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Implementation of Vocational Technology Education Philosophy in Competency-Based Curriculum Design: A Systematic Literature Review

Andi Putra[1,2*], Nizwardi Jalinus[1], Ernawati[1], Fadhilah[1]
[1] Department of Doctoral Programme in Vocational Technology Education, University Negeri Padang, Indonesia.
[2] Department of Informatics, Sekolah Tinggi Technology Payakumbuh, West Sumatera, Indonesia

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ABSTRACT

Vocational technology education plays a strategic role in preparing a skilled workforce that is competent in accordance with industry needs. This article aims to analyse the implementation of vocational technology education philosophy in competency-based curriculum design through a systematic literature review approach. This study uses the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method by analysing 35 journal articles from various academic databases published between 2015 and 2024. The review results show that the philosophy of vocational technology education is based on three main principles: work-based learning, industry linkage, and holistic competency development that includes cognitive, affective, and psychomotor aspects. The implementation of this philosophy in competency-based curricula is realized through: (1) the integration of theory and practice learning with a balanced ratio; (2) collaboration between educational institutions and industry in formulating competency standards; (3) an authentic assessment system that measures overall competency mastery; and (4) learning that is responsive to technological developments and labour market demands. This study recommends the need to strengthen synergy between stakeholders, continuously update the curriculum, and improve the capacity of educators to optimize the implementation of the philosophy of vocational technology education in competency-based curricula.

1. Introduction

Vocational technology education plays a strategic role in preparing competent and job-ready human resources in line with the demands of global industrial dynamics. Since the first Industrial Revolution in the 18th century, the technical labor gap has widened and the concept of large-scale technical and vocational education and training has begun to be advocated. In this context, vocational technology education does not merely aim to transfer theoretical knowledge, but rather emphasizes the development of practical competencies that can be directly applied in the world of

* Corresponding author.
E-mail address: andiputramkom@gmail.com
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work (Nasution, 2024). The educational philosophy underlying this educational theory guides our perspective on the ideas and objectives of vocational education, helping stakeholders gain a deeper understanding of the essence, objectives, values, processes, and evaluation of vocational technology education.

As the professional landscape continues to evolve, educational institutions are required to innovate in preparing students to face future challenges. Educational competencies are advocated in the United Nations 2023 Sustainable Development Goals, with UNESCO encouraging countries to provide inclusive, equitable, and lifelong learning opportunities for all. In response to these demands, competency-based curricula have become an increasingly popular approach in vocational education systems in various countries, both in developing and industrialized countries (Chen et al., 2024). This approach emphasizes the achievement of specific competencies that can be measured and verified, with a focus on learning outcomes rather than just the learning process.

The link between technical and vocational training institutions and industry is essential to improve productivity and better employment opportunities, enabling industry to inform training institutions of their skill needs. Collaboration between the worlds of education and industry is a key element in ensuring the relevance of the curriculum to actual labor market needs. Recent research emphasizes the importance of industry involvement in aligning, implementing, and evaluating vocational curricula, which includes curriculum synchronization, work culture development, and assessment of curriculum implementation (Gomes et al., 2024). However, the implementation of this linkage faces various challenges, including changing industry demands and rapid technological advances, misalignment between the curriculum and industry needs, limited resources and infrastructure, and weak quality assurance systems (Muriuki & Dominic, 2024).

Competency-based curriculum development in vocational education and training has received increased attention in recent years. This approach focuses not only on mastery of theoretical knowledge, but also on the ability to apply that knowledge in real work situations. Competency is defined as the knowledge, skills, and attitudes that a person must possess in order to adapt to current life and face future challenges. In the context of vocational education, the development of holistic competencies that encompass cognitive (knowledge), affective (attitudes and values), and psychomotor (practical skills) aspects is essential (Liao et al., 2023).

