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INFORMATION SYSTEMS EDUCATION JOURNAL

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Ten Year Assessment of Learning Outcomes of a Computer Information Systems (CIS) Program

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Abstract

In recent years greater attention has been paid to develop learning outcomes for academic programs and then to develop methods to assess these learning outcomes. Generally speaking, there are two kinds of outcomes: course outcomes and program outcomes. Assessments of these learning outcomes in institutions of higher education are mandated by the accrediting organizations. This paper describes a methodology used by a Computer Information Systems program in a small undergraduate institution to develop its learning outcomes, to collect assessment data, and to evaluate or assess its course and program outcomes during a ten year period. The data collection and the subsequent data analysis showed the strengths and weaknesses of the program and we were able to address a number of these weaknesses.

Key words: Course outcomes, Learning outcomes, Learning outcome assessments, Measurement, Outcome based education, Program outcomes, and Programs metrics.

1. INTRODUCTION

In recent years greater attention has been paid to develop learning outcomes for academic programs and then to develop meaningful assessment methods to evaluate these outcomes. Assessment is a systematic and on-going process of collecting, interpreting, and acting on information relating to the goals and outcomes developed to support the mission and purpose of an institution (Osters, 2003). According to Acharya (2003), assessments should help us to answer the following questions: (1) What do we want the students to learn? (2) Why do we want them to learn it? (3) How can we help them to learn it? (4) How do we know what they have learned? Also Osters (2003) pointed out that assessments should help us to improve what we are doing. Assessment begins with the articulation and development of measurable outcomes. Generally speaking, there are two kinds of learning outcomes: course outcomes and program outcomes. The course outcomes should describe what students are expected to learn from an individual course, while program outcomes should describe what a student is expected to accomplish after completing the coursework from the program. Maki (2002) pointed out that learning outcome assessments must be based on institutional curiosity to seek answers to questions about student learning, why they learn, how well they learn, when they learn, and explores how pedagogies and educational experiences develop, and foster student learning. Maki (2002) also pointed out that innovations in pedagogy or integration of diverse methods of teaching and learning into a program of study, redesign of a program, reconceptualizing the role of advising, or establishing stronger connections between curriculum and non-curriculum represents some of the kinds of changes that faculty and staff may undertake to improve student learning and development based on their interpretations of learning outcome assessment results.

2. PROGRAM LEARNING OUTCOME DEVELOPMENT

Learning outcomes should describe what students will be able to demonstrate in terms of knowledge, skills, and values upon completion of a course, a span of several courses, or a degree program (Osters, 2003). Clear statement of learning outcomes serves as the foundation to assess the effectiveness of the teaching and learning process. According to Osters (2003), the three essential components of a measurable learning outcome are: (1) Student learning behaviors, (2) Appropriate assessment methods, and (3) Specific student performance criteria. Student behaviors describe what students are expected to demonstrate by the completion of the course. Action verbs like demonstrate, apply, define, analyze, etc. are used to describe student behaviors. Assessment methods are tools and techniques used to determine the extent to which the stated learning outcomes are achieved. Student performance criteria should be expressed in specific and measurable terms that are acceptable to a specific course or series of courses. A variety of methods, qualitative and quantitative, direct and indirect, should be used to assess the learning outcomes. Keep in mind that a simple letter grade alone does not provide adequate feedback to student's performance, because the letter grade alone does not sufficiently identify with the strengths and weaknesses of individual learning outcomes. If the grading system is accompanied by a rubric where the individual outcome components are addressed, then this tool can be used to pinpoint the weakness and strengths of the student's performance.

It is very important to define the learning outcomes of a program/course in specific and precise manner. Spady & Marshall (1994) wrote:

> "Outcomes are clear, observable demonstrations of student learning that occur after a significant set of learning experiences…Typically these demonstrations, or performances, reflect three things: (1) what the student knows; (2) what the student can actually do with what he or she knows; (3) the student's confidence and motivation in carrying out the demonstration. A well-defined outcome will have clearly defined content or concepts and be demonstrated through a well-defined process beginning with directive or requests such as explain, organize, or produce."

