Constructing Two Closed Loops for Quality Control in Instructional Management

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CONTEXT
OBE (Outcome-based education) has been introduced into China for several years and has been adopted by more and more universities in recent years, especially since China becoming a provisional member of the Washington Accord in 2013. However, many universities pay more attention to the OUTCOME but ignore the process control during implementing OBE. In fact, many so-called OBE systems are open-loop systems. This is mainly because of the lack of simple and effective methods for instructional managers.

PURPOSE
We want to construct closed-loop control instructional management system in our university.

APPROACH
We consider the instructional management in two phases: educational program design and implementation. For each phase, we design a set of coherent tables to collect process data which covers the key points in instructional management process. These tables are used for quality control in instructional management.

RESULTS
Our methods are very simple and effective for quality control in instructional management. Employing the two closed-loop control methods, the following three changes occurred: Firstly, the colleges submit not only the program document but also the revising report for review. Through preparing the revising report, the colleges can understand the OBE method better. Secondly, it is very convenient for experts to review the revised programs according to both program document and revising report because they not only can see the results but also can see the reasons. Finally, the instructional managers can easily monitor and control the process of educational programs design and implementation. Traditionally, the instructional managers were just concerned with designing the educational objectives without consider their implementations and achievements, and even though they know they are not achieved, they do not kwon the reasons. Now, they do, because the closed-loop quality monitoring can tell them the details in the key check points.

CONCLUSIONS
We have constructed two closed loops for quality control in instructional management by employing the designed tables. These tables have been used in the instructional management of several undergraduate programs in our university. As a result, the teaching quality of these programs has been improved totally, as well as two undergraduate engineering degree programs are accredited by CEEAA (China Engineering Education Accreditation Association).

KEYWORDS
Outcome-based education, closed-loop control, instructional management.

Introduction

Outcome-based education (OBE) is an educational theory that bases each part of an educational system around outcomes (Spady, 1994). The role of the faculty adapts into instructor, trainer, facilitator and/or mentor based on the outcomes targeted.

Outcome-based methods have been adopted in education systems around the world, at multiple levels. Australia and South Africa adopted OBE policies in the early 1990s but have since been phased out at primary and secondary levels (Allais, 2007; Donnelly, 2007). The United States has had an OBE program in place since 1994 that has been adapted over the years (Austin, 2014; U.S. Department of Education, 2016). In 2005 Hong Kong adopted an outcome-based approach for its universities (Kennedy, 2011). Malaysia implemented OBE in all of their public schools systems in 2008 (Mohayidin, 2008). The European Union has proposed an education shift to focus on outcomes, across the EU (European Commission, 2013). In an international effort to accept OBE, the Washington Accord was created in 1989; it is an agreement to accept undergraduate engineering degrees that were obtained using OBE methods.

OBE has been introduced into China for several years and has been adopted by more and more universities in recent years, especially since China becoming a provisional member of the Washington Accord in 2013. However, many universities pay more attention to the OUTCOME but ignore the process control during implementing OBE. In fact, many so-called OBE systems implemented in China are open-loop systems. This is mainly because of the lack of simple and effective methods for instructional managers.

In this paper, two closed-loops for quality control in instructional management in our university are presented. Employing the closed-loop control methods, instructional managers can easily monitor and control the process of educational programs design and implementation.

Two Closed-loop Control in Instructional Management

We consider the instructional management in two phases: educational program design and implementation. For each phase, we design a set of coherent tables to collect process data which covers the key points in instructional management process. These tables are used for quality control in instructional management.

Closed-loop control in educational program design

Most universities in China design an educational program as a programmatic document. Generally, such a program includes educational objectives, graduation requirements, curriculum, *etc*. and an educational program will be revised about every four years. For example, the programs of our university were revised in 2005, 2009, and 2014 respectively in the past decade.

