Advancing workforce competency: Singapore's integration of competency-based education

Caleb Or[A]

[A] *Independent Researcher, Singapore*

Abstract

This opinion piece investigates the evolution of Singapore's education system through the integration of Competency-Based Education (CBE), driven by global economic changes and the country's vision for a future-ready workforce. It explores how CBE's focus on mastery over rote learning prepares learners for real-world challenges, fostering critical thinking and adaptability. Anchored by policies like SkillsFuture and collaboration with industry, this article examines Singapore's commitment to lifelong learning and skill mastery, enhancing employability and resilience among Singaporeans. The discussion contributes to educational reform, highlighting Singapore's innovative model that aims to equip learners with the competencies needed to thrive in the 21st century. By analysing current trends, implementation strategies, and potential challenges, it provides a comprehensive overview of CBE's impact on higher education in Singapore, offering insights and recommendations for future developments.

Correspondence

caleb.chin.poh.or@gmail.com [A]

Introduction

Singapore's education system has long been known for its excellence, consistently topping global rankings and serving as a benchmark for educational success worldwide (OECD, 2022; Education GPS, 2022). This reputation is built on a foundation of rigorous standards, high-stakes testing, and a culture of academic achievement. However, in recent years, Singapore has embarked on a transformative journey, moving beyond traditional metrics of educational success to embrace Competency-based Education (CBE) (Singapore Institute of Technology, 2024). This shift is not merely an educational reform; it is a strategic response to the change in the global economic landscape, characterised by technological advancements, the rise of the knowledge economy, and the increasing premium on adaptability and lifelong learning. CBE is an approach where students advance based on their ability to demonstrate competency in specific skills and knowledge areas, as opposed to traditional time-based education systems. This paradigm shift is essential in addressing the dynamic needs of the modern workforce. Singapore's education system has been undergoing a shift towards a more holistic approach that values competencies and skills as much as academic success (De Souza, 2018). This change is driven by global trends, such as technological advancements, which have altered the demands of the workforce. Recognising this, Singapore has been focusing on developing 21st Century Competencies in its learners (Ministry of Education, n.d.). These competencies include critical and inventive thinking, civic literacy, global awareness, and cross-cultural skills—attributes essential for success in the contemporary world.

Despite the significant progress, it is important to clarify what CBE entails, as there is sometimes confusion regarding its definition. CBE is not merely about teaching competencies; it involves a comprehensive model where learning is personalised, and learners advance based on their demonstration of mastery in specific skills and knowledge areas (Anderson, 2018). Unlike traditional education systems that are time-based, CBE allows learners to progress at their own pace. This approach is designed to ensure that students acquire and demonstrate the competencies necessary for success in their personal and professional lives. CBE emphasises learner advancement based on the mastery of skills and content rather than traditional age or time-based criteria, offering a more personalised learning experience tailored to each learner's strengths, needs, and interests. The shift involves significant alterations in policy and practice to foster learner-centred solutions (Patrick, 2021). The move away from a one-size-fits-all model towards CBE aims to prepare learners more effectively for a dynamic and changing world by nurturing lifelong learning mindsets and accommodating diverse learning pathways.

The Singapore Institute of Technology (SIT) is currently at the forefront of transforming the traditional educational model in higher education. SIT emphasises the importance of upskilling and reskilling through CBE, a method that values certified skills and competencies over just paper qualifications. This approach is responsive to the needs of a changing job market, where the shelf-life of skills is becoming shorter due to technological innovation. SIT's

Applied Learning Conference in 2023 was a platform where education and workforce development experts converged to discuss the transition from a focus on degrees to a recognition of skills and real-world competencies (Singapore Institute of Technology, 2024). The same year, the National University of Singapore (NUS) and Nanyang Technological University (NTU) expanded their admission criteria to include more candidates through aptitude-based admissions. This initiative allows for a more comprehensive assessment of applicants, considering their talents and achievements outside traditional academic scores. NTU, for instance, reported that over half of its new learners were selected through this approach, significantly up from 38% in 2019. NUS, too, implemented special nomination schemes and expanded its holistic admissions by asking applicants to respond to specific questions aimed at revealing their broader competencies and interests (National University of Singapore, n.d.; Nanyang Technological University, n.d.).

