

# **A Model for Using a Capstone Experience as One Method of Assessment of an Information Systems Degree Program**

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## **ABSTRACT**

Student attainment of educational outcomes is a core purpose of any institution of higher education and assessment provides a vehicle through which a program of study is able to ascertain how well it is achieving its stated learning outcomes and how program improvement might be achieved. Assessment of student learning begins with the clear definition and articulation of learning outcomes, followed by offering learning experiences, assessing student achievement of learning outcomes and using the results to improve teaching, learning, planning and allocation of resources (Middle States Accreditation Commission, 2005). A renewed emphasis on assessment is leading to the identification and implementation of additional ways to objectively and formally conduct program assessment with one direct method incorporating the evaluation of a capstone experience project deliverable. A well-defined capstone experience is comprehensive in nature allowing for the assessment of a wide range of abilities. A capstone based assessment method includes mapping project deliverables and other artifacts to specified learning outcomes, establishing a scoring rubric that defines performance criteria, collecting and analyzing data and reporting results. Through this type of analysis, program strengths are revealed and program weaknesses are identified. Subsequently program improvement plans can be developed and ultimately increases in student learning can be realized.

**Keywords:** Assessment, Capstone Experience, Rubrics, Learning Outcomes, Information Systems Programs

## **1. INTRODUCTION**

Assessment is an important and integral part of any information systems program and it is what we do as faculty members in each course that we teach. Assessment, however, is more than evaluating student performance in a course or even evaluating how well a course meets its intended objectives; the macro view of assessment critiques how well a program achieves its stated student learning outcomes. According to Rogers (2003), the primary question program level outcomes assessment must answer is “Can students demonstrate the ability to perform at an acceptable level?” and formal program assessment is a means through which evidence is provided that students are able to demonstrate “knowledge or skill directly linked to specific program outcomes” (Rogers, 2003 pp. 8).

The assessment process as well as assessment results have important implications for curriculum development, classroom instruction and program improvement. The primary aim of assessment is to foster learning of worthwhile academic content by all students (Wolf, Bixby, Glenn, & Gardner, 1991). Assessment results help to determine how well a program is meeting its instructional goals and help to

identify where alterations to the curriculum or instructional practice might need to be made. According to McGinnis and Devlin (2002) and reported by the Centre for the Study of Higher Education in Australia (2003), “The relationship between assessment practices and the overall quality of teaching and learning is often underestimated, yet assessment requirements and the clarity of assessment criteria and standards significantly influence the effectiveness of student learning. Carefully designed assessment contributes directly to the way students approach their study and therefore contributes indirectly, but powerfully, to the quality of their learning” (pp. 1). They go on to say that assessment often defines the curriculum for students so is a potent strategic tool when carried out properly. Poorly designed assessment they state, “has the potential to hinder learning or stifle curriculum innovation” (pp. 1). The American Association for Higher Education identified nine principles of good assessment. True assessment begins with educational values driving what we choose to assess and how we choose to perform assessment and it is through assessment that we meet our responsibilities to our students and the public (AAHE, 1991). Summarily, it can be stated that assessment, when done systematically and

comprehensively, becomes the driving force behind program improvement, the ultimate goal of an instructional program.

Formal documentation of the implementation of assessment plans is part of the work of every program of higher education. This is because assessment has become a driving force in the accreditation review process as accreditation has moved away from measurements of institutional capacity to evaluation of institutional quality (Council of Regional Accrediting Commissions, 2004). The new standards of quality look beyond capacity to assessing congruence between mission, learning goals, curricular offerings and student outcomes. This requires institutions to use student learning data as part of their self-reflection report and to demonstrate how they use that data to improve their educational programs (Council of Regional Accrediting Commissions, 2004). This trend is being emphasized by all accrediting bodies including those that accredit colleges/universities and those that accredit specific programs within a college or university. In 2001, the Accrediting Board of Engineering Technologies (known as ABET) became the recognized agency for evaluating and accrediting information systems programs. Their review process includes an examination of eight standards, the first of which focuses on a program's assessment practices. Specifically the intent of the standard states that, "The program has documented educational objectives that are consistent with the mission of the institution. The program has in place processes to regularly assess its progress against its objectives and uses the results of the assessments to identify program improvements and to modify the program's objectives" (ABET, 2007 pp. 11). The Association to Advance Collegiate Schools of Business (AACSB) also includes assessment, which they label as 'assurance of learning,' as a major component of the accreditation process. According to the AACSB standards guidelines, assurance of learning "evaluates how well the school accomplishes the educational aims at the core of its activities" (AACSB, 2005 pp. 57). They further specify that the learning process is different from the demonstration that students achieve learning goals. In essence, assurance of learning is aimed at assessing how well students meet all the learning goals of a program. This extends well beyond simply assessing student achievement in a specific course. Other accrediting bodies may use different verbiage but the purpose is the same; educational programs need to demonstrate that program initiatives are aligned with learning outcomes and students are meeting those learning outcomes at a high level. It is through these processes that continual quality improvements are made.

