CDIO-BASED SYLLABUS DESIGN IN THE CONTEXT OF TEACHER EDUCATION

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ABSTRACT

Although the CDIO framework was originally developed to serve the purpose of producing the next generation of engineers, it has been implemented for non-engineering programs such as development practice (Martins, Ferreira & Quadrado, 2017), informative media (Thollar & Rian, 2020), food science and technology, music and audio technology, library information services, chemistry, and business (Malmqvist et al., 2016). Yet not much literature has focused on how the framework can be adopted for teacher education programs. This paper starts with arguments for the feasibility of CDIO application in the context of teacher education at a university in Vietnam. It argues that a teacher also goes through the cycle of conceive, design, implement and operate, and that the CDIO standards fit the requirements of quality assurance and accreditation conventionally set for teacher educational programs. In the paper, a CDIO-based syllabus for English language teacher education programs is proposed. The syllabus contains four pillars (disciplinary knowledge and reasoning, personal and professional skills and attributes, interpersonal skills, and conceive, design, implement and operate English programs in the school context), each of which consists of knowledge, skills, and attitudes necessary for the teaching profession. While more evidence may be needed to prove its effectiveness, the syllabus has successfully described the most essential requirements for a high school teacher, serving as a guide for the lecturers as they redesign courses for the program.

KEYWORDS

CDIO syllabus design, CDIO standards, teacher education, non-engineering programs, Standards 1, 2, 3

INTRODUCTION

Over the past decade, the CDIO approach has gained its popularity among educators of both engineering and non-engineering programs. The flexibility of this framework allows curriculum designers to apply it to quite a few other fields than engineering. Previous studies have reported that the CDIO implementation in non-engineering disciplines can produce better quality assurance and strengthen the connection to the professional context (Crawley et al., 2014; Malmqvist et al., 2016; Thollar & Rian, 2020). Along similar lines, a group of colleagues at Vinh University, Vietnam have attempted to formulate a CDIO-based syllabus for teacher education, based on which a set of learning outcomes (LOs) for the English language teacher education program was established. In this paper, we will explain why the CDIO framework might be a good fit for teacher education, and then describe how the CDIO teacher education syllabus was constructed. In addition, the paper will present the process of converting this general syllabus into a bank of LOs for a specific program, in this case, the English language teacher education.

LITERATURE REVIEW

CDIO Implementation in Non-Engineering Disciplines

The benefits of CDIO implementation in non-engineering disciplines have been reported in several previous studies. Malmqvist et al. (2016), for example, assert that the CDIO framework can be applied in science, business, performing arts and other areas. The study examined six cases of CDIO implementation, including Food Science and Technology, Music and Audio Technology at Singapore Polytechnic, Singapore; Business and Library and information Services at Turku University of Applied Science, Finland; and Chemistry and International Business at Vietnam National University-Ho Chi Minh City, Vietnam. The results indicate that the CDIO approach is applicable in non-engineering disciplines as long as a professional context of the education is identified and the CDIO standards are translated to the said context. The adaptation of the CDIO framework allowed those programs to be reformed systematically and encouraged the faculty to improve pedagogical competence. It also led to better program management and multi-disciplinary collaboration amongst staff and students. In addition, the CDIO syllabus promoted integration of critical and creative thinking as well as ethics and responsibilities.

Past research has also explored cases in which the CDIO syllabus was adapted for non-engineering programs. For instance, Fahlgren et al. (2018) described why and how the CDIO framework was implemented to a BSc program in biomedicine at Linköping University. The rationale for the adaptation was that new employment categories were being created for alumni while the main focus of the program had always been to provide graduates with academic skills, which had resulted in substantial decrease in enrolment rate. The educators, therefore, initiated the adaptation of the CDIO framework to include a clearer educational profile and assist learners to develop skills that were necessary for their work outside academia. The redesigned program contained project-integrated courses that facilitated learners' professional skill development. These projects run parallel with courses that focused on disciplinary subjects. The outcome of a CDIO syllabus survey, which was distributed to the students and professionals, showed that the CDIO framework is beneficial for programs within the biomedicine field (Fahlgren at al., 2019).