After an exhaustive research the faculty members developed a number of outcomes for the CIS program and from this list we were able to select six measurable outcomes for our program. The American Association of Higher Education's (AAHH) (1996) nine principles of good practices for assessing student learning were used in the selection process. We also used a number of other research documents from the AAHE's assessment web site. Our hope is that the graduates of our program will be able to show that they have accomplished these six outcomes by receiving a degree from the CIS program. The following list shows the learning outcomes developed by the CIS program.

1. Students will demonstrate the skill to write complete, complex programs that are fully tested.
2. Students will demonstrate the skill to develop a complete information system that incorporates feasibility study, analysis, design, systems development, testing, implementation and maintenance.
3. Students will demonstrate the ability to solve problems using the computer as a tool, using either application packages or custom programs.
4. Students will demonstrate the ability to work as a team member in a problem-solving situation.
5. Students will demonstrate the ability to investigate existing literature in Information systems.
6. Students will demonstrate the ability to communicate effectively.

Fig 1

3. COURSE LEARNING OUTCOME DEVELOPMENT

Once these outcomes were developed, we set out to see how these outcomes can be accomplished through our course offerings. We know that we have to develop a set of outcomes for each of our courses, keeping in mind that there must be a match between these course outcomes and the program outcomes. In other

words, the stated program outcomes must be accomplished through the course outcomes. Faculty who are teaching the individual courses are asked to take the program outcomes and see how these outcomes can be accomplished through their courses. Also these are the outcomes a faculty would like his/her students to know at the completion of that particular course. Axelsson and Melin (2010) pointed out that when learning outcomes are developed in a transparent and clear way, students will be able to use them before, during and after the course. The importance of measurability and clarity of the course outcomes were emphasized. Faculty members developed a set of learning outcomes for each course from which we selected five or six outcomes for each individual course. We then developed a table to show the relationship between program outcomes and courses offerings. We also agreed that when we develop new courses in the future, we need to pay greater attention to the course outcomes to see how the new course will satisfy the program outcomes. By adding new rows in Table 2 we will be able to get a quick view of the relationship between the course and program outcomes.

Course Number	Course Title
CIS 119	Visual Basic Programming
CIS 218	Introduction to Information Systems
CIS 252	Introduction to C++ Programming
CIS 260	Cobol Programming
CIS 353	Systems Analysis
CIS 363	Data Base Structures
CIS 443	Data Communication
CIS 465	Management Information Systems
CIS 495	Senior Project
Electives	
CIS 352	Data Structures Using C++
CIS 340	Java Programming
CIS 370	Network Operating Systems
CIS 455	Computer Hardware & Software
CIS 460	Web Development
CIS 470	Information Assurance
CIS 480	Internships
CIS 485	Emerging Technology

Table 1

Required Courses	Learning Outcomes					
	1	**2**	**3**	**4**	**5**	**6**
CIS 119	X		X			X
CIS 218			X	X	X	X
CIS 252	X		X			X
CIS 260	X		X			X
CIS 353		X	X	X	X	X
CIS 363		X	X	X	X	X
CIS 443			X	X	X	X
CIS 465			X	X	X	X
CIS 495	X	X	X		X	X
Electives						
CIS 352	X		X			X
CIS 340	X		X			X
CIS 370			X	X	X	X
CIS 455			X	X	X	X
CIS 460		X	X	X	X	X
CIS 470			X	X	X	X
CIS 480			X		X	X
CIS 485			X		X	X

Table 2

The current CIS course offerings (course numbers and corresponding course titles) are listed in Table 1 for reference. Table 2 shows a mapping of the courses and the CIS program outcomes.

Upon completion of this course, students will be able to demonstrate proficiency in:

1. A disciplined approach to problem solving methods and algorithm development (CIS-O#1, 3)

2. The syntax and vocabulary of Visual Basic.Net (CIS-O # 1)

3. The usage of Visual Basic.Net Programming Environment (CIS-O #1)

4. Developing complete Visual Basic programs that include specification, design, code, debugging, testing, and documentation. (CIS-O #1)

5. Using computers as a tool in problem solving (CIS-O # 3)

6. Communicating the program development process in a predetermined format (CIS-O #6)

Fig 2

As mentioned earlier, we have developed a number of outcomes for each course. Faculty members also developed a number of rubrics for each course to assess the achievement of each student.

The outcomes developed for CIS 119 (Visual Basic Programming) are given above. Similar outcomes were developed for all the other courses in our curriculum.

