Shifting the Program Design Focus: In Preparation for the 4-Year Degree
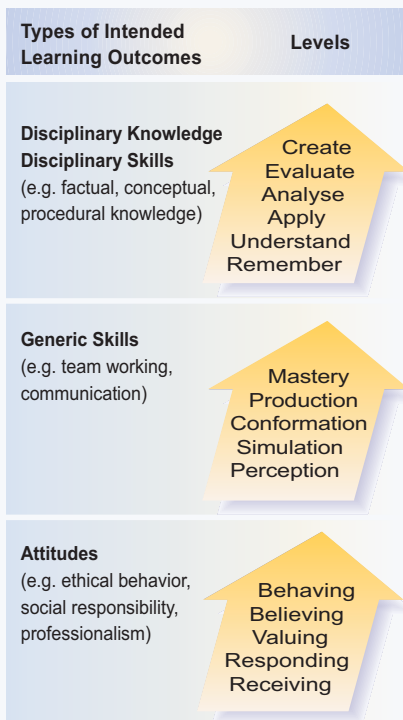
HKUST is on its way to the implementation of a four-year degree. One major implication of this is that some thought is required in planning for the curriculum, courses, and assessments. In this edition, we will look at "Intended Learning Outcomes", including what they are in general terms and in a HKUST context, how assessments can be aligned with intended learning outcomes for the benefit of student learning and development. We will start by going through the types of intended learning outcomes and the desired levels to be achieved by students over a 4-year program. This will be followed by four program document examples from different universities.

Intended Learning Outcomes

The Accreditation Board for Engineering and Technology (ABET) defines the term "outcomes" as follows:

- "Program **outcomes** are statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program".

These are the three types of intended learning outcomes and the levels expected to be achieved by students over a program.

Types of Intended Learning Outcomes	Levels
Disciplinary Knowledge Disciplinary Skills (e.g. factual, conceptual, procedural knowledge)	Create Evaluate Analyse Apply Understand Remember
Generic Skills (e.g. team working, communication)	Mastery Production Conformation Simulation Perception
Attitudes (e.g. ethical behavior, social responsibility, professionalism)	Behaving Believing Valuing Responding Receiving

Now let us take a closer look at the "Disciplinary Knowledge" part by using Bloom's Taxonomy of Cognitive Outcomes and see how the progression can go within a four-year time frame.
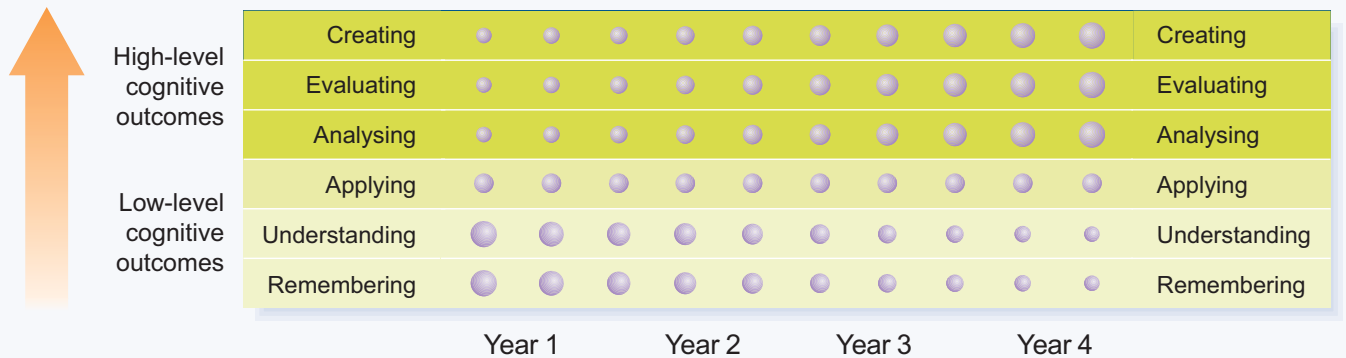
Using Anderson et al's Taxonomy of Cognitive Outcomes as a Framework for the Disciplinary Knowledge of 4-Year Program Design

In **Anderson et al's Taxonomy of Cognitive Outcomes**, different levels of learning are identified. They move from the "simplest to the most advanced". The levels and the related cognitive processes are listed in the table below:

Levels of Learning:	Cognitive Process:
Level 6: Creating	Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure
Level 5: Evaluating	Make judgments based on criteria and standards
Level 4: Analysing	Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose
Level 3: Applying	Carry out or use a procedure in a given situation
Level 2: Understanding	Construct meaning from instructional messages, including oral, written, and graphic communication
Level 1: Remembering	Retrieve relevant knowledge from long-term memory

<The levels of learning and related cognitive processes>

Over the 4-year degree program there should be a broad development trend from lower to higher cognitive outcomes which would look like this:

	Year 1		Year 2		Year 3		Year 4		
Creating									Creating
Evaluating									Evaluating
Analysing									Analysing
Applying									Applying
Understanding									Understanding
Remembering									Remembering

High-level cognitive outcomes

Low-level cognitive outcomes

In the early years, lower level cognitive outcomes, i.e. "Remembering" and "Understanding" are given stronger emphasis. The level moves upwards as the year moves on. Higher level outcomes like "Evaluating" and "Creating" would have more emphasis in later years. It is a curriculum team's responsibility to ensure this development over the program and to make sure the four types of intended learning outcomes are covered.

In the process of writing learning outcomes, the curriculum team would use associated action verbs for different levels of learning. Some verbs are listed in the table for consideration.

Levels of Learning:	Associated Action Verbs:
Level 6: Creating	Hypothesise, Design, Construct, Plan, Invent, Devise
Level 5: Evaluating	Judge, Test, Monitor, Detect, Co-ordinate
Level 4: Analysing	Differentiate, Discriminate, Distinguish, Deconstruct
Level 3: Applying	Use, Execute, Implement
Level 2: Understanding	Clarify, Illustrate, Categorise, Predict, Compare, Contrast
Level 1: Remembering	Recognise, Identify, Define, Retrieve, Recall, Record

<Verbs appropriate to different levels of Anderson et al's Taxonomy>

ABC LIVE at HKUST

At HKUST, program outcomes need to be aligned with HKUST's seven graduate attributes — called **ABC LIVE**:

*A*cademic Excellence

*B*road-based education

*C*ompetencies and capacity building

*L*eadership and teamwork

*I*nternational outlook

*V*ision and an orientation to the future

*E*thical standards and compassion

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Examples of Program Documents

In this part, four assessment documents from different universities for Science, Engineering, Business, and Social Science and Humanities will be discussed. You will see the extracted "Learning outcomes" and "Assessment" in each example. Annotations include the type of learning outcomes and how the assessments align with those learning outcomes.
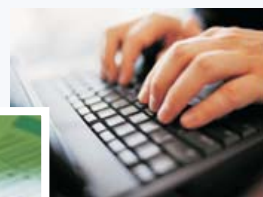
Example for Science

Name of Institute: University of Minnesota
Department: Biology
URL: *http://www.mrs.umn.edu/committees/asl/biology.shtml*

The Biology Department of University of Minnesota uses summative, formative and sustainable assessments to measure students' attainment of learning in different areas. There is a very strong alignment between the intended learning outcomes and the assessments.

Students Learning Outcomes:

1. Students will be able to summarize the major ideas of biology accurately and concisely and to apply these ideas to a variety of organisms and situations.

2. Students will be able to perform successfully a variety of field studies and laboratory experiments.

3. Students will be able to prepare and present clear, cogent, and appropriate talks and papers dealing with a number of biological topics.

Methods of Assessment:

1. Unit or course examinations, term papers
2. Standardized examinations
3. Oral presentations
4. Written lab report and/or poster sessions
5. Senior Seminar
6. Faculty-supervised research project and other research-related activities
7. Portfolio includes lab report and related materials, along with summaries of any additional research experiences

Disciplinary Knowledge

Disciplinary Skills

Disciplinary Skills and Attitudes

Generic Skills

This summative assessment aligns with Learning Outcome 1.

This summative assessment aligns with Learning Outcome 1.

This formative assessment aligns with Learning Outcomes 1, 2 and 3.

This formative assessment aligns with Learning Outcomes 2 and 3.

This sustainable assessment task aligns with Learning Outcomes 1, 2 and 3.

This formative assessment aligns with Learning Outcome 2.

This sustainable assessment task aligns with Learning Outcomes 1, 2 and 3.

