MODULE REVIEW AND REDESIGN VIA SELF-EVALUATION USING CDIO STANDARDS

Sin-Moh CHEAH

Hui Bee LEE

Singapore Polytechnic

ABSTRACT

The Diploma in Chemical Engineering (DCHE) of Singapore Polytechnic (SP) has been using the CDIO Framework to re-design its 3-year curriculum since 2007. In its continual efforts for improvement, the DCHE Course Management Team (CMT) applied the 12 CDIO standards to the design of new modules as well as the review and re-design of existing modules. This paper shares the latest initiative on the latter endeavour, beginning from a course level self-assessment to its dissemination to individual modules, to identify key areas of improvement in the respective modules.

We first briefly explain previous efforts to integrate the 12 CDIO Standards into the institution's Academic Quality Management System (AQMS), which is based on the same Plan-Do-Check-Act (PDCA) principles of ISO9001, which allows us to carry out a course-level self-evaluation consistent with the requirements of our AQMS. We then focus on the current effort, which extends the use of the CDIO Standards to the module-level. This arises from our recognition of the challenges by faced by a module co-ordinator in reviewing a module. By considering a module as a product, we draw correspondence between the CDIO process of conceiving, designing, implementing and operating a product; with the module design and development process espoused in the SP AQMS. We then share our interpretations of the CDIO Standards in terms of their applicability to module design and development, with the aim of assisting module coordinators in formulating action plans that support the execution of module reviews.

Finally, we present an example with the current module entitled *Plant Safety and Loss Prevention*. The self-evaluation conducted against relevant Standards enables the module co-ordinator to identify significant areas of improvement and also align itself with the course-level CDIO implementation. The result can be a complete module revamp, where key learning activities are identified and encouraged ownership of module with the development procedure.

(306 words)

KEYWORDS

Continual improvement, chemical engineering, integrated curriculum, Standards 3, 8, 12

<u>NOTE</u>: Singapore Polytechnic uses the word "courses" to describe its education "programs". A "course" in the Diploma in Chemical Engineering consists of many subjects that are termed "modules"; which in the universities contexts are often called "courses". A teaching academic is known as a "lecturer", which is often referred to a as "faculty" in the universities.

INTRODUCTION

The Diploma in Chemical Engineering (DCHE) of Singapore Polytechnic (SP) embarked on a journey to revise and reorganize – “revamp” – its 3-year curriculum using the CDIO Framework beginning late 2006 post the CDIO Conference in Montreal, Canada. The revised curriculum was rolled out in April 2008, in the beginning of Semester 1 of Academic Year (AY) 2008, for the first cohort of 120 Year 1 students to learn chemical engineering delivered “the CDIO way”. Details of work done had been covered elsewhere (Cheah, Phua & Ng, 2013).

As part of the continual improvement process, we had integrated the use of CDIO Standards into our Academic Quality Management System (AQMS), which is based on the same Plan-Do-Check-Act (PDCA) principles of ISO9001 (Cheah, Koh & Ng, 2013). In the context of AQMS, SP’s generic product is education and training, which in turn translates into the different diploma courses that it offers to its students. A “course” is defined as a “series of planned learning experiences in a field of study that is integrated and made coherent by a common set of aims”. A course is composed of many modules; which is defined as the “basic unit or component of courses offered by the school” with its own set of aims, intended learning outcomes, instructional strategies and assessment scheme. A course is made up of 34-38 modules offered over a period of 3 years, comprising a mix of mostly course-specific modules (core and electives), basic mathematics and sciences, and institutional modules. Each module is managed by a team of faculty lead by a module coordinator. As part of the module review processes mandated by the AQMS, the module coordinator is required to submit electronically a module review report at the end of each academic year documenting the outcomes of the development work carried out by the module team to improve the module.