Although there have been many studies discussing vocational education and competency-based curriculum separately, there are still limitations in the literature that comprehensively analyze how the philosophy of vocational technology education is implemented in competency-based curriculum design. This knowledge gap is important to bridge, given that educational philosophy provides a fundamental basis for determining the direction, objectives, and methods of curriculum development. Therefore, this study aims to analyze the implementation of vocational technology education philosophy in competency-based curriculum design through a systematic literature review approach. By identifying the philosophical principles underlying vocational technology education and analyzing how these principles are translated into curriculum design practices, this study is expected to contribute theoretically and practically to the development of a more effective vocational education system that is responsive to the needs of industry and society.

2. Methodology

This study applies a systematic literature review (SLR) approach to analyze the integration of vocational technology education philosophy in competency-based curriculum development. This approach was chosen because it is able to systematically collect and synthesize research findings, thereby providing a comprehensive overview of philosophical concepts, curricular practices, and the

direction of contemporary vocational education development. All stages of the study followed the PRISMA guidelines to ensure transparency and traceability of the research process.

The literature search was conducted in a structured manner through six academic databases, namely Scopus, Web of Science, ERIC, IEEE Xplore, Google Scholar, and ScienceDirect. The articles reviewed were limited to publications from 2015 to 2024 in English and Indonesian. The search strategy used a combination of keywords related to vocational education, philosophy of education, competency-based curriculum, and curriculum design, and was applied to titles, abstracts, and keywords to ensure the relevance of the literature obtained.The study selection was conducted through the stages of identification, screening, eligibility, and inclusion in accordance with the PRISMA flow.

The inclusion criteria included peer-reviewed articles and reputable proceedings that explicitly discussed the philosophy of vocational technology education or competency-based curriculum and were available in full-text form. Articles that were irrelevant, duplicates, or did not meet methodological standards were excluded from the analysis. The selection process was carried out by two independent reviewers to minimize bias.

The methodological quality of the selected articles was assessed using the JBI Critical Appraisal Checklist. Each article was evaluated independently by two reviewers, and differences in assessment were resolved through discussion until agreement was reached. Articles with quality below the minimum threshold were not included in the synthesis stage. Data from studies that met the criteria were systematically extracted, covering research characteristics, philosophical frameworks, and aspects of competency-based curriculum implementation.

Data synthesis was conducted using a narrative synthesis approach with thematic analysis to integrate findings from various research contexts. The analysis was conducted deductively and inductively to identify the philosophical principles of vocational education, the main characteristics of competency-based curricula, forms of education and industry collaboration, and implementation challenges encountered. The validity of the research was maintained through the application of consistent protocols, the involvement of multiple reviewers, systematic documentation, and adherence to the principles of academic integrity.

3. Results

3.1 Overview of Search Results and Literature Selection

The systematic literature search conducted on six electronic academic databases yielded 1,247 articles in the initial identification stage. After eliminating duplicates using reference management software, 892 articles remained for screening based on title and abstract. Further evaluation of compliance with inclusion and exclusion criteria resulted in 156 articles passing to the stage of eligibility for full-text reading. In the final stage, after methodological quality assessment using the JBI Critical Appraisal Checklist instrument, 35 articles met the criteria of quality and relevance for inclusion in the final analysis. The included articles came from various geographical contexts, including countries in Asia (40%), Europe (31%), America (23%), and Australia (6%), with publications ranging from 2015 to 2024.

The distribution of articles based on research design showed considerable variation, with 14 articles using a quantitative empirical study approach, 12 articles using a qualitative approach, 6 articles using mixed methods research, and 3 articles in the form of conceptual or theoretical studies. The fields of study that were the focus of the articles were also diverse, covering engineering and mechanical education (28%), information technology (20%), health and nursing (17%), business and management (14%), and other vocational fields such as hospitality, culinary arts, and agriculture (21%). This diversity of contexts and methodological approaches provides a strong foundation for

identifying consistent conceptual patterns in the implementation of vocational technology education philosophy in competency-based curriculum design.

3.2 Philosophical Principles of Vocational Technology Education

An analysis of the included literature identifies three main philosophical foundations that consistently underpin contemporary vocational technology education. First, the philosophy of pragmatism emerges as the dominant orientation in vocational education, emphasizing practical, utilitarian, and real-world problem-solving learning. Pragmatism in the context of vocational education prioritizes the principle of learning by doing, where knowledge is constructed through direct experience and meaningful practical activities. This philosophy views education as not separate from the realities of life and work, but rather as organically integrated with the practical needs of individuals and society.

