

THE IMPACT AND BENEFITS OF THE CDIO APPROACH

A Case Study of the Diploma in Chemical Engineering at Singapore Polytechnic

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Singapore Polytechnic

A JOURNEY BEGINNING IN 2006

Two major changes in the education of chemical engineers took place around 2006: (1) Emergence of Chemical Product Design; and (2) Emphasis on General Transferable Skills.

Chemical product design was beginning to emerge as an important discipline in chemical engineering. New opportunities had opened up for chemical engineers in areas such as pharmaceuticals, biotechnology, nanotechnology, product development, and sustainable development.

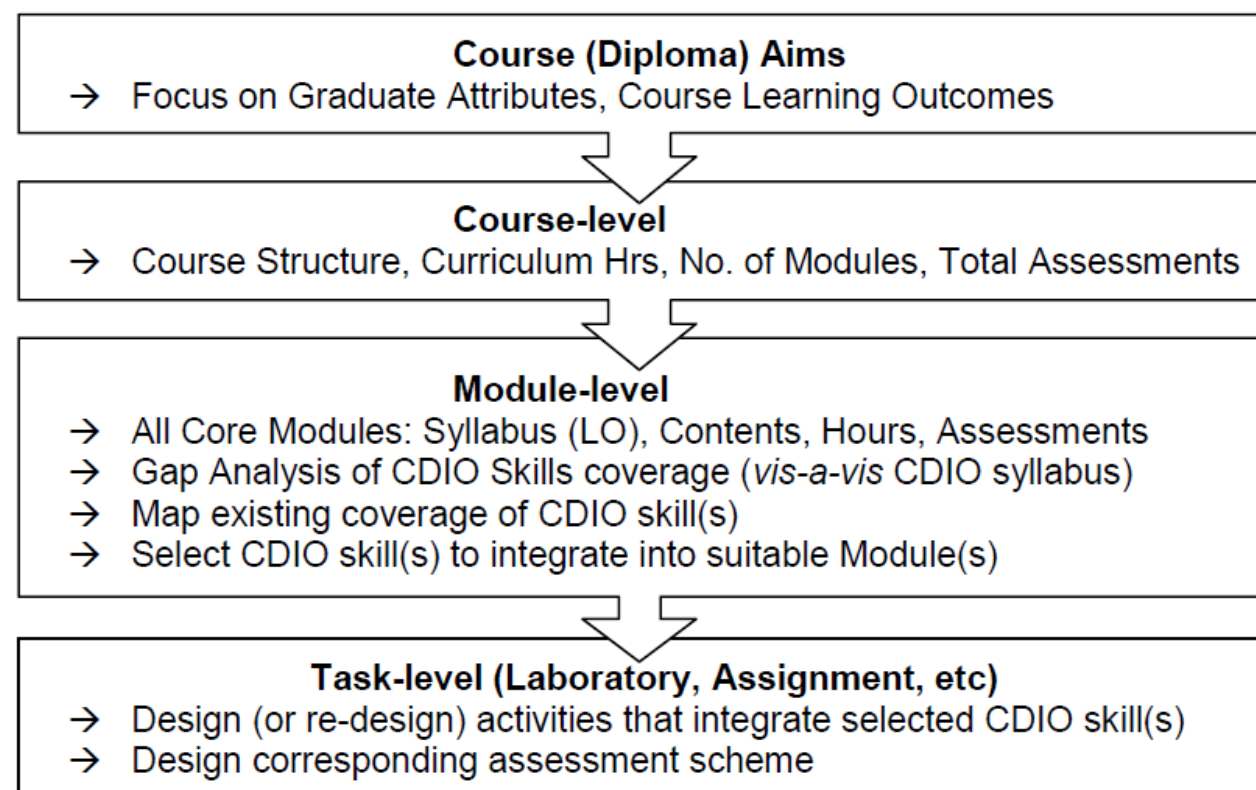
There was a growing dissatisfaction among the chemical industries with chemical engineering education. Much of the criticisms had been levelled at the inadequacy of soft skills among chemical engineers or chemical engineering graduates.