This paper reports of the current initiative where we apply the CDIO Standards to individual core modules in our curriculum, as a checklist to provide guidelines to module coordinators in leading their teams through the module review process. This will enable them to identify training and other needs (budget, equipment, laboratory space, etc.) and proposed changes in the curriculum (use of active learning, integrated learning experience, etc.). It builds on the self-evaluation exercise using the same CDIO Standards at the course-level to identify areas of improvement. The course-level self-evaluation exercise is carried out by the DCHE Course Management Team (see Figure 1) as part of the overall course management process, which resulted in new initiatives and action plans to continually improve the course.

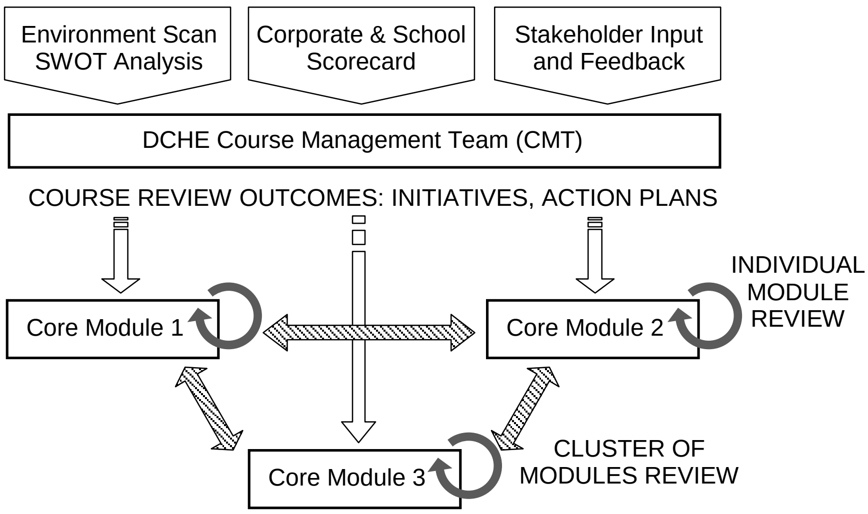

Figure 1. Course review outcomes

CHALLENGES IN EXISTING MODULE REVIEW PROCESS

Periodic review and enhancement of curricula in engineering is vital to maintaining the currency and quality of undergraduate degree programs (Carew & Cooper, 2008). The need to review and update curriculum has numerous drivers including: the need to keep pace with the rapid evolution of technology; shifting social expectations and aligned shifts in legislation and regulation of engineering work; and the changing expectations of the regulators of and participants in higher education (e.g. students, academics, government and accrediting bodies). The process of reviewing curriculum, however, is challenging on many fronts, and can appear overwhelming to those leading the review and implementing subsequent changes to the curriculum (Carew & Cooper, 2008).

Becoming a module coordinator can be intimidating for a lecturer – new and old alike. The myriad of activities and responsibilities that come with module coordination can be challenging for one to handle, especially for a module with laboratory components. Figure 2 shows typical considerations the module team need to address when conducting a module review. Coupled with the multitude of deadlines from various supporting department such as Organisation Development (which oversees the conformance of the AMQS), Finance, Estate Development, etc, as well as the occasional audit, can lead to some module coordinators overlooking or failing to sufficiently address key aspects of module components during the review process. Often the process becomes a last minute rush for many module coordinators just so that they can get the paperwork out of the way before the start of a new academic year.