As highlighted in 'The Future of Jobs Report 2023' by the World Economic Forum, rapid technological advancements and global economic shifts are continually reshaping job requirements. To thrive in today's dynamic environment, learners must acquire specific skills and competencies that are directly applicable to the workforce. CBE ensures that education is closely aligned with these demands by focusing on mastery of relevant skills rather than traditional time-based metrics. This approach not only enhances employability by equipping students with practical, job-ready skills but also fosters adaptability, enabling them to navigate future changes in the job market. By emphasising continuous learning and skill development, CBE helps bridge the gap between education and employment, ensuring that learners are well-prepared to meet the challenges and seize the opportunities presented by the rapidly changing economic landscape (World Economic Forum, 2023). The World Economic Forum report is significant because it echoes Singapore's adoption of CBE in higher education and how it offers a comprehensive overview of its implementation. By examining the origins, development, and benefits of CBE in Singapore's higher education, this paper seeks to contribute insights to the discourse on CBE. This study not only sheds light on the evolving nature of education in response to global economic shifts but also highlights the critical role of CBE in preparing learners for the challenges and opportunities of the future. It serves as an analysis and proposal, offering informed perspectives on the implementation of CBE. This paper aims to present a discussion on the potential benefits and challenges of CBE, utilising existing literature and papers to substantiate its arguments. By drawing on a variety of sources, the paper provides a dimension on how CBE can transform higher education to meet the demands of the modern workforce better. Rather than presenting empirical research findings, this paper offers recommendations and insights stemming from current trends. This approach allows the paper to address the evolving needs of education and industry, emphasising the importance of aligning educational outcomes with labour market demands. The paper also considers the implementation challenges of CBE by acknowledging these hurdles and provides a view of both the opportunities and obstacles associated with CBE.

Literature review

CBE is rooted in the early 20th century, influenced by Frederick Taylor's (1911) scientific management principles, which aimed to enhance workplace efficiency. These principles were later adapted to educational contexts to promote standardisation and effectiveness. CBE prioritises specific competencies—skills, knowledge, and behaviours crucial for professional success—assessed through learner demonstrations in real-world or simulated settings. This model significantly departed from traditional education methods that focus on time spent on coursework rather than mastery of skills.

The formal adoption of CBE by the U.S. Office of Education in the late 1960s represented a shift towards more accountable and practical educational outcomes. In the 1970s, David McClelland's (1973) advocacy further propelled the integration of CBE into higher education, advocating a shift from institutional reputation as a measure of graduate competence to true competence reflective of workplace demands. Spady (1977) defined CBE as an approach that developed curriculum from detailed analyses of societal roles, certifying learner progress based on performance rather than time spent in education, thus preparing learners with the competencies necessary for the workforce.

Today, CBE is widely implemented across various sectors, particularly in medical training, where it enhances the quality and safety of healthcare. The Accreditation Council for Graduate Medical Education (2016) mandated CBE in medical programmes, highlighting its critical role. Modern definitions by Levine and Patrick (2019) and Frank et al. (2010) focused on the model's adaptability and outcome orientation. Levine and Patrick (2019) advocated for a learner-empowered approach with personalised learning paths and supportive assessments to achieve mastery. Frank et al. (2010) defined CBE as focusing on graduate abilities tailored to societal and patient needs, enhancing accountability and flexibility in medical education.

Research indicated that global economic shifts profoundly impacted the workforce, necessitating the adaptation of education systems to better prepare learners for emerging challenges and opportunities. Studies like 'The Future of Jobs Report 2023' by the World Economic Forum emphasised the rapid pace of technological advancements and evolving job requirements, demanding a workforce with relevant, up-to-date skills. CBE played a crucial role in this context by focusing on the mastery of specific competencies that were directly applicable to the job market. This approach not only enhanced employability by ensuring that learners possessed the necessary skills but also fostered adaptability, enabling them to navigate the complexities of an ever-changing economic landscape. Further evidence from Anderson (2018) and Misko and Circelli (2022) highlighted how CBE effectively bridged the gap between education and employment, preparing learners to meet both current and future labour market demands. By aligning educational outcomes with industry needs, CBE supported the development of a resilient, skilled workforce capable of thriving amidst global economic transformations.

Constructivist theories promote education that is focused on learners, flexible, and tailored to their needs, which matches well with the main ideas of CBE. Constructivism, as explained by educators and theorists like Jean Piaget (1952) and Lev Vygotsky (1978), states that learning is an active, creative process. Learners are not empty vessels to be filled with knowledge; instead, they are active participants in their learning journey, constructing knowledge through interaction with their environment and reflection on their experiences. This perspective aligns with the CBE approach, which prioritises the acquisition of competencies—defined as a combination of skills, knowledge, and attitudes—through hands-on experiences and problem-solving tasks. CBE's focus on mastering specific competencies supports the development of critical thinking by requiring learners to apply knowledge in various contexts, analyse problems, and devise innovative solutions (Surr & Redding, 2017). Adaptability is fostered through personalised learning paths that allow learners to navigate through content at their own pace, adapting their learning journey as needed. Specialised skills are developed through targeted learning experiences that are closely aligned with industry standards and real-world applications, ensuring that learners are prepared for the demands of the workforce.

Boritz and Carnaghan (2003) explored the benefits of CBE within the accounting profession and identified several key advantages. This educational model emphasised a learner-centred approach that allowed learners to progress at a pace suited to their learning speeds and needs. The researchers noted that CBE provided enhanced flexibility in educational practices, accommodating a variety of learning styles and paces, which in turn could potentially increase learner engagement and success rates. Additionally, CBE focused on the practical application of skills and knowledge, preparing learners effectively for the challenges they would face in the professional world. The definition of competencies within CBE frameworks also facilitated the alignment of educational programmes with the specific requirements of the accounting industry, thereby improving the employability of graduates.

