

AC 2007-1558: ASSESSING THE EFFECTIVENESS OF AN OUTCOME-BASED INFORMATION SYSTEMS CURRICULUM

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Assessing the Effectiveness of an Outcome-Based Information Systems Curriculum

Abstract

This paper proposes a method for assessing the effectiveness of an outcome-based Information Systems (IS) Curriculum. Two sets of learning outcomes are identified to provide focus to an IS curriculum: the college major learning outcomes, which form the basis of the curriculum and serve as a focus for curricular design and improvement and the University learning outcomes, which are higher-level outcomes. Master course syllabi are developed for all courses in the curriculum and posted on the University Intranet and on Blackboard[®]. All master course syllabi include the course contributions to specific learning outcomes. Instructors use the master syllabus to design course content and develop learning experiences that are used to address particular learning outcomes. Students develop an electronic portfolio that includes samples of their most important learning experiences which may be projects, term papers, extracurricular experiences, as well as capstone and internship reports. The electronic portfolio is regularly reviewed and assessed by faculty members to monitor student progress and assess their achievement of various learning outcomes. A course-outcome matrix is developed for program assessment. The matrix includes a list of all IS courses, their learning outcomes and the expected achievement levels for these outcomes. At the end of a semester, all courses are analyzed for their effectiveness in covering various learning outcomes. The results of this analysis are used to identify courses that seem weak in covering particular outcomes. This exercise allows the IS College to study the effectiveness of individual courses and the program overall in achieving the college and University learning outcomes. It is anticipated that using a measurement tool such as the course outcome matrix may enable academic institutions monitor and improve information systems programs.

1. Introduction

Universities in the USA and worldwide are taking a critical look at their educational systems. A recent US national panel report calls for a dramatic reorganization of undergraduate education to ensure that all college students receive not just access to college, but an education of lasting value¹. The report also recommends colleges to help students become “intentional” life long learners, and to create new assessments that require students to apply their learning to the real world. In an effort to shift the focus from the traditional teaching/lecture style to a student-centered learning style, a number of academic institutions in the US have moved to an outcome-based education framework. Outcome-based education is a method of teaching that focuses on what students can actually do after they are taught. All curriculum and teaching decisions are made based on how best to facilitate the desired outcome. This leads to a planning process that is different from the traditional educational planning. The desired outcome is first identified and the curriculum is created to support the intended outcome².

Zayed University (ZU) is an academic institution located in the United Arab Emirates (UAE). It is a laptop-based University where all classrooms are wired. Faculty use of instructional technology is encouraged to facilitate and enhance student learning. ZU has recently adopted an

academic framework that is driven by learning outcomes while still using the grade point average system^{2, 3}. The ZU academic program model is a hybrid approach that can accommodate learning outcomes to measure the learning process and uses grades to accommodate the classic academic system⁴. The College of Information Systems (IS) has developed a curriculum based on the academic program model and driven by a set of well-chosen learning outcomes. This curriculum uses the IS2002 model curriculum as a basis and is designed to reflect the UAE needs for graduates that are well prepared to enter the workforce and to assume their place of responsibility in the nation. The goal of the College is to produce graduates having strong technology and communication skills as well as a good understanding of business practices and work ethics.

The academic program model is driven by two sets of learning outcomes at both the college and University levels. All IS courses are developed to address College and University level learning outcomes. Master course syllabi are developed to show the course contributions to various learning outcomes. During their studies, students are required to develop and present an electronic portfolio that includes various samples of their most important learning experiences. This study shows how learning outcomes can be used as a basis to focus an IS curriculum. As students use their electronic portfolios to demonstrate achievement of the learning outcomes, faculty members use master course syllabi to develop their courses and make sure to include pieces of evidence for achieving a learning outcome. A course-outcome matrix is used by the College to map all the courses with their particular outcomes as well as track the outcome achievement level. The matrix is also used as a tool for analyzing the performance of the IS curriculum in covering all learning outcomes.

