Assessing Capstone Experience

Introduction

Capstone experiences can come in many forms (i.e. internship, capstone projects, senior design projects, practicum, and thesis). Regardless of their form, they all serve the purpose of providing opportunities for students to integrate and to apply knowledge that they have acquired throughout their studies.

Capstone experience can be assessed through various methods such as oral presentation, report, poster presentation or display, portfolio, journal, and peer/self review. These assessment methods serve the purpose of assessing students' learning both in terms of generic skills and academic knowledge (e.g. to assess students' development of team-work, interpersonal, and problem-solving skills; and to assess students' development of a capacity for reflective learning) in the capstone experiences that they choose to engage in. Capstone experiences can be used to provide faculty or department information on the strengths and weaknesses of their curricula by assessing and observing students' performance.

Oral Presentation

What is Oral Presentation?

Oral presentation offers students a platform to demonstrate their communication and language skills in presenting information and expressing their knowledge about their design. In addition, students also learn to work as a team because the oral presentation for capstone design projects tends to be conducted in teams. An oral presentation can be facilitated with the use of visual aids such as handouts or PowerPoint slides.

Example

Engineering students at the University of Cambridge are asked to design and build a “mobile robot” or an “Autonomous Guided Vehicle (AGV)” as part of their design project. These mechanical devices consist of electronic circuits and control software. Students working on the project are allocated into teams, where teams are further divided into sub-teams. Below describes a guideline for students’ presentation of a design project proposed by the University of Cambridge (University of Cambridge, 2012).

(a) First Presentation [Team-based] can cover these areas:

- The strategies used in designing and building the AGV or mobile robot (the product)
- The mechanical design/layout of the AGV or mobile robot
- The plans for electrical sensors/interfaces for the product
- The software layout/construction for the AGV or mobile robot (including to mention the ability to detect failures or crashes in a system)
- The job distribution (Who did what during the process of designing and building the AGV or mobile robot?)
- The sketches and cardboard models for the product

Duration: 10 minutes with 5-10 minutes for Q&A

(b) Final Presentation [Sub-team based] can cover these areas:

- A brief review of the overall design strategy of the AGV or mobile robot (the product).

- The sub-team designs for the product
- The problems faced when implementing the design
- The changes made to the original design and the rationale behind those changes
- Any remaining problems regarding the design (optional)
- A brief statement on its likely performance

Duration: 15 minutes with 10 minutes for Q&A

References:

- Harrison, W. (n.d.). Senior Capstone (Computer Science) – Sample slides for the final presentation. Retrieved from http://www.cs.pdx.edu/~warren/Capstone/PAGES/Sample%20Slides%20-%20final%20project.ppt
- University of Cambridge. (2012). 1B Integrated design project 2012 - 2013 Retrieved from http://www.eng.cam.ac.uk/DesignOffice/idp/resources/current/idp_manual.pdf

Report

What is a Report?

Engineering students may be asked to write a progress report or a capstone design report when they participate in a capstone design course. For progress report, the submission may be weekly or monthly depending on the decisions made by the teaching staff. Report writing skills are especially essential for engineering students. As they enter their profession as engineers, they are often required to write up technical reports. Thus it is important to let students gain early exposure to the nature of report writing so that they are well-prepared to write competently and be able to express their understanding and constraints about the design in written form. In addition, students learn to work as a team when writing report. For instance they have to make decision in allocating the work load among team members and they have to accommodate to each others different writing style. Furthermore, transferable skills like the possession of IT skills and the ability to solve problems can be assessed through a report (Curtin University, n.d.).

Example

Mechanical Engineering students completing a capstone design project at Georgia Technical Institute will submit a progress report as part of their assessment. The content of the progress report proposed by Georgia Technical Institute (Georgia Technical Institute, n.d.) includes:

- *An executive summary*: is not equivalent to the introduction. It exists as an independent section of the report and is much like an abstract, which summarizes the key points and findings of the complete report. The contents for the executive summary describe the motivation of the design, the approaches used in the design, and the results. For instance what is the design problem and what are the technical problems.
- *An introduction*: illustrates the design problem and the motivation for the design problem, and discusses about the technical problems and challenges regarding the design.
- *A section regarding "existing products and applicable patents"*: discusses about existing designs developed in the market, or in the process of research and development; documents patent search and its impact on the design, additionally, if there already is an

existing design or design that is similar to the design that the students are making, discuss about the reasons why they continue their design.

- *A section on the specifications of the design*: for instance the identification and description of the users' needs and specifications.
- *A section on the marketing research plans*: for instance it can describe the methodologies such as surveys, focus group interviews, and gathering marketing information through internet resources, studies, and from experts.
- *A section summarizing the accomplishments*: for instance what is still to be done, discuss about the progress and a proposed schedule for completion of the project, which focuses on the challenges and primary dates.
- *Bibliography*: the resources (literatures and electronic materials)
- *Appendices*: the figures, tables, and calculations made.