The studies by Hatcher et al. (2013) and Iglar et al. (2013) provided comprehensive insights into the benefits of CBE within professional psychology and family medicine, respectively. Both studies underscored CBE's significant role in aligning educational outcomes with professional competencies essential in clinical and therapeutic settings. Hatcher et al. (2013) highlighted that CBE bridged the gap between theoretical knowledge and practical application in psychology, enhancing learners' readiness for professional practice through the development of crucial skills such as critical thinking, ethical judgment, and interpersonal skills. Similarly, Iglar et al. (2013) demonstrated that CBE in family medicine not only advanced the mastery of practical skills but also personalised the learning process, allowing medical trainees to progress at their own pace. This tailored approach led to higher learner satisfaction and more effective preparation for real-world medical responsibilities. Both studies collectively illustrated how CBE could transform medical education by fostering a more skilled and adaptable healthcare workforce that is better prepared to meet the dynamic needs of patients and the healthcare industry.

In their article, Hawkins et al. (2015) examined the implementation of CBE and discussed its benefits within the medical field. Their research revealed that CBE focused on developing specific competencies crucial for medical practice, which in turn led to more targeted and effective medical training. The study highlighted that residents trained under CBE frameworks were often better prepared for clinical responsibilities due to the emphasis on mastering relevant skills before progressing. Additionally, the shift to CBE helped address the need for more personalised learning paths, allowing residents to spend more time on areas needing improvement while accelerating through competencies they master more readily.

Studies initiated around 2016, such as those by Burnette (2016) and Cunningham et al. (2016), highlighted the growing global appreciation for CBE and its role in redefining educational success. These studies pointed to the effectiveness of CBE in aligning educational goals with specific professional skills required in the workforce, promoting a learner-centred approach that allowed learners to progress at their own pace, thereby enhancing flexibility and engagement. Furthermore, the use of simulation in medical education, as explored by Nousiainen et al. (2016), had shown that despite higher initial costs, the integration of practical, risk-free training environments significantly improved the competence of medical residents, suggesting that the benefits justified the investment. This type of training ensured that medical professionals were well-prepared and more confident in their practical skills, potentially reducing errors in clinical practice (Nousiainen et al., 2016). Adding to the body of evidence, Rainwater (2016) examined the perceptions of faculty and learners within CBE frameworks and found that both groups benefited from the tailored, competency-focused approach of CBE. This method facilitated a more engaging learning environment and provided clear, practical benefits by directly linking educational activities to real-world applications.

Throughout 2017, research has consistently supported the effectiveness of CBE across various educational fields, underscoring its impact on enhancing educational outcomes and employability. Studies by Geressu (2017) emphasised the need for educational programmes in vocational settings in Ethiopia to align closely with labour market demands through active stakeholder engagement, significantly boosting graduate employability. Ye et al. (2017) highlighted how CBE improved learner engagement and retention by customising the learning experience to fit individual needs and professional aspirations, thereby better-preparing learners for the workforce. In higher education, Lurie and Garrett (2017) revealed that CBE provided personalised and flexible learning experiences, focusing on practical skills rather than traditional examinations. This led to more precise assessments of learner capabilities and enhanced both academic success and employability. Similarly, in the field of engineering education, Henri et al. (2017) affirmed that focusing on key competencies through CBE, rather than traditional educational metrics, with continuous feedback and real-world problem-solving scenarios, developed practical skills that aligned well with industry requirements. Riley and Riley's (2017) study on CBE in graduate medical education demonstrated that CBE allowed for more customised and efficient training, focusing on essential clinical competencies and offering the flexibility to meet individual training needs. This approach not only ensured that all medical graduates reached the required level of competence but also improved their readiness for clinical roles, suggesting potential innovations in medical training by fostering more targeted and practical learning experiences.

Subsequently, Mindham and Schultz (2019) delved into the effects of apprenticeship and employability skills programmes on learners pursuing technical education. Their research uncovered a significant finding: learners engaged in these programmes were more likely to continue their education beyond high school. This increase in educational continuation could be attributed to the direct relevance of the apprenticeship experiences and employability skills training to real-world job markets, which often motivated learners by providing clear pathways to career advancement and job security. Mindham and Schultz (2019) also noted that these programmes helped bridge the gap between theoretical knowledge and practical application, making learning more tangible and directly linked to employment opportunities.

Through a systematic literature review, Abelha et al. (2020) demonstrated that competency development in higher education significantly correlated with enhanced graduate employability, emphasising the importance of blending practical skills with academic knowledge. Similarly, Katoue and Schwinghammer (2020) highlighted how CBE enhanced learner engagement by tailoring education to individual needs and aligning educational outputs with labour market demands, thereby improving employability by equipping learners with in-demand skills. This personalised approach also supported diverse learning styles, fostering inclusive educational practices. In the field of medical education, Harris et al. (2020) and Crawford et al. (2020) showed that CBE significantly improved medical training. They noted that CBE ensured medical residents not only learned the necessary materials but also achieved proficiency in critical competencies, thus preparing them more effectively for the complexities of the healthcare environment. This was particularly important in medical training, where the ability to apply knowledge in clinical settings was crucial. Crawford et al. (2020) also found that CBE facilitated a more structured and transparent assessment process, which helped medical residents meet rigorous professional standards and better prepared them for actual medical practice.

