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Course Design in Competency-Based Education: An Approach Based on the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) Model

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This paper presents an agenda to guide, coordinate, and promote empirical research Competency-Based Education (CBE) is transforming current teaching and learning through prioritizing skill mastery over traditional time-based instruction. This shift in teaching and learning attempts to ensure graduates are job-ready and aligned with industry demands. However, many institutions and instructors face challenges in designing effective CBE programs due to a lack of structured instructional design frameworks. This paper proposes the CBE-Analyze, Design, Develop, Implement, and Evaluate (ADDIE) Model, which integrates the well-established ADDIE framework with CBE principles. The newly developed model provides a more robust and systematic approach for competency mapping, assessment design, content development, implementation, and continuous evaluation. By adopting this model, instructional designers and educators can create high-quality, scalable, and industry-aligned CBE programs that enhance learner success and workforce readiness.

Keywords: competency-based education, course design, CBE

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Competency-Based Education (CBE) is a teaching and learning approach focused primarily on students demonstrating mastery of specific skills and knowledge. CBE is designed to allow learners to work at their own pace rather than progressing based on time spent in a classroom. Project-based approaches emphasize the application of a student's knowledge, skills, and abilities to create a product, "deliverable," or experience that provides meaningful solutions to real-world problems or questions (Lee et al., 2014). This method prioritizes the demonstration of competency over traditional measures such as grades or credit hours, allowing learners to advance once they prove proficiency through assessments, projects, or real-world applications by combining an intentional and transparent approach to circular design (Boyer & Bucklew, 2019). CBE is highly personalized, matching individual learning preferences and needs, making it particularly effective for adult learners, working professionals, and those seeking flexible education paths. By emphasizing clear learning outcomes, practical skills, and continuous assessment, competency-based education provides an individualized learning environment that provides students the opportunity to acquire the necessary abilities to succeed in their chosen fields.

A 2020 survey of nearly 500 higher education institutions suggested that 13% had fully implemented CBE programs, 47% were in the process of implementing CBE, and 26% expressed interest in adopting CBE (Mason et al., 2020). The survey also found that 82% of the institutions anticipate an increase in the number of CBE programs in the US over the next five years.

CBE is a novel and unique approach because it shifts the focus from time spent in a classroom to actual learning and skill development. This approach is particularly beneficial in today's rapidly evolving job market, where employers seek to hire individuals who can demonstrate real-world competencies rather than having attained a post-graduate degree. By allowing learners to progress at their own pace, CBE provides flexibility for students with different learning speeds, backgrounds, and schedules, making education more inclusive and accessible. It also enhances motivation and engagement, as students can make a direct connection between their coursework and their career goals. Furthermore, CBE reduces inefficiencies in traditional education by eliminating unnecessary repetition and allowing students to build on prior knowledge and experience (Irakliotis & Johnstone, 2014). Because assessments are based on demonstrated mastery, CBE ensures that graduates are well-prepared, competent, and ready to contribute effectively to their unique professions. Thus, CBE is an ideal model for lifelong learning, workforce development, and bridging the gap between education and industry needs.

CBE and Industry Needs

Higher education continues to provide clear economic benefits in the US. Forbes highlights the continued benefits of higher educational attainment in the US, suggesting better employment outcomes and higher earnings for individuals with college degrees (Nietzel, 2022). Employment rates in 2021 were greater for individuals with higher levels of education, with the greatest increase observed among those

with bachelor's degrees or higher. However, the recent COVID-19 pandemic caused a drop in employment for those with lower education levels. The unemployment rate was lowest for those with bachelor's or higher degrees. Annual earnings also reflected educational attainment: in 2020, individuals with higher degrees earned significantly more, with those holding a master's degree earning 17% more than bachelor's degree holders and 63% more than high school graduates. The report reinforces the idea that higher education leads to better economic prospects despite ongoing debates about the costs and benefits of a college education (Nietzel, 2022).

