *Cognitive domain.* Those outcomes/objectives that deal with recall or recognition of knowledge and the development of intellectual abilities and skills. (This domain today remains the one most central to traditional curriculum development programs and to standardized test development and instrumentation.)
- *Affective domain.* Objectives that describe changes in interest, attitudes, and values and the development of appreciation and adequate adjustment. (This domain is often the most difficult to describe due to the lack of clarity and agreement among educators in their specification of appropriate behaviors for assessment. As well, procedures used in this domain remain somewhat primitive by today's evaluation standards.)
- *Psychomotor domain (physical skills).* Those objectives addressing manipulative or motor skill areas, i.e., ice skating, surgical procedures, etc. (This was the last of the three educational domains to be classified in the 1970s.)

The cognitive and affective domains are the most relevant for first-line bioterrorism and emergency readiness training initiatives. The progressive levels of development for both of these domains are outlined below. A more detailed overview of the entire classification system, including definitions of the categories and illustrative action-verb behavioral objectives for each category, can be found in the original works by Bloom and Krathwohl,[6,7] as well as in the review work by the NCHL researchers.[4]

Cognitive domain	Affective domain
1.0 Knowledge	1.0 Receiving/attending
2.0 Comprehension	2.0 Responding
3.0 Application	3.0 Valuing
4.0 Analysis	4.0 Organization
5.0 Synthesis	5.0 Characterization by value or value complex
6.0 Evaluation	

In addition to having a common language to facilitate curriculum planning and assessment, understanding the progressive stages for learning and skill development by individual learners is also important. Based on their work focused on the acquisition and progression of skills, Dreyfus and Dreyfus[8] emphasize that the range of proficiency and expertise varies across different groups, as well as across different career stages. The Dreyfus model of skill development from novice to expert is perhaps more readily understood in relation to the progression of skill development from that of a beginning ice skating student (novice) to Olympic level competition (expert performance). This skill progression model can also be used to facilitate communication and planning among those involved with the development of curricula for course/training events.

The Bloom and Krathwohl taxonomies, as well as Dreyfus' skill progression conceptual framework, have stood the test of time for a number of decades and are widely recognized as important paradigms in planning and developing educational, training, and professional development curricula. They have also been of significant assistance in workforce educational development and training endeavors involving the identification of critical traits and skills for successful performance in relevant situations, job events, and crises.[1] In addition to the bioterrorism and emergency readiness competencies, these models have served as key theoretical and conceptual underpinnings for the development of all course and training event planning activities for the MI-CPHP.

THE MI-CPHP COMPETENCY INTEGRATION APPROACH

The MI-CPHP is part of a national network of 42 centers for public health preparedness. Supported by the CDC, the ASPH, and their partners—the Association of State and Territorial Health Officials (ASHTO) and the National Association of County and City Health Officials (NACCHO)—these centers comprise a workforce development initiative designed to link academic expertise to public health practice by providing educational programming and training assistance. Central to these initiatives is the incorporation of competency-based learning and assessment.

The MI-CPHP has focused its efforts on state and local public health workers in the state of Michigan, working closely with them to identify key training priorities and preparedness objectives.[9] The specific objectives of the MI-CPHP are to:

- Assess the training needs of state and local public health workers in Michigan to determine appropriate curricula;
- Address community needs through implementation of competency-based training and education programs for lifelong learning;
- In partnership with state and local health departments, strengthen the capacity of Michigan's state and local public health workforce for terrorism preparedness and emergency public health response;
- Increase the number, type, and distribution of health professionals who comprise a preparedness and response workforce;
- Evaluate the impact of training offerings in meeting state and national preparedness goals;
- Participate in the network of programs contributing to national terrorism preparedness and emergency response capacity by sharing expertise and resources across jurisdictions; and
- Strengthen the capacity of the University of Michigan School of Public Health to coordinate and apply its academic expertise and resources toward state and national public health preparedness efforts.

During its first year, the MI-CPHP responded to immediate training needs and presented seven on-site courses, reaching approximately 1,000 public health workers representing all of Michigan's emergency management regions. In addition, the center provided more than 100,000 hours of training indirectly through CD-ROM and other Internet resources, exhibits, and media coverage.[9] All of the MI-CPHP training offerings are based on the nine CDC core competencies for public health workers, including the knowledge, skills, and abilities critical to effective and efficient performance of various job functions.