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Example for Engineering

Name of Institute: The University of Texas Pan American
College: Science and Engineering
Degree Program: B.S. in Mechanical Engineering
URL: *http://www.ie.utpa.edu/SLOutcomes/Spring06/CoSE/BSMechanicalEnggSpring06.pdf*

This comes from College of Science and Engineering Student Learning Outcomes Plans and Assessment Reports. The Learning Outcomes are in two parts:

1. School Level: Student Learning Outcomes
2. Department Level: Program Specific Outcomes for Mechanical Engineering

In some programs, the alignment between Learning Outcomes and Assessment might not be as clearly mapped as in this one.

School Level

Students Learning Outcomes (for Science and Engineering College) (p.1)

It will be demonstrated that the student:

1. is able to use knowledge of mathematics, basic sciences and engineering to analyze (identify, formulate, and solve) problems in mechanical engineering.

   :
3. is able to design mechanical devices, systems or processes that meet given specification.

   :
5. is able to communicate ideas effectively in graphical, oral and in written media.

   :
6. understand the professional responsibility of an engineer and how engineering solutions impact safety, economics, ethics, politics, societal, cultural and contemporary issues.

Means of Assessment that Aligns with the above Student Learning Outcomes (p.1)

1. Home work; Tests; Pre-test Examination at the end of senior year; Senior design project; Performance on the Fundamentals of Engineering Examination (FE exam).

   :
3. Senior design Project; Building a model; Oral Presentation and written report.

   :
5. Written and oral Presentation of senior design project

   :
6. Senior design project; Engineering Ethics

Side annotations:

- Disciplinary Knowledge
- Disciplinary Skills
- Generic Skills
- Alternative verbs can be used here to make it more specific, e.g. "able to explain".
- Attitudes
- These summative assessments align with Learning Outcome 1.
- These summative assessments align with Learning Outcome 3.
- These summative assessments align with Learning Outcome 5.
- These summative assessments align with Learning Outcome 6.

Department Level

Program Specific Outcomes for Mechanical Engineering (p.4)

It will be demonstrated that the student:

S1. has the knowledge of chemistry and calculus - based physics
with depth in at least one

S2. has the ability to apply advanced mathematics to problems
involving thermal and mechanical systems

S3. has the ability to apply statistics and linear algebra to problems
involving thermal and mechanical systems

Means of Assessment (p.4)

S1. Pretest, Test, Report, and Homework

S2. Home Work; Test; Senior Design

S3. Home Work and Test

Disciplinary Knowledge

Disciplinary Skills

Disciplinary Skills

These formative/ summative assessments align with Learning Outcome S1.

These formative/ summative assessments align with Learning Outcome S2.

These formative/ summative assessments align with Learning Outcome S3.

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Example for Business

Name of Institute: Eastern Oregon University
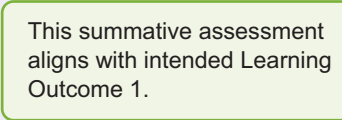**School of Education and Business:** Business Division
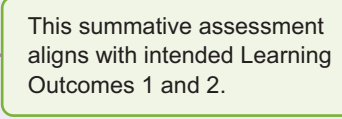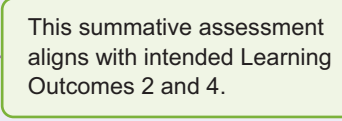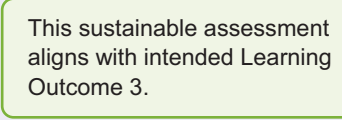**URL:** *http://www.eou.edu/ctl/documents/BUSINESS%20ASSESSMENT%20PLAN.doc*

The alignment between intended learning outcomes and assessments is strongest for intended learning outcomes 1 to 4 and weakest for 5.

Outcomes of the Business Administration Degree Program (p.3)

1. Graduates of the Business Administration degree program will possess an integrated knowledge of the functions and systems of business.

   > Disciplinary Knowledge. "Possess" may be difficult to measure. Cognitive processes such as "summarize" or "infer" could be considered.

2. Graduates of the Business Administration degree program will have developed strong interpersonal and communication skills necessary to succeed in the business environment.

   > Generic Skills

3. Graduates of the Business Administration degree program will have strong technological skills including the use of the Internet, word processing, spreadsheets, and presentation software.

   > Generic Skills and Disciplinary Skills. Depending on what is "used", disciplinary knowledge may be required e.g. subject specific spreadsheets

4. Graduates of the Business Administration degree program will be able to demonstrate the capability of applying business concepts to real world projects.

   > Disciplinary Knowledge. How will students "demonstrate" this? Is this part of an assessment? Can "demonstrate the capability of" be omitted?