References:

- Curtin University. (n.d.). Assessment design – Assessment formats. Retrieved from http://otl.curtin.edu.au/local/downloads/assessment/Assessment%20formats.pdf
- Georgia Technical Institute. (n.d.). ME 4182 First progress report and presentation. Retrieved from http://capstone.gatech.edu/wp-content/uploads/2013/Spring%202013/ME4182_First_progress_report%20r9_hl.pdf
- Jackson State University. (n.d.). Capstone design – Engineering progress report. Retrieved from http://jjackson.eng.ua.edu/courses/capstone/lectures/LECT06%20--%20Engineering%20Progress%20Reports.pdf
- Northeastern University. (n.d.). The capstone design course report format. Retrieved from http://www.coe.neu.edu/Groups/mimecap/CourseInformation/Docs/Capstone%20Report%20Format.doc
- Ryerson University. (n.d.). Template for capstone design weekly progress report. Retrieved from http://www.ee.ryerson.ca/capstone/weekly_report_template.docx
- Tennessee State University. (n.d.). Capstone design manual. Retrieved from http://ww2.tnstate.edu/me/Fall09%20Course%20outlines/CAPSTONEDESIGN%20MANUAL.doc

Poster Presentation or Display

What is Poster Presentation or Display?

Poster presentation or display is used as a visual component that facilitates students to present their design to their clients and supervisors orally. Similar to the oral presentation, students have to demonstrate their communication and language skills in delivering their knowledge about the design to their clients and supervisors.

Example

The capstone design project (University of Alberta, 2012) organized in the field of Electrical Engineering is a one-year course (two semesters). Students participating in a capstone design project at the University of Alberta will conduct a poster presentation and other forms of assessment such as presentation and report in their second semester of the course. The areas that are to be covered in a poster presentation may include (based on the example from the University of Alberta):

- *Background*: gives audience information about the problem investigated
- *Objectives*: states the objectives of the designed product
- *Components*: list the items that are used in the design of the product
- *Development*: gives audience information about how the product was designed (the process)
- *Results & Conclusion*: discuss about the possible improvements
- *Acknowledgment*: expresses gratitude towards the clients and sponsors
- *Bibliography*: states the resources that have been used

An authentic example of a poster presentation at the University of Alberta, can be downloaded here (http://www.ece.ualberta.ca/~ee401/projectdata/2010-11/08/08_poster.pdf).

References:

- Everson, K. M. (n.d.). The scientist's guide to poster design. Retrieved from http://www.kmeverson.org/academic-poster-design.html
- Monash University. (n.d.). 4th year projects: Poster presentation. Retrieved from http://www.eng.monash.edu.au/current-students/download/poster-presentation.pdf

- National University of Ireland – Galway. (n.d.). Poster design: Design tips for research poster presentations. Retrieved from http://www.nuigalway.ie/remedi/poster/media/Poster_Design_Manual.pdf
- Purdue University (n.d.). Agricultural and Biological Engineering Capstone – Poster template. Retrieved from https://engineering.purdue.edu/ABE/InfoFor/CurrentStudents/template2013_2.pptx
- University of Alberta. (2012). EE capstone design: ECE490 (fall) and ECE401 (winter) lecture x01 – Academic year: 2012-2013. Retrieved from http://www.ece.ualberta.ca/~ee401/lectures/syllabus2012-13.pdf
- University of California – Santa Barbara. (n.d.). Mechanical engineering capstone student design projects program. Retrieved from http://www.me.ucsb.edu/projects/poster-competition-2013

Portfolio

What is Portfolio?

Portfolio (Blicblau, 2006) contains a collection of work conducted by the students over a time period. Paulson, Paulson, & Meyer (1991: 60) provides a formal definition of portfolio stating that portfolio is "a purposeful collection of student work that exhibits the student's efforts, progress and achievements in one or more areas. The collection must include student participation in selecting contents, the criteria for selection, the criteria for judging merit and evidence of student self-reflection". A portfolio can be paper-based or electronic-based. Electronic-based portfolio can be hosted on platforms such as "Mahara".

Examples

Example 1: The Capstone Project at Swinburne University of Technology

Students pursuing Mechanical, Robotics, and Mechatronics (R&M) conduct a capstone project at Swinburne University of Technology, where portfolio is being implemented as a type of assessment approach in the capstone project (Blicblau, 2006). The content for the portfolio for the capstone project includes the elements presented below.

Portfolio Content	Format	Assessment Form	Submission
Summary of available projects	Paper, electronic, audio-visual	Students "assess" project and select supervisor	A contract is submitted by both student and supervisor
Project proposal	Audi-visual, web based, written	Peer group, independent assessors	At end of specified time span i.e. 10 weeks from project selection.
Written report Journal or conference paper e-poster - web page Electronic A/V presentation A1 size professional poster Computer programs, models, designs, CAD, FEA and 3D physical structures	Paper Electronic-digital Visual Physical model Computer model Oral presentation	Peer group Independent assessors Ranking Numerical	Subject to specific time constraints: All items submitted at the end of semester two but before the commencement of the exam period.