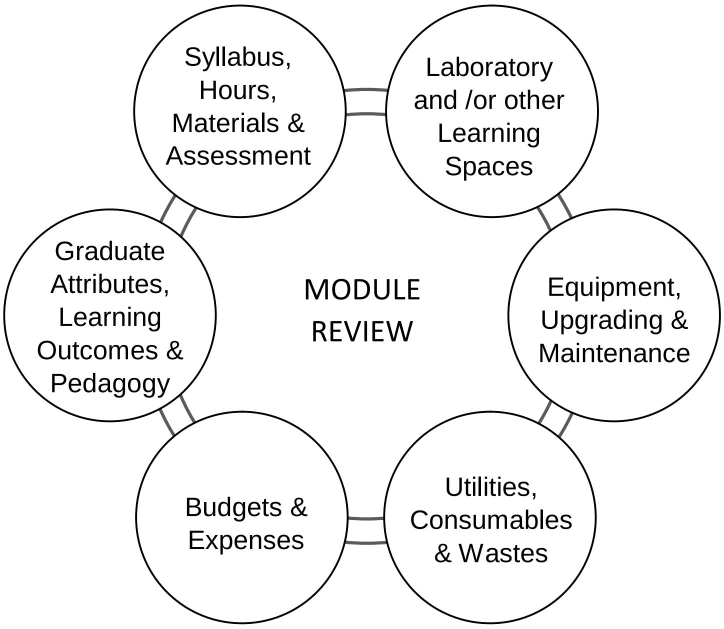

Figure 2. Considerations to be taken during module review

IMPROVING MODULE REVIEW: CORRESPONDENCE WITH C-D-I-O

In this paper we use the term “C-D-I-O” to refer to the process of conceiving, designing, implementing and operating a product or systems; to distinguish it from the broader term of “CDIO” skills which is taken to mean competencies in communication, teamwork, critical and creative thinking, etc.

Komoski (1990) had argued that a curriculum is a process and not a product; noting that (Italics in original text) it “is not a thing nor the simple aggregate of things like curriculum guides, textbooks, other teaching materials, and tests. All such things are tangible products schools used to implement an intangible concept called *curriculum*. Curriculum, which encompassed as a whole yet reduced to its essentials, may be described as the process of *thinking-through*, *facilitating*, and *assessing the learning of intended educational ends*.”

The purpose of this paper is not to debate whether curriculum is a process, product or anything else in between. Suffice to say that based on this view, we can see parallels between module design and development processes with the C-D-I-O processes. Specifically we reviewed topics 4.3, 4.4, 4.5 and 4.6 of Part 4 of the SP-CDIO syllabus “Conceiving, Designing, Implementing and Operating Systems in the Enterprise and Societal Context” and compared it against module design and development processes; and find very close correspondence between the two. This is shown in Table 1.

Table 1. Correspondence between C-D-I-O with module design and development

	CONCEIVE	DESIGN	IMPLEMENT	OPERATE
Relevant Section of SP-CDIO Syllabus	Identify market needs and opportunities Define Function, Concept and Architecture Model System to Verify Goals Develop Project plan	Formulate the Design Plan the Design Process and Approaches Apply Disciplinary Knowledge and Skills Evaluate design/prototype to achieve multiple objectives	Plant the Implementation Process Plan for Hardware Realization Planning for Software Implementing Process Planning for Hardware Software Integration Testing, Verifying, Validating, and Certifying Managing Implementation	Planning Training and Operation procedures Managing Operations Supporting the Product Lifecycle
Module Design and Development	Need analysis (from environmental scans) Develop module aims Prepare learning outcomes Identify module needs (equipment, facility, etc)	Formulate module structure (L:T:P) and assessment types Draft module syllabus Prepare proposal for management approval Prepare Design integrated learning tasks (including lab requirements)	Prepare roll-out plan, module materials (lecture notes, tutorial, PPT, assignments, etc) Prepare lab manuals and test run activities / experiments, recurrent budgets Prepare timetable	Introduce new module Track student learning (e.g. MST, assignments) Conduct module review, e.g. student feedback Prepare module review report and follow-up on action items

We now will use the same CDIO Standards to assist module coordinators in designing new modules, enabling them to interpret the Standards in terms of their applicability in new module design and development. The outcome is shown in Table 2.

