Enabling Competency-based Education: An Illustration

Version: 1.0
Date: September 15, 2016
Author: MedBiquitous
Competencies Working Group
Contact: vsmothers@jhmi.edu

MedBiquitous Standards Public License and Terms of Use

MedBiquitous Standards (including schemas, specifications, guidelines, sample documents, sample code, Web services description files, and related items) are provided by the copyright holders under the following license. By obtaining, using, and or copying this work, you (the licensee) agree that you have read, understood, and will comply with the following terms and conditions.

The Consortium hereby grants a perpetual, non-exclusive, non-transferable, license to copy, use, display, perform, modify, make derivative works of, and develop the MedBiquitous Standards for any use and without any fee or royalty, provided that you include the following on ALL copies of the MedBiquitous Standards or portions thereof, including modifications, that you make.

1. Any pre-existing intellectual property disclaimers, notices, or terms and conditions. If none exist, the following notice should be used: "Copyright © [date of release] MedBiquitous Consortium. All Rights Reserved. http://www.medbiq.org"

2. Notice of any changes or modification to MedBiquitous Standards files.

3. Notice that any user is bound by the terms of this license and reference to the full text of this license in a location viewable to users of the redistributed or derivative work.

In the event that the licensee modifies any part of the MedBiquitous Standards, it will not then represent to the public, through any act or omission, that the resulting modification is an official specification of the MedBiquitous Consortium unless and until such modification is officially adopted.

THE CONSORTIUM MAKES NO WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, WITH RESPECT TO ANY COMPUTER CODE, INCLUDING SCHEMAS, SPECIFICATIONS, GUIDELINES, SAMPLE DOCUMENTS, WEB SERVICES DESCRIPTION FILES, AND RELATED ITEMS. WITHOUT LIMITING THE FOREGOING, THE CONSORTIUM DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND ANY WARRANTY, EXPRESS OR IMPLIED, AGAINST INFRINGEMENT BY THE MEDBIQUITOUS STANDARDS OF ANY THIRD PARTY PATENTS, TRADEMARKS, COPYRIGHTS OR OTHER RIGHTS. THE LICENSEE AGREES THAT ALL COMPUTER CODES OR RELATED ITEMS PROVIDED SHALL BE ACCEPTED BY LICENSEE "AS IS". THUS, THE ENTIRE RISK OF NON-PERFORMANCE OF THE MEDBIQUITOUS STANDARDS RESTS WITH THE LICENSEE WHO SHALL BEAR ALL COSTS OF ANY SERVICE, REPAIR OR CORRECTION.

IN NO EVENT SHALL THE CONSORTIUM OR ITS MEMBERS BE LIABLE TO THE LICENSEE OR ANY OTHER USER FOR DAMAGES OF ANY NATURE, INCLUDING, WITHOUT LIMITATION, ANY GENERAL, DIRECT, INDIRECT, INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES, INCLUDING LOST PROFITS, ARISING OUT OF ANY USE OF MEDBIQUITOUS STANDARDS.

LICENSEE SHALL INDEMNIFY THE CONSORTIUM AND EACH OF ITS MEMBERS FROM ANY LOSS, CLAIM, DAMAGE OR LIABILITY (INCLUDING, WITHOUT LIMITATION, PAYMENT OF ATTORNEYS' FEES AND COURT COSTS) ARISING OUT OF MODIFICATION OR USE OF THE MEDBIQUITOUS STANDARDS OR ANY RELATED CONTENT OR MATERIAL BY LICENSEE.

LICENSEE SHALL NOT OBTAIN OR ATTEMPT TO OBTAIN ANY PATENTS, COPYRIGHTS OR OTHER PROPRIETARY RIGHTS WITH RESPECT TO THE MEDBIQUITOUS STANDARDS.

THIS LICENSE SHALL TERMINATE AUTOMATICALLY IF LICENSEE VIOLATES ANY OF ITS TERMS AND CONDITIONS.

The name and trademarks of the MedBiquitous Consortium and its members may NOT be used in advertising or publicity pertaining to MedBiquitous Standards without specific, prior written permission. Title to copyright in MedBiquitous Standards and any associated documentation will at all times remain with the copyright holders.