The rest of the paper is organized as follows: Section 2 introduces the outcome-based academic program model. Section 3 introduces the IS College curriculum and its learning outcomes. Section 4 shows the development of master course syllabi with the integration of learning outcomes. Section 5 introduces the student e-portfolios and shows the assessment and feedback process. Section 6 addresses the IS program monitoring, assessment and improvement. Section 7 is the conclusion.

2. The Outcome-Based Academic Program Model

The Academic Program Model (APM) at Zayed University (ZU) is designed to serve as the underlying structure that guides colleges in the development of their curricula⁴. The University and College learning outcomes, the assessment and feedback process, the student electronic portfolio, and the laptop-based campus as well as wired classrooms form the infrastructure that supports the APM.

The APM includes learning outcomes at all stages in the student's academic life. The curriculum at ZU involves three main programs:

- The readiness program
- The general education program
- The degree majors programs

The readiness program is a prerequisite for students to be admitted to general education. Students must satisfy competency in English, basic mathematics and Information Technology. Students spend two years in the general education program and the last two years in a major of their choice. All students are assigned a seminar advisor upon joining the university.

After entering their majors, students are assigned a major advisor. Students with the assistance of their advisors develop an individual learning plan. Learning outcomes in the major colleges emphasize planning, decision making and application skills. Furthermore, students are assessed for their ability to demonstrate applied synthesis and integration of knowledge.

The Academic Program Model Learning Outcomes

Currently, the academic program model⁴ is framed by two sets of learning outcomes:

- The Major Learning Outcomes (MALO)
- The ZU Learning Outcomes (ZULO)

The MALOs are course embedded, and the ZULOs are a set of higher intellectual outcomes, which can be achieved at different levels of the students' learning experiences. Students identify how a ZULO is achieved. It may be via taking a particular course or from an extracurricular experience.

There are six ZULOs, which are the over-arching requirements for students to graduate from their major. The ZULOs identify five critical areas, which are significant for students. These are: Critical Thinking and Reasoning, Information Literacy and Communication, Information Technology, Global Awareness, Teamwork and Leadership. During their last semester students need to participate in an internship program and complete a capstone project.

The ZULOs form the framework for the APM and are designed to help students develop higher order intellectual abilities needed for lifelong learning and success. All students must demonstrate accomplishments of the following ZULOs before they graduate:

- **Information Literacy and Communication (ILC):** Students who graduate will be able to recognize information needs, access and evaluate appropriate information to answer those needs, and communicate effectively to a variety of audiences in English and Arabic.
- **Information Technology (IT):** Graduates will be able to use information technology to solve problems and communicate in an ethical way. They will also be critically aware of the impact of information technology on the individual and society.
- **Critical Thinking and Reasoning (CTR):** Graduates will be able to use information, reasoning, and creative processes to achieve goals and make responsible decisions.
- **Global Awareness (GA):** Graduates will be able to relate to communities beyond the local, perceive and react to differences from an informed and reasoned point of view, and be critically aware of implications and benefits of cultural interactions.
- **Teamwork (T):** Graduates will be able to work efficiently and effectively in a group.

- **Leadership (L):** Graduates will be able to assume leadership roles and responsibilities in a variety of life situations and accept accountability for the results.

3. The Information Systems Curriculum and its Learning Outcomes

The IS curriculum, which is based on the IS 2002 model curriculum⁵ and the ABET criteria for accreditation⁶, includes foundation material in: Problem-solving; Object-Oriented paradigm; File Systems; Operating Systems; Systems Architecture; Mathematics for Computing; Computer Networking; and Technical Communication. Furthermore, the curriculum includes independent study components that provide the students with the opportunity to gain in-depth knowledge of current information systems technologies, methods, and practices⁷.