The general procedure of revising educational programs is:

- Firstly, the *Office of Academic Affairs* of our university proposes a guidance document which regulates the guiding ideology, principles, and some requirements of revising educational programs.
- Secondly, the colleges revise the educational programs according to the guidance.
- Thirdly, the *Office of Academic Affairs* invites some educational experts to review the revised educational programs.
- Finally, the corresponding colleges finalize the educational programs according to the review comments.

Traditionally, the experts can only according to the revised educational programs and syllabi for review. There is no other information about the revising progress and evidences. This

requires the experts must be very familiar with both the discipline and OBE theories, and very experienced in instructional management. So reviewing educational programs is a quite subjective and difficult work.

Since 2009, we began to research how to change this status. As a result, we designed a set of tables. When we revised the educational programs in 2014, we demanded each college submit a *Revising Report* in which the tables were included. For each revised educational program, all the tables should be filled in.

1) Educational Objectives

The first table is the formulation of educational objectives (see Table 1). Educational objectives are the starting point of education. In fact, formulating the educational objectives is often very difficult, and reviewing the educational objectives is more difficult. In Table 1, the educational objectives should be described in the first column, and the evidences that were considered during determining the educational objectives should be given in the second column, and the experts from enterprises, it is necessary for engineering education, should be listed in the last column.

Table 1: Formulation of educational objectives

Educational Objectives	Evidences	Experts from Enterprises
The educational objectives of the program are … *(e.g., the educational objectives of Internet of Things Engineering program are to cultivate advanced engineers with all around development of moral, intellectual, physical, and aesthetics, with broad and solid mathematical and engineering foundations, mastering IoT-related theories, methods and skills of computer, perception and communication, with ability of IoT system design and development. The graduates can be engaged in product development and technology management in IoT-related technical fields.)*	*The national and social needs are…* *The institutional mission and cultivation orientation is…* *The advantages and characteristics of the educational program in our college are…*	*The following experts (names and affiliations) from enterprises took part in revising the educational program…*

2) Student Outcomes

The following two tables are about graduation requirements (student outcomes). The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Then Table 2 and Table 3 should be filled in. From Table 2, we can see whether the student outcomes support to attain the educational objectives or not. From Table 3, we can see whether the student outcomes cover those of CEEAA (China Engineering Education Accreditation Association) general criterion 3 or not. The CEEAA General Criterion 3 is about students outcomes.

Table 2: Relationship between student outcomes and educational objectives

Objectives / Outcomes	Objective 1	Objective 2	…
Outcome 1	√		
Outcome 2		√	
…			

Table 3: Relationship between student outcomes of each educational program and those of CEEAA General Criterion 3

Criterion 3 / Program	Outcome 1	Outcome 2	…
Outcome 1	√		
Outcome 2		√	
…			

3) Curriculum Support

All educational programs must show how they enable students to attain, by the time of graduation, outcomes as listed in CEEAA General Criterion 3 as well as any applicable characteristics defined within the educational program criteria. The curriculum support should be designed and Table 4 should be filled in. Each student outcome is decomposed into several characteristics. For each characteristic, the curriculum and qualified benchmark should be designed to enable students to attain that characteristic.

Table 4: Curriculum Support

Students Outcomes	Characteristics	Curriculum	Qualified Benchmark
(e.g.) An ability to apply knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline.	*An ability of mathematical modelling*	*Calculus Linear Algebra Probability Theory*	*Pass all exams of the corresponding math courses and complete at least one mathematical modelling project in Probability Theory.*
	…	…	…
…	…	…	…

4) Core Curriculum

In China, most of undergraduate programs have curricular guidelines established by the *Higher Education Steering Committee of Ministry of Education*. Generally, our curricula should cover the knowledge areas and topics of corresponding educational program. In order to check the coverage, we design a table (see Table 5) to partition the knowledge areas and topics into different courses. Using Table 5, we can easily check whether a core topic is missed (no check mark in the corresponding row) or not, whether a topic is covered repeatedly (more than one check mark in the corresponding row) or not, and whether a course is unnecessary (no check mark in the corresponding column) or not.

