ENGINEERING EDUCATION: INSTITUTIONALIZATION, INTERNATIONALIZATION, AND GRADUATE ATTRIBUTES

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ABSTRACT

Internationalization is becoming an agenda of growing strategic importance to higher education institutions across the world driven by influences of globalization. Embedding the internationalization process within the CDIO context would certainly benefit the higher education institutions and the attributes of their graduates. This paper suggests embedding implicitly the internationalization process within the CDIO standards without the needfor creating additional mandatory or optional ones. The case of institutionalizing the internationalization process at the Australian College of Kuwait is then presented and discussed.

KEYWORDS

Internationalization, Globalization, Institutionalization, Graduate Attributes, CDIO, Standards: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

INTRODUCTION

Due to the internationalization, liberalization, and globalization trends, there is an increase in interdependence, innovation and research, convergence of economies, and liberalization of trade and markets. Within the context of engineering education, changes in the nature of knowledge are imposing new requirements on the academic systems such as relevance, quality, accreditation, graduate's employability and mobility, innovation, and entrepreneurship (Stier, 2004).

Therefore, engineering colleges at the world-class universities are nowadays taking into account globalization and international dimensions in the various aspects of their activities including: teaching and learning, curriculum development, student services, and innovative assessment methods, etc. Internationalization is becoming a key institutional strategy in engineering education to support sustainable economic development (Knight, 1999, 2004, 2015).

Nowadays, internationalization of the curriculum is geared towards what students will experience rather than what they will learn and how they will demonstrate their learning. An internationalized curriculum should engage students with informed research and cultural and linguistic diversity and develop their perspectives as global citizens. It will also foster their ability to interpret local concerns within a global context.

To this end, the CDIO is introduced to contextualize engineering education. The concept of Conceiving, Designing, Implementing, and Operating engineering activities, offers an excellent structure for internationalizing engineering education. The CDIO standards capture in one framework the effective practices of successful engineering education, which were identified through benchmarking of programs worldwide (Crawley et Al., 2007). Consecutively, several studies were conducted to emphasize on the internationalization aspects and suggest formalizing this concept in the form of additional optional (Malmqvist et al., 2017) or mandatory CDIO standards (Campbell and Beck, 2010). However, these were addressed by updating the CDIO syllabus without amending its 12 standards.

In this paper, the concept of embedding the internationalization process implicitly within the available 12 CDIO standards is firstly addressed after a thorough investigation of the evolution of internationalization during the last two decades. Second, the steps adopted at the Australian College of Kuwait (ACK) to institutionalize the suggested concept are presented.

INTERNATIONALIZATION

Internationalization at the national sector and institutional levels were initially defined as: "the process of integrating an international or intercultural dimension into the teaching, research, and service functions of a higher education institution" (Knight, 1994, 1999, 2004). More recently, this definition had been generalized to: "the process of integrating an international, intercultural, or global dimension into the purpose, functions or delivery of postsecondary education" (Knight, 2015).

An internationalized higher education institution is associated with success in research funding, recruitment of international faculty and students, student mobility (inbound and outbound), availability of abundant resources to conduct advanced research, and a favorable governance structure.

The Evolution of Internationalization's Definition

By comparing the similarities and differences between the two definitions above, one would extract the evolution of internationalization in the past two decades. Starting with the first invariant, it is clear that internationalization is still regarded as a *process* in the sense that it keeps evolving according to the surrounding inputs and desired outputs. Although these inputs and outputs should be ideally common among nations and institutions in order to reach a positive convergence of the internationalization process towards a better world and future for humanity, it is an unfortunate fact that divergent concepts and ideologies about internationalization had emerged in the past few decades which made the possibility of unifying the implementation of internationalization questionable.

Three forms of ideologies about internationalization had been identified (Stier, 2004): idealism, instrumentalism and educationalism. Idealists regard higher education institutions that implement internationalization as the savior of humanity. From their perspective,

internationalized curricula would increase the awareness of global life-conditions and social injustice, thus spreading equity and eliminating social injustice. On the other hand, instrumentalism ideologists view internationalization as a mean of maximizing nations' and/or institutions' profits, economic growth and ideologies for the sake of sustainable development. As for educationalists, the role of internationalization is to enrich the individuals' (e.g. students' and academics') soft and technical skills by placing them in a broader internationalized study environment. As such, a better commitment to learning, personal growth and long-life learning are acquired.