The Information Systems curriculum includes five learning outcomes, which form the basis of the curriculum. The Major Learning Outcomes (MALOs) are defined as follows:

- **Problem identification and analysis (PIA):** Graduates will be able to recognize, define, and classify problems
- **Problem solving (PS):** Graduates will derive solutions and evaluate their success
- **Information technologies and applications (ITA):** Graduates will understand the capabilities, use, and application of information technology
- **Systems theory and practices (STP):** Graduates will demonstrate understanding of system types, structures, standards and metrics
- **Technical communication (TC):** Graduates will organize, develop, present and evaluate technical material

All course syllabi have to explicitly identify the course contribution to achieving one or more learning outcome. Furthermore, a web based master course syllabus is developed and posted on the intranet and Blackboard to facilitate student access to course information, course content and to provide consistency and transparency of all course syllabi. All course syllabi use the master course syllabus as a basis to cover course content and provide information on which learning outcomes are covered.

4. Learning Outcomes in the Master Course Syllabus

The master course syllabus is a critical component that addresses the integration of desired learning outcomes into particular courses. A master course syllabus is developed for all IS core and elective courses. The components of the master course syllabus include course number and title, objectives, topics, learning outcomes, and evidence of outcome achievement. The course description is taken from the University course catalogue. The course objectives provide focus on the course content. The course topics are listed to provide guidance and allow coverage of critical components of the course. The course learning outcomes are shown in a table. The University learning outcomes as well as the IS Major learning outcomes are listed along with the expected level of achievement respective to that course.

For example, Table 1 shows that students who take the CIS 215 course on programming and problem solving have the potential to achieve the Information Technology (IT) learning outcome at the developing (Dev) level. For that particular learning outcome, students can use their work as primary evidence to show their achievement of that particular learning outcome. Additionally, students taking this course may achieve a developing (Dev) level for the Critical Thinking and Reasoning (CTR) outcome. However, for this learning outcome, students may only choose to use their work as secondary (temporary) evidence of their achievement of that outcome.

Table 1. CIS 215 Course Topics Supporting Learning Outcomes

Outcome	ZU Learning Outcome					CIS Learning Outcome				
	IT	ILC	CTR	GA	TL	PIA	PS	ITA	STP	TC
Level	Dev		Dev			Dev.	Dev.			
Primary Evidence	✓									
Secondary Evidence			✓			✓	✓			

Table 2 shows that students who take the CIS 245 course on Web Development have the potential to achieve the Information Technology (IT) learning outcome of the ZU learning outcomes at the developing level. For this particular learning outcome, students can use their work as primary evidence. Also, students taking this course may achieve three MALOs at the developing level, which are PIA, PS and TC. For these MALOs, students may decide to use their work as primary or secondary evidence of their achievement. Primary evidence means that the assignment is significant enough to stand alone in the student e-portfolio as evidence for the achievement of the learning outcome. For example a major course project would qualify as primary evidence.

Table 2. CIS 245 Course Topics Supporting Learning Outcomes

Outcome	ZU Learning Outcome					CIS Learning Outcome				
	IT	ILC	CTR	GA	TL	PIA	PS	ITA	STP	TC
Level	Dev.					Dev.	Dev.			Dev.
Primary Evidence	✓					✓				✓
Secondary Evidence							✓			

The course assessment activities and standards component of the master course syllabus provides information on the in-class activities to test the knowledge and understanding of the course content by students. Furthermore, assignments are used to test student’s abilities to apply their knowledge.

The final component of the master course syllabus specifies the rationale that supports the achievement of the learning outcomes. For example, Table 3 shows the course objectives that support the learning outcomes for the CIS 245 course. For instance the rationale for the IT ZULO states that: “Students learn new skills for developing websites and web-based applications using HTML, DHTML and XML” which supports the IT learning outcome.

Table 3. Course Topics Supporting Learning Outcomes

Learning Outcome	Course topics that support the Learning Outcome
PIA	This outcome is addressed in topics 6, 7 and 8.
PS	This outcome is addressed in topics 6,7 and 8.
TC	Students will have to complete and present their final project. This supports the technical communication learning outcome.
IT	Students learn new skills for developing websites and web-based applications using HTML, DHTML and XML. Also, students complete a major project that deals with issues on e-commerce.

