# INSIGHT JOURNAL

UNIVERSITI TEKNOLOGI MARA CAWANGAN JOHOR

**International, Refereed, Open Access, Online Journal**

Volume 4 2019

eISSN : 2600-8564

Indexed in MyJurnal MCC

**INSIGHT JOURNAL (IJ)**
UiTM Cawangan Johor Online Journal Vol. 4: 2019
**eISSN :2600-8564**
Published by UiTM Cawangan Johor
insightjournal.my

## About

INSIGHT Journal is an online, open access, international refereed research journal established by Universiti Teknologi MARA Cawangan Johor, Malaysia. It is indexed in MyJurnal MCC.

INSIGHT Journal focuses on social science and humanities research. The main aim of INSIGHT Journal is to provide an intellectual forum for the publication and dissemination of original work that contributes to the understanding of the main and related disciplines of the following areas: Accounting, Business Management, Law, Information Management, Administrative Science and Policy Studies, Language Studies, Islamic Studies and Education.

**Reprints and permissions**



**Disclaimer**

# TABLE OF CONTENTS

INSIGHT JOURNAL Volume 4
Published by UiTM Cawangan Johor, Malaysia
eISSN 2600-8564

# CDIO Implementation in Fluid Mechanics at UiTM Sarawak: Student Centered Learning

**Beatrice Bidaun[1], Amir Nazarudin[2], Narita Noh[3] and Siti Nur Aishah Mohd Noor[4]**

**[1]Lecturer, Faculty of Civil Engineering**
**Universiti Teknologi MARA Cawangan Sarawak, Malaysia**
***beatricecb@uitm.edu.my***

**[2]Lecturer, Faculty of Civil Engineering**
**Universiti Teknologi MARA Cawangan Sarawak, Malaysia**
***amir724@uitm.edu.my***

**[3]Senior Lecturer, Faculty of Civil Engineering**
**Universiti Teknologi MARA Cawangan Johor, Malaysia**
***naritanoh@uitm.edu.my***

**[4]Senior Lecturer, Faculty of Civil Engineering**
**Universiti Teknologi MARA Cawangan Johor, Malaysia**
***aishah@uitm.edu.my***

**Abstract**

This paper generally discusses the initial implementation of CDIO to Fluid Mechanics, a course in Diploma in Civil Engineering UiTM Sarawak. CDIO has been introduced since 2013 in the Faculty of Civil Engineering as a key driver to ensure students are industry- ready upon graduation. However, the implementation viewed to be still at the surface level due to lack of proper module being introduced for civil engineering courses. This paper highlights and depicts the method of CDIO implementation as a part of learning activities. Preliminary findings indicate that, CDIO has been successfully implemented based on student's performance. Continuous Quality Improvement report reveals student's attainment for CDIO assignment is 84.9% on the average score and 100% passes for 82 students' sample. However, there are rooms for improvement and betterment of the task given as well as preparation of rubric in the future. It is important to continuously monitor the impacts of CDIO in civil engineering courses for student achievement in fostering the generic skills to fulfill modern engineering demand during working life.

**Keywords:** CDIO, teaching pedagogy, student performance.

## 1. Introduction

Conceive-Design-Implement-Operate (CDIO) has been introduced in the Faculty of Civil Engineering since the year 2013. The main goal is to educate students to master a deep working knowledge of technical fundamental, therefore, be the leaders in the creation and the operation of new products and systems. Students are also expected to be able to understand the strategic impact and importance of research and technological development (Che Maznah, Hamidah & Mazidah, 2017). CDIO will also boost graduates' relevant skills such as thinking skills and problem-solving skills that will prepare them for the working environment. In tertiary education, conventional method emphasizes on exam result, which is stressing on cognitive domain but lacking in psychomotor skills, problem-solving skills and critical thinking skills (Edward, 2001; Dandan, 2018). Industry feedback reveals that a majority of these students is found not ready for working life due to skills gap. Hence, in 2013, a complete CDIO framework is being implemented in the teaching and learning activities for Diploma in Civil Engineering, UiTM but the implementation is still considered to be at the surface only. This paper covers on the implementation of CDIO at course level, specifically Fluid Mechanics.

## 2. Basic Concept of CDIO

Conceive-Design-Implement-Operate (CDIO) is a modern teaching and learning approach that is widely used throughout the world in countries such as America, Europe and Asia. CDIO has become a part of teaching methodology for undergraduate study in order to grasp the graduate skills for working life. According to Edward (2001), CDIO is initiated by Massachusetts Institute of Technology (MIT) during late 1990s to produce graduates that will possess engineering knowledge and other professional generic skills such as technical knowledge and reasoning, personal and professional skills, and interpersonal skills as depicted in Figure 1.