Table 2. DCHE Interpretation of Applicability of CDIO Standards at Module Level

CDIO Standard & Brief Description	Interpretation in SP DCHE Context at Module-level	Suggested Action for Module Review
Standard 1 **CDIO as Context** Adoption of the principle that product and system lifecycle development and deployment - Conceiving, Designing, Implementing and Operating - are the context for engineering education	Module had been CDIO-enabled and the rationale for doing so had been explained to students and reinforced at regular intervals	MC to increase action in communicating to students that we are using CDIO as context of chemical engineering education
Standard 2 **CDIO Syllabus Outcomes** Specific, detailed learning outcomes for personal, interpersonal, and product and system building skills, consistent with program goals and validated by program stakeholders	No validation per se at module-level, other than sending them for accreditation purposes by to IChemE UK, NUS and NTU. Here we refer more to the alignment between module outcomes and course aims, which is mapped to SP Holistic Education (HE) Graduate Attributes (GA)	MC to refer to handed out (for AY1415 cohort) for mapping of module contribution to course aims MC to regularly review and improve learning outcomes in module syllabus, lesson plans, and other learning tasks (e.g. lab manual, assignment sheet, etc)
Standard 3 **Integrated Curriculum** A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal, and product and system building skills	Module-level integration that includes both technical and CDIO skills, facilitated by cluster review of related core modules	MC to review (via cluster) to further strengthen existing coverage; or to include new skills such as lifelong learning or self-directed learning; to progressively develop these skills over the 3 years in suitable modules
Standard 4 **Introduction to Engineering** An introductory course that provides the framework for engineering practice in product and system building, and introduces essential personal and interpersonal skills	DCHE has a Year 1 Stage A module CP5045 *Introduction to Chemical Engineering* (*ICHE*) that serve as "anchor" to more in-depth learning of both technical and CDIO skills in later years	Only applicable for MC of CP5045. No action required of other MCs.
Standard 5 **Design-Implement Experiences** A curriculum that includes two or more design-Implement experiences, including one at a basic level and one at an advanced level	Besides *ICHE* and *Final year Project* (*FYP*) that offer basic and advanced level Design – Implement (D-I) experiences, the latter of which is supported by 2 other modules namely Introduction to *Chemical Product Design* (*ICPD*) and Chemical *Product Design & Development* (*CPDD*) Other core modules can offer basic or intermediate level D-I experiences as needed, e.g. *Chemical Reaction Engineering*	No action required of MC in general, unless one is contemplating introducing D-I experiences in his/her module is to refer to Standards 6, 7, 8 as well (especially in terms of resources required, e.g. lab space, recurrent budget, etc)

Table 2 (cont'd). DCHE Interpretation of Applicability of CDIO Standards at Module Level

Standard 6 **CDIO Workspaces** Workspaces and laboratories that support and encourage hands-on learning of product and system building, disciplinary knowledge, and social learning	Not restricted to physical spaces. Besides lab spaces, this is taken to also include virtual platform to support e-learning e.g. skills in online collaboration as well as equipment needed to support lab-based learning	MC to use this Standard to review the module's need of F&E or other OOE requirements; as well as to review the module's HBL-readiness plus any other ICT-related needs, e.g. use of iPad
Standard 7 **Integrated Learning Experiences** Integrated learning experiences that lead to the acquisition of disciplinary knowledge, as well as personal, interpersonal, and product and system building skills	This is not restricted to lab-based activities, but all other forms of learning tasks such as out-of-classroom assignments, homework	MC to review if existing activities can be improved, or propose new activities – see also Standard 3, 6 and 8; for example to include coverage of new skill(s)
Standard 8 **Active Learning** Teaching and learning based on active experiential learning methods	The use of active and experiential learning methods in Lectures and Tutorials, especially in non-lab modules; and includes the use of ICT to support learning and to promote interactions in large classes	MC to review and identify suitable method(s) for use in selected lectures and/or tutorials; preferably by way of a lesson plan See also Standards 6 (e.g. using ICT for active learning) & 7
Standard 9 **Enhancement of Faculty CDIO Skills** Actions that enhance faculty competence in personal, interpersonal, and product and system building skills	These include familiarity with the underpinning knowledge of CDIO skills, including product design and development; as well as how to teach these CDIO skills to students	MC to review his/her skill needs and translate these requirements into the SDP – cross-reference proposed action items for module vis-à-vis – for example: Standards 2 (writing learning outcomes), 3 & 7 (designing integrated curriculum and learning experiences), 6 & 8 (ICT for active learning), 11 (assessment)
Standard 10 **Enhancement of Faculty Teaching Skills** Actions that enhance faculty competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning	These include facilitation skills, reflective practice, flipped learning, designing integrated learning experience, use of ICT in T&L, etc	
Standard 11 **CDIO Skills Assessment** Assessment of student learning in personal, interpersonal, and product and system building skills, as well as in disciplinary knowledge	Focus is on alignment to SP HE GA, and arising from that – the relevant learning outcomes	MC to review his/her module's assessment of CDIO skills is adequately carried out, aligned to intended learning outcomes and consistent with required level of proficiency
Standard 12 **CDIO Program Evaluation** A system that evaluates programs against these twelve standards, and provides feedback to students, faculty, and other stakeholders for the purposes of continuous improvement	This work adapts the Standards for *module* level review, to identify areas for improvement in the module. This can ride on existing AQMS module review process without additional resources or administrative load on the lecturer's part	MC to record all areas of improvements in the template provided which will become basis for input into e-Module Review, SDP or various budgetary submissions