There is a pressing need to rethink workforce preparation for future jobs and to align talent more effectively with opportunities (LinkedIn Economic Graph, 2023; Zhang & West, 2019). Georgetown University's (2023) report projecting jobs, education, and training suggests that 72% of all US-based jobs will require training, postsecondary education, or both by 2031. This projection suggests that such training and education will be critically important to ensure the future workforce receives the proper training. The World Economic Forum (2023) states that, over the next five years, skill gaps and difficulties in attracting talent will be the primary obstacles hindering industry growth and transformation.

CBE and industry needs are closely aligned because CBE is designed to bridge the gap between current educational approaches (e.g., class time, tests, papers) and the workforce by ensuring students acquire the skills employers consider more critical for new hires. Employers seek graduates who can identify and resolve issues within their area of expertise (Ford & Myer, 2015). Unlike traditional education models that emphasize credit hours and course completion, CBE focuses on measurable competencies, meaning students must demonstrate real-world skills before advancing. This approach ensures that graduates are not just knowledgeable but also job-ready (with skills and abilities more aligned with the needs of the employer).

One of the ways CBE meets industry needs is by collaborating with employers and industry experts to define the competencies required for specific roles—a critical partnership. These competencies often include technical skills, problem-solving abilities, communication, and adaptability, making CBE graduates highly valuable in today's rapidly evolving job market. Additionally, because CBE programs are flexible and self-paced, they allow working professionals to upskill or reskill efficiently, helping industries address skills gaps and labor shortages more effectively and efficiently than traditional degree programs.

Industries benefit from CBE programs because such teaching and learning propose to produce employees who are assessed based on their ability to perform in real-world scenarios rather than their ability to pass standardized tests. This demonstration of skills in handling and solving real-world issues leads to better hiring decisions, lower training costs, and improved employee performance. Fields like healthcare, IT, business, and manufacturing increasingly rely on CBE models to ensure professionals meet industry standards before entering the workforce. A study on the performance of nursing students following the CBE model reported that undergraduate nursing students taking CBE demonstrated higher proficiency than students enrolled in traditional courses (Fan et al., 2015). The study's quasi-experimental design

supports causal attribution by comparing a CBE group with a traditional teaching group. By using pre-test and post-test measurements, the design ensures robust and reliable findings that link the CBE intervention to improved student performance. Ultimately, CBE provides a direct pipeline of skilled, competent workers, making it a powerful solution for industries looking to keep pace with technological advancements and market demands.

Challenges in Competency-Based Instruction

While CBE offers many benefits, it also comes with several challenges. One major challenge is the need for robust and reliable assessment methods to accurately measure student competencies. Unlike traditional grading systems, CBE requires personalized evaluations, which can be time-consuming and resource intensive. Moreover, instructors must learn how to translate the curriculum principles into practical learning activities (Hoogveld et al., 2002). Additionally, because CBE allows students to learn at their own pace, institutions must provide strong support systems, including mentors and advisors, to keep learners engaged and on track.

Another challenge that needs to be considered is the recognition and acceptance of CBE credentials by employers and other educational institutions. Due to the fact that CBE differs so significantly from traditional degree programs, some employers may not fully understand or value competency-based transcripts, courses, or curricula. Further, integrating CBE into existing education systems requires significant restructuring, including new policies, faculty training, and technological investments to support personalized learning (C-Ben, 2017; Parsons et al., 2023).

Finally, individual students in CBE programs need to be highly self-motivated and disciplined, as the flexible structure can be challenging for those who struggle with time management. Without strict deadlines and scheduled classes, some students may find it difficult to stay on track and complete their programs in a timely manner. Despite these challenges, CBE continues to gain traction as institutions refine their approaches and address these obstacles.

Instructional Designers Working with CBE

Instructional designers working with Competency-Based Education (CBE) may face several challenges in designing, implementing, and evaluating compelling learning experiences. One major challenge is creating well-defined competencies and measurable learning outcomes that accurately reflect the skills and knowledge students need. Unlike traditional curriculum design, CBE requires instructional designers and content matter experts to uncouple complex subjects into specific, assessable competencies, which can be time-consuming and challenging.

