

Managing healthcare training activities in colleges using the CDIO approach

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Abstract

Training healthcare professionals at the college level needs innovation toward a competency-based approach that closely links theory and professional practice. The CDIO (Conceive – Design – Implement – Operate) approach has proven effective in engineering training, but its application to healthcare management is currently limited to confirming its philosophical suitability and has not yet been concretised into a framework of management content that can be directly applied in practice. Using a combination of document analysis and theoretical modelling, this study compares the characteristics of college-level healthcare training with the 12 CDIO standards. Based on this, a management framework consisting of six components is proposed: managing objectives and learning outcomes; managing the curriculum; managing teaching and clinical practice; managing faculty and practical guidance; managing facilities and the training environment; and managing the evaluation of training outcomes and linking training with human resource utilisation. The research results contribute to supplementing the theoretical basis of competency-based training management in the health sector, while also providing a reference tool for college principals to review, organise, and improve training management toward standardisation. The study also clarifies theoretical limitations and proposes directions for further empirical verification.

Keywords— training management, health sector, CDIO approach, college, learning outcomes.

I. PROBLEM STATEMENT

A well-trained and qualified healthcare workforce is a prerequisite for ensuring the quality of healthcare services and achieving sustainable health development goals (World Health Organisation [WHO], 2016). In Vietnam, colleges training in health-related fields such as nursing, midwifery, pharmacy, medical laboratory technology, medical imaging technology, rehabilitation technology, and general practitioners play a major role in providing most healthcare technicians for the primary healthcare system (Ministry of Labour, Invalids and Social Affairs, 2017). However, some domestic studies show that training management at these schools still leans towards administrative management, and the connection between theory and clinical practice is limited, leading to a gap between the

competence of graduates and the requirements of actual practice (Le Thi Mai Huong, 2018; Nguyen Van Tinh, 2016).

Internationally, reforms in healthcare workforce training towards integrating clinical competence, systems thinking, and professional skills have been strongly recommended since the beginning of the 21st century (Frenk et al., 2010). Simultaneously, competency-based education and outcome-based education have been established as common standards in modern medical training (Harden & Laidlaw, 2012). In this context, the CDIO approach – developed at the Massachusetts Institute of Technology for engineering education (Crawley et al., 2014) – has been noted by several studies as having the potential to be transferred to other highly practice-oriented training disciplines,

including the health sector, due to its focus on performance competence (Biggs & Tang, 2011; Zhou & Fagerholm, 2019).

However, existing studies on CDIO in medical education largely focus on confirming the philosophical suitability or conducting trials within a single course or a narrow discipline (Le Thi Phuong, 2019; Nguyen Minh Sang, 2022), while Zhou and Fagerholm (2019) simultaneously pointed out that CDIO, when applied to medical education, still faces barriers regarding the standardization of competency assessment and the organizational capacity of the teaching staff. To date, no work has developed a comprehensive content management framework that can be directly applied to managing training at the college level in the health sector in Vietnam. This is the research gap that this article aims to address.

The objective of this study is to develop a content framework for managing health-related training activities in colleges using the CDIO approach. To achieve this objective, the study answers two questions: (i) In what aspects is health-related college training compatible with the CDIO philosophy and standards? (ii) Based on this, what components should the content of training management activities be structured into to ensure both the logic of the CDIO cycle and suitability to the specific characteristics of medical training?

II. RESEARCH METHODOLOGY

The study employs a qualitative design, combining document analysis with theoretical modelling. The aim is to develop a management content framework at the initial stage of a broader research direction on health science education management using the CDIO approach.

The data consists of secondary documents, comprising three groups: current legal documents on vocational education and healthcare in Vietnam (Law on Vocational Education, National Assembly, 2014; Law on Medical Examination and Treatment, National Assembly, 2023; Decision No. 1982/QĐ-TTg, Government, 2016; Circular No. 09/2017/TT-BLĐTBXH, Ministry of Labour, Invalids and Social Affairs, 2017); original documents on CDIO, including the CDIO Syllabus and the system of 12 CDIO Standards (Crawley et al, 2014); and domestic and international research published between 2010 and 2024 related to CDIO and training management in the health sector. Documents were selected based on three criteria: being current legal documents or published scientific works;

Directly related to CDIO, competency-based education/output standards, or the characteristics of health science training; and prioritising publications from the last 10–15 years, with the addition of some classic literature as a theoretical foundation (Crawley et al., 2014; Frenk et al., 2010).