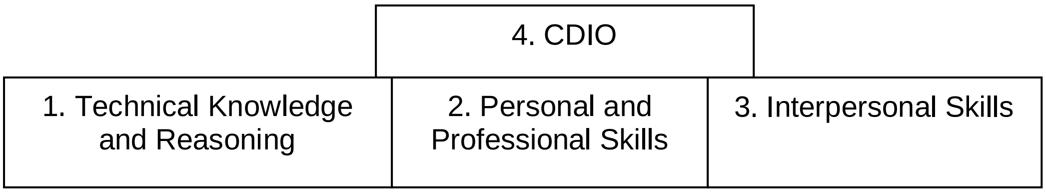



Figure 1 Building blocks of knowledge, skills, attitudes necessary to Conceive, Design, Implement and Operate Systems in the Enterprise and societal Context (CDIO). Source (Edward, 2001)

The CDIO model refers to the four stages of Conceiving, Designing, Implementing and Operating solutions that address complex engineering problems. Based on ("CDIO Region," n.d) the definition of Conceive is inclusive of defining the customer needs. Meanwhile, Design comprises the creation of the plans, drawings and algorithms that will describe the framework or planning of implementation. Implement refers to the transformation of the design into a product, including manufacturing, testing and validation. Lastly, Operate considers how the implemented product will deliver the functionality of the product. Over the years, CDIO is observed to be able to promote student centered learning instead of the traditional teacher centered learning as often seen in many engineering education (Zhongwei, Homgguamg & Jinhua, 2011; Nor Hayati et al., 2014; Ludușan, 2015 ). Andrés and Juan (2017) claimed that project-based learning following the CDIO approach can also be linked to learning through play methodologies. CDIO also encourages flipped classroom in engineering education as implemented in Singapore Polytechnic that engages students with learning activities inside and outside of the classroom as shared by Sin, Dennis and Lee (2017).

## 3. Implementation of CDIO in Fluid Mechanics

This course requires students to complete an assignment as a part of their ongoing assessment. The main objective of the assignment is to assess students' understanding on selected topic based on their cognitive ability. Traditionally, students were given a set of questions that needed to be answered theoretically by calculations only. However, through CDIO approach, the assignment instructions were redesigned to suit the CDIO attributes that enhances students' knowledge and skills. The assignment was extended to testing or verifying the output (of the assignment) to ensure the validity of the design. This transformation is changing students' mindset from "I know how to calculate" to "I know how to solve the problem". The assignment for this course is to assess problem solving and critical thinking skill as specified by the CDIO learning sequence by the faculty.

The assignment problem (focus of this study) was designed to comprehend the buoyancy principal i.e. the ability to float any structure on water in partially submerged condition. The students were given a task to design, produce and test a simple boat that can float with minimum loading of 900 g. The only material allowed to be used was 2 sheets of aluminum foil. Students were divided into a small working group which consisted of maximum of 4 members. Instructions paper of the assignment was given to the students as guidelines and the time allocated for completion was 4 hours only. Upon completion, students have submitted two items i.e. a report that comprised of the overall framework inclusive of the boat design calculations with justifications, and the boat model. Lecturers evaluated the work of students based on the report and verified the design by testing the boat model in water together with students.

CDIO approach no longer requires an answer scheme (as traditional method would have been) but emphasizes on how the problem is being solved and successfully tested in real situation. Hence, lecturers must prepare a comprehensive rubric (of the selected syllabus topic) that allows the evaluation of problem solving and critical thinking skills in completing the task as shown in Table 1. The evaluation criteria are no longer stressing on the values calculated theoretically on paper but more towards the process of actually solving the problem by identifying the problem definition, analyzing the problem based on current scenario, developing a framework of the solution, implementing the process and evaluating the outcomes.