The Middle States Accreditation Commission outlines the assessment of student learning as a four-step cycle (Middle States Accreditation Commission, 2005). Assessment begins with the clear definition and articulation of learning outcomes, followed by offering experiences to achieve those learning outcomes, assessing student achievement of those learning outcomes and using the results to improve teaching, learning, planning and allocation of resources (Middle States Accreditation Commission, 2005). In fact, consistent, ongoing enactment of assessment processes and procedures provides the data needed to improve educational quality and subsequently creates the

evidence needed to demonstrate achievement of educational outcomes, the core purpose of any institution of higher education.

There are many valid approaches to assessment including quantitative and qualitative measures, formative and summative, direct and indirect. Hence, it is generally recommended that multiple processes and multiple mechanisms be utilized both at the course level and the program level. Traditional course-embedded techniques have included such activities as final examinations and student evaluations. Traditional program level assessment has often utilized direct measures such as a stand-alone test given at the end of the student's educational experience and indirect measures such as surveys administered to graduating seniors, alumni and employers. While these are all worthy techniques, the renewed emphasis on assessment is leading to the identification and implementation of additional ways to objectively and formally conduct program assessment. One such method is the use of a student project deliverable completed in a capstone experience course as a component of an assessment plan.

A capstone experience is a culminating experience, oftentimes a well-thought out project that is comprehensive in nature and allows students to demonstrate a range of abilities (Palomba and Banta, 1999). The capstone experience draws from previous work undertaken by the student during their course of study. As Palomba and Banta (1999) point out, a well-defined capstone project provides the type of rich information needed to make them valuable assessment tools for individual students or programs. Further, as Suskie (2004) notes, capstone experiences provide excellent direct evidence of student learning as they provide "tangible, visible, self-explanatory evidence of exactly what students have and haven't learned" (pp. 95) and as the Middle States Commission on Higher Education notes, as a direct measure, capstone experience assessment helps to establish that "actual learning has occurred relating to a specific content or skill" (Middle States Commission on Higher Education, 2003 pp. 28).

## **2. STUDENT LEARNING OUTCOMES**

The first step in any assessment process is to identify what is to be assessed. In an educational environment, what is to be assessed, are the learning goals of a program of study. From an accreditation standpoint, assessment includes the evaluation of the knowledge, skills, and abilities the individual student possesses and can demonstrate upon completion of their educational program. These are generally articulated in the form of learning outcomes. Learning outcomes should be specified from an operational perspective; often they begin with the phrase, "The student will be able to." This distinguishes learning outcomes from learning goals which may be defined as intangible ideas related to educational aims and objectives. Further, to adequately carry out assessment techniques, it is important for learning goals to be stated in measurable terms.

Generally a program of study will have 5-10 generally defined learning outcomes. Then within each general learning outcome, if more detail is desired, a set of specific learning outcomes may be identified. To summarize, learn-

<b>General Learning Outcome 1: Theoretical foundations and applications of IT</b>
<i>The graduate has a thorough understanding of the theoretical foundations and practical applications of information technology. (Knowledge)</i>
<b>General Learning Outcome 2: Foundation in business</b>
<i>The graduate has a solid foundation in commonly accepted business principles and practices (Knowledge/skill)</i>
<b>General Learning Outcome 3: Statistical and mathematical models</b>
<i>The graduate has skills in utilizing basic statistical and mathematical models for summarizing and analyzing data. (Skill)</i>
<b>General Learning Outcome 4: Business problems and IT solutions</b>
<i>The graduate is able to recognize, define and analyze real-world business problems, and develop, evaluate and implement information technology solutions to address them. (Knowledge/skill)</i>
<b>General Learning Outcome 5: IT as a system</b>
<i>The graduate has a demonstrated comprehension of IT as a system and the integral components of that system including people, processes, hardware, software, communication mechanisms and data. (Knowledge/skill)</i>
<b>General Learning Outcome 6: Information systems development</b>
<i>The graduate possesses knowledge, skill and technical depth in Information Systems development using appropriate methods, techniques and tools. (Skill/knowledge)</i>
<b>General Learning Outcome 7: Ethical, social and global implications</b>
<i>The graduate has an awareness of and ability to articulate positions on the ethical, social, and global implications of IT. (Attitude)</i>
<b>General Learning Outcome 8: Team membership and leadership</b>
<i>The graduate has acquired skills as a team contributor to projects, especially IT projects, and is able to assume various roles on a team project, including leadership. (Attitude/skill)</i>
<b>General Learning Outcome 9: Effective communications</b>
<i>The graduate has the ability to effectively communicate – orally, in writing and using symbolic methods and modeling – with both technical and non-technical IT stakeholders. (Skill)</i>

**Table 1. General Student Learning Outcomes for an Information Systems Program of Study**

ing outcomes should be well defined in behavioral terms, should address the three dimensions of learning (skills, knowledge and aptitude) and should be stated in such a way that they can be measured or assessed. An example set of general learning outcomes from a state university's Information Systems Program with a foundational area of business is presented in Table 1. The program of study represents an undergraduate (baccalaureate) level and is designed around the IS2002 curriculum and ABET curriculum standards.