4. EARLY LEARNING OUTCOMES ASSESSMENT

Data collection and analysis of the course outcomes for each course is described in a previous paper (Abraham, 2006). This paper will be concentrating on the data collection and analysis for a period of ten years. At the end of each academic year we consolidate the data collected during the Fall and Winter semesters and report back to the academic dean who collects the data for accreditation and program assessment purposes. Please see appendix B for a sample form for this reporting. This form is developed by the office of the academic dean and used by all programs/departments in the University for uniform reporting. Column one states the outcomes while column two lists the course that satisfy the outcome and these course come from the previous mapping (table 2). Column three lists the activities that a student will perform to satisfy the fulfillment of the outcome. Column four lists the percentages of students who met or exceeded the outcome expectations. The last column lists the actions taken by the program to address the issues raised during the data analysis. Columns one, two and 3 are self-explanatory while columns four and five need some explanation. We have made two assumptions to generate the data in column four. It is assumed that if a student has received more than 70% for an outcome then he/she has met the requirements for that outcome. For example if a student has received an aggregate of more than 70 % for the program development (outcome 1) then that student has met the requirements for outcome 1. It is assumed that if more than 80% of the students in a class met the requirements for an outcome, then that class has met the requirements for that outcome. For example if more than 80% of the students in Visual Basic Class (CIS 119) have met the outcome 1 requirements, then the whole class has met the requirements for outcome 1. The 70% and 80% guidelines are quite arbitrary and we thought that those numbers are suitable for our purpose. Only the students who have completed the course are included in this analysis. As mentioned elsewhere, we are a small institution and thus all courses are not offered all semesters. So the outcome assessment data collected every year may consist of data from uneven offerings. For example we offer CIS 119 (Visual Basic Programming) every semester while CIS 340 (Java Programming) will be offered only once in a year. To make things more difficult we offer some courses only once in two years.

The outcome analysis revealed a lot of strengths and weakness of our course offerings and course delivery. Colum five lists the changes we have already implemented or the changes we are planning to implement as a result of the yearly outcome analysis. Some of these changes are easy to implement while some others need budget support from administration. For example we were able to emphasis the importance of more team work in all upper level courses as a result of the evaluation in early years. Some of the changes require hardware and software implementation and these kinds of changes need support from the administration.

5. TEN YEAR ASSESSMENT

We have been collecting and reporting the yearly outcome assessment data to the academic dean for almost ten years. Last year we had an accreditation visit from the North Central and thus we were asked to produce a five/ten year report of our program outcome assessment to be included in the final self-study report. The faculty members from the CIS program generated a ten year outcome assessment report. I am very happy to report that the visiting team was very impressed with the progress we have made in the outcome collection and analysis and we have received our 10 year unconditional accreditation.

We are a small institution with a low but steady enrollment and thus 100 and 200 level classes are offered every semester while 300 and 400 level classes are offered in a two year cycle. Data from all classes are collected every semester and combined into an annual report to the dean. For the ten year report we combined all these annual data into one document. A copy of this report is presented in appendix A. Column one of this report restates the six program outcomes and column two lists the course that will satisfy these outcomes as

described for table 4 above. Column three lists the average for each course for the ten year period. This average is generated from the yearly data that is reported to the administration at the end of each academic year. The ten year average is calculated for each course and then for each outcome and listed in column 4 of table 6. As stated before the 100 and 200 level classes are offered more times than the 300 and 400 level classes and thus they have a greater effect on the ten year outcome average. We also calculated a final average by taking the average for all the six outcomes. In its current form the report shows that we as a program are doing well and our students are satisfying the stated program outcomes well.

6. LESSONS LEARNED

To draw reasonable conclusions from learning outcome assessments, we should make our assessments as fair as possible. Lam (1995) pointed out that a fair assessment is one in which students are given equitable opportunities to demonstrate what they know. Suskie (2000) suggested the following steps to make our assessments methods as fair as possible: (1) Have clearly stated learning outcomes and share them with your students, so they know what you expect from them, (2) Match your assessment to what you teach and vice versa, (3) Use different measures and many different kinds of measures, (4) Help students learn how to do the assessment tasks, (5) Engage and encourage your students, (6) Interpret assessment results appropriately, (7) Evaluate the outcomes of your assessments.