The following are potential benefits of the self-evaluation exercise at module-level:

- Provide clearer guidance in the processes toward module improvements
- Provide better focus on key areas of student learning, e.g. integrated learning experience, active and experiential learning
- Provide direct linkage of module development needs to resource availability (financial, workspaces, etc), which are usually a constraint
- Aligned to the overall organization's planning timeline
- Encourage module coordinators to take ownership of the changes in their modules

In short, our initiative brings together a holistic review of different aspect of module management that is shown in Figure 2, covering not just the technical content of the module, but also addresses other stakeholder requirements (e.g. Finance, Human Resources, Estate Development, etc). Most importantly, there is continuity between course-level review and improvements in the individual modules that comprise the course.

A training session was conducted for all DCHE academic staff in March 2014, towards the end of the Academic Year 2013/2014. Every module coordinator is required to complete the module-level self-evaluation form, a typical section of which is shown in Table 3.

Table 3. Selected section (Standard 3) of DCHE Module-Level Self-Evaluation Form

STD	**CDIO Standard** (Figure in Bracket: 2012 Course-level Self-Evaluation Scoring)	**Module Self-Evaluation Outcomes** (Please provide appropriate examples)	**Moving Forward:** Possible Module Action Plan(s) – Input to MODULE REVIEW	**Staff Development & Resource Needs** – Input to SDP, FIN, etc (Note 1)
3	**Integrated Curriculum (4)** A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal and product and system building skills.			

Note 1: These are acronyms for our internal systems for staff development and finance respectively

DISCUSSION: APPLICABILITY OF CDIO STANDARDS AT MODULE-LEVEL

Although it is desired that all the 12 CDIO Standards be used for self-evaluation at the course-level, not all standards are applicable when the focus shifted to the review of individual modules. One case is obviously Standard 4, which is somewhat "exclusively" devoted to an "introductory" engineering module, typically is met by a core module in Year 1 curriculum. In DCHE, that module is *Introduction to Chemical Engineering,* taught to all 120 enrolled students in Semester 1 in Year 1. Also noteworthy is Standard 5, which provides for additional design-implement experiences over and above those already covered at the basic-level (in the module *Introduction to Chemical Engineering*) and advanced-level (in the capstone *Final Year Project*). The application of this standard is perhaps limited by available curriculum hours and resources to one or two more modules with basic- or intermediate-level design-implement experiences.