Another difficulty is developing high-quality assessments that accurately measure mastery rather than basic knowledge recall. Instructional designers are charged with creating performance-based assessments, real-world tasks, and adaptive learning experiences that align directly with competencies, often requiring integrating advanced technologies, such as learning management systems (LMS) and adaptive learning platforms, which can be complex to implement and maintain.

Additionally, instructional designers must ensure that learning materials and resources support self-paced learning while maintaining engagement. Designing for a diverse group of learners where each student progresses at a different speed requires a flexible yet somewhat structured approach that accommodates different learning styles, backgrounds, and levels of prior knowledge.

There is also the challenge of faculty and institutional buy-in. Since CBE differs significantly from traditional education models, instructional designers must work closely with instructors (content matter experts) and administrators to help them adapt to new teaching strategies, assessment methods, and student support systems. Resistance to change, lack of familiarity with CBE, and the need for ongoing training can slow down implementation.

Lastly, ensuring that CBE programs align with accreditation and regulatory standards can be challenging. Many educational institutions must meet specific requirements for credit hours and instructional time, which can conflict with the mastery-based approach of CBE. Instructional designers are critical in helping navigate such potential constraints while maintaining the integrity of competency-based learning. Despite these challenges, CBE offers a promising approach to personalized education, and instructional designers play a crucial role in its success.

Need for a New Model

While several surveys have evaluated institutional interest in CBE, a comprehensive analysis is needed to understand how institutions design and implement CBE (Lurie & Garrett, 2017). The need for the proposed CBE-Analyze, Design, Develop, Implement, and Evaluate (ADDIE) Model arises from the growing demand for structured yet flexible approaches to designing CBE programs (C-Ben, 2017; Parsons et al., 2023). CBE has become increasingly popular due to its alignment with industry needs and its emphasis on skill mastery. However, many institutions struggle with implementing it effectively due to the lack of a clear, standardized instructional design framework. The CBE-ADDIE Model fills this gap by integrating well-accepted instructional design principles from the ADDIE framework while maintaining the flexibility and learner-centered focus of CBE.

One major challenge in CBE implementation is ensuring that competency mapping, content development, and assessment strategies are systematically designed to create a seamless learning and assessment experience. Many existing CBE programs lack a consistent development process, leading to inconsistencies in course structure, assessment rigor, and learner engagement. This proposed model attempts to provide a step-by-step approach—from analyzing industry-aligned competencies to designing meaningful assessments, developing adaptive learning materials, implementing effective facilitation methods, and continuously evaluating program success.

Additionally, instructional designers, faculty, and institutions need a replicable model that ensures CBE programs maintain high-quality standards while remaining scalable and adaptable across different fields (C-Ben, 2017; Parsons et al., 2023). The CBE-ADDIE Model balances structure with flexibility, which might allow educators to design courses that meet both individual learners' needs and employer/

industry expectations. By applying this model, institutions can create cohesive, competency-driven programs that improve learner outcomes, reduce skill gaps, and enhance workforce readiness.

CBE-ADDIE Model

The CBE-ADDIE Model explores the integration of Competency-Based Education (CBE) with the ADDIE framework, a systematic approach designed to ensure the creation of effective and learner-centered educational experiences. By aligning the five stages of the ADDIE model—Analyze, Design, Develop, Implement, and Evaluate—with the principles of CBE, this section provides a guide to building and refining competency-based curricula (C-Ben, 2017; Parsons et al., 2023). Each stage of the model plays a critical role in shaping the learning process, from identifying competencies and assessing learner needs to designing assessments, creating content, and continually improving instructional strategies. This approach emphasizes the alignment of learning outcomes with real-world skills, offering a structured pathway for developing courses that meet both educational standards and industry requirements. Through the CBE-ADDIE model, educators can design and deliver impactful learning experiences that equip students with the practical competencies needed for success in their professional fields. Figure 1 provides a visual representation of this alignment.