Second, social constructivism is an important epistemological foundation for understanding how vocational competencies are developed. This perspective emphasizes that learning is an active process in which learners construct knowledge and skills through interaction with their social and cultural environment, including the industrial context and professional practice communities. Effective vocational learning is seen as a process of enculturation into authentic work practices, not merely the transfer of technical information from instructors to learners. Social constructivism emphasizes the importance of legitimate peripheral participation, which is the gradual involvement of learners in professional practice communities that enable them to progressively develop their identities and competencies as practitioners.

Third, humanism emerges as a philosophical dimension that complements the pragmatic and constructivist orientations in vocational education. The humanistic perspective emphasizes the importance of holistic individual development, not only as technically competent workers, but also as individuals who are fully developed in cognitive, affective, and moral dimensions. The philosophy of humanism in vocational education advocates the importance of developing soft skills, professional character, critical thinking skills, and the capacity for lifelong learning. The integration of pragmatism, social constructivism, and humanism forms a comprehensive philosophical framework that views vocational education as a process that prepares individuals not only to obtain employment, but to develop continuously in their careers and lives.

3.3 Essential Characteristics of Competency-Based Curriculum

A synthesis of the literature identifies five fundamental characteristics that define competency-based curriculum in the context of vocational technology education. The first characteristic is an orientation toward clearly defined and measurable learning outcomes. The curriculum is designed by first establishing the specific competencies that learners must master, then aligning all components of the curriculum, including learning content, instructional strategies, and assessment systems, to facilitate the achievement of these competencies. This approach differs fundamentally from traditional curricula, which tend to focus on content coverage or learning duration.

The second characteristic is its learner-centric nature, which places learners at the center of the learning process. Competency-based curricula recognize that each learner has a different learning speed, learning style, and prior learning experience. Therefore, the curriculum is designed with flexibility that allows for personalized learning paths, where learners can advance to the next competency after demonstrating mastery of the prerequisite competencies, without being rigidly bound to the temporal structure of semesters or school years. The principle of mastery learning is applied, whereby students are given the opportunity to attempt assessments repeatedly until they achieve the specified competency standards.

The third characteristic is the integration of theoretical knowledge and practical skills in the competency structure. Competencies in the vocational curriculum are not understood solely as the ability to perform technical procedures, but as a complex combination of declarative knowledge (knowing what), procedural knowledge (knowing how), and conditional knowledge (knowing when and why). Each competency is broken down into cognitive components that include conceptual understanding and scientific principles, psychomotor components that include technical and procedural skills, and affective components that include professional attitudes, work ethics, and dispositions toward continuous learning.

The fourth characteristic is an authentic assessment system that measures students' ability to apply competencies in real work contexts or realistic simulations. Assessment does not rely solely on written tests, but uses a variety of evaluation methods such as skill demonstrations, portfolios of work, problem-based projects, case studies, and workplace performance assessments. Assessment criteria are clearly developed in the form of rubrics that describe the levels of competency mastery, enabling objective, transparent, and reliable assessment. Formative assessment is used continuously to provide feedback that supports the learning process, while summative assessment is used to verify competency achievement.

The fifth characteristic is responsiveness to industry needs and technological developments. Competency-based curricula are designed through a needs analysis process that involves industry stakeholders to ensure the relevance of the competencies developed to the demands of the contemporary world of work. Curriculum review and revision mechanisms are carried out periodically and systematically to accommodate changes in industry practices, professional standards, and technological innovations. The flexibility of the curriculum allows for the addition or modification of competency modules without having to overhaul the entire program structure, keeping the curriculum relevant in the context of rapid change.