The second invariant between the former and the updated definitions is the "integration of international and intercultural dimension" which is the core aspect of internationalization that opens the door for relationships between and among nations, cultures or countries. One should not confuse though such integration with the flow of people, capital, ideologies, media and cultural impulses across borders which is usually referred to as globalization (de Wit, 2001). Indeed, the internationalization of higher education is considered to be a response to, and even a product of, globalization. In other words, "internationalization is changing the world of education and globalization is changing the world of internationalization" (Knight, 2015). Therefore, it is not strange that the word "global dimension" is added to the new definition of internationalization as an indicator of its strong dependence on globalization.

Finally, the previously discussed dimensions are no more integrated solely into "the teaching, research, and service functions of a higher education institution", they are integrated into "the purpose, functions or delivery of postsecondary education" in the newer definition. Once again, as a response to globalization, it is nowadays required that internationalization is integrated as part of the higher education institutions' missions, visions and core values in addition to their other teaching, research and community service functions. Another important aspect is that internationalization is no more restricted to higher education institutions but also to any other post-secondary education sector (Knight, 2015).

CDIO

The CDIO defines the premise of conceive-design-implement-operate as the context of engineering education. As such, graduating engineers should be able to "conceive-design-implement-operate complex value-added engineering systems in a modern team-based environment" (Crawley, Malmqvist, Lucas & Brodeur, 2011). In other words, graduating engineers should appreciate the engineering process by identifying and/or analyzing engineering problems, designing potential solutions and contributing to the development of these solutions in the form of engineering products, and do so while working in engineering organizations. Consequently, 12 standards were derived as a guideline for educational program reform and evaluation, create benchmarks and goals with the worldwide application, and provide a framework for continuous improvement (CDIO, 2010).   They are a well-developed international model, a basis of common comparison of student learning outcomes, and a basis for common accreditation (Crawley, Malmqvist, Ostlund, Brodeur & Edstrom, 2014).

For a better understanding of its concept, the CDIO syllabus was developed as a complimentary detailed description of the knowledge, skills, and attitudes necessary to become successful young engineers (Crawley, Malmqvist, Lucas & Brodeur, 2011). The objectives of the syllabus are to create clear, complete, and consistent set of goals for engineering education in sufficient detail that could be understood and implemented by

engineering faculty (Crawley et al. 2014). The strength of the CDIO syllabus is in its international adaptability across all engineering schools.

INTERNATIONALIZATION & CDIO

Whereas internationalization is a process that requires the incorporation of international and intercultural, global dimensions into higher education systems, the CDIO provides a context of engineering education. Incorporating internationalization into the CDIO framework requires introducing the concepts and dimensions of internationalization within the CDIO standards and/or syllabus. It is here worth recalling the various benefits CDIO institutions would gain by implementing internationalization. Depending on the adopted ideology the advantages would be: economic growth, profit, exchange of know-how, larger labor force, cultural transmission, personal growth, commitment and long-life learning, respect, tolerance among people, social change, redistribution of wealth, personal commitment, etc. (Stier, 2004).

For the sake of the internationalization of CDIO based curriculum, Campbell and Beck (2010) suggested the addition of a 13th standard entitled "CDIO Internationalization and Mobility". This suggestion was not approved and was simply addressed by adding some concepts related to a global perspective, working in an international organization, foreign language, and international norms under the sections 4.1.6, 4.2.5, 3.3 and 2.5.2 in the CDIO syllabus respectively (Crawley, Malmqvist, Lucas & Brodeur, 2011). More recently, Malmqvist, Edström, and Hugo (2017) proposed the creation of optional CDIO standards, one of them being "Internationalization and Mobility" which was inspired from the previous standard proposal of Campbell and Beck (2010). Other 11 additional optional standards were also proposed at that time. Although this approach would look more convincing for the CDIO council, it is still looking into internationalization as a standard rather than a process. An internationalized CDIO curriculum should rather implicitly incorporate international, intercultural and global dimensions in each of the existing standards, rather than creating a separate core or optional standard.