5. The Student Electronic Portfolio

The electronic portfolio is a collection of pieces of evidence that demonstrates skills, learning, and achievements of the learning outcomes. Learning is a developmental process and can be effectively exhibited in a portfolio that includes key learning experiences. The portfolio building process may be summarized in the following steps⁸:

- a. Identification of the areas of skills that a student needs to develop
- b. Development of specific learning outcomes from these skill areas
- c. Identification of appropriate learning strategies to achieve learning outcomes
- d. Identification of indicators that establish the student has achieved learning outcomes
- e. Collection of pieces of evidence that demonstrates the student has met the performance indicators
- f. Organization and presentation of the evidence in a portfolio supplemented with commentaries to support student work

At Zayed University, the purpose of outcome-based learning assessment is to improve the quality of learning and teaching in the College of Information Systems. It is based on three fundamental principles:

- Student learning is the focus in the classroom
- Students must be able to apply their learning beyond the classroom
- Students should become effective, independent, lifelong learners as a result of their educational experience.

Assessment of the learning outcomes through the development of the portfolio addresses these principles by allowing students to demonstrate what they have learned. In the development process students engage in synthesis, documentation, self-assessment, and reflection on their learning experiences. The College requires all students to track and provide evidence of their significant learning experiences. To facilitate this process, students take special courses to learn how to identify and collect pieces of evidence from select classroom projects and out-of-class activities.

Students provide evidence of their achievement by creating an electronic portfolio that shows a compilation of their learning experiences. Each student's electronic portfolio is a collection of critical components of her work, which allows her to demonstrate academic achievement and personal growth, as well as record her progress over time. Moreover, the electronic portfolio allows each student to see the relationships between various educational experiences (curricular and extracurricular) and represents samples of her best work. Portfolios also contain explanations of how those samples demonstrate achievement of the university's learning expectations. Students are also required to write an essay to reflect on their learning experiences in which they explain how they substantiate the level of achievement of a particular learning outcome. In summary, the electronic portfolio is a collection of students' work that:

- Allows students to demonstrate academic achievement and personal growth and record their progress over time
- Allows them to see the relationships between educational experiences, curricular and extracurricular
- Represents some of the best samples of their work, as well as an explanation of how those samples demonstrate their achievement of the university's learning expectations

During their final academic year, students are expected to make an oral defense of their portfolios to an assessment panel. The assessment panel requires students to discuss their development in the University learning outcomes, present pieces of evidence representing their best work, a reflection on the outcome achievements, and a statement of how they have satisfied the College requirements. At the end of the presentation, the assessment panel provides oral and written feedback (assessment report) to students regarding their developmental level in each learning outcome. The assessment report will become part of the student's record. The College then uses the assessment results to determine each student's degree of preparation for the internship. If the results indicate the need for further preparation, an individualized learning plan will be developed for the student.

6. Monitoring the IS Academic Programs Using Learning Outcomes

The components that are used to monitor the IS curriculum effectiveness in addressing the ZU learning outcomes and IS College learning outcomes are: the course syllabus, the student electronic portfolios and the course outcome matrix. Student achievement of the learning outcomes is documented in a course outcome matrix, which shows the coverage of the ZU learning outcomes as well as the College learning outcomes. The matrix also shows the potential student developmental level for each learning outcome. Table 4 shows a list of IS courses with their learning outcomes and potential level of achievement.

Following the completion of a course, students' achievements of learning outcomes and their achievement levels (as decided by the course instructors) are used to analyze the course effectiveness in covering the learning outcomes listed in the syllabus. If the majority of the students do not achieve a particular learning outcome at the anticipated level, then the course may be redesigned to include additional learning experiences to better address that learning outcome. Also, sometimes the instructor's selection of learning experiences such as projects may not be sufficient or adequate. As students develop their electronic portfolio to compile and keep track of their learning experiences, faculty members use the electronic portfolio as a tool to

measure the level of student understanding. The electronic portfolio can also provide important information on the effective implementation of key concepts in the overall IS curriculum. Figure 1 shows the components that are used to monitor the IS program effectiveness.