3.4 Strategies for Implementing Educational Philosophy in Curriculum Design

The implementation of vocational education philosophy in competency-based curriculum design is realized through several interrelated pedagogical and curricular strategies. The first strategy is the integration of theoretical and practical learning through project-based learning and problem-based learning approaches. These two approaches are in line with the principle of pragmatism, which emphasizes learning through meaningful activities and authentic problem solving. In its implementation, students are given complex projects or problems that simulate real challenges in professional practice, requiring them to integrate theoretical knowledge from various disciplines with practical skills to produce viable solutions.

The second strategy is the application of work-based learning in various modalities, ranging from internships, industrial work practices, apprenticeships, to cooperative education. Work-based learning is a concrete manifestation of the philosophy of social constructivism, in which students learn through direct participation in professional practice communities in industry. Structured internship programs allow students to observe, participate, and gradually take on responsibility for authentic work tasks under the supervision of experienced practitioners. This experience not only develops technical competencies, but also facilitates socialization into professional work culture, industry norms, and performance expectations.

The third strategy is the development of a learning environment that simulates real working conditions through teaching factories, workshops, laboratories, or simulation centers equipped with the tools and technology used in industry. This learning environment is designed to bridge the gap between classroom learning and industrial work practices, allowing students to practice in an authentic context while remaining in an educational environment that supports exploration,

experimentation, and learning from mistakes. Teaching factories, for example, integrate real production processes into the curriculum, where students are involved in manufacturing products or providing services that have real economic value, while remaining under educational supervision.

The fourth strategy is differentiation and personalization of learning that accommodates the diversity of learners in terms of initial abilities, learning speed, learning styles, and career aspirations. The implementation of this strategy includes the use of technology-based adaptive learning, the provision of alternative learning paths to achieve the same competencies, recognition of prior learning (RPL) that gives credit for competencies that learners have acquired from work experience or informal learning, and a mentoring and tutoring system that provides individual support. Differentiation does not mean lowering competency standards, but rather providing various methods and support so that all learners can achieve the set standards.

The fifth strategy is the development of transversal competencies or generic skills that cut across various specific vocational fields. Transversal competencies include critical thinking and problem-solving skills, effective communication, collaboration and teamwork, digital literacy, independent learning skills, and adaptability to change. The development of these competencies is in line with a humanistic perspective that emphasizes holistic individual development and prepares students for career flexibility in the context of rapid economic and technological change. The implementation of this strategy includes the explicit integration of transversal competencies into program learning outcomes, the design of learning activities that deliberately develop these competencies, and assessments that evaluate the mastery of transversal competencies separately or integrated with technical competencies.

3.5 The Role of Industry-Education Collaboration

Collaboration between vocational education institutions and the industrial sector has emerged as a critical element in the implementation of the philosophy of vocational technology education and competency-based curriculum design. The results of the analysis identified several dimensions of collaboration that have a significant impact on the quality and relevance of vocational education. The first dimension is industry involvement in the curriculum development and validation process. Industry practitioners, professional associations, and technical experts from companies participate in curriculum committees to provide input on the competencies needed in the world of work, expected performance standards, the latest technologies and practices, and development trends in their respective fields. The process of curriculum validation by industry ensures that the competencies developed in education programs are in line with the actual needs of the job market.

The second dimension is providing access to work-based learning through internship programs, industrial placements, and apprenticeships. Industries open their workplaces as learning environments for students, provide supervisors who act as mentors, and integrate students into real work processes. This collaboration provides mutual benefits, where students gain authentic work experience and practical skills development, while industries gain access to potential young talent, opportunities to evaluate prospective employees, and productive contributions from students during their internship period. The success of work-based learning depends heavily on the quality of collaborative planning between educational institutions and industry, clarity of learning objectives, effective supervision and mentoring mechanisms, and an assessment system that integrates educational and industrial perspectives.

The third dimension is the contribution of industry to educational resources, whether in the form of equipment and technology, learning materials, or human resources. Some industries provide donations or access to expensive modern equipment, enabling educational institutions to facilitate learning with the latest technology without excessive financial burdens. Industry practitioners are

also involved as guest instructors or co-teachers who share their specific expertise and practical experience with students.

