AC 2005-286: USING LEARNING OUTCOMES AND E-PORTFOLIOS TO ASSESS STUDENT LEARNING IN INFORMATION SYSTEMS

Akram Al-Rawi, McKendree University

Azzedine Lansari,

Faouzi Bouslama, Université Laval

Using Learning Outcomes and e-Portfolios to Assess Student Learning In Information Systems

Azzedine Lansari, Akram Al-Rawi, and Faouzi Bouslama
College of Information Systems, Zayed University
P.O. Box 4783, Abu Dhabi, UAE

Abstract

This paper shows how electronic portfolios can be used as an effective tool to assess student academic progress and shows how learning outcomes can be used to provide focus for IS programs. Achievement of learning outcomes enables academic institutions to monitor and improve information systems programs. Two sets of learning outcomes are identified to provide focus to the curriculum. The college major learning outcomes form the basis of the curriculum and serve as a focus for curricular design and improvement. The University learning outcomes are an overarching set of higher-level outcomes. A master course syllabus that includes the course contribution to specific learning outcomes is developed. Instructors use the master syllabus to design course content and build learning experiences that are used to address a desired learning outcome. Students are required to develop an electronic portfolio that includes samples of their most important learning experiences, which may be projects, term papers, extracurricular experiences, and internship reports. The electronic portfolio is reviewed and assessed by faculty members on a regular basis to monitor student progress. During their final semester, students finalize their electronic portfolio and present their achievements to a faculty panel. The electronic portfolios allow students to document and reflect on their learning experiences. Integrating learning outcomes into the curriculum provides a mean for faculty to assess the effectiveness of the academic 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 value[1]. 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 outcome[2].

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 system[4]. 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 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 level and University learning outcomes. Master course syllabi are developed to show the course contributions to various learning outcomes. During their studies at ZU, students are required to develop and present an electronic portfolio that includes samples of their most important learning experiences. This study shows how learning outcomes can be used as a basis to focus the IS curriculum and how students use their electronic portfolios (e-portfolio) to demonstrate achievement of the learning outcomes.

The rest of the paper is organized as follows: Section 2 introduces the ZU outcome-based academic program model (APM). 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 ZU Academic Program Model

The ZU Academic Program Model (APM) is designed to serve as the underlying structure that guides colleges in the development of their curricula[4]. 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 as shown in Figure 1.

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
- The degree majors programs

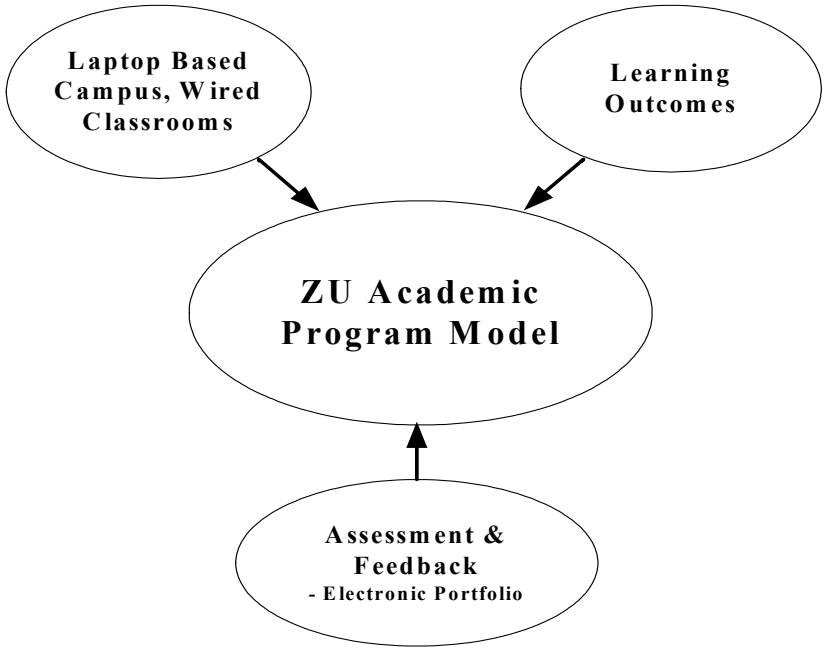

Fig.1. Components Supporting the ZU Academic Program Model

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

The academic program model[4] is framed by three sets of learning outcomes:

- The General Education Learning Outcomes (GELO)
- The Major Learning Outcomes (MALO)
- The ZU Learning Outcomes (ZULO)

The GELO and MALO are course embedded, and the ZULO are a set of higher intellectual outcomes, which can be achieved at different levels of the students' learning experiences. The GELO are designed to help students develop an understanding and the ability to apply the theoretical structures and methodologies of the academic disciplines. There are five GELO: Creative Expression; Culture and Society; Humanities; Language and Communication; and Science, Mathematics and Technology. The GELO knowledge domains are defined as follows:

- **Creative Expression**: Graduates will make artistic form and observe, analyze and reflect on the many dimensions of human experience.
- **Culture and Society**: Graduates will examine and discuss cultural and social issues from multiple perspectives; explore the relationships between different cultures on issues such as economics, politics, psychology, social history, sociology, and technology; identify cultural values and assumptions in different communities; investigate the development of their own cultural values; and appreciate the impact of human society on nature.
- **Humanities**: Graduates will develop an understanding of the history and culture of human experience, enrich the mind and contribute to the development of a more humane world.
- **Language and Communication**: Graduates will communicate effectively in English and Arabic. They will read and listen to comprehend a wide range of written and spoken information, and write and speak effectively in a variety of contexts using diverse media.
- **Science, Mathematics and Technology**: Graduates will use the tools and methodologies of science, mathematics, and technology and their interaction to solve problems and explain the world in a wide environmental, cultural, social and economic context.

The above GELO specify what students should be able to achieve by studying the subjects in a specific knowledge domain. For example studying in Science, Mathematics, and Technology domain should enable the student to comprehend and apply the scientific method as a tool for thinking and seeking knowledge.

There are six ZU Learning Outcomes (ZULO), which are the over-arching requirements for students to graduate from their major. ZULO 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 the internship program and complete a capstone project.

The ZULO, which form the framework for the APM, are designed to help students develop higher order intellectual abilities needed for lifelong learning and success. All students must demonstrate accomplishments in the following ZULO 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 and Leadership (TL)**: Graduates will be able to work efficiently and effectively in a group and will be able to assume leadership roles in a variety of life situations.

3. The Information Systems Curriculum and its Learning Outcomes

The IS curriculum, which is based on the IS 2002 model curriculum[5] and ABET criteria for accreditation[6], 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 practices[7].

The Information Systems curriculum includes five learning outcomes, which form the basis of the curriculum.

- **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
- **Internet technologies and applications (ITA)**: Graduates will understand the capabilities, use, and application of information technology
- **Systems principles and practices (SPP)**: 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 outcomes. Furthermore, a web based common course syllabus is developed and posted on the intranet to facilitate student access of course content information, as well as to provide consistency and transparency of all course syllabi.

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 CIS331 course on Data Structure and Algorithms have the potential to achieve the Information Technology (IT) learning outcome at the accomplished (Acc) level. Furthermore, for that particular learning outcome, students can use their work as primary evidence. On the other hand, students taking this course may only achieve a developing (Dev) level for the Critical Thinking and Reasoning (CTR) outcome. For this learning outcome, students may decide to use their work as secondary (temporary) evidence of their achievement.

Table 1. CIS 331 Course Topics Supporting Learning Outcomes

	ZU Learning Outcomes					Major Learning Outcomes				
	IT	GA	CTR	ILC	TL	PIA	PS	ITA	SPP	TC
Developmental Level	Acc		Dev			Dev	Dev			
Primary Evidence	X					X				
Secondary Evidence			X				X			

Table 2 shows that students who take the CIS 340 course on Web Development have the potential to achieve the Information Technology (IT) learning outcome of the ZU learning outcomes at the developing level. Furthermore, for that particular learning outcome, students can use their work as primary evidence. The rest of the ZU learning outcomes are not addressed in this course. On the other hand, students taking this course may achieve three MALO at the developing level, which are the PIA, PS and TC. For these MALO, 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 340 Course Topics Supporting Learning Outcomes

	ZU Learning Outcomes					Major Learning Outcomes				
Outcome	IT	GA	CTR	ILC	TL	PIA	PS	ITA	SPP	TC
Developmental Level	Dev					Dev	Dev			Dev
Primary Evidence	X					X				X
Secondary Evidence							X			

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 331 course. For instance the rationale for the IT ZULO states that: "Students increase their skills in using software packages to create, compile, and execute computer programs in the course" which supports the IT learning outcome.