Table of Contents

Acknowledgements

The MedBiquitous Consortium wishes to acknowledge the MedBiquitous Competencies Working Group members, invited experts, and other individuals that contributed to the creation of this document.

Co-chairs:

- Rosalyn Scott , MD, Department of Veteran's Affairs
- Tim Willett, MD, SIM-one

Members:

- Andrew Allen, Elsevier
- Paul Bergen, Tufts University
- Terri Cameron, Association of American Medical Colleges
- Mary Jo Clark, American Association of Colleges of Nursing
- Stephen Clyman, National Board of Medical Examiners
- Sascha Cohen, University of California, San Francisco
- Luke Diorio, Association of American Medical Colleges
- James Fiore, American Board of Surgery
- Ted Hanss, University of Michigan
- Erik Hofer, University of Michigan
- Susan Hollar, University of Michigan
- Josh Jacobs, Association of American Medical Colleges
- Chandler Mayfield, University of California, San Francisco
- JB McGee, University of Pittsburgh
- Jim Merritt, Elsevier
- Christian Osian, Knowledge4You
- David Price, M.D., American Board of Family Medicine
- Lesley Southgate, M.D., St. George's University of London
- Christos Vaitsis, Karolinska Institute
- Radu Vestemean, Knowledge4You
- Nabil Zary, Karolinska Institute

Invited Experts:

- S. Toufeeq Ahmed, Vanderbilt University
- Susan Albright, M:ed:Integrate
- Connie Bowe, Partners HealthCare International
- Kelly Caverzagie, University of Nebraska Medical Center
- Sascha Cohen, University of California San Francisco
- Ian Graham, Stawell Regional Health, East Wimmera Health Service, Beaufort & Skipton Health Service,West Wimmera Health Service, SED Clinical Education Practice and Learning
- Simon Grant, JISC-CETIS

- Linda Gwinn, Georgetown University
- Kevin Krane, Tulane University
- Jason Ladicos, one45 Software
- Steven Lieberman, University of Texas Medical Branch
- Linda Lewin, University of Maryland
- Melanie Loving, University of Texas Medical Branch
- Karen Macauley, University of San Diego Hahn School of Nursing and Health Science
- Chandler Mayfield, University of California, San Francisco
- David Melamed, MyEvaluations.com
- Paul Schilling, Schilling Consulting
- David Weiner, LCMSPlus

Introduction

Competency-based education in the health professions is becoming more complex. In addition to using a framework describing the competencies a professional must possess, many educators must describe their learners' progress in terms of milestones or performance levels and document entrustment of key Entrustable Professional Activities (EPAs). To make matters more complex, these facets of competency-based education are interrelated, with milestones describing learner performance in relation to a competency and EPAs requiring certain competencies for a learner to earn entrustment.

Without systems to bring together competency-based assessment data, getting a comprehensive view of a learner's competency development – or a cohort's progress - is extremely difficult. Technology linking competencies, milestones/performance levels, and EPAs is essential to manage the complexities of assessing the health professions learner using a competency-based and performance-based model.

Enabling Competency-Based Education

Open technology standards developed by MedBiquitous serve as a lingua franca for competency-based education systems. Standards make it possible to compile, compare, aggregate, exchange, and transfer data on competency-based education in a meaningful way. With standards-based competency data, organizations can conduct meaningful analyses of their learners: following individual learners over time or comparing them to peers, as well as assessing trends within or across organizations involved in various phases of the continuum.

Purpose of This Document

This document describes how MedBiquitous standards and specifications can be used to represent competency frameworks, milestones/performance levels, EPAs, and levels of entrustment. In addition, it shows how those frameworks can be interrelated.

To illustrate these complex concepts, the MedBiquitous Competencies Working Group chose to create a non-healthcare example to shift focus from the content of the competencies, milestones, and EPAs to the way in which they are interrelated, and the way in which these interrelated structures can be used in competency-based education and assessment. All of the example competencies, milestones, and EPAs in this document are related to the profession of Short Order Cook. This document illustrates how the concepts of competencies, milestones/performance levels, and EPAs can be applied to describe professional expectations. We define some common terms, provide sample illustrations of each facet of competency-based education for the profession, and indicate how those facets are interrelated. Note that we use the generic terms "performance framework" and "performance levels" as opposed to the term "milestones," which has differing interpretations.