Learning outcome assessment must be an ongoing process. According to Rodrigues (2002), assessment must become a part of an institution's culture. We have been doing these assessments for almost ten years now. The faculty in our program felt that the experience of going through the process was very worthwhile, even though it was very time consuming and frustrating. As a result of the data collection and analysis we were able to correct a number of problems in our course offerings as they occurred. The data collection and the subsequent data analysis show our strengths and weaknesses and we were able to address these issues in a timely manner. We strongly believe that the process of data collection and analysis is more important than the final number to understand what is happening in our program at any given point.

We used a number of other assessment techniques other than those described in this paper. All our graduating senior students are required to attend an exit interview. During the interview, a faculty member and the student address the program and course outcomes and solicit recommendation from the students. In addition to oral, written, and poster presentations, faculty members usually visit internship sites to evaluate the performance of the student interns.

7. CONCLUSIONS

Outcome based education promises a better way of understanding student learning, and in turn provide ways to improve the quality of education. To measure or assess the learning outcomes effectively, we need to start with measurable, concise, and specific learning outcomes for our program and individual course that must be shared and explained to the students. Clear and concise measuring tools, techniques, instruments, and methods must also be developed and must be conveyed to the students to avoid confusion and frustration. Assessment data must be collected in an ongoing basis using multiple methods and instruments. Collected data must be analyzed to understand the strengths and weaknesses of the program, courses, teaching, and learning. This information must be used to improve teaching and learning, incorporate innovations in pedagogy, redesign programs and courses, redevelopment of the outcomes, and the development of new tools for assessment. For outcome assessment to be successful it must be ongoing and must be part of the institution's culture. Administrators must recognize the importance of this process by providing financial and collateral support. Outcome based education is here to stay and it is important for educators to be prepared to accept the challenge of developing measurable outcomes for their programs/institutions, assess these outcomes, and then use the assessment data to improve what they are doing.

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Appendix A
Ten Year Outcome Summary

Outcomes	Courses	10 Year Course Averages	10 year Average
Students will demonstrate the skill to write complete, complex programs that are fully tested.	CIS 119 CIS 252 CIS 340 CIS 460 CIS 495	83.25% 82.50% 85.00% 95.00% 96.00%	88.35%
Students will demonstrate the skill to develop a complete information system including feasibility study, analysis, design, systems development, testing, implementation and maintenance.	CIS 353 CIS 363 CIS 460 CIS 495	97.50% 94.00% 94.00% 95.00%	95.13%
Students will demonstrate the ability to solve problems using the computer as a tool, using either application packages or custom programs.	CIS 119 CIS 218 CIS252 CIS 340 CIS 363 CIS 370 CIS 460	83.75% 80.50% 84.00% 84.00% 90.00% 90.00% 95.00%	90.75%
Students will demonstrate the ability to work as a team in a problem-solving situation.	CIS 218 CIS 353 CIS 363 CIS 370 CIS 460 CIS 465	85.75% 95.00% 95.00% 88.00% 89.00% 94.25%	91.17%
Students will demonstrate the ability to investigate existing literature in Information systems	CIS 218 CIS 353 CIS 363 CIS 370 CIS 460 CIS 465 CIS 495	82.00% 86.00% 88.00% 85.00% 90.00% 94.00% 96.00%	88.71%
Students will demonstrate the ability to communicate effectively.	CIS 119 CIS 218 CIS 252 CIS 340 CIS 353 CIS 363 CIS 443 CIS 460 CIS 495	82.75% 82.00% 84.50% 84.00% 90.00% 90.00% 95.00% 90.50% 96.00%	89.52%
		10 Year Program Average	**90.60%**

Appendix B
Academic Program CIS
Learning Outcomes Assessment and Subsequent Actions 2010 – 2011