General learning outcomes tend to be broad in scope and therefore, it is often beneficial to articulate more specific learning outcomes. Adding this level of specificity often makes it easier to develop assessment measures. Table 2 presents a set of specific learning outcomes for a general learning outcome related to business problems and IT solutions. Appendix I depicts an example complete set of general and specific learning outcomes.

<b>General Student Learning Outcome - Business Problems and IT Solutions</b>	
<i>The graduate is able to recognize, define and analyze real-world business problems, and develop, evaluate and implement information technology solutions to address them. (Knowledge/skill)</i>	
<b>Specific Learning Outcomes - The graduate will be able to:</b>	
SLO 1:	Use a systems approach and systems methods for framing problems.
SLO 2:	Perform problem analysis and identify requirement specifications from written descriptions such as case scenarios.
SLO 3:	Clearly express user requirements for information systems according to standard methodologies.
SLO 4:	Create and/or justify conceptual designs to satisfy given requirement specifications.
SLO 5:	Match requirement specifications to technological opportunities and perform benefit/cost tradeoff analyses among design options.
SLO 6:	Demonstrate the ability to integrate knowledge gained through the curriculum and knowledge base in order to follow the Systems Development Life Cycle from identification and analysis of a business problem to the design and implementation of an information technology solution that utilizes appropriate hardware and software components.

**Table 2. Example Set of Specific Student Learning Outcomes**

**3. CAPSTONE COURSE PROJECT AS A VEHICLE OF ASSESSMENT**

An information systems program is defined by what it seeks to offer and is evaluated by what its students attain. Most information systems programs are organized around a collection of courses designed to meet individual program objectives. In addition, many programs provide a culminating experience that brings together program objectives and requires students to demonstrate mastery of objectives by completing a comprehensive project. Depending on how the capstone experience is designed and implemented, the culminating project can be utilized as vehicle for assessing the attainment of learning outcomes.

The first step required to utilize student projects for assessment is to map project criteria to specified learning outcomes. The project may not incorporate all learning outcomes, but it should incorporate a majority of them. The best way to explain how this might be done is to reference an actual implementation of this process. The case of reference is a state university’s Information Systems Program that has received ABET accreditation. As part of the degree requirements for this program, students must successfully complete a senior capstone course entitled ‘IS Integrated Project.’ The major deliverable of the course is a group project in which students design, develop and implement a software system following a prescribed object oriented systems development methodology. The course incorporates concepts of project management, systems development, UML modeling, coding, database management, teamwork and technical writing. The deliverables for the group project include a collection of various documents (referred to as artifacts) and software application source code. Students are also required to make an oral presentation to their peers outlining their project and lessons learned during the course of the semester.

An investigation was undertaken to map project criteria and project artifacts to program specific learning outcomes. Then a set of scoring rubrics was developed to articulate specific criteria to be used in evaluating student achievement of each learning outcome. Scoring rubrics have been found to provide an objective way to standardize a rating process and are relatively easy to implement (Middle States Commission on Higher Education 2003). The rubrics define all dimensions to be assessed through a description of performance criteria and the subsequent assignment of a numerical rating. Generally a rating scale is used that defines various performance levels (for example 1–unacceptable, 2–marginal, 3–adequate, 4–good 5–excellent). Observational or performance criteria are assigned to each rating scale depending on the level of skill required or level of mastery desired. The descriptive nature of the scoring rubric helps to determine the degree to which performance criteria have been met (Moskal, 2000). Rubrics can be applied holistically or analytically. Basically, holistically assigns a score to an entire entity while analytic rubrics assign scoring scales to individual components which are then tallied into a final score. Analytic rubrics provide more formative feedback while a holistic score is more summative. Generally when dealing with assessment of student attaining of learning outcomes, a holistic approach might be used to assess

general learning outcomes while an analytic approach is more appropriate for assessing specific learning outcomes. A sample mapping between a general learning outcome and one of its associated specific learning outcomes, associated artifact and scoring rubric is presented in Table 3. A more comprehensive set of learning outcomes, artifacts and rubrics and the mappings between them is included in Appendix 2.

Learning Outcome	Artifact	Rubric
<b>GLO: Business Problems and IT Solutions</b>		
SLO: Use a systems approach and systems methods for framing problems.	Executive Summary	Executive Summary distinctly states the problem and provides a clear description of how the problem is to be solved and the solution is reasonable and appropriate

**Table 3. Sample Mapping of a Specific Learning Outcome to a Project Artifact and Associated Rubric**

**4. METHODOLOGY**

Once the mapping is complete, the next phase is to implement a methodology for collecting and analyzing data garnered from the project evaluation. There is not one prescriptive method which defines the best way to do this. Every program is different and must develop a methodology that meets its unique needs. However, in general, a methodology will describe when and how the assessment will occur, how the data will be analyzed and reported and what will be used as benchmark measures.