A 21-member curriculum committee oversees all planning and development of the MI-CPHP training offerings. Committee members represent 11 state and county agencies and two state academic institutions. Meeting bimonthly to review and approve MI-CPHP curricula and to guide the course of MI-CPHP activity, the committee strives to ensure that all courses are high quality, competency-based, and applicable to public health practice—as well as of value to local groups engaged in preparedness activities. The curriculum committee also directs the work of an evaluation committee to assess major outcomes from all MI-CPHP training initiatives and courses.[9]

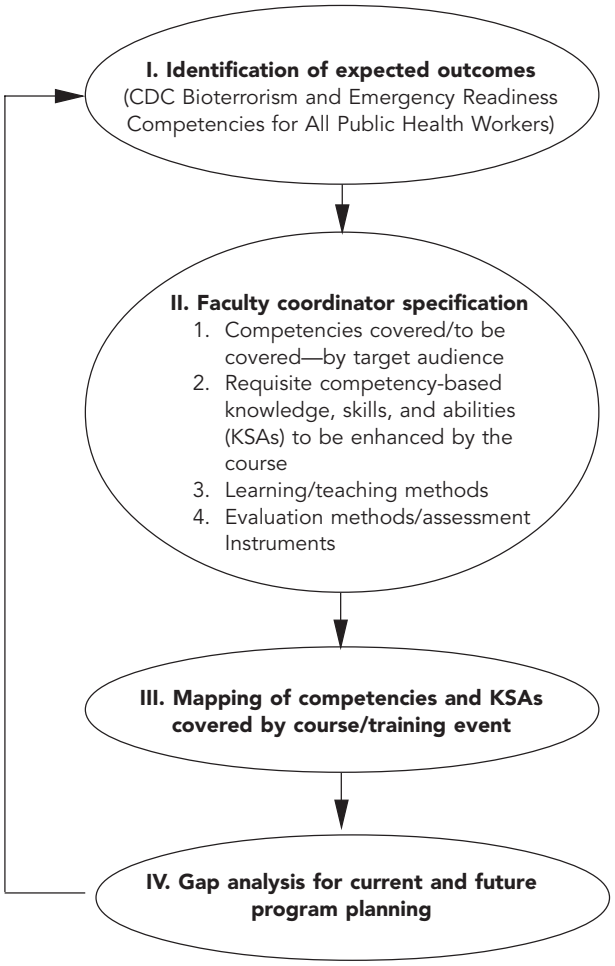
In fall 2003, the curriculum committee initiated the Competency Mapping and Gap Analysis Project to (*1*) review progress in MI-CPHP competency-based initiatives, and (*2*) develop methods for ensuring the adoption and utilization of competency-based learning and assessment methods in all course offerings. The following sections describe the processes and steps involved in disseminating and integrating competency-based practices in all of the MI-CPHP training initiatives. Four primary tools are used to guide all MI-CPHP course and/or training event competency-based learning and assessment planning and development activities: the Learning and Assessment Planning (LAP) Process Flow Chart; Training Event Master Plan; Competency Integration Model (CIM); and Competency Map.

Learning and Assessment Planning process flow chart

A four-step competency-based learning and assessment (LAP) process was developed—based on common educational curriculum and instructional design protocols and practices—to guide future MI-CPHP course and training event planning activities. As depicted in Figure 1, the LAP process begins with the identification of expected outcomes for the programmed learning or training activity (Step I), based on *Bioterrorism and Emergency Readiness: Core Competencies for all Public Health Workers*.[5] The specific competencies for each training event or course are derived from those listed for each of the eight types of CDC-targeted public health workers.

