

# CBML: A brief guide to what's different and its effects on students and faculty

By David H. Tobey, Ph.D.

Director of Research and Assessments

National CyberWatch Center

Competency-Based Mastery Learning (CBML) is an evidence-based instructional design method that combines two techniques developed from research conducted by Benjamin Bloom. His research sought to overturn fundamental assumptions of the *modern* education system which originated in the early 20<sup>th</sup> century<sup>1</sup>. The Outcome-Based Education (OBE) model sought to select those worthy of advancement and career employment by conferring a learning *outcome*—a degree or certificate. OBE replaced an apprenticeship system of education that was not scalable. OBE was designed to make education available to the masses while ensuring efficient utilization of educational institution resources. Bloom believed that this instructional model was failing to meet the needs of most students and employers. The goal of education should not simply be graduation, but instead the development of proficient understanding as a foundation for developing competent performance in career-related learning objectives.

Bloom found the initial path to developing competence requires ascending a hierarchy of knowledge [1]. Over the following thirty years he sought to understand what instructional methods would enable all those with a desire to learn to achieve mastery in their intended field of study. He found the taxonomy of learning objectives which forms the foundation of Competency-Based Education (CBE) was necessary, but insufficient, to achieve the goal of mastery learning [2]. Supported by a team of researchers, Bloom reviewed 15 years of instructional methods intended to raise the capabilities of learners. This systematic and comprehensive review concluded that only personalized instruction could enable nearly all learners to equal the learning gains of the top 2.5%—those high-achieving students whose learning is two standard deviations (or 2-sigma) above the mean learning achievement typical in most learning environments [3]. Personal tutoring of a learner would continually assess the learner's readiness to engage with the learning material and provide the coaching required to overcome learning impediments. Unfortunately, at the time the study was conducted the vision of personalized learning could not be realized. Like the apprenticeship system before OBE, it depended on human tutors that were in short supply and too costly. The existing learning assessment systems could not support Bloom's vision because they focused on recording achievement rather than developing accurate diagnoses of the impediments to learning.

Recent advances in educational neuroscience and digital tutoring make Bloom's vision possible [4]–[8]. By combining CBE with the mastery learning techniques which evidence shows can accelerate and/or deepen learning, CBML enables any person desiring to learn a new domain to achieve mastery of that domain. This guide will briefly review and enumerate the many important differences between OBE and CBML that bring about transformative learning experiences. These differences will be summarized in terms of how they change the student and faculty experience. Finally, resources will be provided for those interested in further exploration of CBML concepts or techniques.

<sup>1</sup> For further information on the history of and differences between OBE and CBML, as well as their relation to Competency-Based Education (CBE) please refer to *A Guide to How Competency-Based Mastery Learning Differs from Outcome-Based Education* (Tobey, 2020) from which this summary brief was adapted.

## How does CBML differ from OBE?

**CENTRAL PURPOSE:** Competency-Based Mastery Learning (CBML) differs from Outcomes-Based Education (OBE). CBML seeks the achievement of learner improvement (regardless of outcome) while the OBE seeks course or institutional achievements, such as grades, degree completion, or certification. The central focus of OBE is on the instructional material that should be covered in a course—OBE is *instruction-centered*. The central focus of CBML is on assessment of the student's learning state to determine how instruction and an instructor may help to mature capabilities—CBML is *learner-centered*.

**ASSESSMENT:** Assessments in CBML are referred to as criterion-referenced tests because they are based on the criteria by which effective job performance is determined. Conversely, OBE uses assessment to classify learners into groups, e.g., letter grades or certified/non-certified, based on designated score ranges. Because they are comparing a learner with subjective expectations they are referred to as norm-referenced tests. In CBML, each assessment is designed to identify why a learner is not properly or fully understanding, applying, or transferring capabilities to perform competently in work-based scenarios. With an accurate diagnosis of learning impediments, the focus of instruction shifts to the content, tools, and techniques that can effectively eliminate obstacles to achieving mastery without a time constraint. The effect of this developmental focus is to increase the number of individuals *capable* of meeting workforce demands. In OBE, summative assessments are designed to identify the amount of student learning as a graded differentiation of achievement within a prescribed timeframe. The effect of this selection focus is to reduce the number of the *qualified* individuals in a competency domain to only those scoring above a "cutoff" on summative credentialing exams. CBML measures the *results of learning* where OBE measures the *results of instruction*. In CBML, assessment is formative, precedes or drives, and is embedded in instruction; in OBE, assessment is summative, occurring after learning, and often as an after-thought in instructional design.