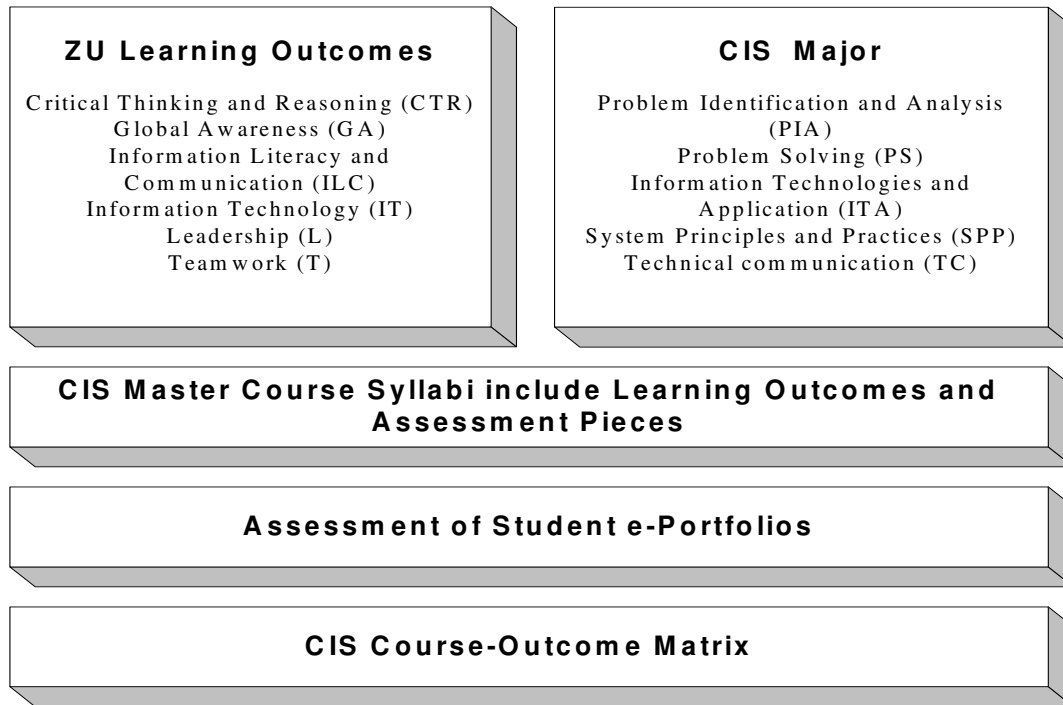


Fig.1. Component used to monitor learning outcome achievement

At the end of each semester, an analysis of the IS curriculum performance to address all learning outcomes is completed by the IS College. Each course is reviewed for its performance in enabling students to achieve a particular learning outcome. Student achievements and comments on whether the assessment piece was effective in addressing a learning outcome are recorded. Data on assessment pieces for each course, which may include course-based learning experiences, and data on student’s performance in achieving a particular learning outcome are collected. The data is then compiled and analyzed for each course. Results of the analysis are compared to the course outcome matrix and used to update the achievement levels, refine the set of learning outcomes, or adjust the course learning experiences. This process allows faculty members to examine how successful they were in integrating learning outcomes in their courses. Furthermore, an in-depth analysis may be performed on a regular basis to assess the effectiveness of the IS curriculum in integrating various learning outcomes. Based on this analysis, specific learning outcomes may be modified or replaced as needed. This is a dynamic process that allows the IS curriculum to stay current and effective in focusing student learning as well as addressing community needs.