Table 1 summarizes the actions that may be applied towards internationalization distributed over the existing CDIO standards. We here emphasize that all the actions listed as "evidences" in the 13th CDIO standard proposed by Campbell and Beck (2010) or in the optional standard proposed by Malmqvist, Edström, and Hugo (2017) are somehow related to the existing 12 standards as detailed in Table 1 below.

Table 1. Implicit incorporation of internationalization dimensions into CDIO standards

Standard	Highlights from the standard	Actions toward internationalization
1. The Context	Conceive stage includes defining customer needs considering technology, enterprise strategy, and regulations; and, developing conceptual, technical, and business plans	The customer can be a global/international customer located anywhere around the world, e.g. an international partner.
	The Design stage focuses on creating the design, that is, the plans, drawings, and algorithms that describe what will be implemented.	Usage of internationally recognized software tools and standards.

		The Implement stage refers to the transformation of the design into the product, process, or system, including manufacturing, coding, testing and validation	Mobility allows students to perform each of these processes in different places around the world.
2.	Learning Outcomes	Learning outcomes are reviewed and validated by key stakeholders, that is, groups who share an interest in the graduates of engineering programs, for consistency with program goals and relevance to engineering practice	International Accreditations. International Stakeholders.
3.	Integrated Curriculum	An integrated curriculum includes learning experiences that lead to the acquisition of personal and interpersonal skills, and product, process, and system building skills (Standard 2), interwoven with the learning of disciplinary knowledge and its application in professional engineering	Adoption of Project Based Learning, taking into account: International projects (or a portion of it). Multinational students working within the same group. International PBL facilitators.
4.	Introduction to Engineering	Students engage in the practice of engineering through problem-solving and simple design exercises, individually and in teams.	Multinational students working together within the same group. Adopting the multi-cultural aspects to the design.
5.	Design-Implement Experiences	Included are all of the activities described in Standard One at the Design and Implement stages, plus appropriate aspects of conceptual design from the Conceive stage.	The conceive stage does not have to solve national or governmental problems. It may tackle international engineering problems.
		Opportunities to conceive, design, implement, and operate products, processes, and systems may also be included in required co-curricular activities, for example, undergraduate research projects and internships	Involving students in International Research projects. Participating in international internship students exchange programs (e.g. IAESTE).
6.	Engineering Workspaces	The physical learning environment includes traditional learning spaces, for example, classrooms, lecture halls, and seminar rooms, as well as engineering workspaces and laboratories	Promote e-learning, remote access to software licenses across countries (mutual interest between international partners), remote access to e-libraries, mobility of students to allow for out-campus and abroad hands-on experience.
7.	Integrated Learning Experiences	Integrated learning experiences are pedagogical approaches that foster the learning of disciplinary knowledge simultaneously with personal and interpersonal skills, and	International partners to provide exercises that allow the students to analyze a product, its design, and the social responsibility of the designer of

		product, process, and system building skills	the product at an international level.
8.	Active Learning	Active learning in lecture-based courses can include such methods as partner and small-group discussions, demonstrations, debates, concept questions, and feedback from students about what they are learning.	Involvement of international faculty members in the same course. Creating multinational and multicultural students groups.
9.	Enhancement of Faculty Competence	Examples of actions that enhance faculty competence include: professional leave to work in industry, partnerships with industry colleagues in research and education projects, inclusion of engineering practice as a criterion for hiring and promotion, and appropriate professional development experiences at the university.	Partnerships with international industries which allow for abroad professional leave, international research projects. International speakers and professional development sessions for faculty members. Encouraging the participation to international conferences, seminars and workshops.
10.	Enhancement of Faculty Teaching Competence	Examples of actions that enhance faculty competence include: support for faculty participation in university and external faculty development programs, forums for sharing ideas and best practices, and emphasis in performance reviews and hiring on effective teaching methods.	External would refer to abroad professional development programs.
11.	Learning Assessment	These methods may include written and oral tests, observations of student performance, rating scales, student reflections, journals, portfolios, and peer and self-assessment.	Inviting international experts to assess the student learning. Conducting simultaneous assessments in different countries using the same assessment tool. Transparent credit transfer approach and policy.
12.	Program Evaluation	A CDIO program should be evaluated relative to these 12 CDIO Standards.	In an internationalized CDIO based institution, internationalization dimensions summarized in this table should be an important factor in evaluating the program.