**4.1 Frequency of Assessment**

Assessment should occur periodically and consistently and at the program level with enough frequency to be effective as a means for driving program improvement. Factors for determining frequency include size of the program and the scheduled offerings of the capstone experience. As an example, for a program with a capstone experience offered three times during the academic year (fall, spring and summer semesters) with an enrollment of approximately 25-30 students a semester, once a year might be deemed adequate. To ensure projects are available when needed for program assessment purposes, projects should be submitted and retained with an IS Program office. A calendar approach might be to conduct the project assessment after the close of the academic year with results reported at the start of the first semester of the subsequent academic calendar. This way results can be utilized for program improvement planning purposes for that year.

**4.2 Data Analysis**

Data analysis planning is an important part of assessment. How the data is collected, reported and analyzed contributes to the usefulness of the process. Considerations must be made in terms of adequacy of data quantity. For instance, if

Specific Learning Outcome	Artifact	Average Score Evaluator 1	Average Score Evaluator 2	Difference
Clearly expresses user requirements for information systems according to standard methodologies.	Use Case Diagram	4.4	4.2	.2
	Use Case Documentation	4.2	3.6	.6

**Table 4. Reporting of Evaluator Ratings**

a large number of projects are submitted, the time requirements of assessing all submitted student projects may outweigh the data usefulness. In this case it may be best to use a subset of projects. In the case outlined above, three capstone experiences with a yearly enrollment of approximately 80-90 students results in approximately 15-20 student projects. Using a random selection of approximately 30% (5-7 in number) for review would be manageable and result in adequate data quantity for assessing program effectiveness and guiding program improvement decisions.

Consistency, validity, objectivity and reliability must all be accounted for. Consistency and validity is addressed by having each project rated against a set of predefined scoring rubrics previously mapped to specific learning outcomes. To maintain objectivity and to avoid the potential for bias, references to student names should be deleted from the projects. Reliability in assessment results may be increased by requiring each project to be rated by two different faculty members, and if possible, these faculty members should be not the faculty members of record who were assigned to teach the capstone course.

Faculty members asked to review the projects rate each artifact based on a pre-defined scale (such as scale of 1-5; 5 being the highest rating) in relation to how well it meets the standards outlined in the accompanying rubrics. Scoring results are then reported. According to Rogers (2003), the percent of students who score at each level should be provided in order to draw direct links between the anticipated or benchmarked and actual outcomes. Summary data should also be provided. In this case, data are categorized and summarized in a weighted average for each specific learning outcome. This is done in two ways. First, an average of the scores for each evaluator for all projects is calculated for each item rated. Table 4 shows an example of how this data is presented. Then the weighted average for both evaluators for each specific learning outcome across all projects is reported. For those learning outcomes which are assessed by more than one artifact, the weighted score is an average across all evaluators, all projects and all artifacts. Table 5 presents a sample worksheet for calculating the final score for a specific learning outcome assessed by multiple artifacts.

Specific Learning Outcome	Artifact	Wt Score*	Rubric
Clearly expresses user requirements for information systems according to standard methodologies.	Use Case Diagram	4.3	Use Case Diagram is complete and correctly drawn using standard UML symbols and is representative of how the system works.
	Use Case Documentation	3.9	Use case documentation is complete for each use case and defines system flow meeting specified system requirements.
<b>SLO Average Weighted Score – all artifacts</b>		<b>4.1</b>	

\*Weighted score is averaged across all projects and evaluators

**Table 5. Sample Weighted Average Calculation Worksheet for Specific Learning Outcome Assessed by Multiple**

**4.3 Data Reporting**

The intent of this assessment is to use the data analysis for program improvement. The results of the capstone project assessment should be reviewed and assessed in a variety of ways. First a comparison should be made between the ratings given for each learning outcome by the two evaluators. Any discrepancy found should be noted and reviewed to identify the potential basis for the discrepancy and how it might be addressed. Next the average weighted score for each specific learning outcome should be reviewed to identify areas of strength and areas of possible weakness. A benchmark or goal for attainment should be identified. This can be stated in percentages or as in this case where a weighted average is used, as a point along the scoring scale. For instance, on a scale of 1-5, one being the lowest, a benchmark goal set in the middle would be 2.5. Benchmark criteria are program independent but it is incumbent upon the program to identify what their minimal level of acceptability in regards to

attainment of learning outcomes must be in order to deem their program as meeting its objectives. Any item which falls below a stated benchmark level should be slated for further review and an action plan for improvement should be devised. Table 6 shows a sample reporting of learning outcomes by weighted score. The fifth listed specific learning outcome falls below a target benchmark of 3.0 and as such an improvement plan is devised as depicted in Table 7. Generally a program improvement plan includes an examination of the learning outcomes in terms of current applicability and value and then an investigation of why students were not achieving expected mastery. This type of investigation often leads to ideas and a course of action to address the problem. The next implementation of the assessment procedure will render information as to whether program improvement in regards to this specific learning outcome has been achieved.