Outcome	Course or Graduation Requirement	Assignment/Measurement	% of Students Who Met or Exceeded Expectations(% Attainment Desired) **80%**	Actions Taken or to be taken* ***Actions in bold print have been taken**
Students will demonstrate the skill to develop complete, complex programs that are fully tested.	CIS 119, CIS 340, CIS 460, CIS 495	Programming Assignments and projects	CIS 119: 85% CIS 340: 90% CIS 460: 100% CIS 495: 100 %	**We modified the way specification is developed. We now use a standard format to develop the spec.** Continue to emphasis the importance of design and spec.
Students will demonstrate the skill to develop a complete information system that incorporates feasibility study, analysis, design, systems development, testing, implementation and maintenance.	CIS 353, CIS 460, CIS 495	CIS 353: A project where students developed an information system as a team. CIS 460: Students developed a web site as a team CIS 495: Each student developed a complete system individually.	CIS 353: 94% CIS 460: 94% CIS 495: 84%	**We incorporated project management and object oriented aspects in CIS 353**. We are planning to include the above concepts in CIS 460 and 495.
Students will demonstrate the ability to solve problems using the computer as a tool, using either application packages or custom programs.	CIS 119, CIS 218, CIS 340, CIS 353, CIS 455, CIS 460, CIS465, CIS 495	Assigned Lab projects Assigned Homework problems Case Studies Programming assignments	CIS 119: 84% CIS 218: 82% CIS 340: 85% CIS 353: 90% CIS 455: 100% CIS 460: 100% CIS 465: 90% CIS 495: 84%	We are constantly reassessing and modifying our assignments, projects, and case studies in these classes to incorporate more software tools. Also we are watching the changes in technology
Students will demonstrate the ability to work as a team member in a problem-solving situation.	CIS 218, CIS 353, CIS 460, CIS 465	Team projects to do Web search, Complete lab projects, Develop Systems, Develop web sites and Complete Case Studies	CIS 218: 89% CIS 353: 94% CIS 460: 92% CIS 465: 100%	**We incorporated some web2.0 tools in CIS 218** We need to pay more attention to individual performance in teams
Students will demonstrate the ability to investigate	CIS 218, CIS 353, CIS 455, CIS 460,	Research papers with references using APA format	CIS 218: 82% CIS 353: 86%	**We are emphasizing the importance of proper**

existing literature in Information systems.	CIS 465, CIS 495		CIS 455: 96% CIS 460: 90% CIS 465: 95% CIS 495: 100%	**citations and APA formatting in every class.** We need to do a better job in educating our students to reduce plagiarism incidents
Students will demonstrate the ability to communicate effectively	CIS 119, CIS 218, CIS 340, CIS 353, CIS 455, CIS 460, CIS 465, CIS 495	Presentation of lab Assignments Presentation of Research Papers PowerPoint Presentations Poster Presentations	CIS 119: 80% CIS 218: 82% CIS 340: 84% CIS 353: 90% CIS 455: 95% CIS 460: 91% CIS 465: 90% CIS 495: 84%	**We provided specific guidance for proper report preparation, proper format and presentation in all classes**

Action taken or to be taken: (column 5)
1. Earlier assessment data showed that some components of the program development (outcome 1) need more attention. This year we refined the rubric to include more details of the assignments. We developed a standard format for developing the specification. We need to pay more attention to the idea of software engineering rather than developing just programs.
2. We spent a lot of time guiding the senior project students to develop real world projects (outcome 2) that will help them to see the complexities that are associated with developing a real technology project. This year's projects showed a substantial improvement over previous years. We are planning to keep the pressure on them to improve the quality of the senior projects. We are also in the process of incorporating project management tools in CIS 465.
3. We are constantly assessing the use of software packages in our classes. We always use the most recent releases of the software packages. We are also constantly assessing our assignments, Cases Studies, and projects to increase the problem solving skills of the students. We are getting ready to use Microsoft Office 2010 in our classes.
4. Majority of our upper level classes are now using team based projects and they are required to present their team projects orally in addition to their written paper.. We are using a rubric to assess the team involvement.
5. Majority of our upper level classes are now required to write and present research papers. We are emphasizing the importance of proper formatting, citations, and reference. We are also emphasizing the dangers of plagiarism in all our classes.

Assumptions for Columns 4 in the above table
1. It is assumed that if a student received more than 70% for an outcome then he/she has met the requirements for that outcome. For example if a student has received an aggregate of more than 70 % for the program development (outcome 1) then that student has met the requirements for outcome 1.
2. It is assumed that if more than 80% of the students in a class met the requirements for an outcome, then that class has met the requirements for that outcome. For example if more than 80% of the students in Visual Basic Class (CIS 119) have met the outcome 1 requirements, then the whole class has met the requirements for outcome 1. Only the students who completed the course is included in this analysis