Definitions

In developing MedBiquitous standards, the working group used these operational definitions.

Competency: a statement describing a specific ability, or set of abilities, requiring specific knowledge, skill and/or attitude. Competencies are used to set performance standards that must be met [Albanese 1]

Competency Framework: an organized and structured representation of a set of interrelated and purposeful competency objects. [Competency Framework]

Competency Object: An umbrella term used to describe any abstract statement of learning or performance expectations, and information related to the statement. Statements can be learning outcomes, competencies per se, learning objectives, professional roles, topics, classifications/collections, etc. The Competency Object may include additional data to expand on or support the statement. The Object is abstract in the sense that it does not inherently contain information about connections of the statement to individuals or events or other objects. [Competency Framework]

Performance Framework: A set of performance levels and criteria associated with a competency framework. [Performance Framework] The ACGME Milestones are examples of performance frameworks.

Milestones: The ACGME defines as "competency-based developmental outcomes (eg, knowledge, skills, attitudes, and performance) that can be demonstrated progressively by residents and fellows from the beginning of their education through graduation to the unsupervised practice of their specialties." [Milestones]

EPAs: Ten Cate defines as "units of professional practice, defined as tasks or responsibilities to be entrusted to the unsupervised execution by a trainee once he or she has attained sufficient specific competence. EPAs are independently executable, observable, and measurable in their process and outcome, and therefore, suitable for entrustment decisions." [ten Cate 1]

Short Order Cook Competency Framework

This section provides a hierarchical listing of the competencies in our example short order cook competency framework. The numbering system used corresponds to the identifier for the competency.

C1. Plan a menu.
- C1a. Select dishes that are meal-appropriate, nutritionally balanced, seasonally appropriate, and feasible for the kitchen and eating environment.
- C1b. Provide dishes that attend to specific nutritional needs of diners and address cultural issues.
- C1c. Purchase sufficient groceries to prepare the planned menu for the expected number of guests.

C2. Ensure access to appropriate tools.
- C2a. Review kitchen utensils, preparation tools, pots, pans, and appliances to ensure adequate tools for the menu.
- C2b. Store tools so that they may be easily accessed during the preparation and cooking processes.

C3. Prepare ingredients.
- C3a. Chop, crush, or carve ingredients using knives, food processors, and blenders
- C3b. Grate cheese safely and effectively.
- C3c. Crack eggs without breaking the yolk.
- C3d. Beat eggs with appropriate tool and to appropriate consistency.
- C3e. Combine ingredients effectively and efficiently

C4. Perform core cooking skills.
- C4a. Boil and simmer water and other liquids.
- C4b. Prepare cooking surface (preheating, greasing, etc).
- C4c. Sautee, flip, and move food during the cooking process.
- C4d. Recognize when foods are done cooking.

C5. Ensure food and personal safety.
- C5a. Prevent food borne illness associated with cooking and food preparation.
- C5b. Prevent cuts through proper cutting and knife handling.
- C5c. Safely use electric and gas stoves.
- C5d. Safely use electric and gas ovens.

C6. Communicate effectively
- C6a. Politely request menu selection from a diner, offering information or insights when requested.
- C6b. Accurately record orders and any substitutions or special requests.
- C6c. Clearly communicate with servers regarding menu selections and food readiness or delays.
- C6d. Request help from others when needed, clearly assigning roles and responsibilities.
- C6e. Inquire as to the acceptability of the meal after diners have started eating, offering to correct any mistakes or replace any dish that is not acceptable.

C7. Present food to the diner.
- C7a. Plate food in a manner both attractive and appropriate to the diner's needs.
- C7b. Serve the requested dish to the diner.

Short Order Cook Performance Framework

This illustration shows what a subset of a short order cook performance framework would look like. It defines performance levels for two of the competencies in the Short Order Cook Competency Framework. For this example we have chosen performance level labels that mirror those used by the ACGME. The specification does not require using these labels.

Competency C1a. Select dishes that are meal-appropriate, nutritionally balanced, seasonally appropriate, and feasible for the kitchen and eating environment.