Learning Outcome	Wt Score
<b>GLO: Business Problems and IT Solutions</b>	
SLO: Use a systems approach and systems methods for framing problems.	3.9
SLO: Clearly express user requirements for information systems according to standard methodologies.	4.1
<b>GLO: Team Membership and Leadership</b>	
SLO: Participate as a contributing member to a team developing an information system solution and apply teamwork skills in the development of an IS solution to a business problem.	4.3
SLO: Identify the qualities needed to be an effective leader and explain the roles of leadership and teamwork in developing and implementing information systems.	3.7
<b>GLO: Information systems development</b>	
SLO: Model the conceptual design of an information system using the Unified Modeling Language and demonstrate proficiency in constructing UML models.	2.9

Table 6. Sample Reporting by Weighted Scores

Program Improvement Planning Document
Specific Learning Outcome under Review:
<i>Model the conceptual design of an information system using the Unified Modeling Language and demonstrate proficiency in constructing UML models</i>
Potential Areas for Review:
<ul style="list-style-type: none"> <li>Review learning outcomes and learning objectives in Systems Analysis and Design course offerings</li> <li>Survey faculty knowledge of the Unified Modeling Language</li> <li>Review student access to UML modeling tools</li> </ul>
Potential Actions:
<ul style="list-style-type: none"> <li>Sponsor faculty workshops on the Unified Modeling Language</li> <li>Sponsor student organization presentations on UML modeling tools</li> <li>Construct and post on department web site links to freely available UML tutorials</li> <li>Faculty discussion on incorporation of UML concepts in multiple courses, including introducing the development of simple UML models in the introduction to Information Systems course</li> </ul>

Table 7. Sample Improvement Plan

5. CONCLUSION

Assessment is an integral part of program improvement and an effective assessment plan must include formal processes that adequately evaluate students' attainment of learning

outcomes. These processes should employ multiple techniques and methodologies including direct measures as well as indirect measures. Direct methods provide evidence that a student has attained a certain level of mastery while indirect measures provide information about perceptions of learning (Middle States Commission on Higher Education, 2002). Both measures are needed, because as the Middle States Commission on Higher Education (2002) cites, "one determines whether a student has learned, and the other explains why a student has learned" (pp. 6).

Capstone based assessment is a direct form of evaluation. This process requires the identification of program learning outcomes, establishment of scoring rubrics that are used in the evaluation of project artifacts and mapping of artifacts to specific learning outcomes. Through this type of analysis, program strengths are revealed and program weaknesses are identified. This provides the type of information needed to devise appropriate courses of action that, in turn, result in overall program improvement, program improvement that is directly related to strengthening the attainment of student learning.

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**Appendix I.**

**Example Set of General and Specific Learning Outcomes for a Sample Undergraduate Program in Information Systems**

**General Learning Outcome 1: Theoretical foundations and applications of IT**

*The graduate has a thorough understanding of the theoretical foundations and practical applications of information technology. (Knowledge)*

**Specific Learning Outcomes** - The student is able to:

- 1.1 Define concepts of an information infrastructure and apply strategies and tools for implementing, accessing and using information systems. (Knowledge/skill)
- 1.2 Differentiate and understand the role and function of various current and emerging technologies, including – but not limited to – computer hardware, networking, programming, database and Web technologies. (Knowledge/skill)
- 1.3 Show how an information system is a strategic and integral component of a Global organization. (Knowledge/skill)
- 1.4 Compare and contrast various implementations of the information systems function, such as centralized, distributed and outsourced. (Knowledge)
- 1.5 Match specific classes of application systems – including transaction processing systems, management information systems, decision support systems, and enterprise resource planning systems – to their use in an organization. (Knowledge/skill)
- 1.6 List the stages of technology adoption and assimilation. (Knowledge)
- 1.7 Identify information technology literature and the current topics and issues related to the management of information systems. (Knowledge/skill)

**General Learning Outcome 2: Foundation in business**

*The graduate has a solid foundation in commonly accepted business principles and practices (Knowledge/skill)*

**Specific Learning Outcomes** - The student is able to:

- 2.1 Be able to compare and contrast the information delivered by two information systems with regard to summarization and accuracy of information, time frame and timeliness of information and relevance of information to the recipient. (Knowledge/skill)
- 2.2 Be able to enumerate (suggest) controls that can be incorporated into an information system to ensure or encourage conformance with legal regulations, accounting standards, business policies and business procedures. (Skill/knowledge)
- 2.3 Be able to explain how managers use accounting information to plan operations, control behavior, and make decisions. (Knowledge)
- 2.4 Be able to understand the benefits, costs and limitations of accounting systems. (Knowledge)
- 2.5 Develop and enhance basic knowledge of various managerial problem-solving techniques as well as honing interpersonal, communications, and critical thinking skills. (Knowledge)
- 2.6 Be able to identify current issues in managerial accounting. (Knowledge)
- 2.7 Be able to identify current and emerging management principles and concepts and how they are applied in large and small organizations. (Knowledge/skill)
- 2.8 Be able to explain the dynamics underlying leadership and managerial effectiveness within organized settings. (Knowledge/attitude)
- 2.9 Be able to identify salient aspects of the history, philosophies and language of the field of management as it relates to business environments, strategies and tactics. (Knowledge)
- 2.10 Understand basic global economic principles. (Knowledge)
- 2.11 Differentiate the various aspects and elements of cost. (Skill)
- 2.12 Measure a firm's profit. (Skill)
- 2.13 Calculate marginal revenue and marginal cost. (Skill)