**INSTRUCTION:** CBML instruction seeks to improve efficiency of learning where OBE seeks to improve efficiency of instruction. In OBE learning objectives are based on the content to be covered. The efficiency of information transmission is measured by the number of individuals achieving completion of the course or degree program in the expected amount of time, e.g. 4-6 years for an undergraduate degree. This focus on efficient information transmission minimizes the time and cost investment in limited instructional resources (talent and technology). The trade-off is that not all learners will achieve proficiency of understanding or competence in application in the time provided. For example, prior studies found many students required up to seven-fold (700%) more time that was allotted under OBE to achieve mastery [9]. These results are consistent with Bloom's [3] analysis showing that only the top 2 ½ to 5% of students master all concepts in an OBE course. Conversely, the learning objective of CBML is mastery of each concept, action, or judgment before moving on. Success is measured by the breadth of mastery achieved by the learners in the time provided. Anderson's [9] study cited above found if students are provided sufficient time to master fundamental capabilities, their subsequent learning speed approaches that of the fastest learner. In sum, success in OBE is measured by how quickly and how many individuals complete the course. In CBML success is measured by how quickly and how many requisite capabilities are mastered.

## What's New about CBML for Students?

**STUDENT-CENTERED:** Competency-Based Mastery Learning (CBML) is a student-centered method of instruction that develops the capabilities employers demand in those they hire and promote. Unlike courses you may have taken in the past, CBML does not have a set schedule of topics to cover each week, some of which you already know, and some of which you lack the prerequisite knowledge to learn. There are no midterm or final exams. Instead, CBML assessments are diagnostic. You can take these assessments as many times as you need. *You don't study for the assessments, the assessments study you.* The diagnostics produce recommendations for what you should learn next. The CBML system delivers and adapts the instruction so your instructor can dedicate their time and expertise to assist you in overcoming any learning obstacle. Rather than instructing, course faculty become your *success coaches*.

**CAREER-READINESS:** Within a few weeks after taking past courses you might have remembered a few concepts and been able to apply even less. Unlike CBML, these courses were designed to guide you towards earning an *outcome*—a grade, a degree, or a certificate. Many students have mistakenly believed that passing grades, a college degree or a technical certificate will guarantee a good job upon graduation. To the contrary, much evidence shows that the traditional *Outcome-Based Education* (OBE) results in many students being unemployed or underemployed because they lack the capabilities that employers demand.<sup>1</sup> One such required capability is passing an industry-accepted certification exam. A 2014 study found that only 5% to 30% of students graduating from OBE education programs were able to pass technical certification exams [10]. Conversely, in the medical professions where CBML courses have become the norm, pass rates of 98-100% are typical [11], [12].

**(RE-)LEARNING HOW TO LEARN:** Why is CBML so much better at readying you for a career? The secret ingredient is *decision feedback*. The multiple-guess exams and essay questions used in OBE ask you recall the information you have learned. You only need to remember the correct answers for the test which is why cramming feels helpful. However, a master is not someone who *knows it all*. That only helps in solving yesterday's problem. Today's workplace dynamics require people to identify what they *don't know* [13]. *Knowing what you don't know* enables you to seek the information or assistance needed to avoid costly errors or to learn from your mistakes [14]. A master does not study to take a test. A master tests their understanding, plans, and actions to assess what needs further study. CBML assessments will help you to identify your lack of knowledge, misunderstanding, or misconceptions by asking you to judge how confident you are that an answer shown is correct or incorrect. If you use the feedback to support a *reflective, active, continual, and episodic* (RACE) learning strategy [15] you will be *learning-how-to-learn*—one of the most valued workplace skills [16]–[18]. How do you RACE towards mastery? Whenever you lack absolute certainty that the answer shown is correct or incorrect select “Don't Know” and write down topic to be reflected upon later. Actively take notes while you read or listen to instructional material—don't highlight or try to memorize. Continually update your notes between assessment attempts based on the feedback provided. Make lists or tables of both the right and wrong answers for each topic—knowing the incorrect choices is a another secret of success. Plan four to ten assessment-reflection-study episodes over several days for each learning module. If you require more than 10 attempts to achieve mastery, then you are not adequately practicing the RACE learning strategy. Reach out to your instructor often for coaching on the most effective learning strategies or to gain clarification on concepts.

<sup>1</sup> For further information, please see *A Guide to How Competency-Based Mastery Learning Differs from Outcome-Based Education* (Tobey, 2020).

## What's New about CBML for Faculty?

**GUIDE-AT-THE-SIDE:** The flipped classroom concept introduced the notion of the instructor becoming a guide-at-the-side instead of the sage-on-the-stage. This transition was based on research showing that adult learners learn best when self-directed [19]. In the OBE version lectures were placed online for students to peruse when they desired. However, the summative and achievement-oriented assessments failed to inform faculty or students how to learn on their own [20]. CBML uses formative assessments. These diagnostic instruments guide students in choosing their next learning assignment. As a student gains mastery of prerequisite capability, progressively more challenging instruction is provided. If a student demonstrates a lack of knowledge, the digital tutor can suggest reviewing the instruction again and/or consulting supplemental learning resources. If a student demonstrates misunderstanding, the digital tutor can assist in resolving confusion by presenting similarities and differences between concepts or processes. If a student demonstrates misconceptions the digital tutor can present examples that help the student realize why their mental model is faulty [21]. The alternative instructions are added to the digital tutor by faculty (or other subject matter experts) based on the content most likely to foster conceptual change [22]. In sum, CBML diagnostic assessments inform the digital tutor and faculty how best to guide student learning pathways. Most importantly, this guidance extends beyond the technical aspects of a course. With the path to content mastery assured by the digital tutor, faculty can direct attention to the learning impediments of work/school balance, career preparation, or other life challenges. Therefore, faculty should identify alternative instruction resources and be prepared to become more than a sage-on-the-stage, or even a tutor—*CBML faculty are life coaches*.