5. Graduates of the Business Administration degree program will perform effectively and efficiently in business managerial positions.

   > Attitudes

6. Faculty, administrators, and staff of the business division create an environment that fosters excellence in learning.

   > These are not intended learning outcomes for students.

7. The Business Administration Degree Program provides the necessary education and experiences that enable graduates to be effective leaders in a global business environment.

Student Outcomes Assessment (p.4)

1. **National Exam—Major Fields Test**. Used to assess fundamental knowledge of business concepts. Scores will be compared to the national average. This test will normally be administered in BA 498 Business Policy and Strategy.

   > This summative assessment aligns with intended Learning Outcome 1.

2. **Integrated Case Study.** Used to assess students' ability to integrate knowledge and use it to make decisions and to assess effectiveness as a member of a team. (Scoring rubric Appendix). The case study will be required for BA 498 Business Policy and Strategy.

   > This summative assessment aligns with intended Learning Outcomes 1 and 2.

3. **Senior Project.** To assess students' ability to apply business concepts and the capability of planning and organizing a major task as well as to assess students☐ oral and written communication skills and team skills. (Scoring rubrics Appendix). To take place in BA 490 Senior Project.

   > This summative assessment aligns with intended Learning Outcomes 2 and 4.

4. **Technology Portfolio.** To assess whether students' have advanced technological skills. Assessment will take place in BA 325 Information Management. (Scoring rubric Appendix).

   > This sustainable assessment aligns with intended Learning Outcome 3.

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Example for Humanities and Social Science

Name of Institute: University of Maryland University College
Department: Communication, Arts, and Humanities
Program: Baccalaureate Degree Program in Humanities
URL: *http://www.umuc.edu/outcomes/susplans/HUMS.pdf*

Overall, the alignment between intended learning outcomes and assessments is quite strong for all outcomes except for 1 and 14.

Program Outcomes (p.7):

Upon completion of the Baccalaureate Degree Program in Humanities, graduates will be able to:

1. Use effective oral communication skills to present ideas in both public and interpersonal settings

2. Create written communication appropriate for the purpose and which meets standards of style and grammatical correctness.

3. Write analytical, critical, research-based prose that addresses interdisciplinary issues.

4. Evaluate technological concepts related to computers and components of information systems.

5. Use online resources to locate scholarly articles and other materials for interdisciplinary research.

6. Address recognized research needs by retrieving, evaluating, and using information appropriately.

7. Use primary and secondary sources to conduct interdisciplinary research effectively.

8. Apply mathematical and numerical reasoning skills.

9. Exhibit quantitative skills necessary for analysis and synthesis of quantifiable human experience.

10. Analyze issues across traditional discipline boundaries.

11. Identify key concepts and principles of natural sciences.

> Generic Skills for intended Learning Outcomes 1-10.

> Disciplinary Knowledge, Disciplinary Skills

> Disciplinary Knowledge, Disciplinary Skills

> Disciplinary Knowledge, Disciplinary Skills

> Disciplinary Knowledge, Disciplinary Skills

12. Analyze the influence of science on the development of contemporary Humanities perspectives.

> Disciplinary Knowledge, Disciplinary Skills

13. Demonstrate knowledge of and appreciation for the traditions and major ideas within the sphere of Asian economic, political, cultural, and historical developments.

> Disciplinary Knowledge, Attitudes. How would students "demonstrate" this? Would it be part of an assessment? Consider to use alternative words such as "explain" or "describe".

14. Integrate knowledge of other cultures to respond appropriately to a varietuy of cross-cultural situations.

> Disciplinary Knowledge, Disciplinary Skills, Attitudes

15. Evaluate current events based on chronological knowledge of various historical events, ideas, and individuals.

> Disciplinary Knowledge, Disciplinary Skills

16. Use knowledge of other cultures, politics, ethics, and human rights to positively impact the community, work, or physical environment.

> Disciplinary Knowledge, Disciplinary Skills, Generic Skills, Attitudes

Methods of Assessment (p. 8-11):

1. Research paper

> This summative assessment aligns with Learning Outcome 2.

2. Examinations (Course/Chapter)

> This summative assessment aligns with Learning Outcomes 4, 6, 8, 11 and 15.

3. Essay/writing task

> This formative assessment aligns with Learning Outcomes 3, 5, 7, 9, 10, 12, 13 and 16.

CLI Fifth Round Awarded Projects have Begun!