Collaboration in the development of learning materials, such as case studies based on real industry situations, learning modules that use industry application examples, or tutorial videos produced in actual work environments, increases the authenticity and relevance of learning content. The fourth dimension is partnerships in applied research and technological innovation. Vocational education institutions and industry collaborate on research projects that address real technical challenges faced by industry, develop product or process innovations, or adapt new technologies to the local context. These research partnerships not only produce valuable solutions for industry, but also provide valuable learning opportunities for students and educators to engage in authentic innovation processes. In addition, research partnerships can be a mechanism for updating educators' knowledge and skills, ensuring that they remain current with technological developments and industry practices.

The fifth dimension is the mechanism for continuous feedback and evaluation from industry regarding the quality of graduates and the effectiveness of programs. Tracer studies or alumni tracking studies involving employer feedback provide important data on the suitability of graduates' competencies to job requirements, the strengths and weaknesses of programs, and recommendations for curriculum improvement. Some institutions have developed advisory boards consisting of industry representatives to provide strategic guidance and conduct periodic reviews of programs. This feedback mechanism is essential to ensure continuous improvement and responsiveness of the curriculum to the dynamics of industry needs.

3.6 Challenges in Implementation

Although the literature shows various good practices in implementing the philosophy of vocational technology education in competency-based curricula, the analysis also identifies a number of significant challenges faced by educational institutions. The first challenge is the limited infrastructure resources and practical equipment that meet contemporary industry standards. Many vocational education institutions, especially in developing countries, face a gap between the equipment available in workshops or laboratories and the technology used in industry. This gap not only affects the quality of practical learning, but also reduces students' confidence and can create a competency gap when they enter the workforce. Investing in the procurement and maintenance of modern equipment requires substantial financial allocation, which is often a constraint for educational institutions with limited resources.

The second challenge is the competency gap among educators or vocational instructors, both in terms of mastery of the latest technology and understanding of pedagogical approaches that are in line with competency-based curricula. Many vocational educators have a solid educational background but limited industry experience, or conversely, have rich industry experience but need to develop their pedagogical skills. The transition from a content-based curriculum to a competency-based curriculum requires fundamental changes in instructional practices, from teaching-centered to learning-centered, from knowledge transmission to learning facilitation, and from written test-based assessment to authentic performance assessment. These changes require comprehensive and ongoing professional development programs for educators.

The third challenge is the rapid pace of technological change and competency requirements in several industrial sectors, particularly in the fields of information technology, digital media, and advanced manufacturing. This rapid pace of change creates the risk of curriculum obsolescence, where curricula that have been painstakingly developed become outdated before they can be fully implemented or before a cohort of students completes the program. Educational institutions face a

dilemma between providing a relatively stable foundation of fundamental knowledge and skills versus responding quickly to emerging skills required by industry. Strategies to overcome this challenge require modular and flexible curriculum design, more frequent review and update mechanisms, and strong partnerships with industry for early warning of changing competency needs.

The fourth challenge is the complexity of developing and implementing a competency assessment system that is valid, reliable, and feasible. Competency assessment requires evaluation of students' ability to demonstrate performance at a standard level set in an authentic context. Developing valid assessment instruments requires in-depth analysis of competency dimensions, performance criteria, and appropriate assessment conditions. The assessment process itself is more time-intensive than traditional assessments, requires trained assessors, and creates a significant workload for educators. In addition, the implementation of the mastery learning principle in competency-based curricula, where learners are given the opportunity to be reassessed until they reach the standard, creates logistical and administrative complexities.

The fifth challenge is resistance to change from various stakeholders, including educators who are accustomed to conventional approaches, students and parents who are more familiar with time-based systems and traditional grading, and even some industries that do not yet fully understand the value proposition of competency-based curricula. Change management is a critical aspect in the implementation of competency-based curricula, requiring effective communication strategies to explain the rationale, benefits, and implications of change, as well as systematic support to facilitate the transition of all stakeholders.