Critical Deficiencies	Novice			Aspirational
Does not select dishes, providing a haphazard and mismatched offering of food or no food at all. Dishes selected cannot be prepared due to unsuitability of the cooking environment.	Dishes are appropriate for the meal (ie breakfast or lunch). Dishes are focused on carbohydrates or high-fat proteins, failing to offer seasonally appropriate fruits or vegetables. Learner experiences a minor "glitch" in the cooking process, realizing that he/she is missing two or more necessary tools. Diners have great difficulty eating the food because it is not suitable for the dining environment (ie a diner receives a dish requiring a fork and knife, but no knives are	Selects dishes that are both meal-appropriate and nutritionally balanced. The meal contains fruits or vegetables, but not those in season. The cook has the tools appropriate to prepare the planned menu. Diners may have minor difficulty eating the food in the dining environment (ie diners eating on the go receive finger food, but the size of the finger food is a little large and awkward to eat.)	Selects dishes that are meal-appropriate, nutritionally balanced, and contain seasonal fruits or vegetables. The cook has the tools appropriate to prepare the planned meal, and diners have no difficulty whatsoever eating the food in the dining environment.	Seasonally appropriate and nutritious dishes are paired to complement one another in a manner ideal for the dining environment, offering an exceptional dining experience. With the appropriate tools, the cook flawlessly executes food preparation.

				available to diners).

Competency C3e. Combine ingredients effectively and efficiently

Critical Deficiencies	Novice			Aspirational
Does not combine ingredients.	Combines ingredients without regard for order and technique.	Combines ingredients using either the appropriate order or the appropriate technique, but not both.	Combines ingredients using appropriate order and technique. Appropriately performs basic techniques such as mixing.	Combines ingredients using appropriate order and technique. Appropriately performs advanced techniques such as folding.

Short Order Cook Entrustable Professional Activities

Note that the EPAs below are numbered E1-E3. These designations are used in the unique identifier for the EPA. The parenthesis indicate the competencies to which the EPA is related.

E1. Prepare a meal as a solo cook. (C1-C5, C6c, C7a)

E2. Work as a line cook on a larger service. (C2b, C3, C4, C5, C6d, C7a)

E3. Serve a diner. (C6 a, b and e, C7b)

Levels of Entrustment

This section illustrates what levels of entrustment would look like for one of the example EPAs. Each EPA would have levels of entrustment that define the degree to which a learner is being entrusted to perform the activity. These labels are based on the work of Olle ten Cate and the International Competency-Based Medical Education Collaborators [ten Cate 2]. The specification does not require using these labels.

EPA E1. Prepare a meal as a solo cook.

Be present and observe	Act with Direct Supervision	Act with Indirect Supervision	Act without supervision	Provide supervision
Observes menu planning and preparation while maintaining personal safety.	Demonstrates multiple meal preparation competencies (ie Plan a menu, obtain ingredients, prepare a meal) with some prompting from supervising short order cook.	Prepares a meal independently, calling on a nearby, available short order cook for minimal assistance.	Prepares a tasteful and nutritious meal without assistance.	Provides supervision for overall meal preparation or aspects of meal preparation for other short order cook trainees.

Technical Representation

The concepts illustrated in this document are also illustrated technically in XML using the MedBiquitous Competency Object specification and the MedBiquitous Competency Framework and Performance Framework standards (Table 1). The XML files created for this illustration are all conformant to MedBiquitous technology standards.

Table 1. MedBiquitous specifications and standards that can be used to represent competencies, competency frameworks, performance frameworks, and other tools used in competency-based education.

Statement or Framework	Corresponding MedBiquitous specification/standard
Competency statements (including competencies per se, learning outcomes, learning objectives, etc.)	Represent each statement individually using the Competency Object specification
Competency frameworks (including learning outcome frameworks and other hierarchical or non-hierarchical sets of statements)	Represent the hierarchical relations among competency objects using the Competency Framework standard
Performance frameworks (including milestones, performance levels, etc.)	Performance Framework standard
Entrustable Professional Activities (EPA)	Each EPA can be represented using the Competency Object specification
Levels of Entrustment	Performance Framework standard

First, each individual competency is represented as a Competency Object. The Competency Objects are then aggregated into a Competency Framework, with relations among the Competency Objects defined. Performance Frameworks define levels of performance levels (aka milestones) for each competency. Each EPA may be represented as a Competency Object, with a corresponding Competency Framework defining the relationships between the EPA and competencies in the Competency Framework. Levels of entrustment are represented as a Performance Framework defining levels of entrustment for an EPA.