Along similar lines, Thollar and Rian (2020) surveyed the application of CDIO to a non-engineering educational environment with four adaptations of CDIO standards: Clinical Engineering Education, Business Systems in Education Network for Practical Information Technologies, Short-term ICT-based International Workshop, and Teaching Business Concept of Creating Shared Value. It was found that during this adaptation process, the curriculum was designed with closer attention to stakeholders' needs and requirements. It, therefore, included cross-departmental subjects and offered more integrated learning experiences and design-implement experiences.

Another case of CDIO adaptation in non-engineering disciplines was reported by Martins, Ferreira and Quadrado (2017). In this paper, the authors explained how CDIO was used in the process of designing a master-in-development-practice program. The scholars applied the full stack of CDIO standards in the spirit of problem solving and project development process. The curriculum was constructed to enhance learners' development of competences that are necessary for sustainable development goals. It was reported that the faculty members found the framework useful. Based on this evidence, the authors contend that it is possible to adapt the CDIO approach to support the design of a non-engineering program.

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CDIO Implementation in Teacher Education

Although CDIO adaptation for non-engineering programs have been reported by other educators too (Petrova et al., 2017; Tangkijviwat et al., 2017), the literature in CDIO application to teacher education is still in its infancy. Among the very few publications related to this topic is the paper by Dunbar, Seery and Gordon (2006). The authors presented the process of integrating the CDIO philosophy into the newly revised modules of an undergraduate teacher education program. The adaptation framework they deployed shows a cyclical process, as shown in Figure 1.
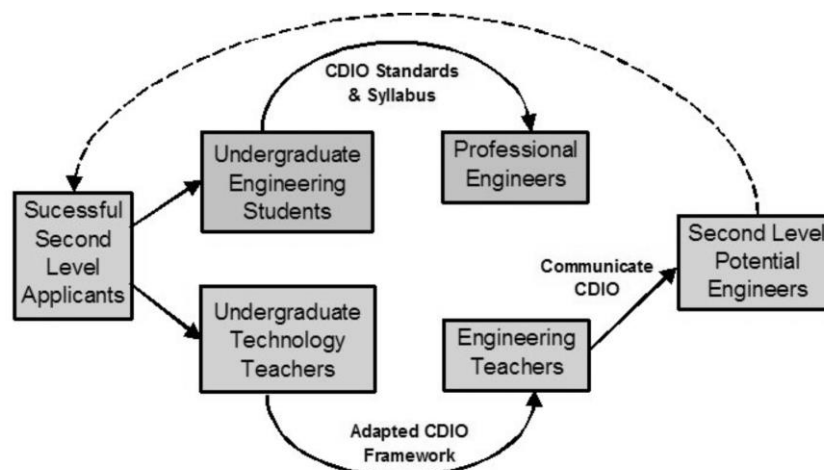

Figure 1 Adapting CDIO for Teacher Training (Dunbar, Seery & Gordon, 2006)

One of the procedures carried out in the reported process is to determine the students' learning styles. An analysis of the students' learning experienced when faced with an alternative educational paradigm was carried out, too. In addition, inter-group variations of student attitudes and preferences were examined. The research methods and instruments included questionnaire surveys, focus group interviews and evaluation mechanism. The results suggested that the students were highly motivated, holding positive attitudes towards the more collaborative learning environment. These findings have highlighted the advantages of the CDIO framework for teacher education programs.

CONTEXT OF THE WORK

Vinh University has adapted the CDIO framework for its educational programs since 2016 (Tran, Tran & Nguyen, 2020). As it is a multi-disciplinary university providing both engineering and non-engineering programs, the implementation of the CDIO approach was a tenuous process at first. Most of the faculty had very little experience with curriculum development and the CDIO philosophy. However, as more and more staff members were given opportunities to attend workshops and conferences on syllabus design and CDIO, we managed to perform a comprehensive review of all 43 then-running programs. A CDIO expert group was formed to provide faculty members involved in the curriculum design with consultation and guides. Within two years, the then-existing programs were redesigned, showing that our efforts were paid off. The new curricula were launched in September 2018. In 2020, another curriculum review was carried out. Changes and modification have been made to the program LOs and specifications. In September 2021, the revised versions started to go into effect. In short, this five years experience of CDIO adaptation can be described as a struggling, laborious but very rewarding process.