Brauer (2021), Romanova (2022), and McMullen et al. (2023) collectively highlighted the critical components and benefits of CBE in higher education and vocational training. Brauer (2021) examined the intricacies of designing and assessing competence-based curricula, emphasising the necessity of clear, well-communicated educational goals that resonated with the needs and aspirations of learners. The study advocated for curricula that were relevant to future careers and adaptable to various learning styles, thereby enhancing engagement and retention. Additionally, the importance of practical, learner-centred assessments was highlighted, advocating for evaluation methods that went beyond traditional exams to include real-world tasks mirroring job scenarios. Building on this foundation, Romanova (2022)

focused on the direct integration of employability skills into vocational education curricula. The findings revealed that explicit inclusion of these skills not only improved learners' self-assessment of competencies but also significantly boosted their career aspirations. This approach effectively bridged the gap between educational experiences and job market requirements, preparing learners to meet employer expectations and enhancing their career prospects. Expanding on the work of Brauer (2021) and Romanova (2022), McMullen et al. (2023) confirmed the broad benefits of CBE. The study demonstrated that CBE significantly improved both educational and employment outcomes by focusing on the mastery of competencies rather than traditional learning metrics. McMullen et al. highlighted that CBE supported academic success and ensured learners were job-ready upon completion of their studies, equipped with the skills most sought after in their respective industries.

Implementation of CBE in Singapore

The successful integration of CBE in Singapore was significantly attributed to the country's national education policies and strategic initiatives, such as the SkillsFuture movement. These frameworks facilitate the transition towards a more skills-oriented education system and underscore Singapore's commitment to developing a resilient and adaptable workforce. SkillsFuture, launched in 2015, stands out as a cornerstone initiative aimed at promoting continuous learning and skills mastery across various life stages (SkillsFuture Singapore, 2023). This initiative emphasises personalised learning journeys and the mastery of skills aligned with individual interests and job market demands, thereby driving career development and economic success. Building on this foundation, the SkillsFuture initiative encompasses a broad range of programmes and schemes tailored to support Singaporeans at different stages of their learning journeys, from students to early-career professionals, mid-career switchers, and lifelong learners. Notably, the SkillsFuture Credit, a financial endowment provided to all citizens aged 25 and above, encourages individuals to invest in their skill development and lifelong learning (SkillsFuture Singapore, n.d. -a). This initiative signals the Singapore government's strategic investment in its citizens' future capabilities.

Another significant component is the SkillsFuture Work-Study Programmes, which integrates academic theory with practical application, facilitated by polytechnics and the Institute of Technical Education (SkillsFuture Singapore, n.d.-b). These programmes enable a seamless blend of classroom instruction and hands-on training, providing learners with valuable industry experience and qualifications recognised in the workforce. This dual-structure learning model exemplifies the synergy between education and industry, ensuring that curricula remain relevant to industry needs.

Moreover, the Skills Frameworks are tailored to key sectors of the economy. These include (1) healthcare, which focuses on the necessary skills and competencies for various roles to meet the sector's evolving demands; (2) infocomm technology (ICT), which addresses the tech industry's needs by outlining essential skills for careers in software development, cybersecurity, data analytics, and more; (3) finance, which identifies competencies required for roles in banking, insurance, and financial services to handle modern financial challenges; (4) advanced manufacturing, which highlights skills for roles in robotics, automation, and smart manufacturing to support technological advancements; (5) logistics, which covers skills for efficient supply chain management, transportation, and logistics services crucial for global trade; and (6) built environment, which focuses on competencies in construction, architecture, and urban planning to promote sustainable development and innovative building practices.

Additionally, the SkillsFuture Series offers concise, industry-relevant training programmes in emerging fields such as data analytics, finance, tech-enabled services, and digital media, further empowering Singaporeans with cutting-edge skills essential for the evolving economy. Collectively, these initiatives underpin Singapore's dedication to building a skilled and resilient workforce. Complementing these efforts, the Continuing Education and Training (CET) system is another critical element of Singapore's strategic framework for CBE, providing structured and formal mechanisms for adult learning and professional development (Ministry of Manpower, n.d.). Through CET, individuals could access a wide range of programmes aligned with industry needs, ensuring that the skills acquired remained relevant and current.

Furthermore, Professional Conversion Programmes (PCPs) are designed for mid-career professionals transitioning into new industries or job roles. These programmes, developed in partnership with industry players, address specific skills gaps and provide rigorous training and practical experience in fields such as cybersecurity, data analytics, and digital marketing (Workforce Singapore, n.d.; Ministry of Manpower Singapore, 2024). By maintaining an agile and adaptable workforce, the Singapore government effectively prepares its citizens for the demands and opportunities presented by technological advancements and economic changes.