To view the XML files representing the illustrations in this document, click the links that follow.

- Short Order Cook Competency Framework (Competency Framework)
- Short Order Cook Performance Framework (Performance Framework)
- Short Order Cook Entrustable Professional Activities (Competency Framework - this shows how the EPAs relate to competencies)
- Short Order Cook Levels of Entrustment (Performance Framework)

Each individual EPA is documented (Competency Object).

E1. Prepare a meal as a solo cook.

E2. Work as a line cook on a larger service.

E3. Serve a diner.

Each individual competency is documented as well (Competency Object):

C1. Plan a menu.
  - C1a. Select dishes that are meal-appropriate, nutritionally balanced, seasonally appropriate, and feasible for the kitchen and eating environment.
  - C1b. Provide dishes that attend to specific nutritional needs of diners and address cultural issues.
  - C1c. Purchase sufficient groceries to prepare the planned menu for the expected number of guests.
C2. Ensure access to appropriate tools.
  - C2a. Review kitchen utensils, preparation tools, pots, pans, and appliances to ensure adequate tools for the menu.
  - C2b. Store tools so that they may be easily accessed during the preparation and cooking processes.
C3. Prepare ingredients.
  - C3a. Chop, crush, or carve ingredients using knives, food processors, and blenders
  - C3b. Grate cheese safely and effectively.
  - C3c. Crack eggs without breaking the yolk.
  - C3d. Beat eggs with appropriate tool and to appropriate consistency.
  - C3e. Combine ingredients effectively and efficiently
C4. Perform core cooking skills.
  - C4a. Boil and simmer water and other liquids.
  - C4b. Prepare cooking surface (preheating, greasing, etc).
  - C4c. Sautee, flip, and move food during the cooking process.
  - C4d. Recognize when foods are done cooking.

C5. Ensure food and personal safety.
        C5a.   Prevent food borne illness associated with cooking and food preparation.
        C5b.   Prevent cuts through proper cutting and knife handling.
        C5c.   Safely use electric and gas stoves.
        C5d.   Safely use electric and gas ovens.

C6. Communicate effectively
        C6a.   Politely request menu selection from a diner, offering information or insights when requested.
        C6b.   Accurately record orders and any substitutions or special requests.
        C6c.   Clearly communicate with servers regarding menu selections and food readiness or delays.
        C6d.   Request help from others when needed, clearly assigning roles and responsibilities.
        C6e.   Inquire as to the acceptability of the meal after diners have started eating, offering to correct any mistakes or replace any dish that is not acceptable.

C7. Present food to the diner.
        C7a.   Plate food in a manner both attractive and appropriate to the diner's needs.
        C7b.   Serve the requested dish to the diner.

References

Albanese

Albanese MA, Mejicano G, Mullan P, Kokotailo P and Gruppen L. Defining characteristics of educational competencies. *Medical Education* 2008; 42(3):248-55.

Competency Framework

ANSI/MEDBIQ CF.10.1-2012, Competency Framework. MedBiquitous Website. http://medbiq.org/std_specs/standards/index.html#Competencies . Accessed August 30, 2016.

Milestones

Accreditation Council for Graduate Medical Education. Milestones. http://www.acgme.org/What-We-Do/Accreditation/Milestones/Overview Accessed August 30, 2016.

Performance Framework

ANSI/MEDBIQ PF.10.1-2015, Performance Framework. MedBiquitous Website. http://medbiq.org/std_specs/standards/index.html#performance_framework. Accessed August 30, 2016.

ten Cate 1

ten Cate O. Nuts and bolts of entrustable professional activities. J Grad Med Educ 2013;5:157–8.

ten Cate 2

Ten Cate O, Hart D, Ankel F, Busari J, Englander R, Glasgow N, Holmboe E, Iobst W, Lovell E, Snell LS, Touchie C, Van Melle E, Wycliffe-Jones K; International Competency-Based Medical Education Collaborators. Acad Med. 2016 Feb;91(2):191-8.