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Among the 43 programs that the University offers, the teacher education programs account for around 30%. These include programs such as Bachelor of Chemistry Education, Bachelor of Mathematics Education, Bachelor of Physics Education, Bachelor of Geography Education, Bachelor of English Education, Bachelor of History Education, Bachelor of Biology Education, Bachelor of Physical Education and so forth. During the first four years of curriculum renovation, equal attention was paid to the application of the CDIO philosophy in teacher education as to other disciplines. There was no collaboration among the faculty members of different programs. However, since 2021, the University administrators started to put immense emphasis on developing teacher education programs. By that time the faculty had realized that no matter which subject a teacher student would teach in the future, they should possess certain skills and attitudes that are necessary for the teaching profession. For these reasons, a group of experienced curriculum designers and educators were assigned to execute a project to design a CDIO teacher education syllabus. This general syllabus would be used as a guide for the 14 teacher education programs to establish their own set of LOs. This would allow the programs to provide stakeholders with a general picture of a teacher student graduating from Vinh University and at the same time show them the competencies that are specific to each program.

APPROACH AND PRODUCT

In order to construct the CDIO teacher education syllabus, the expert group held a few meetings in which they discussed approaches they would use. After a lot of discussion, they reached a consensus that the syllabus would be built on the basis of:
- The Vietnamese Qualifications Framework for Higher Education (See Table 1)
- K12 teacher standards (Vietnam Ministry of Education and Training, 2018)
- The CDIO syllabus and philosophy
- The University's mission, vision, goals, and educational philosophy
- The characteristics of the teaching profession
- The needs of stakeholders (yielded from the stakeholder survey previously done in another project)

Table 1 Vietnamese Qualifications Framework

Knowledge	Skill	Level of Autonomy and Responsibility
A. Solid practical knowledge and advanced theoretical knowledge of the discipline B. Fundamental knowledge of social sciences, politics and law C. Knowledge of technology to meet job requirements D. Knowledge of planning, execution and supervision of plans E. Fundamental knowledge of management and administration of professional activities	A. Necessary skills of solving complex problems B. Leadership skills C. Entrepreneurship skills D. Skills of creating work for self and others E. Critical thinking F. Skills of using alternative solutions in changing environment G Skills of evaluating the work after completing it and assess the results by team members H. Skills of explaining a problem and solution to other people I. Skills of transferring knowledge and skills in performing specific or complex tasks J. Proficiency at Level 3 in a foreign language	A. Work independently or in teams in a working environment that is subject to change B. Take responsibility for self and for the team C. Instruct and supervise others' performance of a specific task D. Self-direct, make professional conclusions and defense personal opinions E. Make plans, manage resources, evaluate and improve practice