To support this comprehensive approach, the implementation of CBE in Singapore's higher education system necessitated significant changes in curriculum design, assessment methods, and faculty roles. A pioneering example of CBE in Singapore is SIT, which was the first local institution to introduce this innovative approach. SIT incorporated CBE into its curriculum to better align educational outcomes with industry needs, ensuring that graduates were well-prepared for the workforce. This approach involved close collaboration with industry partners to develop programmes that met current market demands, providing students with hands-on experience and industry-relevant skills (Singapore Institute of Technology, 2024).

Discussion

Many institutions in the U.S. have adopted CBE, particularly in higher education and adult learning sectors (Anderson, 2018; Garfolo & L'Huillier, 2016). Unlike Singapore's nationwide, government-led approach, CBE implementation

in the U.S. was more institution-specific, driven by individual colleges or universities. This has led to a wide variation in CBE models and practices. Like Singapore, CBE in the U.S. faced challenges related to assessment methods and the need for comprehensive support systems for educators and learners. Finland's education system is renowned for its learner-centred approach, which emphasises individualised learning and teacher autonomy (Kimonen et al., 2017). While not labelled explicitly as CBE, many principles aligned with competency-based approaches, including personalised learning paths and a focus on real-world skills. Finland's approach effectively integrates competency-based principles within a broader, holistic educational philosophy. Australia has made significant strides in vocational education and training (VET) through a competency-based framework. Like Singapore, Australia's VET system is closely aligned with industry needs, ensuring that vocational qualifications reflect the competencies required by employers (Misko & Circeli, 2022). However, Australia's challenge lies in extending CBE principles beyond vocational training to wider education sectors. Higher education in Singapore can learn from this by adopting a comprehensive, multi-faceted approach to achieve similar goals. To extend CBE principles, higher education in Singapore can align more with CBE practices, redesign curricula to integrate competency-based elements, and provide extensive training for educators. Implementing robust assessment strategies that go beyond traditional exams and strengthening industry partnerships for practical learning opportunities are also crucial. Additionally, integrating technology, starting with pilot programmes, and engaging the community and stakeholders will ensure widespread adoption and support. This strategy will help Singapore build a more adaptable and future-ready workforce by embedding CBE principles in its higher education, thereby avoiding the challenges faced by Australia in broadening the application of CBE.

Based on the findings, a theoretical framework has been proposed to elevate CBE in higher education to the next level. This framework also works alongside Singapore's existing CET system because the two serve distinct yet complementary purposes. The CET system focuses broadly on lifelong learning and general upskilling, offering a variety of training programmes to enhance overall workforce skills. In contrast, the CBE framework specifically targets the development of competencies required for particular job roles within key industries, ensuring that training programmes are highly relevant and tailored to current and future industry demands. This targeted approach provides clear career pathways, supports workforce mobility, and facilitates the recognition of prior learning, making training more goal-oriented and practical. Integrating CBE with CET enhances the effectiveness of Singapore's workforce development initiatives, ensuring they are comprehensive and precisely aligned with industry needs. This combination is crucial for maintaining a competitive and adaptable workforce in a rapidly changing economic landscape.

The depicted theoretical framework for CBE encapsulates an approach to education that is transformative, holistic, and reflective of the multifaceted nature of learning (Figure 1). At its core, this framework recognises the continuum of 'Lifelong and Lifewide Learning'—a concept that extends beyond traditional classroom settings to include the spectrum of experiences that contribute to a person's learning journey. These experiences contribute significantly to an individual's competency profile and align with the principles of lifelong learning theory (Jarvis, 2006) and experiential learning theory (Kolb, 1984). This dimension acknowledges that learning occurs throughout life, in a variety of contexts and through numerous experiences. From professional development to informal personal interests, every experience serves to enhance an individual's skill set. The recognition of such learning validates diverse educational backgrounds and respects the knowledge acquired through life's many roles and environments.
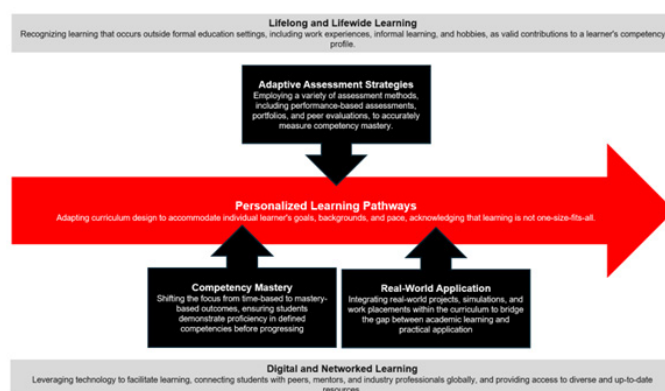

Figure 1. Proposed CBE framework.