Table 5: Core Curriculum

Core Knowledge Areas	Topics	Core Curriculum			
		Course1	*Course2*	*Course3*	*…*
Area 1	*Topic 1*	√			
	…	√			
…	…		√		

5) Course Syllabi

A course syllabus describes the specific goals, topics, examination and some other information for the course. According to Table 4 and Table 5, the course syllabi come into being naturally. The specific goals come from the first two columns in Table 4. The topics corresponding to course in Table 5 should be covered. To design the examination (see Table 6) should consider the qualified benchmark in the last column of Table 4. Formative assessment is needed.

Table 6: Examination

Specific Goals of the Course	Examination	Proportion
An ability of mathematical modelling	*Homework*	*10%*
	Matlab Experiment	*20%*
	Projects	*30%*
	Midterm Exam	*20%*
	Final Exam	*20%*
…	…	…

6) The Closed-Loop control

From the educational objectives of program to the examination in course syllabi, the closed-loop control in educational program design is constructed (see Figure 1).

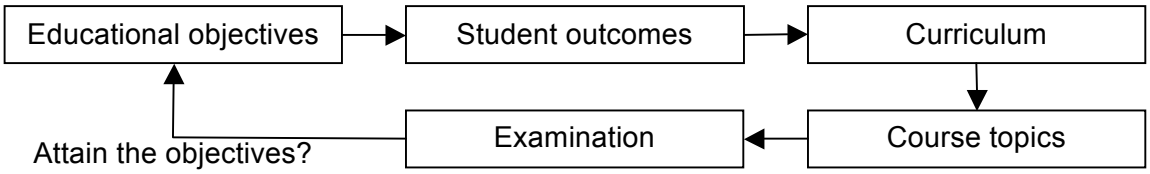

Figure 1: Closed loop control in program design

Closed-loop control in educational program implementation

In order to improve the educational programs continuously, we ask the colleges must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained.

According to ABET accreditation criteria (ABET, 2015), assessment is defined as one or more processes that identify, collect, and prepare the data necessary for evaluation, and evaluation is defined as one or more processes for interpreting the data acquired though the assessment processes in order to determine how well the student outcomes are being attained.

Table 7: Teaching quality monitoring and continuous improvement system

Monitoring Points	Quality Standards	Assessment	Frequency	Executor	Improvement	Supervisor
(e.g.) Educational objectives	*Conformity*	*Alumni survey*	*Every 4 years*	*Vice Dean*	*Revise objectives*	*Dean*
	Acceptance	…	…	…	…	…
	Achievement	…				
Student outcomes	…					
Course Teaching	…					
…	…					

A table is designed for constructing such a teaching quality monitoring and continuous improvement system (see Table 7).

We ask the colleges to set appropriate monitoring points in teaching procedures and to establish the quality standards for each monitoring point. Then, describe the assessment processes used to gather the data upon which the evaluation of each monitoring point is based as well as the frequency with which these assessment processes are carried out, how the results of evaluation processes are systematically used as input in the continuous improvement of the program, and the assessment executor and improvement supervisor. Examples of data collection processes may include, but are not limited to, specific exam questions, student portfolios, internally developed assessment exams, senior project presentations, nationally-normed exams, oral exams, focus groups, industrial advisory committee meetings, alumni survey, or other processes that are relevant and appropriate to the program. The programs need to design more work tables on demands.

Consequently, the closed-loop control in teaching implementation is constructed as shown in Figure 2.