The scope of other standards should be broad enough to be applicable to all modules. Of utmost importance are Standard 1, which requires that the new module be designed in the same context of chemical engineering education as the rest of the modules making up the diploma course; and Standard 2, which mandates the alignment of learning outcomes stipulated in a new module with the desired graduate attributes articulated in the diploma. This is to ensure that the overall learning outcomes of DCHE education is consistent with the requirements of all key stakeholders, most notably the chemical processing industry that the diploma serves.

Special mention is made to Standard 6, for which we expanded its application by interpreting it to include virtual workspaces, in addition to physical laboratories and workshops. This is because not all modules in DCHE have a laboratory component. Interpreting Standard 6 strictly in terms of physical workspaces will severely limit the applicability of this standard to the module review process. We have therefore widened the scope of this standard to include softwares such as those based on dynamic simulation or 3-D plant layout designs.

A key question that arose from the module-level self-evaluation exercise is how, or if it is necessary, to carry out the scoring for each standard (where applicable) at the module-level. Questions were also asked how one derived an overall score of 4 (for example) for a given standard at the course-level given that a course is made of many modules; not all of which had been CDIO implemented, or implemented to the same degree. Indeed, in the DCHE curriculum, the chemistry, mathematics, and general education modules are all serviced by staff from other diplomas who have not adopted CDIO.

The DCHE Course Management Team takes the position that a curriculum, taken as a whole as a “product” (in contrast to “process” view, e.g. Komoski, 1990) is able to deliver effective learning much better than the sum of its parts (i.e. individual modules). Hence, when scoring against the rubrics during course-level self-evaluation, a score of 4 (for example), implies an aggregate effect contributed by individual modules to the overall course; even if not all modules in the course had attained a score of 4. The course-level score should henceforth represents a target that individual module should strive to achieve.

Lastly, it is worth pointing that in coming up with the interpretation of CDIO Standards as applied to the module level, the team gained new insights on the broad applications of the Standards, leading in turn to better appreciation on how to use the Standards. During the module review process, new ideas came up that was not previously considered when the team first interpret the Standards in module-level terms. This will be illustrated with an example, as described in the next section.

EXAMPLE: REVIEW OF *PLANT SAFETY & LOSS PREVENTION* (YEAR 3 CORE MODULE)

Plant Safety & Loss Prevention is a 60-hour core module of DCHE curriculum that had been shifted from Year 2 to Year 3 effective Academic Year (AY) 2015/2016 as part of the course structure rationalization process. The module does not have a laboratory component and is non-examinable. Assessments are carried out formatively via a mid-semester test sandwiched between two assignments, followed by a summative end-semester test. This module had not been “CDIO-enabled” as yet, by virtue of it lacking a laboratory component, which is the “target” for the majority of our earlier curriculum innovation and implementation.

Several areas of improvement in the DCHE curriculum had been identified earlier resulting from a (course-level) self-evaluation exercise that we conducted using the 12 CDIO Standards (Cheah, Koh & Ng, 2013). These are broad action plans that the DCHE CMT will then review and decide which module(s) for which they best be applied. The respective module coordinators will then undertake more in-depth review at the module-level and be able to identify concrete suggestions for improvement.

In the case of *Plant Safety & Loss Prevention*, the selected outcome of the module review is shown in Table 4. Note that description of each CDIO Standard in column 2 has been omitted for clarity, and only standards deemed relevant to this module are shown.