**General Learning Outcome 3: Statistical and mathematical models**

*The graduate has skills in utilizing basic statistical and mathematical models for summarizing and analyzing data. (Skill)*

**Specific Learning Outcomes** - The student is able to:

- 3.1 Use basic statistical and mathematical models to analyze and summarize data. (Skill)
- 3.2 Interpret, analyze, and present data in a form meaningful to management. (Skill/knowledge)

**General Learning Outcome 4: Business problems and IT solutions**

*The graduate is able to recognize, define and analyze real-world business problems, and develop, evaluate and implement information technology solutions to address them. (Knowledge/skill)*

**Specific Learning Outcomes** - The student is able to:

- 4.1 Use a systems approach and systems methods for framing problems. (Skill/knowledge)
- 4.2 Perform problem analysis and identify requirement specifications from written descriptions such as case scenarios. (Skill)



- 4.3 Clearly express user requirements for information systems according to standard methodologies such as Use Case diagrams and corresponding Use Case Documentation. (Skill)
- 4.4 Create and/or justify conceptual designs to satisfy given requirement specifications. (Skill)
- 4.5 Match requirement specifications to technological opportunities and perform benefit/cost tradeoff analyses among design options. (Skill/knowledge)
- 4.6 Implement hardware and/or software designs to provide working solutions, including use of appropriate programming languages, web-based systems and tools, design methodologies, and database systems. (Skill)
- 4.7 Demonstrate the ability to integrate knowledge gained through the curriculum and knowledge base in order to follow the Systems Development Life Cycle from identification and analysis of a business problem to the design and implementation of an information technology solution that utilizes appropriate hardware and software components. (Knowledge)

**General Learning Outcome 5: IT as a system**

*The graduate has a demonstrated comprehension of IT as a system and the integral components of that system including people, processes, hardware, software, communication mechanisms and data. (Knowledge/skill)*

**Specific Learning Outcomes** - The student is able to:

- 5.1 Balance and integrate human and technical aspects of information systems, services, and products. (Knowledge/skill/attitude)
- 5.2 Understand the interplay between people, processes and technologies. (Knowledge/attitude)
- 5.3 Explain in system terms the fundamental characteristics and components of computer and telecommunications hardware and system software and demonstrate how these components interact. (Skill)
- 5.4 Name the three constituents (users, IT Management, Executive Management) of an organization that have a role in information system adoption and implementation and compare and contrast the roles that they play. (Skill/knowledge)
- 5.5 Articulate the organizational and societal impacts of data communications and Internet technologies. (Skill/knowledge)
- 5.6 Describe methods for capturing data/information for the purposes of retaining organizational knowledge. (Skill)
- 5.7 Exhibit fundamental software skills in using common productivity software applications. (Skill)

**General Learning Outcome 6: Information systems development**

*The graduate posses knowledge, skill and technical depth in Information Systems development using appropriate methods, techniques and tools. (Skill/knowledge)*

**Specific Learning Outcomes** - The student is able to:

- 6.1 Analyze the flow and structure of information in user tasks and organizational processes with the appropriate formal tools and methods. (Skill/knowledge)
- 6.2 Model the conceptual design of an information system using the Unified Modeling Language and demonstrate proficiency in constructing Use Case Diagrams, Class Diagrams, Sequence Diagrams and Statechart Diagrams. (Skill)
- 6.3 Develop an application solution based on visual modeling techniques that applies basic database concepts and appropriate programming principles. (Skill)
- 6.4 Illustrate the nature and use of IS development methodologies and explain the responsibilities at all stages of the systems development life cycle. (Knowledge)
- 6.5 Implement hardware and/or software designs to provide working solutions, including use of appropriate programming languages, web-based systems and tools, design methodologies, and database systems. (Skill)

**General Learning Outcome 7: Ethical, social and Global implications**

*The graduate has an awareness of and ability to articulate positions on the ethical, social, and Global implications of IT. (Attitude)*

**Specific Learning Outcomes** - The student is able to:

- 7.1 Develop and defend positions on social, and ethical issues relevant to the roles of IT practitioners and managers. (Attitude)
- 7.2 Explain the use of a professional Code of Ethics to evaluate specific actions of IT practitioners and managers. (Knowledge)
- 7.3 Articulate the roles in ethical decision making that IT practitioners and managers play both within organizations and between organizations participating in the Global economy. (Knowledge)
- 7.4 Present and discuss the professional and ethical responsibilities of IT practitioners and managers. (Knowledge/attitude)
- 7.5 Identify the obligations incumbent upon IT practitioners and managers for protection of individual privacy as well as organizational security in IT systems. (Knowledge)
- 7.6 Compare and contrast the dominant ethical models and articulate the ways in which their own ethical decision making process is driven by these models. (Knowledge/attitude)