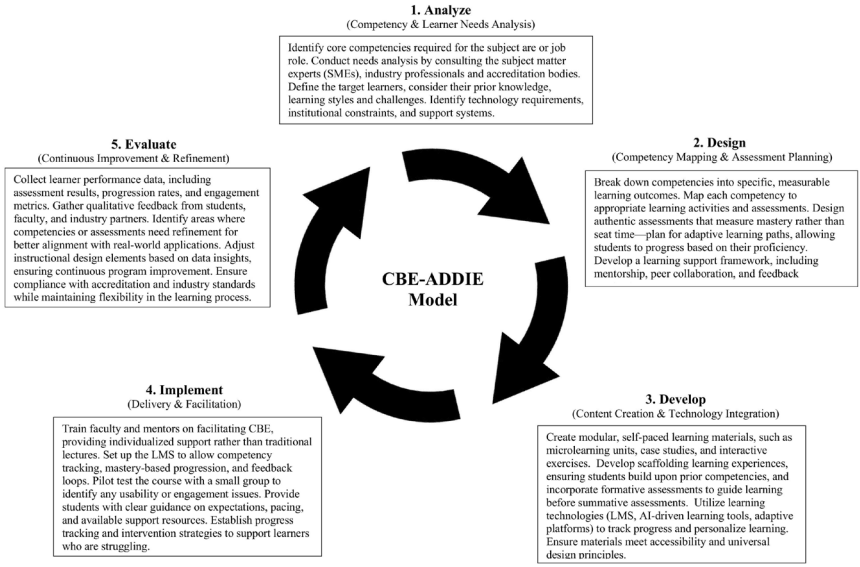

Figure 1
Competency-Based Education (CBE) – Analyze, Design, Develop, Implement, Evaluation (ADDIE) Model

Analyze (Competency & Learner Needs Analysis)

In the *Analyze* phase, the primary task is identifying the core competencies required for a given subject area or job role. For instance, in a healthcare program for nursing, subject matter experts (SMEs) and industry professionals, such as hospital administrators and experienced nurses, could collaborate to define competencies like patient care, critical thinking in emergencies, or medical record-keeping. A thorough needs analysis would involve reviewing industry standards and accreditation requirements from organizations such as the American Nurses Credentialing Center (ANCC). By conducting interviews, surveys, or focus groups with these stakeholders, course designers can gain insight into the competencies that are most essential to the job.

Furthermore, learner analysis ensures that the course content is appropriate for the target audience. For example, in a nursing program, learners may range from those with limited healthcare experience to those with prior clinical knowledge. The design of the course must, therefore, account for varying levels of knowledge, diverse learning styles, and specific challenges, such as a learner's familiarity with medical terminology or clinical procedures. At this stage, identifying technological needs (e.g., the use of simulation software or an adaptive learning platform) and understanding institutional constraints (e.g., budget or resources) is critical to ensuring that the learning environment aligns with both the learner's and institution's requirements.

The Analyze phase of the CBE-ADDIE model is critical to:

- Identify core competencies required for the subject area or job role.
- Conduct needs analysis by consulting subject matter experts (SMEs), industry professionals, and accreditation bodies.
- Define the target learners, considering their prior knowledge, learning styles, and challenges.
- Identify technology requirements, institutional constraints, and support systems.

Design (Competency Mapping & Assessment Planning)

Once competencies and learner needs are clearly defined, the *Design* phase focuses on mapping each competency to specific, measurable learning outcomes and selecting appropriate assessments. For instance, in a computer science program, competencies such as "coding proficiency in Python" and "ability to solve algorithmic problems" can be broken down into specific learning outcomes like "Students will be able to write a basic Python program" and "Students will be able to implement and optimize sorting algorithms." These outcomes are aligned with performance-based assessments, such as coding challenges, algorithm design tasks, or even project-based portfolios that demonstrate a student's mastery of the competencies.

The unique strength of the CBE-ADDIE model lies in the integration of adaptive learning paths. In the case of a learner struggling with a specific competency (e.g., difficulty understanding certain algorithms), the system could offer supplementary resources, additional practice problems, or a one-on-one tutoring session before

allowing the student to move on. This adaptability ensures that learning is tailored to the individual while still being aligned with the core competencies.