'Personalized learning pathways' in higher education are characterised by their focus on the individual's learning needs and outcomes. It involves adapting curriculum design to accommodate individual learners' goals, backgrounds, and learning paces. It recognises that a one-size-fits-all approach to education is ineffective and aims to provide tailored learning experiences (Piaget, 1954; Tomlinson, 2001; Vygotsky, 1978). To accurately reflect a learner's progress and adapt to their unique learning journey, these pathways utilise a range of 'Adaptive Assessment Strategies'. These strategies are designed to go beyond the traditional examinations, recognising the importance of situating learning within practical and authentic contexts. It employs a variety of assessment methods to accurately measure competency mastery. This includes performance-based assessments, portfolios, and peer evaluations, which provide a holistic view of a learner's abilities (Black & Wiliam, 1998; Wiggins, 1993). For instance, learners might be tasked with project-based activities that challenge them to deploy their skills to navigate complex scenarios similar to those they might encounter in their professional lives. This shift aims to not only test knowledge but also assess the learner's ability to apply it in a meaningful way. Further enriching this assessment approach, portfolios offer a window into the learner's development over time. These collections, which may span the entirety of a learner's academic career, encapsulate a body of work showcasing growth, creativity, and proficiency. Complementing these methods are peer evaluations, which introduce diverse perspectives into the assessment process. By including feedback from classmates, assessments become more comprehensive, allowing learners to benefit from the collective insights of their learning community.

At the heart of personalised pathways is the principle of 'Competency Mastery.' This principle underlines the requirement that learners demonstrate a thorough understanding and proficiency in specific competencies before they move forward in their educational trajectory (Bloom, 1968; Spady, 1994). Mastery is often demonstrated through tangible, 'Real-World Application' of skills and knowledge. It shifts the focus from time-based to mastery-based outcomes, ensuring students demonstrate proficiency in defined competencies before progressing (Billett, 2011; Lave & Wenger, 1991). Curricula are carefully interwoven with opportunities such as internships, collaborative projects, and simulations that reflect the complexities of the modern workplace. These experiences are instrumental in bridging the gap between theoretical knowledge and its application, ensuring that learners are not just academically competent but also equipped to employ their skills in the workforce effectively. The transition from knowledge acquisition to its application is pivotal, underscoring the relevance of what is learned within academic institutions to the outside professional world. The goal is for learners to not only absorb information but also become adept at utilising this information in real-life situations.

Finally, these learning pathways are facilitated by 'Digital and Networked Learning.' This component leverages the expansive reach of educational technology to connect learners with a broader community (Garrison, 2011; Siemens, 2005). It encompasses the use of digital platforms for learning management, virtual simulations, online collaborations, and the creation of professional networks with peers and mentors. Access to diverse digital resources and communities enriches the learning experience, keeping it current and relevant. Educational technology also enables the creation of digital portfolios, where learners can curate and showcase evidence of their competencies, further personalising their learning pathways and providing a repository of their achievements.

In summary, the framework describes a highly adaptable, rigorously practical, and expansively networked learning model that ensures learners are equipped to meet the challenges and opportunities of an ever-changing landscape. Through this integrated approach, CBE becomes a channel for academic growth and personal and professional development, transcending traditional education models to foster lifelong learning. The following section will outline the implementation strategies to bring the framework to fruition (Figure 2).
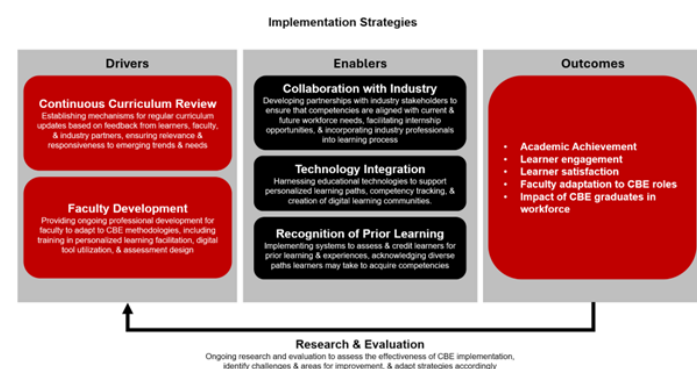

Figure 2. CBE implementation strategies.

The implementation strategies for CBE, as presented, cover foundational drivers, supporting enablers, and a cyclical process of research and evaluation. Drivers such as 'Continuous Curriculum Review' and 'Faculty Development' serve as the cornerstone of the CBE framework. Regular curriculum updates ensure that educational content is engaging and aligned with the evolving trends and demands of the workforce. 'Faculty Development' is integral, equipping educators with the necessary tools and expertise to deliver CBE methodologies effectively, enhancing their ability to support personalised learning, adeptly use digital tools, and design assessments that reflect learner competencies.

'Enablers' play a pivotal role in operationalising the core components or 'Drivers' of the system. They are essentially the mechanisms through which the foundational aspects of CBE are put into practice. Collaboration with Industry' stands as a critical enabler. It builds connections between academics and the industry, ensuring that the skills and knowledge imparted to learners are aligned with current and future market needs. By bringing industry stakeholders into the educational fold, from curriculum design to the provision of internships, this collaboration ensures that learning is closely knitted with practical, professional demands, giving learners the relevant experience and insight they need to succeed after graduation. 'Technology Integration' is another enabler that plays a role in education. By incorporating educational technologies, institutions can create personalised learning paths and maintain accurate records of competency development. Technology fosters digital learning communities that extend beyond the classroom, offering platforms for collaboration, discussion, and the exchange of ideas, thus enriching the educational experience. 'Recognition of Prior Learning' is an inclusive approach that values and validates the diverse experiences and skills that learners bring to their educational journeys. This enabler acknowledges that competencies can be acquired through various means, not exclusively through formal education. By recognising and crediting prior learning, educational institutions can provide learners with a more tailored educational path that builds upon their existing knowledge base and skills.