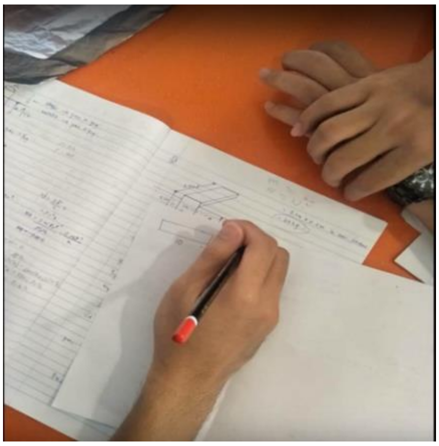
In the buoyancy assignment, the rubric was constructed to assess the ability of students to apply their buoyancy principle knowledge to design their boat model by a trial and error process to ensure the boat will be able to carry 900 g of load and to remain stable on water. Students identified the weakness of their initial design by testing the first boat model and improved their second boat model design. This trial and error exercise exposes students to develop critical and creative thinking in order to solve the problem. It shows that CDIO can develop students' ability to be self-centered and engage students with experiential learning process that requires students to think beyond textbooks and lecture notes. Students were also actively involved in ensuring their boat model can be fully operated (floating and stable) within the time frame. This scenario transformed the typical dull learning environment (in traditional class) to a lively learning environment that does not only encourage students centered learning but also peer learning. Students were given the freedom to use their creativity to solve the problem. This proves that the application of the theories learned in lectures is no longer restricted to laboratory work only as shown in Figure 1. Learned theories can also be applied within the classroom where students have the freedom to explore other possible methods of learning and independently manage the resources and sources to solve a problem within the time frame.

INSIGHT JOURNAL
Universiti Teknologi MARA Cawangan Johor

**INSIGHT JOURNAL Volume 4**
**Published by UiTM Cawangan Johor, Malaysia**
**eISSN 2600-8564**

### Table 1: CDIO ENGINEERING PROBLEM SOLVIN EVALUATION

| C-D-I-O | Category | Mark | E | D | C | B |
|---|---|---|---|---|---|---|
| **C** | **Problem definition** | 5 | 1 | 2 | 3 | 4 |
| | | | Define precisely the problem to be solved by thinking through the key facts about the problem, and gather any | | | |
| | | | Able to define vaguely the problem to be solved with buoyancy principle | Able to define broadly the problem to be solved with the weight of boat and buoyant force. | Able to define moderately the problem to be solved with weight of boat, density of fluid and buoyant force. | Able to define substantially the problem to be solved by thinking through the weight of boat, buoyant force, density of fluid and displaced volume. |
| **C** | **Problem analysis** | 5 | 1 | 2 | 3 | 4 |
| | | | Selecting and using information to analyse suitable dimensions of boat that can cater the minimum required | | | |
| | | | Able to recognise the buoyancy principle | Able to describe the buoyant force and the weight of boat | Able to analyse the weight of the boat and buoyant force | Able to analyse the weight of boat, the buoyant force and the boat dimension |
| **D** | **Plan development** | 5 | 1 | 2 | 3 | 4 |
| | | | Shows a well-developed plan that include the action steps for implementation and the timeline. | | | |
| | | | Produce a poor plan with many missing elements. | Produce a moderate plan with few missing elements. | Generate an acceptable plan with sufficient elements. | Generate a good plan with sufficient elements. |
| **I** | **Plan Implementation** | 5 | 1 | 2 | 3 | 4 |
| | | | Supervised and monitored to ensure that the plan is followed accurately, implementing corrective action when | | | |
| | | | Implementation is carried out with a close supervision | Implementation is carried out with frequent supervision | Implementation is carried out with a periodical supervision. | Implementation is carried out with a minimum supervision. |
| **O** | **Outcome evaluation** | 5 | 1 | 2 | 3 | 4 |
| | | | Evaluate outcome of the executed plan, to measure and analyse its success, whether the designed boat is effective in carrying the minimum required mass. | | | |
| | | | Able to recognise the outcomes (the designed boat has failed) | Able to identify the outcomes (why the design of boat has failed) | Able to explain the outcomes (why the design of boat has failed) | Able to evaluate the outcomes and the designed boat can carry the minimum required mass |



Design and planning process
(Conceive & Design)

Boat model fabrication
(Implement)

Problem identification

Boat model (first trial)

Boat model improvement
(second trial)

Testing (Operate)

**Figure 2: Workflow on assignment task**

### 3.1 Student performance

Student attainment is evaluated through continuous quality improvement (CQI) report as shown in Table 2. This assignment addresses Program Outcome 2 (PO2) and Course Outcome 2 (CO2). It shows that students are capable to complete the task with minimum supervision from the lecturer. On the average score, student attainment is 84.9% with all students scoring more than 50%. The lowest score is 80% while maximum score is 86%. Referring to the average score, it is concluded that student achievement is excellent based on PO's performance criteria matrix. This proves that CDIO is effective for lecture class. Traditionally, students were only able to test their ability on operating system, equipment, software or product during laboratory or studio sessions. However, with the implementation of CDIO students are able to create any framework, solution based on software, or product even during lecture.