The Design phase of the CBE-ADDIE model is used to:

- Break down competencies into specific, measurable learning outcomes.
- Map each competency to appropriate learning activities and assessments.
- Design authentic assessments (e.g., performance-based tasks, simulations, portfolios) that measure mastery rather than seat time.
- Plan for adaptive learning paths, allowing students to progress based on their proficiency.
- Develop a learning support framework, including mentorship, peer collaboration, and feedback mechanisms.

Develop (Content Creation & Technology Integration)

In the *Develop* phase, course designers create content that is modular and self-paced, allowing students to move through the material at their own pace. For instance, a nursing course might be broken down into bite-sized learning modules on various topics such as patient assessment, pharmacology, and ethical issues in healthcare. These modules could include a combination of microlearning units (e.g., short video lessons or readings) and interactive exercises like case studies, quizzes, or simulations.

Formative assessments are integrated throughout to ensure learners are consistently progressing. For example, a simulation-based formative assessment could test a nurse's ability to respond to a simulated medical emergency, while a short quiz on medication administration could ensure the learner has mastered that competency before moving on to the next. Additionally, learning management systems (LMS) and adaptive learning platforms can be used to track individual progress, giving learners and instructors real-time feedback on areas of strength and areas needing improvement. This technology enables the creation of personalized learning paths, where content and assessment can adapt to the learner's demonstrated mastery.

The Develop phase of the CBE-ADDIE model is used to:

- Create modular, self-paced learning materials, such as microlearning units, case studies, and interactive exercises.
- Develop scaffolded learning experiences, ensuring students build upon prior competencies.
- Incorporate formative assessments (quizzes, reflections, peer evaluations) to guide learning before summative assessments.
- Utilize learning technologies (e.g., LMS, AI-driven learning tools, adaptive platforms) to track progress and personalize learning.
- Ensure materials meet accessibility and universal design principles.

Implement (Delivery & Facilitation)

The *Implement* phase shifts the focus to delivering the course and ensuring that facilitators are adequately trained to support learners. For instance, in the case of

an IT certification course, faculty members and mentors are trained to provide individualized support through targeted feedback rather than traditional lecture-based instruction. Using tools such as a learning management system (LMS), instructors can track a student's progress against competencies and intervene when necessary.

A crucial part of the implementation process is piloting the course with a small group to identify any usability issues or gaps in content delivery. For example, during the pilot phase, learners might report that the interactive exercises are too complex or that the adaptive feedback is not timely enough. Based on this feedback, course designers can refine the course materials and adjust the pacing or structure before full-scale rollout. Establishing clear communication channels for learners, such as office hours or discussion boards, further helps ensure that learners are supported throughout the course.

The Implement phase of the CBE-ADDIE model is helpful to:

- Train faculty and mentors to facilitate CBE, providing individualized support rather than traditional lectures.
- Set up the LMS to allow competency tracking, mastery-based progression, and feedback loops.
- Pilot test the course with a small group to identify any usability or engagement issues.
- Provide students with clear guidance on expectations, pacing, and available support resources.
- Establish progress tracking and intervention strategies to assist struggling learners.

Evaluate (Continuous Improvement & Refinement)

Finally, the *Evaluate* phase ensures the ongoing improvement of the course. After the course is launched, performance data—such as completion rates, assessment scores, and engagement metrics—are collected and analyzed. For example, in a corporate training program, assessment results might reveal that a particular competency, like "effective team collaboration," is being poorly mastered by a significant portion of learners. Feedback from learners and instructors can be used to refine the assessments or content in this area, by adding more collaborative activities or real-world problem-solving scenarios.

Additionally, industry feedback, especially from employer partners or accreditation bodies, can be used to adjust course content and competencies to better align with industry needs. This feedback loop allows for continuous improvement, ensuring that the CBE-ADDIE model evolves together with learner needs and industry demands (C-Ben, 2017; Parsons et al., 2023).