The analysis process consists of 3 steps: (1) systematizing the characteristics of college-level health science training (objectives, curriculum, practical proportion, professional ethics, facilities, evaluation) from regulatory documents and related studies; (2) deductive mapping of each characteristic with the 12 CDIO standards using content analysis techniques to determine the level of compatibility; (3) inductive synthesis of similar standard groups into management content components, cross-referencing with the 4 management functions (planning - organizing - directing - controlling) to ensure a complete and logical proposal framework.

This study is a conceptual framework-building step based on literature analysis, and has not undergone empirical surveys or expert consultations using Delphi techniques; therefore, the proposed framework needs to be validated for reliability and feasibility in subsequent studies before being recommended for widespread application, and its generalizability to medical training systems outside of Vietnam also needs careful consideration.

III. RESEARCH RESULTS - DISCUSSION

3.1. Theoretical basis

Training management is understood as the process of purposeful and planned influence by the management entity (principal, school management levels) on the components of training activities – objectives, curriculum, teaching organisation, staff, facilities, and assessment – in order to ensure the quality and effectiveness of training (Le Viet Chung, 2021). At the university and college level, training management is increasingly approached from a competency-oriented perspective, in which output standards play a central reference role for all management activities (Nguyen Quoc Chinh, 2021).

The CDIO (Conceive – Design – Implement – Operate) approach is an educational model developed by Crawley et al. (2014) to train learners to fully implement the entire cycle of ideation, design, implementation, and operation of a product, process, or system in a real-world professional context. This

approach is concretised through 12 CDIO standards, encompassing everything from the training context, learning outcomes, and curriculum design to teaching methods, assessment, and curriculum improvement.

College-level health science training in Vietnam comprises seven main fields (pharmacy, nursing, midwifery, general practitioner, medical laboratory technology, medical imaging technology, and rehabilitation technology), organised according to the List of College-Level Training Fields (Ministry of Labour, Invalids and Social Affairs, 2017), characterised by a dominant proportion of practical and internship components and high demands on professional ethics standards.

3.2. Compatibility between college-level health science education and the CDIO approach

The results of the document analysis using the inferential comparison process (section 2) show that college-level training in the health sector has a high degree of compatibility with the CDIO philosophy and standards in the following four aspects.

(1) Regarding training objectives: the output competency structure of the health sector – fundamental biomedical knowledge, clinical and paraclinical skills and professional attitudes and ethics – corresponds to the logic of competency formation according to the CDIO cycle, in which professional competencies are formed through the stages of problem identification, solution design, implementation and operation in the context of real profession (Crawley et al., 2014). Table 1 specifically compares the 4 stages of the CDIO cycle with the corresponding manifestations in training activities of the health sector.

Table 1. Comparison of the CDIO cycle with training activities in the health sector at the college level.

CDIO phase	Manifestations in health science training
Conceive (Idea Formation)	Identifying patient/community health problems based on fundamental biomedical knowledge.
Design	Selecting the appropriate technical procedures and care protocols based on the patient's condition.
Implement	Perform technical procedures and care interventions under professional supervision at the practice facility.

Operate	Monitor, evaluate care outcomes, and make adjustments in a hospital/community setting.
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Source: Compiled by the author from Crawley et al. (2014); Ministry of Health (2021).

(2) Regarding program structure: the college program in the health sector already integrates theory - practice - internship with a dominant proportion of practice, similar to the requirements for design-implement experiences in Standard 5 of CDIO (Crawley et al., 2014).

(3) Regarding the training environment: the system of practice rooms, simulation rooms and the network of hospital internship facilities correspond to the requirements for learning space supporting professional practice in Standard 6 of CDIO, and are in line with WHO recommendations (2016) on close links between training institutions, hospitals and the community in training medical personnel.