Table 3. Course Topics Supporting Learning Outcomes

Learning Outcome	Description of course topics that support the Learning Outcome
PIA	The course provides tools for analyzing problems by studying and analyzing several standard algorithms, including the advantages and tradeoffs of using different approaches to problem solution
PS	A major orientation of the course is the use of data structures and their manipulation algorithms in computer programs that solve problems.
CTR	This outcome is addressed through the activities of analyzing different alternatives for solving problems.
IT	Students increase their skills in using software packages to create, compile, and execute computer programs in the course.

5. The Student Electronic Portfolio

The electronic portfolio is a collection of evidence that demonstrates skills, learning, and achievements of the learning outcomes. Learning is a developmental process and can be exhibited in a portfolio that includes key learning experiences. The portfolio building process may be summarized in the following steps[8]:

- Identification of the areas of skills that a student is intended to develop
- Development of specific learning outcomes, from these skill areas
- Identification of appropriate learning strategies to achieve learning outcomes
- Identification of indicators that establish the student has achieved learning outcomes and indicate what evidence was used
- Collection of evidence that demonstrate the student has met the performance indicators
- 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 addresses these principles by allowing students to demonstrate what they have learned. In the development process they engage in synthesis,

documentation, self-assessment, and reflection on their learning experiences. The College requires students to track and provide evidence of their significant learning experiences. To facilitate this process, students take special courses to learn how to collect pieces of evidence selected from classroom projects and out-of-class activities.

Students provide evidence of their achievement by creating an electronic portfolio showing 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 student 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 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

Student achievement of the learning outcome is documented in a matrix, which shows the achievement of the ZU learning outcomes as well as the College learning outcomes. The matrix also shows the student developmental level for each learning outcome. Figure 2 shows the components that are used to monitor the program effectiveness.