The 'Outcomes' derived from these strategies are multifaceted. They encompass improved 'Academic Achievement', where the application of CBE methodologies is anticipated to elevate academic performance. 'Learner Engagement' is expected to rise as learners find their educational experiences more aligned with their interests and career paths. 'Learner Satisfaction' may increase as learners perceive their learning journey as more personalised and tailored to their needs. Additionally, 'Faculty Adaptation to CBE Roles' is projected to be positive, with educators becoming more adept at facilitating a CBE-focused curriculum. Lastly, the 'Impact of CBE Graduates in the Workforce' is predicted to be significant, with graduates entering the job market possessing a stronger and more applicable set of skills.

The implementation strategies also highlight an ongoing 'Research & Evaluation' phase, critical for assessing the efficacy of CBE strategies, identifying potential areas for improvement, and ensuring that the implementation

remains relevant and practical. This continuous loop of feedback and refinement informs an educational model that is resilient, adaptable, and responsive to the needs of both learners and the industry.

Challenges

In traditional educational settings, existing methodologies and assessment systems often dominate, creating a significant barrier to the adoption of innovative approaches like CBE. Faculty and administrators frequently express scepticism about the efficacy of CBE, questioning whether it can be effectively applied across diverse academic disciplines. This scepticism stems from concerns about the standardisation of competencies, the adaptability of CBE to less skill-oriented subjects, and the potential increase in administrative workload required to implement CBE frameworks (Garfolo & L'Huillier, 2016). Additionally, some educators worry that CBE might oversimplify complex learning processes and reduce academic freedom in curriculum design (Johnstone & Soares, 2014; Kelchen, 2015). The resistance is also rooted in comfort with established methods and uncertainty about the outcomes of new educational models (Anderson, 2018). The transition to CBE also requires substantial investments in new learning materials, extensive training for educators, and the integration of advanced technology platforms. These requirements can strain institutional budgets, making it challenging to gather the necessary resources and support for successful implementation (Garfolo & L'Huillier, 2016).

Developing fair and comprehensive assessments within the CBE framework is a huge challenge. These assessments need to be continuously refined and validated to ensure they accurately reflect real-world requirements and the intended learning outcomes. This process demands a deep understanding of both the competencies being assessed and the industries learners will enter after graduation. Furthermore, the integration of technology in CBE, while beneficial, brings additional complexities, particularly in ensuring equitable access for all learners. Disparities in access to technology, known as the digital divide, can hinder the effectiveness of CBE for learners who lack the necessary technological resources, potentially widening educational inequalities (Lee et al., 2023).

As institutions attempt to expand CBE programmes to include more learners, they face the challenge of scaling up without diluting the quality of education or individualised learning experiences. CBE programmes require a high degree of customisation to meet the unique needs of each learner, which can be resource intensive. Moreover, maintaining consistency and standardisation across various programmes and institutions is essential for the credibility of CBE certifications. This standardisation ensures that all learners receive a quality education that meets established competencies, regardless of where or how they learn. However, achieving this consistency on a large scale can be difficult, as it involves synchronising curriculum, teaching methods, and assessment across different educational environments (Pluff & Weiss, 2022).

Proposed solutions

To effectively address the challenges of adopting CBE, it is crucial to engage and support faculty through dedicated workshops and training sessions. These educational opportunities help faculty understand the fundamental principles and potential benefits of CBE, aligning their teaching methods with competency-based objectives. Additionally, developing incentive programmes that reward educators for designing and implementing effective CBE strategies can motivate faculty to participate actively in the transition process. Such incentives might include recognition, career advancement opportunities, and grants for educational research (Hatcher et al., 2013).

Financial constraints often hinder the adoption and expansion of CBE. To overcome these limitations, institutions can explore flexible funding models that include partnerships with industry and government bodies. These partnerships can provide essential financial support for developing and testing CBE programmes. Pilot programmes requiring lower initial investments can serve as proof of concept, demonstrating the effectiveness of CBE before committing to full-scale implementation. This approach not only mitigates financial risk but also builds a case for broader institutional and governmental support (SkillsFuture Singapore, 2023).

Employing innovative assessment methods that leverage technology to create adaptive, personalised assessments can enhance the implementation of CBE. These assessments allow educators to measure a broad spectrum of competencies effectively, adapting to each learner's learning pace and style. Collaboration with industry experts is vital to ensure that these assessments maintain relevance to professional standards and real-world scenarios. Such collaborations can help ensure that competency assessments are both rigorous and directly applicable to the demands of the workforce (Nousiainen et al., 2016). Educational technology platforms are essential for supporting CBE. These platforms should be accessible and user-friendly, providing the necessary tools for both educators and learners to engage with the curriculum effectively. Additionally, integrating digital literacy training can enhance the ability of all participants to utilise these technologies effectively. This investment ensures that the technology not only supports CBE but also enhances the overall learning experience, making education more interactive and engaging (OpenGov Asia, 2019).