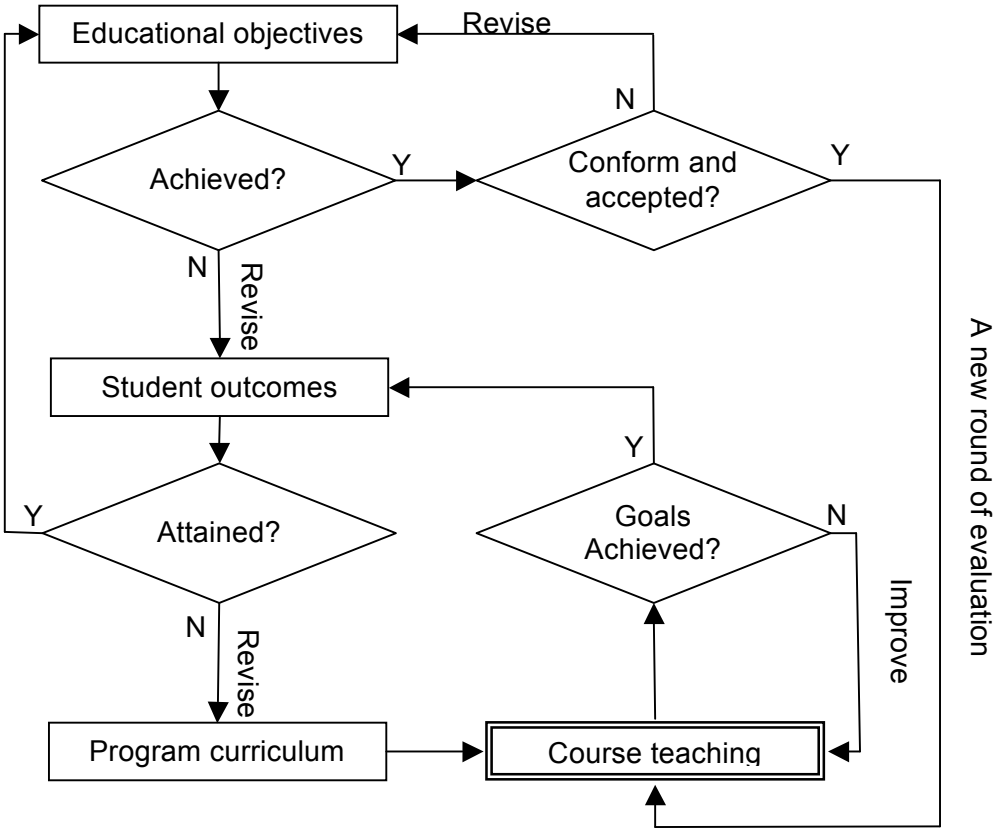

Figure 2: Closed loop in control in educational program implementation

First, we start from monitoring the quality of course teaching that is the most basic execution part. In this part, we mainly check whether the specific goals of each course are achieved or not. If not, the problems should be feedback to the responsible teacher to improve the course teaching. After that, we evaluate whether the student outcomes are attained or not. If not, the evaluation results should be sent to the corresponding responsible teachers to revise the curriculum. Finally, we investigate whether the educational objectives are achieved by the program, accepted by the students and employers, and conform to the social needs or not. If not, the objectives or student outcomes should be revised.

Results

Our methods are very simple and effective for quality control in instructional management. Employing the two closed-loop control methods, the following three changes occurred:

- The colleges submit not only the program document but also the revising report for review. Through preparing the revising report, the colleges can understand the OBE method better.
- It is very convenient for experts to review the revised programs according to both program document and revising report because they not only can see the results but also can see the reasons.
- The instructional managers can easily monitor and assess the program design process and teaching implementation process. Traditionally, the instructional managers were just concerned with designing the educational objectives without consider their implementations and achievements, and even though they know they are not achieved, they do not kwon the reasons. Now, they do, because the closed-loop quality monitoring can tell them the details in the key check points.

Conclusions

We have constructed two closed loops for quality control in instructional management by employing the designed tables. These tables have been used in the instructional management of several undergraduate programs in our university. As a result, the teaching quality of these programs has been improved totally, as well as two undergraduate engineering degree programs are accredited by CEEAA.

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Acknowledgements

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