The Evaluate phase of the CBE-ADDIE model allows designers to:

- Collect learner performance data, including assessment results, progress rates, and engagement metrics.
- Gather qualitative feedback from students, faculty, and industry partners.
- Identify areas where competencies or assessments need refinement for better alignment with real-world applications.

- Adjust instructional design elements based on data insights, ensuring continuous program improvement.
- Ensure compliance with accreditation and industry standards while maintaining flexibility in the learning process.

Implementation Challenges

While the CBE-ADDIE instructional framework offers a clear structure for course design, its successful implementation often involves addressing several critical challenges. One of the primary obstacles is the resistance to change among faculty and institutional stakeholders who are accustomed to traditional teaching methods. In many cases, educators may find the shift to a competency-based approach, which emphasizes self-paced learning and mastery over time, difficult to embrace. To overcome this, a comprehensive faculty training program is essential, not just to equip instructors with the technical skills necessary for CBE but to help them understand the pedagogical advantages of personalized, learner-centered education. Additionally, piloting the course with a smaller group of faculty and providing ongoing support and mentorship will ease the transition and help faculty feel more confident in implementing CBE principles.

Another common challenge is the technological and infrastructure limitations present at many institutions. CBE often relies on sophisticated digital platforms, such as Learning Management Systems (LMS) and adaptive learning tools, to track progress and facilitate mastery-based learning. However, not all institutions have the resources to implement these technologies effectively. In these cases, it is essential to focus on cost-effective solutions and open-source platforms that can serve as alternatives. For example, many institutions have successfully used Moodle or Canvas as a starting point for tracking learner competencies without requiring major infrastructure investments. Moreover, starting small with low-tech or hybrid solutions can also be an effective strategy to test the waters before scaling up to more technology-heavy implementations.

Finally, a primary concern is ensuring that the CBE-ADDIE framework aligns with institutional policies and accreditation requirements, which can sometimes be at odds with the flexible nature of competency-based education (C-Ben, 2017; Parsons et al., 2023). Institutions may face difficulties ensuring that CBE courses meet the traditional seat time or other criteria set by accrediting bodies. To address this, course designers must engage early with accreditation bodies and institutional administrators to ensure that the course meets compliance standards without sacrificing the core principles of CBE. Compliance can be achieved by designing modular, competency-based assessments that are aligned with real-world applications and meet accreditation requirements while offering students a flexible, self-paced learning experience.

Conclusion

The standard approach to Competency-Based Education (CBE) development follows a structured process that ensures students achieve mastery of predefined competencies through self-paced, personalized learning experiences. Traditionally, CBE development begins with competency identification, where industry experts, educators, and accrediting bodies collaborate to define the essential skills and knowledge learners must demonstrate. These competencies are then broken down into measurable learning outcomes that guide curriculum development. The next step involves designing modular course structures, where content is divided into discrete units, each aligned with a specific competency. Assessments in traditional CBE models focus on performance-based evaluation, including case studies, simulations, and real-world projects, rather than time-based assessments like standardized exams. The learning process is self-paced, allowing students to progress upon demonstrating mastery, with faculty serving as mentors or facilitators rather than traditional instructors. Finally, the program undergoes continuous evaluation, leveraging student performance data and feedback to refine the course structure and instructional materials.

Compared to the CBE-ADDIE Model, the standard approach to CBE development is often less structured in its design phases and varies widely across institutions. The CBE-ADDIE Model offers a systematic, replicable, step-by-step approach that integrates the ADDIE instructional design framework into CBE development. It provides a clear roadmap, ensuring that each phase—Analyze, Design, Develop, Implement, and Evaluate—is aligned with competency mapping, adaptive learning, and continuous improvement. Unlike the standard approach, which may focus heavily on industry-aligned competencies and self-paced learning, the CBE-ADDIE Model emphasizes instructional design principles, ensuring that assessments, content development, and learner support are strategically planned and integrated. This structured model helps instructional designers create CBE programs that are not only competency-driven but also pedagogically sound, leading to greater engagement, better learning outcomes, and stronger alignment with workforce needs.

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