The sixth challenge relates to the difficulty of establishing and maintaining effective and sustainable partnerships with industry. Although industry-education collaboration is recognized as a critical element, practices in the field show that many partnerships are ad-hoc, fragmented, or unsustainable in the long term. Differences in organizational culture, expectations, priorities, and time horizons between educational institutions and industry can create mismatches that hinder effective collaboration. Industry often expects short-term tangible benefits from partnerships, while educational institutions focus on long-term learning outcomes. Building mutual understanding, trust, and reciprocal value propositions requires a substantial investment of time and effort from both sides.

3.7 Best Practices and Recommendations

Based on a synthesis of various case studies and successful practices in different contexts, this study identifies a number of best practices and recommendations for more effective implementation. First, the importance of institutional commitment and strong leadership in supporting curriculum transformation. Successful implementation of competency-based curricula requires more than just changes to curriculum documents; it requires systemic changes in organizational culture, structure, policies, and institutional practices. Visionary and committed leadership provides strategic direction, mobilizes resources, overcomes resistance, and maintains momentum for change.

Second, the development of educator capacity through comprehensive, ongoing, and practical professional development programs. Effective professional development programs go beyond one-off workshops or training sessions to include continuous learning through communities of practice, peer coaching, mentoring, and opportunities for experiential learning in industry. Educators need to develop not only a conceptual understanding of competency-based curricula, but also practical skills in designing competency-based learning, implementing student-centered instructional strategies, developing authentic assessment instruments, and using technology to support learning.

Third, a modular and flexible curriculum design allows for more responsive adaptation to changing needs and facilitates personalized learning. The modular structure allows learners to take

a combination of competency modules that suit their career paths, accommodates credit transfers between programs or institutions, and facilitates lifelong learning where individuals can return for upskilling or reskilling by taking specific modules without having to repeat the entire program.

Fourth, investment in educational technology to support competency-based learning, assessment, and curriculum management. Sophisticated Learning Management Systems (LMS) can facilitate adaptive learning, track learners' progress toward competency achievement, provide digital portfolios for documenting evidence of learning, and offer learning analytics for informed decision making. Simulation and virtual reality technologies can provide immersive and safe learning environments for practicing complex or dangerous skills. Digital assessment platforms can automate certain aspects of assessment, improving efficiency and consistency.

Fifth, developing a structured, mutually beneficial, and sustainable industry-education partnership model. Best practices include formalizing partnerships through a Memorandum of Understanding or a clear cooperation agreement, establishing a governance structure such as an advisory board or steering committee with balanced representation from education and industry, regular communication and coordination mechanisms, and clearly defined roles and responsibilities. Effective partnerships are built on the principle of reciprocity, where both parties give and receive value, rather than a unidirectional relationship.

4. Conclusions

This systematic literature review shows that the application of vocational technology education philosophy contributes substantially to the development of an effective and adaptive competency-based curriculum. A philosophical foundation that combines pragmatism, essentialism, and progressivism has proven capable of bridging the gap between theoretical learning and the practical needs of industry. The integration of these philosophical principles has resulted in a curriculum framework that not only emphasizes the mastery of technical skills but also develops critical thinking, problem-solving, and adaptive competencies needed to face the dynamics of technological developments and transformations in the productive sector.

The implementation of a competency-based curriculum grounded in vocational education philosophy has proven successful in creating a holistic, outcome-based learning ecosystem. Synergy between educational institutions and industry stakeholders is a determining factor in ensuring the relevance of curriculum content to the competency standards required by the job market. This collaborative approach facilitates the transfer of practical knowledge, access to the latest technology, and experiential learning opportunities through industrial work practices, which simultaneously increase the employability and competitiveness of vocational technology education graduates.

Despite showing positive prospects, the implementation of the vocational technology education philosophy in curriculum design still faces various strategic challenges that require comprehensive intervention. Limitations in learning infrastructure, disparities in educator competencies, and the rigidity of education regulations are significant obstacles to the operationalization of a responsive and innovative curriculum. To optimize the effectiveness of implementation, a sustained commitment is needed from the government, educational institutions, and the industrial sector to provide resource support, educator capacity building, and policy refinement that supports flexibility and innovation in the vocational technology education curriculum in Indonesia.

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