If the offering is targeted for multiple audiences, the CDC competencies are reviewed with respect to each of these groups (Step II). Once faculty/training coordinators identify the competencies to be integrated into both the learning and assessment activities for the training event, they are next asked to delineate the specific knowledge, skills, and abilities that are to be enhanced by the course—more specifically, what are attendees "to know" and be able "to do" after the course or training interactions. They also outline the specific learning and evaluation methods for measuring training intervention outcomes and impact. In Step III, the specific KSAs for the training activity are also designated or "mapped" in relation to the complete CDC competency listing. This KSA map (the "Competency Map") is then used for modification of the course/training event prior to the initial offering, as well as for ongoing review and improvement of repeated initiatives. In addition, it is deployed for overall curriculum analysis in relation to the adequacy of the training, based on specific gaps revealed by the mapping process (Step IV).

Figure 1. Competency-based learning and assessment plan process flow chart



SOURCE: The Bioterrorism and Emergency Readiness Training Initiative, Michigan Center for Public Preparedness, The University of Michigan School of Public Health, Ann Arbor, MI.

KSAs = knowledge, skills, and abilities

Training Event Master Plan

Once faculty and/or training coordinators have completed the LAP processes, including the preliminary mapping and review of the competencies to be covered, they use the Training Event Master Plan to record final decisions regarding the training initiative, including specific core competencies and sub-competencies; KSAs to be enhanced; learning methods; and assessment/evaluation instruments.

An example of a master plan for a specific MI-CPHP course is shown in Figure 2. The master plan outlines the course name, faculty/coordinator(s), competencies and sub-competencies, and KSAs for each course offering. It identifies any training process voids and reinforces the importance of linking the assessment methods to both the types of competencies covered and the assessment methods that will be utilized.

Competency Integration Model

Prior to any final mapping activities, faculty/coordinators are provided a Competency Integration Model (CIM)—often referred to as the Competency Cube—that integrates the previously discussed Bloom learning and assessment and Dreyfus development theories with the CDC-specified competencies. As shown in Figure 3, a three-dimensional model is used to depict the integral relationships of the three overarching bioterrorism and emergency readiness competency domains (which subsume related competencies, sub-competencies, and specific KSAs) with both skill development stages and the level of learning typically involved with each stage.

The CDC competency model includes three global domains for competency for each of the eight groups of public health workers targeted for bioterrorism and emergency readiness training (as depicted on the *y*-axis of the cube). These domains include preparedness and planning, response and mitigation, and recovery and evaluation. Across these three domains, there are nine core competencies and 75 related sub-competencies, stated in behavioral or action-oriented verbs, for outcome measurement purposes. Each of these competencies, as depicted on the *z*-axis of the cube, can be classified in relation to the level of cognitive functioning or learning required in the training initiative based on Bloom's *Taxonomy of Educational Objectives* (*y*-axis).[6] As

Figure 2. Competency-based learning and assessment program development—sample Training Event Master Plan

Course/faculty	*Target audience(s)/ date(s)*	*CDC-specified core and sub-competencies*	*Faculty specification of knowledge, skills, and abilities to be enhanced*	*Learning methods*	*Assessment/ evaluation instruments*
1. Bioterrorism & Emergency Preparedness—A State and Local Perspective—Core Course #1	Public health leaders (3/25)	I. Preparedness and planning: 8 core competencies and 42 sub-competencies II. Response and mitigation: 1 core competency and 19 sub-competencies III. Recovery and evaluation: 3 sub-competencies	1. Describe the public health role in the national, state, and local emergency management and homeland security systems for all hazards with special emphasis on bioterrorism preparedness and response. 2. Describe the emergency management and response system, including chain of command and jurisdiction. 3. Describe functional roles and appropriate actions in emergency response. 4. Recognize limitations in knowledge, skills, and abilities and identify key resources or assets for supplemental assistance or referral. . . . 16. Access the Internet for . . .	Lectures Readings Class simulation activities	Pre/post written test Case analysis Observation checklist

SOURCE: The Michigan Bioterrorism and Emergency Readiness Training Initiative, Michigan Center for Public Health Preparedness, University of Michigan School of Public Health, Ann Arbor, MI.

well, the competency can be matched to the specific skill level of the learner/trainee in relation to Dreyfus' model of skill development (*x*-axis).[8]

As illustrated in the Competency Cube, the skill stages for the MI-CPHP course/training curricula here have been designated starting with "awareness," progressing to "proficiency," and then to "expert" performance at the highest level. These stages fit well with Bloom's progression of cognitive learning. For instance, at the awareness or new role/trainee level, the acquisition of specific related knowledge (facts and concepts) and comprehending their meanings and relationships is about all that can be expected in related courses and training events. However, with additional training and exercises, other skills can be developed in relation to application and analytical proficiency. With even more advanced educational and experiential opportunities, an individual in a specific role can progress skill-wise into the mastery level, with the capability of both synthetic (to develop a plan for; to create exercises; etc.) and evaluative cognitive functioning.