Table 4. Results for Self-Evaluation of *Plant Safety & Loss Prevention* module

STD	**CDIO Standard** (Figure in Bracket: 2012 Course-level Self-Evaluation Scoring)	**Module Self-Evaluation Outcomes** (Please provide appropriate examples)	**Moving Forward:** Possible Module Action Plan(s)	**Staff Development & Resource Needs**
1	CDIO as Context (5)	The application of safety principles and management is applied to various stages of the life cycle of a process plant, viz. Research ➔ Development and Design ➔ Operation and Decommissioning	To communicate explicitly and draw analogies between CDIO stages to process plant life cycle for application of safety and loss prevention principles. This can be done with a note/slide to demonstrate parallelism between stages of plant life cycle and CDIO stages.	NIL
2	CDIO Syllabus Outcomes (4)	Module learning outcomes can be pegged to higher level, in order to align better with SP institutional Mission (work, life and world ready); and the set of SP Holistic Education Graduate Attributes.	Along with Standard 3, to review learning outcomes in a concerted 'cluster review' to achieve identified attributes of DCHE with SP Vision Beyond 2014. This can be done during Diploma training and sharing sessions.	NIL
3	Integrated Curriculum (4)	The knowledge and competency on safety is core, and has already been integrated with some DCHE modules, e.g. (1) Safe work practice with Year 1 *Introduction to Chemical Engineering* (2) Hazard and Operability Studies with Year 3 *Plant Design Economics and Sustainable* Development (3) Risk assessment with practical modules and Year 3 *Final Year Project*. There are room for more robust integration.	The integration of skills with other modules, can be achieved by using the same case studies, and/or same process simulation models used in other modules. For example, the ethical study on Bhopal Disaster in Year 1, will now be studied in terms of causes of failures, layer of protection analysis. The Amine Treating Unit (ATU) from EnVision dynamic simulation, will be used to further integrates topics from several Year 2 core modules such as *Separation Processes*, *Heat Transfer & Equipment*, *Process Instrumentation & Control*.	Collection of case studies can be obtained from the US Chemical Safety Board, (CSB) as well as other resources e.g. Internet, for case of Bhopal

Table 4. (cont'd) Results for Self-Evaluation of *Plant Safety & Loss Prevention* module

6	Engineering Workspaces (3)	Although this is a non-practical module and has no actual demand on physical workspaces, learning will take place via virtual workspaces in the domain of dynamic simulation using EnVision process models. Flipped learning will also be used.	To prepare case studies based EnVision ATU process model and include use of online spaces with classroom activities instead of pure lecturing (e.g. short lecture clips, YouTube or CSB videos, self-assessment quiz) for suitable topics in the module. Explore use of existing pilot plants to achieve desired learning outcomes in safety and loss prevention, e.g. discerning suitability of existing relief valve locations and identifying suitable relief scenarios.	Training on educational pedagogy e.g. flipped learning, ICT tools. Familiarization with existing pilot plants
7	Integrated Learning Experiences (4)	An existing exercise on the use of critical thinking skills on process trouble shooting is available. There is scope to include more critical thinking skills, and broaden coverage to include systems thinking, and thinking in multiple perspectives.	To introduce flipped learning so that students can develop self-directed learning skills essential for lifelong learning, and to design learning tasks based on EnVision ATU process model that incorporate systems thinking.	Training on how to design integrated learning experiences, in particular with the use of ICT.
8	Active Learning (4)	Piloted Problem-based learning (PBL) on 2 topics (Chemical safety – GHS; and Fire/Explosion hazards) in AY13/14.	To re-structure module for active learning – include PBL and flipped learning in AY15/16. To explore feasibility of reducing current tutorial class size, from 40/class to 20/class to facilitate group discussion in class.	Training in using online tool, e.g. Socrative to administer testing using concept questions.
9	Enhancement of Faculty Competence (4)	Staff had been teaching other core modules in which CDIO skills are integrated, including supervision of *Final Year Projects* (*FYP*s)	Staff can continue to refine competence in personal and interpersonal skills, and product, process, and system building skills through more CDIO-type *FYP*s.	NIL
10	Enhancement of Faculty Teaching Competence (4)	Staff completed training on Problem-based learning (in Jun 2013 & Mar 2014).	As per Standard 7 above, and Standard 11 below, staff can continue to enhance competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning.	As per Standards 7, 11

Table 4. (cont'd) Results for Self-Evaluation of *Plant Safety & Loss Prevention* module