Table 4. Learning Outcomes in the College of Information Systems

			ZULOs						MALOs				
			IT	GA	CTR	ILC	T	L	PIA	PS	ITA	STP	TC
1	CIS 125	Discovering IT	B	B		B				B	B		B
2	CIS 210	Intro. to IT and Systems	B		B	B	B		B	B	B	B	B
3	CIS 215	Comp. Foundations	D		D				D	D			
4	CIS 225	Intro. Prog/Prob Sol.	B		D				B	B			
5	CIS 235	Info. Security Basics	D	B	B	B			D	D			
6	CIS 245	Web Development	D						D	D			D
7	CIS 255	Networks/Telcomms	D				D				D		D
8	CIS 270	ICDL	D										B
9	CIS 295	Independent Studies	D								D		D
10	CIS 300	Technical Writing (English)			D	D			D		D		A
11	CIS 301	Technical Writing (Arabic)	D	D		D			D		A		D
12	CIS 305	IT Local/Global Cultures	D	A		D		D	D		D		D
13	CIS 306	IT Local/Global Cultures (Arabic)	D	D		D			D		A		D
14	CIS 320	Prog/Prob Sol. I	D		D				D	D			D
15	CIS 325	Prog/Prob Sol. II			D				A	A			
16	CIS 330	Global Information Security	D	D	B	B					D	D	D
17	CIS 335	Information Security Technologies	D	B	D	D			D	D			
18	CIS 340	Computer Graphics	A		A						A		
19	CIS 345	Multimedia Systems					D		D	D			
20	CIS 350	Comm. Networks I	A				D				A		D
21	CIS 355	Comm. Networks II	A		D		D				A		
22	CIS 360	Management of Information Systems	A	B	D		D		D	D	A	D	
23	CIS 365	Database Systems	A		A				A	A			D
24	CIS 395	Independent Studies	A								A		D
25	CIS 430	Information Security Management	D	D	B	D					D	D	D
26	CIS 440	Enterprise Web Appl'ns	A						D		A		
27	CIS 450	Comm. Networks III	A		D						A		
28	CIS 460	Sys Analysis & Design	D		D				D				A
29	CIS 470	Applied Database	A		A					A			D
30	CIS 475	IT Sys Development	D		D				D				D
31	CIS 490	Internship	D		D					D			D
32	CIS 495	Independent Studies	A								A		D
33	CIS 497	Special Topics	A								A	D	
34	CIS 498	Senior Seminar	D		D		D			D			D
35	CIS 499	Capstone	A		A	A	A		A	A	A		A

MALOS:

PIA – Problem Identification and Analysis

PS - Problem Solving

ITA- Information Technology Applications

STP – Systems Theory and Practice

TC – Technical Communication

LEVELS: B – Beginning, D – Developing, A - Accomplished

ZULO:

IT – Information Technology

GA – Global Awareness

CTR – Critical Thinking and Reasoning

ILC – Information Literacy and Communication

T – Teamwork

L - Leadership

7. Conclusion

This paper provides a method for assessing the effectiveness of an outcome based IS curriculum. College and University learning outcomes form the framework of the academic program and provide focus to the curriculum. In addition, student electronic portfolios are used to assess student academic progress and achievement of various learning outcomes. The master course syllabus shows the course contributions to various learning outcomes and the expected achievement level. By using the master course syllabus, instructors design their course content and develop specific learning experiences to address the desired outcomes. An electronic portfolio is developed by students and includes samples of key learning experiences as well as how learning outcomes are achieved. Faculty members assess the electronic portfolios and provide feedback to students on a regular basis. Students present their final portfolio before they graduate. A course-outcome matrix developed by the college includes a list of all the IS courses with their respective learning outcomes and potential achievement level. At the end of each semester an analysis of outcome achievement for the course is completed. The results of this analysis are used to identify courses that fail to address particular outcomes. Faculty members can also use that information to assess the effectiveness of their pieces of evidence and modify them as needed. Finally, every three to four years, an in-depth analysis is performed to investigate how effective the IS curriculum is at integrating all learning outcomes. It is anticipated that integrating learning outcomes into IS curricula can provide a means for colleges and universities to assess the effectiveness of their programs to foster student learning.

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