INSTITUTIONALIZATION OF INTERNATIONALIZATION

Internationalization has become an indicator of quality in higher education (De Wit, 2011, p.39). Mainstreaming internationalization requires an integral process-based approach to be adopted by higher education institutions. This process is referred to as 'institutionalization" of internationalization. Institutionalization becomes a critical component of the internationalization process of engineering education. It is defined as the establishment of formal organizational

features and support with a level of permanence that extends further than the usual publishing or project cycles (Youtie, Li, Rogers & Shapira 2017).

To achieve the optimal outcomes of internationalization, there are specific institutionalization routes which must be adhered to by the institution. Curriculum, course development, faculty activities, scholarship with the pedagogy, and reward and recognition are clear evidence of the institutionalization of service-learning among faculty members. Meanwhile, courses, student culture, co-curricular transcripts documenting service and service-learning scholarships are demonstrations of the institutionalization of service learning among students.

The institutionalization process can be addressed from different dimensions: government policy, higher education institution level, and basic academic unit and individual professor level (Shin, 2013). However, when discussing institutionalizing internationalization, it is important to note that the process of internationalization is not a straightforward one, it is cyclical rather than linear (Qiang, 2003). Accordingly, institutionalization may be viewed along two dimensions: some higher education institutions will adopt international elements in a sporadic and irregular manner in terms of procedure and structure, and others will develop precise, strategic and systematic procedures (Qiang, 2003).

The institutionalization process within any higher education institution will vary. However, regardless of the differences, there are certain steps that seem inevitably common. These steps are summarized in Figure 1 below.
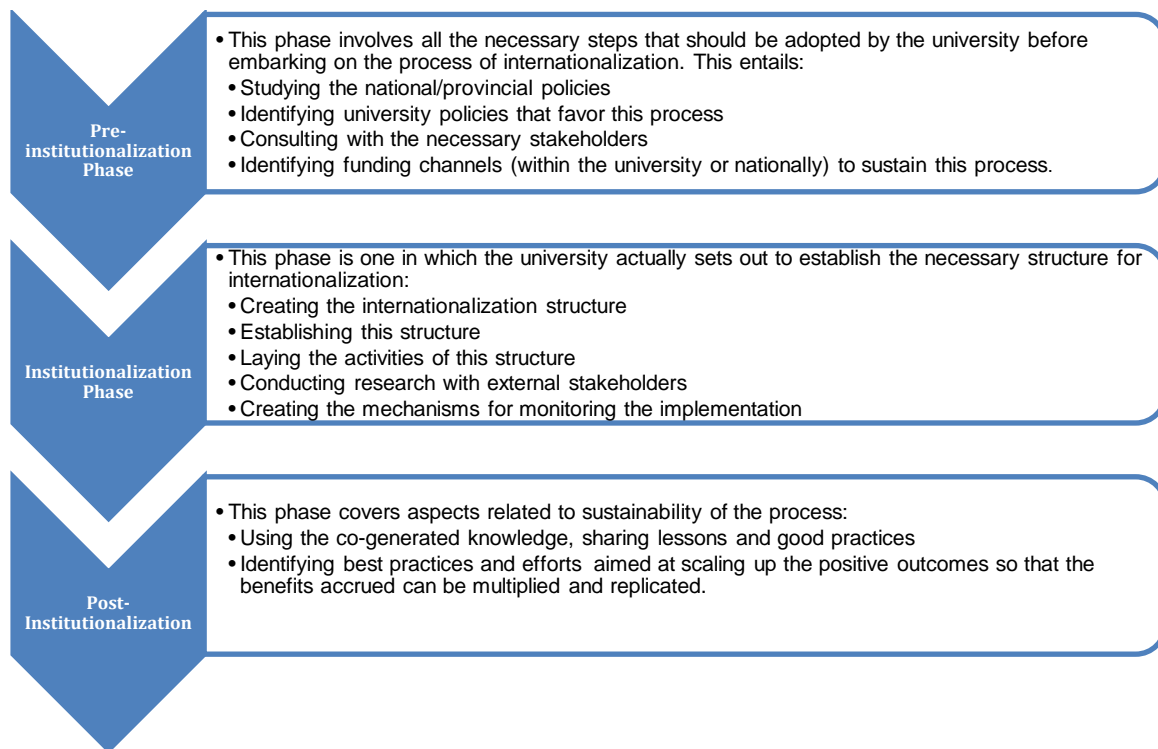