**General Learning Outcome 8: Team membership and leadership**

*The graduate has acquired skills as a team contributor to projects, especially IT projects, and is able to assume various roles on a team project, including leadership. (Attitude/skill)*

**Specific Learning Outcomes** - The student is able to:

- 8.1 Understand that information systems projects require collaboration as well as individual effort. (Knowledge/attitude)
- 8.2 Participate as a contributing member to a team developing an information system solution and apply teamwork skills in the development an IS solution to a business problem. (Skill)
- 8.3 Demonstrate acknowledgment of and respect for the different attributes, opinions, and roles of team members. (Attitude)
- 8.4 Identify the qualities needed to be an effective leader and explain the roles of leadership and teamwork in developing and implementing information systems. (Knowledge)

**General Learning Outcome 9: Effective communications**

*The graduate has the ability to effectively communicate – orally, in writing and using symbolic methods and modeling – with both technical and non-technical IT stakeholders. (Skill)*

**Specific Learning Outcomes** - The student is able to:

- 9.1 Research, plan, and develop effective oral presentations and written reports. (Skill)
- 9.2 Evaluate validity of sources, efficiently gather information, and apply problem-solving skills in the development of effective system documentation, white papers, and other written reports. (Skill)
- 9.3 Deliver engaging, organized, and professional presentations. (Skill)
- 9.4 Design and produce electronic content, printed documentation, and system models using standard notations, generally accepted design principles, and effective language. (Skill)
- 9.5 Exhibit professionalism in appearance, presentation time management, and presentation structure (introduction, body and conclusions) when making formal oral presentations. (Skill)
- 9.6 Effectively use multimedia content and supplements in oral presentations. (Skill)

**Appendix II.**

**Assessment of IS Program Learning Outcomes: Mapping of Learning Outcomes, Artifacts and Rubrics**

<b>Artifact</b>	<b>Rubric</b>	<b>Specific Student Learning Outcome (SSLO)</b> <i>*multiple learning outcomes may be mapped to one artifact</i>	<b>Rating (scale of 1-5)</b>
Security/ Privacy Statement	Security and Privacy Statement articulates a plan for dealing with system security and data privacy that is appropriate for the system	SSLO 7.5: Identify the obligations incumbent upon IT practitioners and managers for protection of individual privacy and organizational security in IT systems.	
Planning Form	Planning form includes a comprehensive listing of tasks that represent all phases of the software development life cycle	SSLO 6.4: Illustrate the nature and use of IS development methodologies and explain the responsibilities at all stages of the systems development life cycle.	
Weekly Status Forms	Student weekly status forms demonstrate adequate level of contribution to the project performed	SSLO 8.1: Understand that information systems projects require collaboration as well as individual effort.	
Weekly Status Forms	Student weekly status forms demonstrate student is performing as an active team participant showing cohesiveness, equal distribution of work	SSLO 8.2: Participate as a contributing member to a team developing an information system solution and apply teamwork skills in the development of an IS solution to a business problem.	
Executive Summary	Executive Summary distinctly states the problem and provides a clear description of how the problem is to be solved and that solution is reasonable and appropriate	SSLO 4.1: Use a systems approach and systems methods for framing problems	
Executive Summary	Executive Summary provides a feasible justification for why the problem should be solved.	SSLO 4.5: Match requirement specifications to technological opportunities and perform benefit/cost tradeoff analyses among design options.	
Case Scenario	Case Scenario tells the story of the proposed software application from a user perspective.	SSLO 4.2: Perform problem analysis and identify requirement specifications from written descriptions such as case scenarios.	
Use Case Diagram	Use Case Diagram is complete and correctly drawn using standard UML symbols and is representative of how the system works	SSLO 4.3: Clearly express user requirements for information systems according to standard methodologies. SSLO 4.4: Create and/or justify conceptual designs to satisfy given requirement specifications. SSLO 6.2: Model the conceptual design of an information system using the Unified Modeling Language and demonstrate proficiency in constructing UML models.	
Use Case Documenta-	Use case documentation is complete for each use case and defines system flow meeting	SSLO 4.2: Perform problem analysis and identify requirement specifications from written descriptions	