HOW THE CURRICULUM WAS REVAMPED WITH CDIO

The revamp of the 3-year Diploma of Chemical Engineering (DCHE) programme consisted of a 2-prong approach:

1. Integration of skills such as teamwork, communication, critical thinking, etc. systematically **into carefully designed learning activities in laboratory sessions or assignments** in selected core chemical engineering modules.
2. **Integration of CDIO skills in conceiving, designing, implementing, and operating an engineering product, process or system using chemical engineering principles.**

Specific changes in course structure were made. New modules were introduced through merging or removing existing overlapping or obsolete modules.



The General Approach of CDIO Implementation into Core Modules

GAP ANALYSIS, SKILL MAPPING & INTEGRATION

CDIO Skills: INTRODUCE & TEACH				CDIO Skills: UTILIZE	
Stage 1A	Stage 1B	Stage 2A	Stage 2B	Stage 3A	Stage 3B
Introduction to Chemical Engineering	N.A.	Engineering Mathematics IIA	Engineering Mathematics IIB	Process Control & Optimization	
Basic Mathematics	Engineering Mathematics I	Fluid Mechanics	Rotating Equipment	Separation Processes I	Separation Processes II
Analytical & Physical Chemistry	Inorganic & Organic Chemistry	Heat Transfer & Equipment	Chemical Reaction Engineering	Thermodynamics	
Materials in Practice	Pharmaceutical Microbiology	Process Instrumentation	Environmental Engineering	Project (CDIO DBE)	Project (CDIO DBE)
Chemical Process Principles & Simulation	Introduction to Chem Thermodynamics	Plant Safety & Loss Prevention	N.A.	Free Elective 1	Free Elective 3
N.A.	Intro to Chemical Product Design	Product Design and Development	Product Design and Development (cont'd)	Free Elective 2	Free Elective 4
Stakeholder Module No. 1	Teamwork and Communication Toolbox	N.A.	Stakeholder Module No. 2	N.A.	Stakeholder Module No. 3
		Industrial Training Programme	Industrial Training Programme		

A gap analysis was conducted to capture **baseline information** what existing CDIO skills are already covered in our curriculum, and to what level of competency. The result from the gap analysis was a **CDIO skill map**.

This skill map served as a basis to decide how best to integrate the CDIO skills in the most impactful manner.

The general approach taken is to first introduce and teach students specific skills in Year 1, which are then extensively practiced in Year 2. By Year 3 they are expected to be able utilize the skills where appropriate and display skill transfer from one module to another.

Integrating a selected CDIO skill across a three-year curriculum

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SUCCESSSES AND CHALLENGES

<i>Reducing technical content and/or insufficient time to cover content</i>	<i>High workload and ability to teach “soft” CDIO skills</i>
<p>Existing laboratory practices that required students to prepare themselves well before attending the laboratory sessions were leveraged on.</p> <p>Some precious curriculum hours were freed up by transferring factual knowledge needed for the laboratory practicals into background materials.</p>	<p>Three skills most familiar to everyone were chosen: teamwork, communication, and personal skills and attitudes such as critical thinking and time management.</p> <p>The underpinning knowledge of these skills were related to the prior working experience of the faculty by getting them to share some work-related situations where they need to use these skills. This enabled a realization that these skills are already well-established generic skills for effective learning and performance in real work contexts. The notion of integrating them with subject content knowledge and teaching them was indeed quite doable</p>