(Accessed from Blicblau, 2006)

Example 2: Introduction to Civil Engineering Design at Massachusetts Institute of Technology

A course on Civil Engineering design introduces Civil Engineering students to techniques, theories, and tools of engineering design, to solve engineering problems creatively, to problems regarding design, and to civil engineering practices. The course covers several design cases with a focus on infrastructures (such as bridges, roads, and buildings). The course introduces a large scale design case, which is subsequently used in the teachings of other design subjects like the capstone design subject (Einstein, n.d.a).

According to Einstein (n.d.b), the content for a portfolio should include:

- Explanation of the design problem and the development of the concepts for the design.
- Sketches or illustrations that depict the design, pictures of the design
- Explanation of the rationale or theories behind the design
- The planning of the design
- Solutions to resolve designing problem and the limitations of the design
- Documentations of the actual implementation of the design for instance prototyping and testing the design, simulations tests, the budget scheme and cost allocation.

References:

- Blicblau, A. S. (2006). *Capstone portfolios for learning and evaluation*. Paper presented at the 2006 AAEE Annual Conference, Auckland, New Zealand.
- Einstein, H. (n.d.a). 1.012 Introduction to Civil Engineering Design, Spring 2002. MIT OpenCourseWare: Massachusetts Institute of Technology. License: Creative Commons BY-NC-SA. Retrieved from http://ocw.mit.edu/courses/civil-and-environmental-engineering/1-012-introduction-to-civil-engineering-design-spring-2002
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- Paulson, F. L., Paulson, P. R., & Meyer, C. A. (1991). What makes a portfolio a portfolio? *Educational Leadership*, *48*(5), 60-63.

Journal

What is Journal?

Journal (or Design Notebook) is used to maintain a timely record of the activities conducted within a capstone course, where students sign, date and document the activities they have done on a daily or a weekly basis (depending on the course requirement). The activities may cover the following contents such as meetings and work with group members, subjects involved in the research, financial sources (regarding funding, budget, expenses), and exploring and discovering engineering problems and ideas (Simon Fraser University, n.d.). The journal can also be utilized by students as a reflective piece of assessment regarding their learning experiences. The dated items within a journal can be presented electronically through the use of blogs (Curtin University, n.d.).

Example

Mechanical Engineering students conducting a capstone course at Stanford University have to maintain an individual design notebook. The design notebook is much like a journal, where students have to sign and date every page of their work as they gradually complete it. Below shows the contents for the design notebook as proposed by Stanford University (Stanford University, n.d.).

The content for the design notebook documents the design process and shall include:

- The alternatives the students made at each step in the design such as what they have chosen or rejected, the calculations performed in the making of the design
- Results from the tests conducted in the making of the design
- Early sketches, outlines and plans for different aspects of the design
- References and notes on related literature such as what are the conclusions the students have made from reading the literature or discussions with field experts.
- Questions, notes, and ideas from team meetings
- A summary of the conversations with the vendors and associates

References:

- Curtin University. (n.d.). Assessment design – Assessment formats. Retrieved from http://otl.curtin.edu.au/local/downloads/assessment/Assessment%20formats.pdf
- Simon Fraser University. (n.d.). Engineering journal guidelines. Retrieved from http://www2.ensc.sfu.ca/~whitmore/courses/ensc305/pdf%20files/Engineering_Journals.pdf
- Stanford University. (n.d.). Design notebook. Retrieved from http://www.stanford.edu/class/me113/cgi-bin/index.php?n=AssignmentsPage.DesignNotebook

Peer/Self Review

What is Peer/Self Review?

Peer Review is an evaluation process conducted among peer members of the team, whereas self review is an evaluation process conducted on yourself. The evaluation is normally conducted using an evaluation form that contains questions and statements related to your own performance and/or the performance of an individual within the team.

Example

The Senior Electrical Engineering Design Project at the University of New Orleans includes a team evaluation form (or peer evaluation form), where students have to evaluate the performances of their team members and themselves on a 4-point scale (University of New Orleans, n.d.). The evaluation form contains questions and statements regarding their performance. Students are rated according to the following aspects:

- Attendance on scheduled class day
- Their contribution to the:
    - weekly progress report
    - project as a whole
    - final presentation
    - final meeting
- Completion of assigned tasks in a timely manner
- Individual's ability to design electrical engineering tasks
- Specific group contributions

References:

- Mills, J. E. (2007). *Multiple assessment strategies for capstone civil engineering class design project*. Paper presented at the 2007 AAEE Annual Conference, Melbourne, Australia.
- University of New Orleans. (n.d.). Team evaluation form. Retrieved from http://www.uno.edu/coe/depts/ee/documents/form_team_evaluation.pdf