11	CDIO Skills Assessment (3)	As in Standard 7, only critical thinking is assessed in a limited extent. Scope for more assessment of this and other CDIO skills as mentioned previously.	To ensure that assessment tasks are constructively aligned to each topic's intended learning outcomes via suitably designed integrated learning activities.	NIL
12	CDIO Program Evaluation (3)	Changes in legal and other Singapore requirements e.g. Singapore Standards (SS) 506 on Occupational Safety Health Management System and SS586 Globally Harmonised System on Hazards Communications had recently been announced.	To review existing and improve on coverage of SS506 and SS586; and design new learning tasks that incorporate these standards. Other areas of improvement as mentioned in above will be captured in existing module review process in AQMS. Training needs and outcomes will be reported in SDP and tracked in module review.	Workshops on SS506 and/or SS586 offered by Singapore Chemical Industry Council or others

CONCLUSIONS

This paper has shared our approach in adapting the 12 CDIO Standards originally formulated for course-level self-evaluation for module-level self-evaluation. Experience from piloting this with several lecturers yielded new insights and broadened our understanding on the versatility of the applications of the Standards. We presented an example of how a Year 3 core module in the Diploma in Chemical Engineering is reviewed using this approach and found these Standards to be extremely useful in bringing together different aspects of module coordination, design (or redesign) and development that often proved intimidating even to experienced lecturers. We argued that scoring achieved at the course-level can serve as benchmarks towards which each module that made up the course should strive to achieve. At the time of this writing, we are still in the process of revamping the module Plant Safety and Loss Prevention, which is planned to be offered to students in April 2015. We hope to survey our students for their learning experience with this redesigned module and report on our efforts in subsequent CDIO Conference.

REFERENCES

Carew, A., and Cooper, P. (2008) Engineering Curriculum Review: Processes, Frameworks and Tools, *Proceedings of the Annual SEFI Conference,* Melbourne.

Cheah, S.M., Koh, C.A. and Ng, H.T. (2013). Using CDIO Self-Evaluation for Quality Assurance and Accreditation, *Proceedings of the 9th International CDIO Conference*, Massachusetts Institute of Technology and Harvard University School of Engineering and Applied Sciences, Cambridge, Massachusetts, June 9 – 13

Cheah, S.M., Phua, S.T. and Ng, H.T. (2013). The Chemical Engineering CDIO Experience after 5 Years of Implementation, *Proceedings of the 9th International CDIO Conference*, Massachusetts Institute of Technology and Harvard University School of Engineering and Applied Sciences, Cambridge, Massachusetts, June 9 – 13

Cheah, S.M., and Koh, H.W. (2014). Designing New Module in Chemical Engineering using CDIO: General Approach, *Proceedings of the 8th International Symposium on Advances in Technology Education*, Nanyang Polytechnic, Singapore, September 24-26

Komoski, P.K. (1990). Needed: A Whole-Curriculum Approach. *Educational Leadership*, 72-78

ACKNOWLEDGEMENT

The authors would like to thank Mr. Dennis Sale, Senior Education Advisor, Singapore Polytechnic for his assistance in the preparation of this paper.

BIOGRAPHICAL INFORMATION

Sin-Moh Cheah is the Deputy Director (Courses) in the School of Chemical and Life Sciences, Singapore Polytechnic; as well as the Head of the school's Teaching & Learning Unit. He spearheads the adoption of CDIO in the DCHE curriculum. His academic portfolios include curriculum revamp, academic coaching and mentoring, and using ICT in education.

H.B. Lee is Senior Lecturer in the Chemical Engineering Division, School of Chemical and Life Sciences, Singapore Polytechnic. She has recently taken up the role of Academic Mentor, under the Teaching and Learning Unit, to further her interest in educational pedagogies and module development. She is also actively involved in the maintenance of environmental management system, a portfolio she holds with the Organisation Development and Facilities Management Division of the School.

Corresponding Author

Mr. Sin-Moh Cheah
School of Chemical & Life Sciences,
Singapore Polytechnic
500 Dover Road, Singapore 139561
+65 6870 6150
smcheah@sp.edu.sg