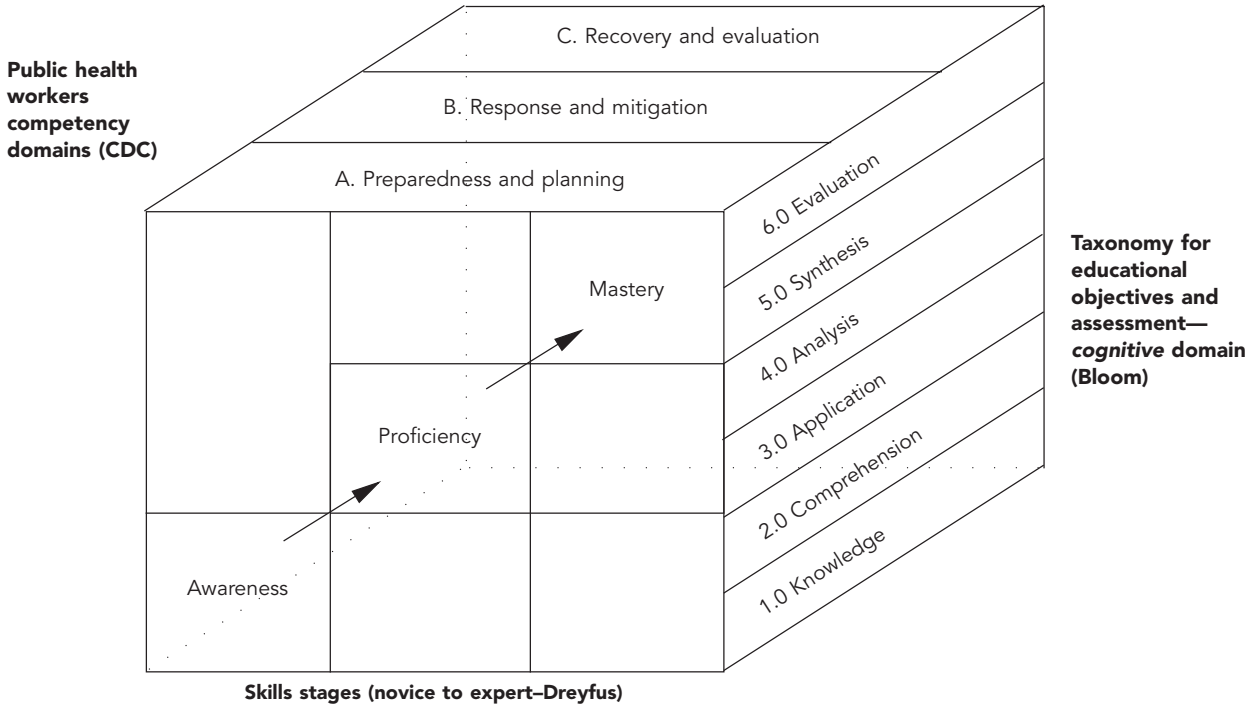
In Figure 4, Core Competency #6 is used to illustrate how the three CIM frameworks can be deployed to facilitate the infusion of competency-based learning and assessment into course/training event offerings. By using both the taxonomy and skill stage frameworks in relation to this core competency, faculty/training coordinators can better identify, specify, and communicate essential learning/training objectives and expected outcomes. In addition, they can plan and outline appropriate teaching methods and assessment approaches for the level of learning (Bloom) associated with the skill/experience stage (Dreyfus) targeted for learner achievement.