(4) Regarding professional ethics requirements: medical ethics standards in health science training correspond to the group of individual-interpersonal and social responsibility competencies in the CDIO competency structure, and also reflect the trend of considering professionalism as a core competency pillar alongside professional competence in international competency frameworks (Harden & Laidlaw, 2012).

Based on the four aspects of compatibility mentioned above, it can be affirmed that applying CDIO to the management of health science education does not require changing the fundamental nature of the current training model, but rather standardising and systematising existing elements within a consistent management framework that is scientifically and legally sound.

The above comparative results both build upon and expand upon previous studies: if Crawley et al. (2014) developed 12 CDIO standards for the context of engineering education, the analysis in the four aspects mentioned above shows that these standards can be fully adapted to the context of medical education without losing the essence of the Conceive – Design – Implement – Operate cycle, thereby concretizing the still generalized assessment of Zhou and Fagerholm (2019) on the potential application of CDIO in medical education.

3.3. Proposed framework for managing training activities in the health sector using the CDIO approach.

Based on the analysis results in section 3.2 and the inductive synthesis step according to the four

management functions (planning – organising – directing – controlling), the study proposes a content framework for managing training activities in the health sector using the CDIO approach, consisting of six closely related components operating in a closed cycle from goal setting to evaluation and improvement (Table 2).

Table 2. Content framework for managing training activities in the health sector according to the CDIO approach.

Management content	Implementation plan	CDIO Standard
<i>Managing goals and outcomes</i>	Specifically, the training objectives are defined according to the healthcare professional cycle; the learning outcomes are designed based on three competency groups: professional expertise, practical skills – communication, and professional attitude and ethics.	1, 2
<i>Training program management</i>	Organise the program using an integrated structure of foundational knowledge – specialised knowledge – practical training – internship; conduct periodic reviews with the participation of healthcare facilities.	3, 4
<i>Managing teaching and clinical practice</i>	Managing the simulation-semi-real-life-practice experience chain; building a coordination process between the school and the practical training facility.	5, 7, 8
<i>Managing the teaching staff and supervising practical sessions.</i>	Develop a team based on an integrated professional lecturer model; establish a mechanism for coordinating full-time lecturers with supervisors at the hospital.	9, 10
<i>Management of training facilities and environment</i>	Invest in and develop a system of skills training rooms and clinical simulation rooms linked to the network of training facilities.	6
<i>Managing and evaluating training outcomes and training-to-human resource utilisation.</i>	Develop a system for assessing performance competence (OSCE, practice assessment, documentation); coordinate three parties: schools, healthcare facilities, and regulatory agencies.	11, 12

3.3.1. Managing Objectives and Outputs

This content plays a guiding role in the entire training management system. Learning outcomes need to be developed according to the healthcare career cycle, while ensuring the three-component structure as per the Vietnamese National Qualifications Framework: knowledge, skills, and level of autonomy and responsibility (Government, 2016). Managing objectives and learning outcomes using the CDIO approach requires schools to publicly disclose, periodically review, and solicit feedback from employers to ensure that learning outcomes accurately reflect actual practice requirements and align with Standards 1 and 2 of the CDIO framework (Crawley et al., 2014).

3.3.2. Training Program Management

CDIO-based curriculum management focuses on horizontal and vertical integration between modules, avoiding fragmentation between theory and practice

(CDIO Standard 3). The development, evaluation, and updating of the curriculum should involve representatives from healthcare facilities to ensure it accurately reflects professional practice and meets the requirements of an early career orientation module for learners, as per Standard 4 (Crawley et al., 2014).

3.3.3. Management of teaching and clinical practice

This content covers the organisation of a learning experience sequence from simulation to semi-practical and practical training at healthcare facilities, according to Standard 5 and corresponding to the Implement and Operate phases of CDIO. A clear coordination process needs to be established between the school and the hospital/practical facility regarding the assignment of supervision, evaluation of the training process, ensuring the safety of learners and patients, and promoting active learning according to Standards 7 and 8 (Crawley et al., 2014).