Addressing scalability concerns requires a modular approach to programme design. By creating CBE programmes that are inherently adaptable, institutions can more easily apply these programmes across different contexts and learning environments. Implementing standardised frameworks that can be customised to meet local needs while maintaining a coherent structure across the institution ensures consistency and quality. This flexibility facilitates easier expansion and adaptation of CBE programmes to various educational settings (Misko & Circelli, 2022).

To effectively implement CBE at the higher education level and address challenges like the digital divide, universities need to invest in expanding digital infrastructure to ensure all students have access to reliable internet and technological

resources, including financial aid for low-income students (OECD, 2022). Equitable access to technology can be achieved through device lending programmes or campus-wide access points (Basilotta-Gómez-Pablos et al., 2022). Continuous professional development for faculty in digital literacy and educational technology is essential for integrating CBE into teaching practices (Laufer et al., 2021). Robust support systems, such as help desks and peer mentoring, should be established to guide students in navigating digital tools and CBE frameworks (Frontiers in Education, 2021). Data privacy and security policies must protect student information, and regular monitoring and evaluation are necessary to identify and address gaps. The CBE curriculum should be inclusively designed to accommodate diverse learning needs, incorporating flexible learning paths and various assessment methods (Basilotta-Gómez-Pablos et al., 2022).

Future directions and prospects

As Singapore continues to refine and expand its CBE framework, the future of this educational approach appears both promising and dynamic. The evolution of CBE in Singapore will likely be influenced by several key factors, including technological advancements, changing industry demands, and potential changes in educational paradigms. The integration of technology in education has been a significant driver of CBE's success in Singapore. Looking ahead, emerging technologies such as artificial intelligence (AI), virtual and augmented reality (VR/AR), and blockchain have the potential to further transform CBE. AI can personalise learning experiences at an unprecedented scale, adapting in real-time to the needs and progress of individual learners (Lee et al., 2023). VR/AR technologies can enhance experiential learning, providing immersive simulations of complex processes and environments that are not easily accessible in traditional classrooms (Yin et al., 2020). Blockchain technology could revolutionise competency certification, allowing learners to maintain secure, verifiable records of their skills and achievements (OpenGov Asia, 2019).

As industries continue to evolve, the demand for new skills and competencies will shape the direction of CBE in Singapore. The rise of green technologies, digital economies, and smart manufacturing, among others, will require the educational system to remain agile, adapting curricula and learning outcomes to prepare learners for emerging sectors. Singapore's strong ties between educational institutions and industry partners will facilitate this alignment, ensuring that CBE remains relevant and responsive to economic changes.

The philosophy underpinning education is also subject to change, influenced by societal changes, research findings, and pedagogical innovations. There is a growing recognition of the importance of soft skills, such as emotional intelligence, creativity, and adaptability, alongside technical competencies. This holistic view of competency may lead to broader curricular transformations within CBE frameworks, emphasising the development of well-rounded individuals capable of contributing to society in diverse and meaningful ways.

Limitation

This paper acknowledges its limitation due to the reliance on secondary data rather than primary research. The findings and recommendations are derived from an extensive review of existing literature and expert analyses. However, the comprehensive synthesis of secondary sources offers significant and valuable perspectives on CBE. This literature-based approach allows for a broad understanding of current trends and expert opinions in the field. Despite the lack of primary data, the study effectively highlights key themes and findings from a wide array of reputable sources. This approach provides a foundation for understanding CBE's potential benefits and challenges. Nevertheless, future research involving primary data collection would be beneficial in offering a more detailed and context-specific understanding of CBE's effectiveness and implementation challenges. Recognising these limitations does not diminish the value of the insights provided but rather underscores the need for continued research to build on this foundational analysis. This acknowledgement is crucial for contextualising the scope and implications of the findings, ensuring that readers understand the breadth of the current study while also recognising areas for further exploration.

Conclusion

Singapore's foray into CBE marks a significant pivot in its educational narrative. This study outlines the nation's journey towards a holistic approach to learning, aligning academic rigour with the practical demands of a fluid global economy. The implementation of CBE, spearheaded by the SkillsFuture initiatives, stresses a commitment to lifelong learning, skill mastery, and the development of versatile competencies. Through an adaptive framework that values real-world application, Singapore's education system aims to produce not just academically proficient graduates but also adaptive thinkers and skilled professionals ready to contribute meaningfully to diverse fields. The success of this model lies in its collaboration with industry partners, integration of technology, and recognition of learning across various life experiences. As Singapore continues to refine its CBE approach, it offers a model of educational reform that is responsive, resilient, and potentially transformative, seeking to equip learners for future challenges. This study shows how CBE can change Singapore's workforce development, making it more responsive to industry needs. Future research should look at how CBE graduates perform in the long run and how these programmes can work in different educational settings.

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