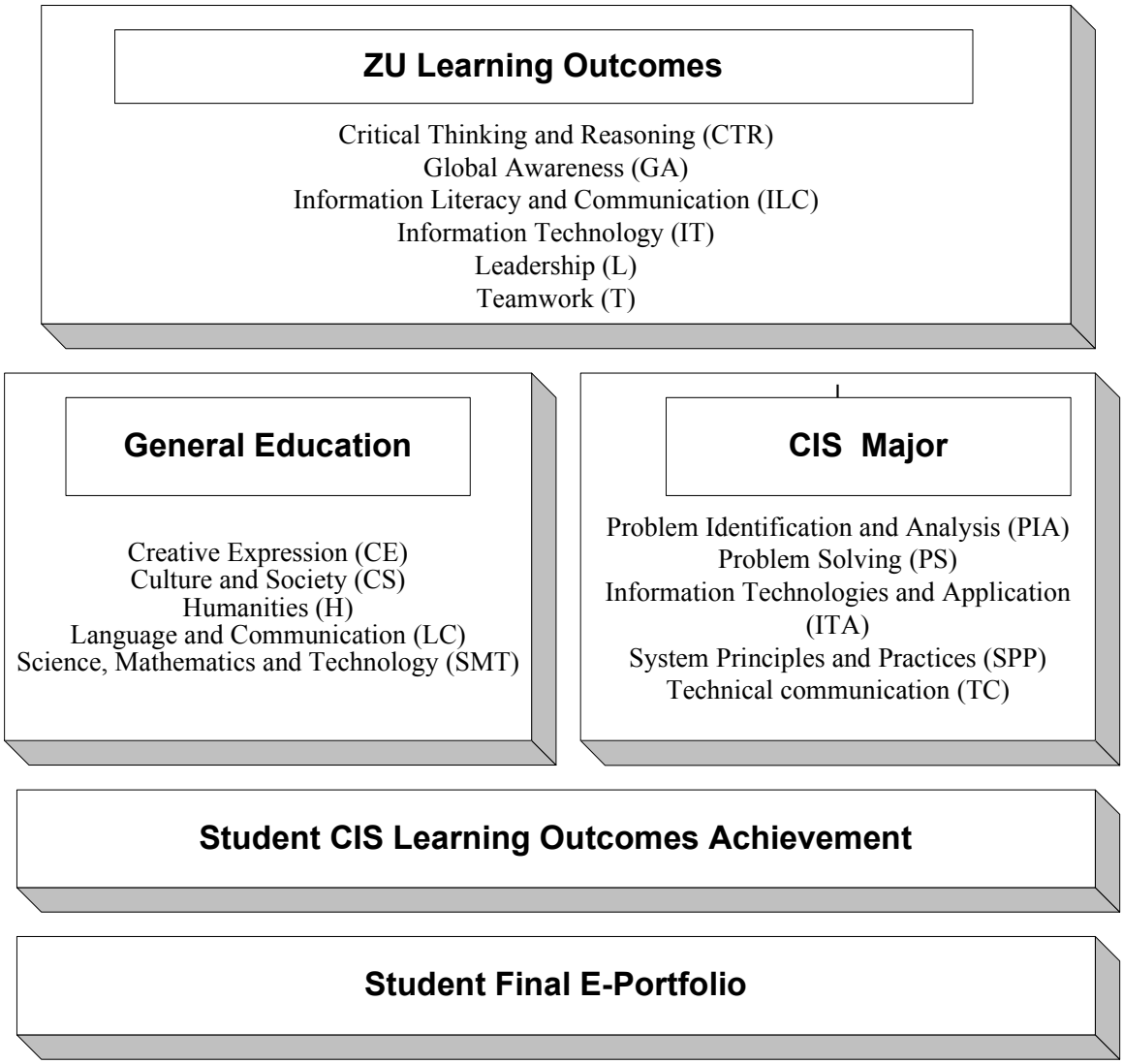

Fig.2. Component used to monitor learning outcome achievement

Based on the student's achievements of the learning outcomes and the anticipated level of achievement set by course instructors, an analysis of the performance of the effectiveness of the course coverage of specific learning outcomes can be performed. For example, if the majority of students do not achieve a learning outcome at the expected level then the course may be redesigned to include more learning experiences to better address that particular learning outcome. Other issues related to learning outcome achievement include the instructor failure to properly cover core topics in the course. The instructor's selection of appropriate learning experiences, such as projects may not be sufficient. Moreover, the student's e-portfolio can be used as a measure of the level of understanding and implementation of critical concepts in the IS program.

7. Conclusion

This paper showed how learning outcomes are used to provide focus for IS program and assess its effectiveness. In addition, the paper showed how electronic portfolios are used to effectively assess student academic progress and achievements. Two sets of learning outcomes were used as a basis to develop the IS curriculum. A master course syllabus, which includes the course contribution to learning outcomes, was developed. Using the master course syllabus, instructors can then design their course content and develop specific learning experiences to address the desired learning outcomes. E-portfolios, which are developed by students, include samples of their most critical learning experiences. Faculty members assess e-portfolios and provide feedback to students. The e-portfolios allow students to document and reflect on their learning experiences. Furthermore, e-portfolios can be used as an effective tool to show student's abilities to potential employers. The combination of the outcome-based IS program and the e-portfolio creates an environment where students can take charge of their learning and where faculty can assess and monitor the program effectiveness.

8. References

1. Greater Expectation: A new Vision for Learning as a Nation Goes to College (2002), National Panel, Published by Association of American Colleges and Universities, 2002. http:// www.aacu.org

2. Furman, G., Outcome-based education and accountability, Education and Urban Society, 26 (4), 1994, pp. 417-437.

3. Fitzpatrick, K., Leadership challenges of outcome-based education. Education Digest, 60, 1995, pp. 13-16.

4. The Academic Program Model (2002), ZU. www.zu.ac.ae

5. IS 2002: Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems. http://www.acm.org/education/curricula.html#IS2002

6. Criteria for Accrediting Computing Programs, Computing Accreditation Commission. http://www.abet.org/criteria_cac.html

7. Al-Rawi, A., Lansari, A., and Bouslama, F., "Model Curriculum for Undergraduate Degree Programs in Information Systems", ASEE Annual Conference, June 20-23, 2004, Salt Lake City, Utah.

8. Love, T., Cooper, T., "Designing Online Information Systems for Portfolio-Based Assessment: Design Criteria and Heuristics", Journal of Information Technology Education, Vol. 3, 2004, pp. 65-81.