Pre-institutionalization Phase
- This phase involves all the necessary steps that should be adopted by the university before embarking on the process of internationalization. This entails:
- Studying the national/provincial policies
- Identifying university policies that favor this process
- Consulting with the necessary stakeholders
- Identifying funding channels (within the university or nationally) to sustain this process.

Institutionalization Phase
- This phase is one in which the university actually sets out to establish the necessary structure for internationalization:
- Creating the internationalization structure
- Establishing this structure
- Laying the activities of this structure
- Conducting research with external stakeholders
- Creating the mechanisms for monitoring the implementation

Post-Institutionalization
- This phase covers aspects related to sustainability of the process:
- Using the co-generated knowledge, sharing lessons and good practices
- Identifying best practices and efforts aimed at scaling up the positive outcomes so that the benefits accrued can be multiplied and replicated.

Figure 1. The institutionalization steps

INSTITUTIONALIZATION OF INTERNATIONALIZATION & CDIO: CASE OF THE AUSTRALIAN COLLEGE OF KUWAIT

To internationalize engineering education, the Australian College of Kuwait adopted the CDIO standards while meeting the Graduate Attributes specified by Engineers Australia. Institutionalizing the CDIO framework entailed changes to the College's overall structures, objectives, and curricula. This reform required the College to undergo pedagogical and institutional modifications in addition to changes to its policies and procedures.

Institutionalizing internationalization is a process of long-term change and was initiated at the level of the College's executive leaders with a clear vision. During the pre-institutionalization phase, the College assessed the level and requirements of internationalization in order to develop the institutional structures for its integration. Prior to the formation of internationalization strategies, the College conducted a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis to produce information that aided in the strategic planning process. Through SWOT analysis, the College identified the internal and external factors which can and cannot be acted upon in order to strategize internationalization. The SWOT analysis aided the College in the identification of the required budget and resources for internationalization. In addition, it served as an important tool for benchmarking practices within the Gulf Region and internationally which resulted in modifications to policies and procedures. For instance, promotion and incentive schemes were enhanced to attract international high caliber faculty and retain existing ones. Conducting quality assurance processes such as SWOT analysis enabled the College to devise targeted strategies to implement the CDIO model and to develop the necessary institutional frameworks along with it.

During the institutionalization phase, the implementation of the CDIO framework resulted in the adoption of a new pedagogical framework based on experiential learning for engineering education. This implied a shift in engineering education to a more integrated curriculum, changes in the curricular structure, and benchmarking the existing curriculum from the perspective of the CDIO syllabus.

As a result, the College amended the Project Based Learning to match the CDIO standards requirements and incorporate the internationalization aspects as described in Table 1. At the moment, 20% of the engineering curriculum is based on this approach which facilitates the process of learning and retention through promoting deep knowledge of technical fundamentals and of practical skills. By following CDIO Standards 3 and 10 under actions towards internationalization, the College has set out agreements with Aalborg University for Project Based Learning (PBL) to enhance the faculty's competencies and share best practices. Furthermore, international workshops and symposiums related to PBL were attended by the College's faculty members. These workshops allowed faculty members to identify areas of similarities and differences between the PBL practiced in Europe and the way it is practiced at the College. "It is impressive how the PBL classrooms are organized in Aalborg, promoting students' collaboration while preserving the privacy and the confidentiality of their work", one of the attendees expressed after his visit to Aalborg. Another faculty member who attended the workshop stated, "the PBL at Aalborg went through several reforms until it reached its current state, which means that the concept of PBL needs to be reviewed and reformed from time to time".