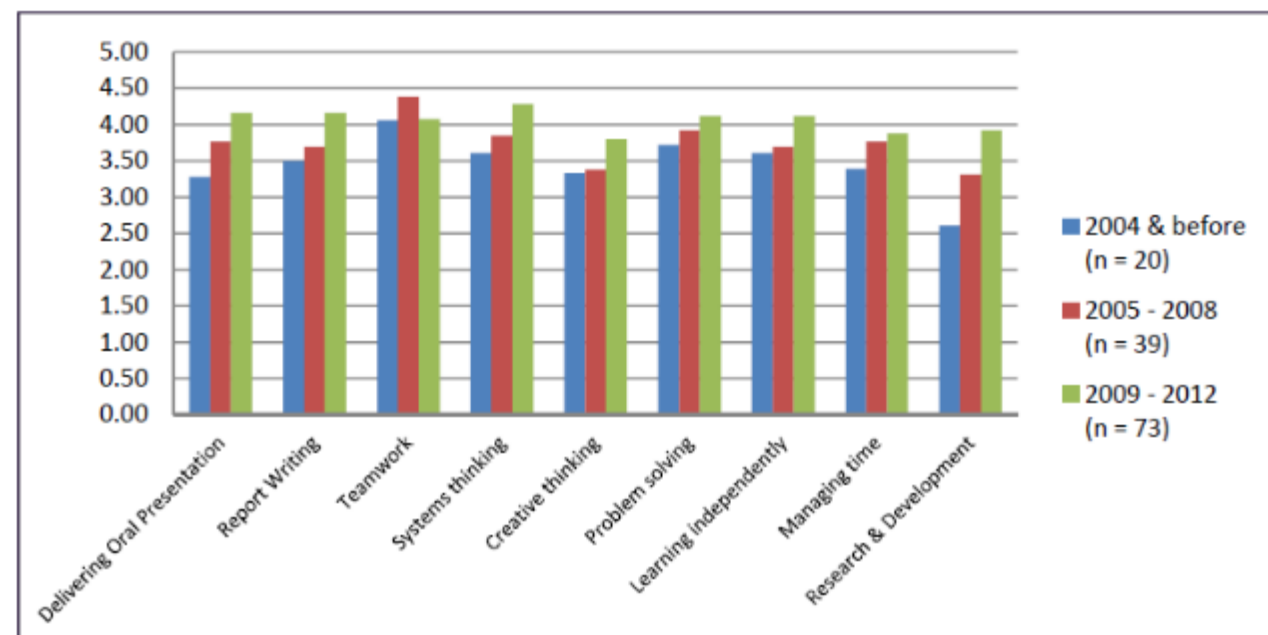
IMPACT OF ADOPTING CDIO

Student Learning Experience

Results from a three-year longitudinal study (AY2008 – AY2010) to ascertain the students’ learning experience showed that students were receptive to the new way of learning.

Recent Graduates

There was an improvement in the graduates’ perception of how well the course had prepared them over the years. Significant improvement was seen in “Oral Presentation”, “Report Writing”, “Systems Thinking”, “Creative Thinking” and “Learning Independently”



Survey results on how well DCHE prepared graduates in various CDIO skills.

CRITICAL SUCCESS FACTORS

<i>Leadership</i>	<i>Early Adopters</i>	<i>Faculty</i>	<i>Education Advisors</i>	<i>Students</i>
<p>Top management must provide its support for faculty willing to “experiment” with CDIO. It is also essential that the CMT leads the revamp effort, to provide the top-down direction while at the same time encourages bottom-up initiatives.</p>	<p>They are more receptive to adopt a pedagogy-driven process to execute the revamp effort. They also help to mentor new faculty in implementing CDIO in the new faculty’s module(s).</p>	<p>Many briefings and training workshops were conducted to clarify the revamp intent, share good practices, provide progress updates.</p>	<p>Effective curriculum revamp requires faculty expertise in both domain knowledge and pedagogy. Discussions with the education advisor (often on one-to-one basis) were very effective at eliciting hidden or implied learning objectives desired by the module coordinator.</p>	<p>We need to manage their expectations, especially for those who are more interested in learning the technical content; and wondered how some skills, such as creative thinking, can be important in their chosen field of study. We need to constantly explain, and reinforce at appropriate intervals, the importance of CDIO skills.</p>