Table 2 The Teacher Education Syllabus

Code	LOs
1	*Disciplinary Knowledge and Reasoning*
1.1	*Apply knowledge of basic sciences in teaching, education and research*
1.1.1	Explain fundamental issues in social sciences, politics and law
1.1.2	Apply fundamental disciplinary knowledge
1.1.3	Apply specialized disciplinary knowledge
1.2	*Apply knowledge of educational science in teaching, education and applied educational research*
1.2.1	Explain the rules of psychological, mental, intellectual, physical and social development that affect learners' learning
1.2.2	Analyze the nature and process of planning for teaching, testing and assessment, and curriculum development
1.2.3	Analyze the nature and process of executing and organizing educational, vocational, cultural and experiential learning activities
1.3	*Apply advanced knowledge to meet the requirements of the society*
1.3.1	Apply advanced knowledge of basic and applied sciences
1.3.2	Apply advanced knowledge of educational science
2	*Personal and professional skills and attributes*
2.1	*Deploy personal and professional skills to solve problems in education*
2.1.1	Apply critical thinking, system thinking, problem-solving and creative thinking
2.1.2	Apply self-study skills for proactive professional development and change adaptation
2.1.3	Apply technologies to design and operate teaching activities and school management
2.1.4	Apply teaching methods for the subject to meet the demand of educational innovation
2.1.5	Apply teacher professional skills to educate learners and build an educational environment
2.1.6	Apply basic practicing and experimenting skills for teaching and research
2.2	*Demonstrate personal and professional attributes of a teacher*
2.2.1	Demonstrate the spirit of continuous learning and self-developing to improve teacher dignity
2.2.2	Demonstrate work ethics and conducts that are suitable to the teaching profession
3	*Interpersonal skills and communication*
3.1	*Apply collaboration and teamwork skills in teaching, education and research*
3.1.1	Apply collaboration skills to share with stakeholders about learning and professional practice
3.1.2	Apply teamwork skills to effectively perform assigned tasks in learning and professional practice
3.2	*Apply communication skills in teaching, education and research*
3.2.1	Use modes of communication suitable to the professional context
3.2.2	Use a foreign language at Level 3 in the Vietnamese National Framework of Reference for Foreign Languages in communication and professional practice
4	*Conceive, design, implement and operate teaching and educational plans*
4.1	*Analyze the social and school context*
4.1.1	Analyze the social context in relation to the K12 or kindergarten educational context
4.1.2	Analyze the school context of teaching and educational plans
4.2	*Conceive, design, implement and operate teaching and educational plans in the social and school context*
4.2.1	Formulate ideas for teaching and educational plans
4.2.2	Design teaching and educational plans
4.2.3	Implement teaching and educational plans
4.2.4	Operate teaching and educational plans

After the first draft of the CDIO teacher education syllabus was made, it was sent out for feedback collection, hence modification. It was a rather strenuous and time-consuming process, during which we continuously argued, debated, reviewed, and revised the product.

Table 2 shows the final version of the syllabus. Constructed from the CDIO syllabus, it is comprised of many items found in the CDIO syllabus. We believe that whether people work as teachers or engineers, they need a group of skills and attributes that are desirable in any profession. Some examples of these skills and attributes are creative thinking, critical thinking, system thinking, life-long learning, teamwork skills, communication skills, communication in a foreign language, ethics, and social responsibility. As it can be seen from Table 2, the CDIO teacher education syllabus contains four pillars: disciplinary knowledge and reasoning, personal and professional skills and attributes, interpersonal skills, and conceive, design, implement and operate teaching and educational programs in the school context. We are convinced that if the central of an engineer's work is a product, process, or system, the central of a teacher's work is teaching and educational activities. Teachers should be able to formulate ideas (conceive); transfer them into a teaching and educational plan (design); carry out the planned activities in class/at school (implement); and finally evaluate, develop, and communicate it to other stakeholders such as administrators, parents and the society (operate). Therefore, instead of using the term *'product, process and system'* for Pillar 4, we used the term *'teaching and educational plans'*

The teacher education syllabus also integrates all the competencies presented in the Vietnamese Qualifications Framework. For instance, items Knowledge A and B in the Vietnamese Qualifications Framework are reflected in LOs 1.1.1, 1.1.2 and 1.1.3; item Knowledge C is reflected in LO 2.1.3; items Knowledge D and E are reflected in LOs 1.2.2 and 1.2.3. Similarly, items Skill A, E, F, and H are reflected in LO 2.1.1, 2.1.3, and 2.1.5; item Skill J is reflected in LO 3.2.2. Furthermore, it meets the standards set by the Ministry of Education and Training (Vietnam Ministry of Education and Training, 2018).

Besides those above features, the common syllabus reflects the University's mission, vision, goals, and educational philosophy. Additionally, it captures the characteristics of teaching and is very likely to meet the needs of stakeholders. Note that each topic/heading is expressed using a Bloom verb that indicates the minimum level of competence students are expected to achieve. This is to make sure no programs would set up too low LOs, which may prevent the program to meet the minimum requirements of the government (shown in the Vietnamese Qualifications Framework). When it comes to designing LOs for specific programs, designers can consider changing the level, hence using a different Bloom verb.