In the case of civil engineering program, CDIO is viewed to be nearly impossible as the end product is normally considered to be of much larger scale and costly such as the construction of highway, building or any relevant structures including dam. But the limitations can be reduced by preparing the problem task based on the fundamental concepts within the scope of the course syllabus. The challenge is to the lecturers to construct students' activities that reflect the fundamental knowledge in classes; applying the concepts in similar real-life engineering situations but simpler enough to be completed by students within the constraints of the classroom, time and cost. CDIO approach is expected to bring engineering education together with engineering practice in classrooms.

**Table 2: Students' attainment for CDIO assignment**

| | CO2 | PO2 | Key performance indicator |
|---|---|---|---|
| Average score | 84.9 | 84.9 | Excellent |
| Number of students > 50% | 100.0 | 100.0 | |
| Minimum score | 80.0 | 80.0 | |
| Maximum score | 96.0 | 96.0 | |

Initially, some lecturers hesitated to implement CDIO as part of teaching and learning activities due to lack of proper training on civil engineering module. But through the persistence and determination of supportive lecturers, CDIO implementation in general has been a success at course level.

There are still rooms for improvement in the implementation of CDIO in civil engineering that can encourage student achievement upon graduation such as:

a. Instruction guidelines for students.
b. Training for lecturers on civil engineering module to ensure lecturers will be able to conduct the class with full understanding and preparation.
c. Preparation of the evaluation rubric.
d. A complete module for Diploma in Civil Engineering should be introduced to help lecturer in teaching and learning process.

**INSIGHT JOURNAL Volume 4**
**Published by UiTM Cawangan Johor, Malaysia**
**eISSN 2600-8564**

## 4. Conclusion

The implementation of CDIO is viewed to be one of the teaching pedagogies which promotes relevant skills for our graduates. CDIO is one of the platforms to encourage flipped classroom – from passive to active. The buoyancy assignment was designed to fulfill all four elements of CDIO (Conceive – Design – Implement – Operate) instead of the traditional method that ends at conceive only (calculations). In completing the task, students can work independently to solve the problem using critical thinking. Students' adaptability towards CDIO assignment is reflected as excellent in student scoring for key performance indicator.

## References

Andrés D. L., & Juan d. J. M. S., (2017). Ten Years Of CDIO Experiences Linked To Toy Design. Proceedings of the 13th International CDIO Conference, University of Calgary, Calgary, Canada, June 18-22, http://dx.doi.org/10.11575/PRISM/10230.

CDIO Regions. (n.d) Retrieve from http://www.cdio.org/.

Che Maznah M. I., Hamidah M. S., & Mazidah M., (2017). Engaging Students Based On CDIO-SCL-OBE Framework. UiTM Manual for FKA

Dandan S., (2018). Comparison of CDIO and Chinese Engineering Education Accreditation for Animation Specialty of TUST 8th International Congress of Information and Communication Technology (ICICT-2018). Procedia Computer Science 131, 765–770.

Edward, F. C. (2001). The CDIO Syllabus A Statement of Goals for Undergraduate Engineering Education. Retrieve from http://www.cdio.org.

Luduşan M., (2015). The Education Change for In Need Student-Centered Learning Procedia - Social and Behavioral Sciences 191, 2342 – 2345.

Nor Hayati S., Ahmed J., Nik Rosli A., Razali H., Salmiah K. (2014). CDIO Framework in Strengthening the Student-Centered Learning Approach. Proceeding of 2th UiTM Colloquium Teaching & Learning, June 3-5, 88.

Sin M. C., Dennis S., & Lee H.B., (2017). Pedagogy for Evidence-Based Flipped Classroom – Part 2: Case Study. Proceedings of the 13th International CDIO Conference, University of Calgary, Calgary, Canada, June 18-22,138, http://dx.doi.org/10.11575/PRISM/10230.

Zhongwei L., Hongguang D., & Jianhua T., (2011). Teaching Examples and Pedagogy of Mechanical Manufacture based on the CDIO-Based Teaching Method. *Advanced in Control Engineering and Information Science.* Procedia Engineering 15, 4084 – 4088.

II J

INSIGHT JOURNAL

UNIVERSITI TEKNOLOGI MARA CAWANGAN JOHOR

International, Refereed, Open Access, Online Journal

Volume 4, 2019

eISSN : 2600-8564