3.3.4. Managing the teaching staff and practical training guidance

Full-time faculty and clinical instructors need to be managed according to an integrated professional faculty model, possessing both pedagogical competence and maintaining professional experience through rotation and regular training at healthcare facilities, in line with CDIO Standards 9 and 10. This also directly addresses the competency barrier pointed out by Zhou and Fagerholm (2019) when applying CDIO to medical education.

3.3.5. Management of facilities and training environment

CDIO-based facility management focuses not on changing infrastructure but on optimising the connection between the simulation space in the school and the actual clinical environment in the practice facility, following a series of increasing levels of complexity to ensure the safety of learners before direct contact with patients (Standard 6, CDIO).

3.3.6. Managing the evaluation of training results and linking training with human resource utilisation.

The assessment system needs to be designed to measure performance competence rather than just testing knowledge, through tools such as OSCE, structured practice assessments, and competency documentation, in line with CDIO Standard 11. Simultaneously, a coordination mechanism between schools, healthcare facilities, and regulatory bodies is necessary for assessment and recruitment, aiming to complete the management cycle according to the principle of continuous improvement as stipulated in Standard 12 (Crawley et al., 2014).

Compared to domestic studies such as Le Thi Phuong (2019) and Nguyen Minh Sang (2022) – which applied CDIO to a single activity (building a rubric for evaluating practice, designing a narrow specialised program) – the aforementioned six-component framework aims to encompass the entire training management cycle at the school level, from objectives, curriculum, teaching organisation, staff, facilities to outcome evaluation. This is the main difference between the proposed framework and previous studies, and also serves as a tool for principals to self-assess the operational level of each management component and identify weak areas.

3.4. Conditions for ensuring the implementation of management content

For the above-mentioned content management framework to operate effectively, several conditions

must be ensured simultaneously. On the part of the school, a development strategy clearly defining competency-based training, an internal quality assurance mechanism operating in a continuous improvement cycle, and a culture of safety and quality maintained consistently within the staff are necessary. On the external part, the system of policies governing vocational education and healthcare (National Assembly, 2014, 2023), professional standards for the health sector (Ministry of Health, 2021), and a stable network of practice facilities are crucial conditions for the successful implementation and operation of the stages in practice.

Overall, the above results reinforce the assertion of Frenk et al. (2010) that reforming healthcare workforce training needs to link clinical competence with systems thinking, and concretise this recommendation into operable management content and conditions at the school level, instead of stopping at macro-level policy orientation.

IV. CONCLUSION

The study systematised the compatibility between college-level health science training and the philosophy and standards of the CDIO approach in four aspects: training objectives, program structure, training environment, and professional ethical requirements. Based on this, the study proposed a management framework comprising six components: managing objectives and learning outcomes; managing training programs; managing teaching and clinical practice; managing faculty and practical guidance; managing facilities and the training environment; and managing the evaluation of training outcomes and the linkage between training and human resource utilisation. These six components operate in a closed cycle, with clear theoretical and legal foundations.

The research's contribution is evident in two aspects. Theoretically, the study contributes to supplementing and concretising the theory of competency-based training management in the field of college-level medical training, a field less studied than technical training. Practically, the management content framework serves as a systematic reference tool, helping principals of health-related colleges review and reorganise training management toward standardisation. It also serves as a reference document for state management agencies (Ministry of Labour, Invalids and Social Affairs, Ministry of Health) in developing and updating accreditation criteria for

health-related training programs based on output standards.

However, the research is currently at the theoretical level, based on document analysis, and has not been verified through surveys of the actual situation at schools or expert opinions; therefore, the suitability and feasibility of each component in the proposed framework need further testing. The next research direction should focus on: (i) surveying the current state of training management in the health sector according to the six proposed components at colleges in the Northern region; (ii) seeking expert opinions using the Delphi technique to refine and verify the reliability of the content framework; (iii) proposing and experimenting with specific management measures based on the validated framework, aiming to improve the effectiveness of medical workforce training using the CDIO approach.

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