tion	specified system requirements.	such as case scenarios. SSLO 4.3: Clearly express user requirements for information systems according to standard methodologies.	
Class Diagram	Class diagram is complete and correctly drawn using standard UML symbols and includes proper listing of attributes and methods for each class as well as properly identifies entity, boundary and control classes.	SSLO 4.4: Create and/or justify conceptual designs to satisfy given requirement specifications. SSLO 6.1: Analyze the flow and structure of information in user tasks and organizational processes with the appropriate formal tools and methods. SSLO 6.2: Model the conceptual design of an information system using the Unified Modeling Language and demonstrate proficiency in constructing UML models.	
<b>Artifact</b>	<b>Rubric</b>	<b>Specific Student Learning Outcome (SSLO)</b> <i>*multiple learning outcomes may be mapped to one artifact</i>	<b>Rating (scale of 1-5)</b>
Sequence Diagram	Once sequence diagram is included for each use case and sequence diagrams are correctly drawn using standard UML symbols and adequately show necessary interactions between classes (objects).	SSLO 4.4: Create and/or justify conceptual designs to satisfy given requirement specifications. SSLO 6.1: Analyze the flow and structure of information in user tasks and organizational processes with the appropriate formal tools and methods. SSLO 6.2: Model the conceptual design of an information system using the Unified Modeling Language and demonstrate proficiency in constructing UML models.	
Database Designs	Database model and data dictionary show tables, attributes and relations appropriately identifying primary and foreign keys where needed.	SSLO 6.3: Develop an application solution based on visual modeling techniques that applies basic database concepts and appropriate programming principles.	
System Models Reviewed Together	All UML models explicitly map to the implementation of the final software product.	SSLO 4.4: Create and/or justify conceptual designs to satisfy given requirement specifications. SSLO 6.1: Analyze the flow and structure of information in user tasks and organizational processes with the appropriate formal tools and methods. SSLO 6.3: Develop an application solution based on visual modeling techniques that applies basic database concepts and appropriate programming principles.	
Source Code	Source code is clear, well-structured, readable, properly commented and compiled and executes without major errors (both system and logic).	SSLO 5.7: Exhibit fundamental software skills in using common productivity software applications. SSLO 6.3: Develop an application solution based on visual modeling techniques that applies basic database concepts and appropriate programming principles.	
Source Code	Source code is clearly decomposed into components according to the design represented in the UML models.	SSLO 6.5: Implement hardware and/or software designs to provide working solutions, including use of appropriate programming languages, web-based systems and tools, design methodologies, and database systems.	
Test Plans and Test Log Form	Test plans have been well developed and utilized with many errors identified and corrected.	SSLO 5.6: Describe methods for capturing data/information for the purposes of retaining organizational knowledge.	
User Guide	A well developed users' guide is included.	SSLO 9.2: Evaluate validity of sources, efficiently gather information, and apply problem-solving skills in the development of effective system documentation, white papers, and other written reports.	
Overall Project Documentation	Project documentation is complete, properly formatted, uses correct symbol notation, correct grammar and is reasonably precise.	SSLO 9.1: Research, plan, and develop effective oral presentations and written reports. SSLO 9.2: Evaluate validity of sources, efficiently gather information, and apply problem-solving skills in the development of effective system documentation, white papers, and other written reports. SSLO 9.4: Design and produce electronic content, printed documentation, and system models using	

Artifact	Rubric	Specific Student Learning Outcome (SSLO) <i>*multiple learning outcomes may be mapped to one artifact</i>	Rating (scale of 1-5)
Team Presentation Report	Team members are prepared and demonstrated intimate knowledge of the team project.	SSLO 9.1: Research, plan, and develop effective oral presentations and written reports.	
	Presentation quality is high as demonstrated by supporting materials and each individual presenter's performance.	SSLO 9.3: Deliver engaging, organized, and professional presentations. SSLO 9.5: Exhibit professionalism in appearance, presentation time management, and presentation structure (introduction, body and conclusions) when making formal oral presentations. SSLO 9.6: Effectively use multimedia content and supplements in oral presentations.	
Individual Reports	Reports describe the system, and provide an assessment and evaluation of the development process as well as the team process and report on the contributions made by the individual student.	SSLO 5.6: Describe methods for capturing data/information for the purposes of retaining organizational knowledge. SSLO 8.4: Identify the qualities needed to be an effective leader and explain the roles of leadership and teamwork in developing and implementing information systems.	
Peer Evaluations	Peer evaluations are complete providing a rating for each team member.	SSLO 8.2: Participate as a contributing member to a team developing an information system solution and apply teamwork skills in the development of an IS solution to a business problem. SSLO 8.3: Demonstrate acknowledgment of and respect for the different attributes, opinions, and roles of team members. SSLO 8.4: Identify the qualities needed to be an effective leader and explain the roles of leadership and teamwork in developing and implementing information systems.	
Project Considered in Totality	Project demonstrates that students understand the concepts of an information infrastructure and are able to apply strategies and tools for implementing, accessing and using information systems. Project demonstrates that students have attained the ability to integrate knowledge gained through the curriculum and knowledge base in order to follow the Systems Development Life Cycle from identification and analysis of a business problem to the design and implementation of an information technology solution that utilizes appropriate hardware and software components. Project demonstrates that students are able to implement hardware and/or software designs to provide working solutions, including use of appropriate programming languages, web-based systems and tools, design methodologies, and database systems.	SSLO 1.1: Define concepts of an information infrastructure and apply strategies and tools for implementing, accessing and using information systems. SSLO 4.6: Demonstrate the ability to integrate knowledge gained through the curriculum and knowledge base in order to follow the Systems Development Life Cycle from identification and analysis of a business problem to the design and implementation of an information technology solution that utilizes appropriate hardware and software components. SSLO 6.5: Implement hardware and/or software designs to provide working solutions, including use of appropriate programming languages, web-based systems and tools, design methodologies, and database systems.	



### **STATEMENT OF PEER REVIEW INTEGRITY**

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