Once faculty/trainers are more familiar with these frameworks, they also begin to incorporate higher-level learning activities and assessment processes into their curricular/training planning endeavors. Without such an understanding of these educational models and practices, the level of instruction tends to be targeted at the knowledge, comprehension, and awareness only stages. Therefore, didactic presentations by experts in the field are more readily relied upon, vs. planning and conducting higher-level learning and assessment activities. Faculty are quite familiar with and often more comfortable with lectures and written tests (most usually in a multiple-choice format) on facts, concepts, and general principles, vs. design and development of more sophisticated training activities and evaluation methods—such as action/experiential-based learning and reflective self, peer, and expert assessment—that facilitate higher-order learning, ultimate performance, and long-term retention.

Curriculum Competency Map

A sample of the first page of the MI-CPHP Master Curriculum Competency Map is provided in Figure 5. The three CDC competency domains and 75 related competencies and

Figure 3. Competency Integration Model



SOURCE: The Michigan Bioterrorism and Emergency Readiness Training Initiative, Michigan Center for Public Health Preparedness, University of Michigan School of Public Health, Ann Arbor, MI.

sub-competencies are listed down the left-hand column of the map. Seven courses held during the first year of training are displayed across the top of the map. Bloom's taxonomic categories are also provided across the top of the columns to assist those completing the mapping activity. As noted, the faculty-specified learning objectives are determined for each class or training session, then analyzed in relation to Bloom's taxonomy and noted on the master Competency Map. Course/training coordinators can readily begin to see both the areas receiving adequate attention per the overarching goals for the learning event, as well as the gaps where additional training emphasis is required for iterative planning and training event development.

The Curriculum Competency Map also provides a picture of both the level of learning (e.g., Bloom's 1.0 Knowledge to 6.0 Evaluation) and skill stage (awareness, proficiency, and mastery) at which the course is currently targeted. For example, if a course is developed for new public health laboratory staff early in their careers, the Competency Map can be reviewed to guide planning and to encourage the utilization of appropriate learning methods ("awareness" skill development) for enhancing knowledge transfer and comprehension regarding the role. If more mastery or proficiency is required for those who have been in this role for a longer period of time, both the teaching and assessment methods can be elevated accordingly to ensure a higher level of functioning in relation to each expected competency.

DISCUSSION AND CONCLUSION

The MI-CPHP is currently conducting its third year of training courses with its many statewide and community-based partners. While the processes outlined in this article at first appear complex and time-consuming, experience has shown that training coordinators quickly embrace the four competency-focused curriculum and training planning tools and are pleased to have common frameworks and vocabulary for developing and reviewing their training endeavors. After an initial, hour-long orientation session focused on the tools, faculty become reasonably proficient at developing their Training Event Master Plans quickly relative to prior course development time investments. This in turn also greatly enhances overall curriculum and training event coordination by providing a master blueprint of the competencies being integrated in each of the offerings, as well as the level of learning and skill development for the targeted public health worker.

The MI-CPHP's attention and commitment to developing uniform competency-based learning and assessment deployment processes and integration techniques has already

Figure 4. Illustration of competency-based learning and assessment curriculum/training event planning

CDC Core Competency #6—Describe communication role(s) in emergency response:
- Within the agency using established communication systems
- With the media
- With the general public
- Personal (with family, neighbors)

Skill stage	*Learning/training objective*	*Taxonomy*	*Teaching/training method*	*Assessment method*
New learner (awareness stage)	Know about the key tasks associated with a communication role	(Cognitive domain—Knowledge–K)	• Lecture • Readings	• Written test
	Comprehend the importance of the communication role in an emergency.	(Cognitive domain—Understanding–U)	• Simulation exercise	• Discussion session
Advanced learner (proficiency stage)	Effectively and efficiently use established communications systems within an agency.	(Psychomotor domain)		• Observation checklist
Highly experienced learner (mastery stage)	Develop a plan for conducting training exercises for emergency response communication simulation activities.	(Cognitive domain—Synthetic–S)	• Trial plan development	• Assessment of trial plans
	Evaluate a trainee reporting an emergency to the media	(Cognitive domain—Evaluation–E)	• Simulation exercise	• Simulation–observation checklist

SOURCE: The Michigan Bioterrorism and Emergency Readiness Training Initiative, Michigan Center for Public Health Preparedness, University of Michigan School of Public Health, Ann Arbor, MI.

led to increased faculty/trainer understanding and comprehension (the "awareness" stage in skill development) of the pedagogical principles and frameworks underlying competency-based training initiatives. The four planning and competency integration tools described in this article have also enhanced the initial development of a common language to facilitate dialogue and planning among individual faculty and overall program/training coordinators. In addition, having a process for initiating competency-based teaching and evaluation methods has lessened faculty/trainer anxieties about how to utilize the CDC competencies in their training initiatives.