The PBL center at ACK collected the feedback of the participants and implemented several changes to the PBL approach as a result of this international exposure. To this end, the PBL classrooms were enhanced to promote privacy and convenience of the students while working on their projects. In addition, the assessment framework of PBL units was enhanced and this resulted in a higher rate of student satisfaction. For instance, an ACK alumni stated when asked about the best learning experience, skill or knowledge acquired at ACK: "PBL is

incredibly useful in the workplace, it is very easy for me to identify what is professional and what is not, how to plan for a project, to design and implement it and more importantly to present and document its outcomes".

The College further invested in recruiting international faculty members. Currently, the College benefits from the presence of a high percentage (88%) of international faculty with diverse experiences and skills. This diversity exposes students to various teaching styles, projects and problems originating from different countries around the world. The College also has students from different countries and cultures which is an added contribution to the diversity of thought within the campus. "I learned to work with teammates each originated from a country and each tackles the problem from his or her own point of view. All these points of views were valid and this was really impressive and beneficial", one of the student's stated when asked about his group work during a PBL experience he had at the College.

To ensure the CDIO based pedagogy is penetrated into the teaching process as per Standards 2 and 11 under actions towards internationalization, the Graduate Attributes were developed in consultation with the international strategic learning partner universities (Central Queensland University in Australia and Cape Breton University in Canada), transnational professional accreditation agency (Engineers Australia), and locally with the ACK Industry Advisory Board. These combined inputs ensure that ACK engineering students acquire an international standard of education which is also tailored to meet workplace expectations within Kuwait and the MENA region. For the benefit of both faculty and students, the ACK graduate attributes were further divided into clusters of abilities and learning outcomes. This provided clarification to faculty in the preparation of individual course materials and assessments as well as guidelines to students regarding specific expectations and outcomes from the learning process.

To institutionalize internationalization as per CDIO standard 9 under actions towards internationalization, the College developed comprehensive strategies for research and development. As a result, since 2015, the College's publications have dramatically increased by 168%.

As stated in table 1 under actions towards internationalization within standards 2 and 7, sustaining the process of institutionalizing internationalization required the College to maintain strategic collaborations with Central Queensland University (CQU) and Cape Breton University (CBU) and expand its cooperation through academic activities, joint research cooperation, and funding. At the school level, the engineering program was accredited by Engineers Australia (EA), and at the institutional level, the College has attained the Quality Management System ISO 9001:2015 certification and became a proud member of the Association of Arab Universities (AARU).

Furthermore, to promote students' mobility and provide them with hands-on experience as elaborated in table 1 standard 5 and 6 under actions towards internationalization, an agreement was set-out with the International Association for the Exchange of Students for Technical Experience (IAESTE) to facilitate international internships for students. This association is connecting more than 80 countries by exchanging over 4000 traineeships each year. Furthermore, the College has introduced a local internship program where as of 2016, 384 engineering students have interned in different international and multinational worksites around Kuwait.

CONCLUSION

This paper has demonstrated the process of embedding internationalization within the CDIO standards without the requirement to create mandatory or optional standards. It has also explained the integrated multidimensional approach adopted by the Australian College of Kuwait to institutionalize internationalization for its engineering education.

The internationalization process at the College has resulted in significant improvements in the teaching practices and pedagogy methods. In addition, there have been tangible improvements in the students' performance. Overall, implementation is in its initial phases and there is still a lack of longitudinal data to assess the long-term outcomes. With that said, the short-term outcomes have been promising. The process of internationalizing education is long-term, multifaceted, and not straightforward. In addition, the involvement of many stakeholders such as the government and policymakers creates challenges that could potentially affect its impact and limit its implementation. Therefore, it is recommended that the impact and effectiveness of internationalization at the Australian College of Kuwait is assessed in 2-5 years and informed by data collected along the way.

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