As the CDIO teacher education syllabus was approved, it was distributed to the departments that offer teacher education programs, including the foreign languages department, which manages the English teacher education program. Based on the CDIO teacher education syllabus, specific program LOs were constructed by faculty members of the departments.

As it can be seen in Table 2, the common syllabus only provides general descriptions of competencies that a teacher student will have obtained by the time they graduate, with no specific reference to the subject a teacher student specializes in. Therefore, for the set of LOs for the English teacher education program, we made specific reference to the subject (English) in different ways.

First, it is clearly stated in the LOs of the English education program (See Table 3) that by the time of graduation, students will have reached Level 5 of English in the Vietnamese National Framework of Reference for Foreign Languages, which is similar to C1 in Common European Framework of Reference for Languages (Council of Europe, 2021). Second, in a few items of the common syllabus (e.g., 1.1, 1.2, 3.1, 3.2, 4.2), the context is mentioned by

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the generic term *'teaching, education and research'*. However, in the English teacher education program, we converted the terms into *'teaching English, education and research'*. Besides, while item 2.1.6 (*Apply basic practicing and experimenting skills for teaching and research*) is included in the common syllabus, it is not present in the English teacher education program. This is because the item refers to skills that are not relevant to English language teachers' work. Finally, whenever possible, we have constructed LOs that are specifically relevant to English language teaching. For instance, item 1.1.3 in the general syllabus (*apply advanced disciplinary knowledge*) has been converted into program LO 1.1.3 (A*pply knowledge of the culture, politics, and society of Vietnam and English-speaking countries and translation skills in teaching English, education, and research*). Likewise, item 1.3.1 in the general syllabus (*Apply advanced knowledge of basic and applied sciences*) has been converted into LO 1.3.1 (*Apply advanced English skills and linguistics in teaching English, research and professional development*).

Table 3 The English teacher education program LOs

Code	LOs
1	*Apply fundamental knowledge of educational sciences, English skills, linguistics and English language teaching methodology in teaching English, education and research*
1.1	*Apply fundamental knowledge of educational sciences and English skills at Level 5 (Vietnamese National Framework of Reference for Foreign Languages)*
1.1.1	Apply fundamental knowledge of social sciences, politics and law in teaching English, education and research
1.1.2	Apply English skills at Level 5 (Vietnamese National Framework of Reference for Foreign Languages) in teaching English, education and research
1.1.3	Apply knowledge of the culture, society and politics of Vietnam and English-speaking countries and translation skills in teaching English, education and research
1.2	*Apply knowledge of educational sciences and English language teaching methodology in teaching English, testing and research*
1.2.1	Apply knowledge of learners' psychological, mental, physical and social development to provide effective English teaching and education.
1.2.2	Apply knowledge of planning, teaching methods, testing and assessment in English teaching and professional development
1.2.3	Apply knowledge of methods to organize educational, vocational, cultural and experiential learning activities
1.3	*Apply advanced knowledge of linguistics, English teaching methodology and curriculum development in teaching English, research and professional development*
1.3.1	Apply advanced English skills and linguistics in teaching English, research and professional development
1.3.2	Apply advanced knowledge of academic writing, English teaching methodology, curriculum and material development in teaching English, research and professional development
2	*Apply personal and professional skills and attributes in teaching English, education and research*
2.1	*Apply personal and professional skills in teaching English, education and research*
2.1.1	Apply critical thinking, system thinking, problem-solving skills and creative thinking to organize English teaching and educational activities and conduct research in social sciences and educational sciences
2.1.2	Apply self-study skills for professional development
2.1.3	Use technologies and digital materials in English teaching, education and research
2.1.4	Apply English teaching methods for competency-based education to meet the demand of education innovation
2.1.5	Use teacher professional skills to educate learners and build a civilized, friendly, safe and democratic educational environment
2.2	*Demonstrate personal and professional attributes of a teacher*
2.2.1	Demonstrate teacher dignity while carrying out English teaching and educational activities