As faculty receive consultation and experience with the tools, their fears and objections are diminished and they further MI-CPHP goals regarding the acceptance and utilization of competency-based pedagogical practices. Once the theory and related processes are translated into practice, and specific techniques for integrating the competencies into the course training events are provided, concerns regarding the actual costs and time outlays for developing competency-based teaching and training methods are also lessened.

Each time a faculty member or trainer utilizes the four integration and planning tools, s/he increases proficiency and mastery in deploying competency-based learning and assessment practices. Furthermore, s/he can increase attention to the level of teaching and training techniques and can be more attuned to elevating them when appropriate for the targeted audience. Finally, as a result of increased understanding and capabilities in developing and utilizing these teaching methods, faculty and trainers have more time to examine their assessment techniques and seek out consultation in applying appropriate evaluation methods and instruments—both in relation to the desired learning outcomes and levels of skill enhancement for their learners.

A major goal for future MI-CPHP competency-based curriculum planning is to align teaching and assessment methods for higher levels of learning and skill retention. Therefore, rather than focusing on content knowledge transfer and comprehension in courses and training events, action-based/experiential activities simulating actual work environment tasks will be used for participant reflection on their skill development, as well as comparison with the assessments of their peers, faculty, or other experts observing their performance.

In summary, competency-based education and training approaches can be formidable and complicated for faculty

Figure 5. Curriculum competency mapping

Competency Domain I: Preparedness and Planning (8 competencies, 75 sub-competencies)	*Awareness*			*Proficiency*		*Mastery*	
	K = Knowledge	*C = Comprehension*		*A = Application*	*AN = Analysis*	*S = Synthesis*	*E = Evaluation*
Competencies/sub-competencies	*1*	*2*	*3*	*4*	*5*	*6*	*7*
	BT core course #1	*Risk commun-ication for health education*	*Risk commun-ication for health officers*	*CERC*	*BT core course #2*	*Psycho-social issues*	*Weapons of mass destruction*
1. Describe the public health role in emergency response in a range of emergencies that might arise.	K				K		K
A. Communicate public health information/ roles/capacities/legal authority accurately to all emergency response partners (other public health agencies, other health agencies, and other government agencies) during planning, drills, and actual emergencies.					A		
B. Evaluate/review the public health laws of the jurisdiction on a regular schedule, to assess that they are current and up-to-date pertaining to BT events.				E			
C. Maintain regular communication with partner professionals in other agencies involved in emergency response. (Includes contributing to effective community-wide response through leadership, team building, negotiation, and conflict resolution.)			A				
2. Describe the chain of command in emergency response.	C				C		
A. Describe the chain of command and management system (incident command system) for emergency response in the jurisdiction.				A			
B. Maintain regular communication with emergency response partners. (Includes maintaining a current directory of partners and identifying appropriate methods for contact in emergencies.)			A				
B.i. Maintain agreements with partners from within the jurisdiction and from other jurisdictions to allow the public health agency to secure assistance and other resources.			A				
C. Maintain regular communication with partner professionals in other agencies involved in emergency response. (Includes contributing to effective community-wide response through leadership, team building, negotiation, and conflict resolution.)			A				

SOURCE: The Michigan Bioterrorism and Emergency Readiness Training Initiative, Academic Center for Public Health Preparedness, University of Michigan School of Public Health, Ann Arbor, MI.

BT = bioterrorism

CERC = Crisis and Emergency Risk Communication

and training coordinators, thereby constraining the acceptance and dissemination of a valuable system for ensuring both baseline capabilities and the elevation of skills in bioterrorism and emergency readiness. The tools provided by the MI-CPHP for increasing faculty and trainer understanding, acceptance, and utilization of competency-based learning and assessment methods provide an initial step toward achieving higher-level leadership and synergies across the many partners involved in public health preparedness, both locally and across the nation.

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