**READINESS TO LEARN:** CBML begins (and ends) with readiness. In a mature CBML program every student working in a learning module has mastered all the prerequisite capabilities. In OBE it is quite common for wide divergence in student capabilities. Consequently, many OBE courses begin with a review of formerly covered content. This review wastes precious learning time for student and instructor alike. In CBML, diagnostic assessments place students in their “zone of proximal development” [23], [24] where the learner is both capable of and challenged by instructional demands. Being in the “zone” increases the motivation to learn and raises student self-efficacy. The result is more engaged learning [25]. Furthermore, each diagnostic instrument is aligned with industry-accepted competency frameworks and/or capability maturity models. The CBML assessments produce an Individual Capability Profile (ICP) which measures a student’s readiness to pass an industry certification or to competently perform specific job tasks. The diagnostics also produce an Individual Development Plan (IDP) that specifies capabilities which must improve to reach the next learning milestone. The aggregated e-Portfolio can inform prospective employers of program graduate readiness to fulfill job responsibilities. Accordingly, CBML instructional design works backwards from target job performance objectives to the Abilities, Skills and Knowledge (ASK) of students [26], [27].

**FAILING FORWARD:** As described above, CBML flips not just instruction but also the central assumptions of OBE. Perhaps the most dramatic reversal is the shift from assessing what students know to assessing what they don’t know! By focusing on the sources of failed understanding, CBML guides faculty in helping students overcome impediments to mastery. Recent advances in learning science studies demonstrate the value of these productive failures [28]. As student mindsets shift from fixed to growth [29], faculty mindsets need to shift from what are the right answers to when, how and why students will arrive at a wrong answer.

## Where can I learn more about CBML?

As the nearly 30 citations cited above demonstrate, CBML is an evidence-based design [30] method for raising the capability maturity of adults—what Malcolm Knowles [19] calls *andragogy*. Besides other classic instructional design texts [31]–[33], several books are recommended that extend beyond this guide to the differences between OBE and CBML.<sup>1</sup>

First is the guidebook written by one of Bloom’s students, Kay Torshen [34]. This book discusses the key principles of CBML while noting some of the early challenges, mostly related to the limitations of learning technology in 1977. The next seminal book sought to address the shortcomings noted by Torshen. This work by James Block, Helen Efthim, and Robert Burns [35] is appropriately titled *Building Effective Mastery Learning Schools*. This book began the accumulation of evidence for CBML effectiveness in raising student capabilities. The cited case studies informed “how-to” chapters for implementing mastery learning in K-12 school districts or in a single classroom. As the implementation of CBML, especially in K-12, gained steam the focus shifted towards assessment as the critical CBML technique for accelerating and deepening learning in post-secondary schools. Elizabeth Jones and Richard Vorhees reviewed these developments in a federally sponsored report [36]. They found that few post-secondary implementations of CBML were applying psychometric analysis to ensure assessment reliability and validity. The following list of effective practices was adapted from their executive summary.

- A senior administrator is a public advocate, leader, and facilitator for creating an institutional culture that is open to change, willing to take risks, and fosters innovations by providing incentives for participant engagement.
- The appropriate stakeholders fully participate in identifying, defining, and reaching a consensus about important performance objectives which define competence.
- Competencies are defined at a sufficient level of specificity that they can be assessed.
- Multiple assessments of competencies provide useful and meaningful information.
- The assessment results are used in making critical decisions about strategies to improve student learning.
- The institution experiments with new ways to document students' mastery that supplement the traditional transcript, such as badges and ePortfolios.

Perhaps one of the most influential books that is highly recommended for a deeper understanding of CBML benefits and challenges is The Christensen Institute’s online book entitled *Hire Education* [37]. The authors describe how the combination of competency-based education and mastery learning will become the *disruptive innovation* that shift the value proposition of a college education. This research report continues to inform federal policy to this day as evidenced by the recent executive order from President Trump which preferences skills over degrees in federal hiring.

Finally, a guidebook for the coming transformation of educational institutions is Bob Sornson’s book entitled *Over-Tested and Under-Prepared: Using Competency Based Learning to Transform Our Schools* [38]. His principles of instructional design emphasize the importance of: 1) job performance based learning objectives; 2) assessing readiness to learn; 3) continual monitoring of student learning progress (and obstacles); 4) personalized instruction; 5) fostering engagement by assessing if students are in their zone of proximal development; and, most importantly, 6) not compromising on the requirement that students demonstrate requisite proficiency (if knowledge), competency (if skill), and mastery (if ability) before advancing to the next learning objective.

<sup>1</sup> For further information, please see *A Guide to How Competency-Based Mastery Learning Differs from Outcome-Based Education* (Tobey, 2020).



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