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Code	LOs
2.2.2	Demonstrate work ethics and conducts that are suitable to the teaching profession
3	*Apply collaboration and teamwork skills in English teaching, education and research to meet the demand of adaption to changes in the professional context*
3.1	*Apply collaboration and teamwork skills in English teaching, education and research*
3.1.1	Apply collaboration skills while working with stakeholders and learners to reach shared goals of teaching, education and research
3.1.2	Apply teamwork skills to facilitate cooperation among team members to complete assigned tasks and maintain a constructive working environment
3.2	*Apply multi-modal communication skills and skills in a second foreign language in English teaching, education and research in multi-cultural environments*
3.2.1	Use suitable modes of communication in teaching English, education and research
3.2.2	Use a second foreign language at Level 3 in the Vietnamese National Framework of Reference for Foreign Languages in communication and professional development in multi-cultural environments
4	*Conceive, design, implement and operate English teaching activities and educational activities*
4.1	*Analyze the social and school context*
4.1.1	Analyze the social context in relation to school context and teachers' roles and responsibilities to develop relationships between school, parents and society
4.1.2	Analyze the school context for teaching and educational activities to build an educational culture, promote democracy in school and maintain a safe learning environment
4.2	*Conceive, design, implement and operate English teaching and educational programs*
4.2.1	Formulate ideas for English teaching and educational activities
4.2.2	Design English teaching and educational plans
4.2.3	Implement English teaching and educational plans
4.2.4	Operate English teaching and educational plans

CONCLUSION

The CDIO teacher education syllabus was developed in order to meet the demand of improving and systematizing teacher education at Vinh University. Given that different departments at the University concurrently provide teacher education programs, it was necessary that a common syllabus be established. In the first place, this was to make sure the learning outcomes designed by these departments share common features of the teaching profession. Furthermore, having different department develop learning outcomes based on a common syllabus will guarantee that each program's learning outcomes reflect the University's vision, mission, goals and educational philosophy.

The syllabus was constructed on the basis of the Vietnamese Qualifications Framework, the CDIO syllabus and philosophy, the University's mission, vision, goals, and educational philosophy, the characteristics of the teaching profession and the needs of stakeholders. It consists of many topics in the CDIO syllabus, for the belief that some skills and attributes are universal. In this era of fast changing workforce, it is crucial to equip our students with competencies that most professions require, such as teamwork skills, communication skills, work ethics, life-long learning, critical and creative thinking, system thinking, and problem-solving.

The CDIO teacher education syllabus has been converted into specific banks of learning outcomes for various teacher education programs, including English teacher education. While the profession is generally stated as *teaching* in the common syllabus, in the specific program learning outcomes, the name of the subject is added to differentiate the programs. If not applicable, an item in the general syllabus may not be present in a specific program. In

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addition, the cognitive level of complexity, and thus the Bloom verb used in the general syllabus, can be changed depending on the characteristics of the program, the needs of stakeholders of the program, and the requirements of the society.

Having a common syllabus brought about tremendous benefits for the program directors and faculty members of the departments that offer teacher education programs. First, it was much more advantageous to have a group of educators and curriculum designers to sit down together and establish a set of common features of all programs. Second, the consensus on universal skills and attributes to be included in the syllabus helped the designers of different programs to easily formulate their program outcomes. Finally, the general syllabus promotes uniformity and consistency among teacher education programs, and hence transparent communication of learning outcomes to their stakeholders.

The usefulness of the CDIO teacher education syllabus may not be limited to its conversion to specific program learning outcomes. It also provides a general description of a teacher's qualifications so that employers can have a clear understanding of their employees' profiles. The syllabus might be used as a reference for policy makers and educational administrators of teacher education in Vietnam. It may be an inspiration for the leaders to put forward regulations and rules that reinforce uniformity and consistency among universities that offer teacher education programs.

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BIOGRAPHICAL INFORMATION

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