Biography

AZZEDINE LANSARI

Azzedine received a PhD in Biomedical Engineering from North Carolina State University in 1992. From 1992-1998, he was a senior researcher at MANTECH, NC. Since 1998, he has been an Assistant Professor at Zayed University. His research interests include systems modeling, educational technology and curriculum design in Information Systems. His teaching interests include Instructional Technology and statistical modeling.

AKRAM AL-RAWI
Akram is a Sun certified Java Programmer and a Professor of CIS at Zayed University, UAE. He has worked at several academic institutions of which the last two were the University of Missouri-Columbia and Columbia College, MO. His teaching interests include programming languages, logic design, and computer architecture. His research interests include computer simulation, web-caching architecture, and curriculum design.

FAOUZI BOUSLAMA
Faouzi received a PhD degree in Electronic Engineering from Shizuoka University, Japan in 1992. From 1992-1994, he was a researcher at Toshiba Co., Tokyo. From 1994-2000, he was Associate Professor of Information Systems, Hiroshima City University, in Japan. He joined Zayed University in August 2000 as an Associate Professor of IS. His research interests include Neural Networks, Fuzzy Logic and Curriculum Design.

Appendix 1. CIS 331 Master Course Syllabus

CIS 331: Data Structure and Algorithms

Course Description
This course is designed to provide a comprehensive introduction to data structures and algorithms, including their design, analysis, and implementation. The course emphasizes importance of data structure choice and implementation for obtaining the most efficient algorithm for solving a given problem. Topics include lists, stacks, queues, trees, graphs, sorting, searching, Big-O complexity analysis, and recursion. The use and implementations of these structures and algorithms using Java language will be discussed

Course Objectives
1. Understand the characteristics of basic data structures.
2. Understand the algorithms for manipulating basic data structures.
3. Understand the elementary concepts of algorithm analysis.
4. Know the basic algorithms for sorting and searching.
5. Understand how to implement sorted and unsorted lists.
6. Understand the stack and queue and their operations.
7. Understand linked list structures.
8. Design the algorithms to implement a stack and a queue.
9. Design and implement an algorithm that creates a singly linked list.
10. Understand recursion and its application to data structures.
11. Apply the concepts of the course in the design and implementation of computer programs for solving problems.

Course Topics
1. Elementary concepts of software development and software engineering, including object-oriented design, incremental development, and information hiding.
2. Lists, stacks, queues, binary trees, and binary search trees.
3. Implementation of data structures using arrays and linked structures.
4. Evaluations of postfix and infix expressions.
5. Linear and binary search.
6. Selection sort, insertion sort, and quick sort or merge sort.
7. Recursion.
8. Additional topics as selected by the instructor.

Course Learning Outcomes

	ZU Learning Outcomes					Major Learning Outcomes				
	IT	**GA**	**CTR**	**ILC**	**TL**	**PIA**	**PS**	**ITA**	**SPP**	**TC**
Developmental Level	**Acc**		**Dev**			**Dev**	**Dev**			
Primary Evidence	**X**					**X**				
Secondary Evidence			**X**				**X**			

Course Assessment Activities and Standards

The basic assessment activities are in-class exams and programming assignments done outside class. Individual instructors may include additional assessment activities. In general, the in-class assessments will test knowledge and understanding of the concepts, and the programming assignments will test the ability to apply the concepts. The programming assignments will include problems of moderate difficulty (100-200 lines or so). This course also includes a major final project to address the major and ZU learning outcomes.

The major final project may be used as primary evidence to support the IT ZULO at the accomplished level and the PIA MALO at an accomplished. The course project may be used as secondary evidence to support the CTR ZULO at the developing level and PS MALO at the developing level.

Course Objectives Supporting Learning Outcomes

Learning Outcome	Description of course topics that support the Learning Outcome
PIA	The course provides tools for analyzing problems by studying and analyzing several standard algorithms, including the advantages and tradeoffs of using different approaches to problem solution
PS	A major orientation of the course is the use of data structures and their manipulation algorithms in computer programs that solve problems.
CTR	This outcome is addressed through the activities of analyzing different alternatives for solving problems.
IT	Students increase their skills in using software packages to produce, compile, and execute computer programs in the course.