This is the fifth year of the Continuous Learning and Improvement (CLI) through teaching innovation project. The focus of the fifth round CLI projects is on the improvement of student learning. Research (Biggs 2003) in recent years has shown that to bring about more effective learning, students should be encouraged to adopt a deep learning approach, which can be achieved by such methods as engaging students in authentic learning experience, adopting student-oriented approach in teaching, using appropriate forms of assessments, and setting the students' workload at an appropriate level. In order to evaluate the impact of their teaching innovations on student learning, CLI project leaders are encouraged to make systematic effort to collect solid evidence of improvement in students' performance. Twelve CLI projects have been awarded: one program-level, six course-level and five adaptations.

Here's a quick glimpse of the sub-projects and their main objective:

Program Level

Pilot Courses for Science General Education in the Four-Year University Curriculum, Michael Wong (PHYS)

To develop and offer new joint-department General Education (GEE) based on inter-disciplinary themes.
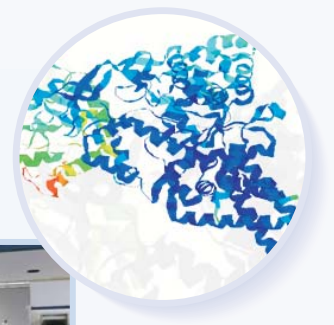
Course Level

Spreadsheet Engineering - The Application of Excel's Macro Programming Language, (Visual Basic for Applications) to Core Courses within Chemical Engineering, John Barford (CENG)

To provide structured teaching of Excel - Visual Basic Application (VBA) in an introductory first year course and application of VBA throughout major core courses during the remainder of the UG degree courses.
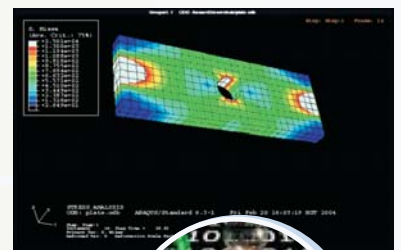
Enhanced Student Learning in Civil Engineering Courses Using CAS Calculators, Thomas Hu (CIVL)

To develop teaching materials using a new solution methodology for engineering problems using a new class of calculators embedded with Computer Algebra Systems (CAS).

Assessment Strategies in Problem-based Learning, Mike So (ISMT)

To develop assessment strategies to align effectively teaching methods and learning outcomes to assessment in problem-base learning.

A Learning-by-Example Learning Module for Programming Courses, James Kwok (ISMT)

To develop an online learning module delivered through LMES to help business school students to learn their first programming language in a more effective way by means of learning-by-example.

Course Level

Biochemical Basis of Parkinson's Disease & the Therapy, Yi Fan Han (BICH)

To develop a 3D animation software package for biochemistry and biology major students to demonstrate the biochemical basis of Parkinson's Disease including the symptoms, pathology and therapy.
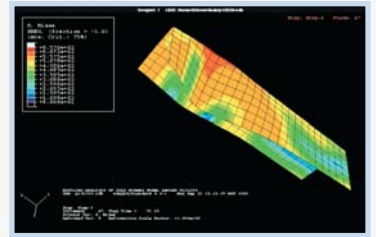
Virtual introduction to Biomolecules and their metabolic intermediates, Robert Ko (BICH)

To offer a step-by-step approach to understanding the structures, properties, and functions of major types of biological molecules.

Adaptations

An adaptation is any attempt to modify or enhance an existing innovation, which could be a teaching aid or method, implemented in any one of the previous CLI projects.

Production of advanced illustrative animations of finite element simulation for teaching in structural mechanics and stress analysis courses, Ricky Lee (MECH)

To generate more advanced illustrative animations of finite element simulation for teaching in structural mechanics and stress analysis courses.

Extending GONG to enable audio podcasting for teacher/learner communication, Jogesh Muppala (COMP)

To adapt the GONG tool to enable bi-directional audio communication between the student and the teacher with the content available as podcast.
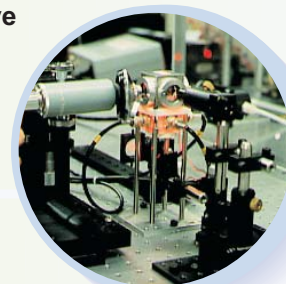

Adapting Gong for LANG208, John Milton (LANG)

To produce a simplified audio recorder that can be incorporated into any web page.

Bioinformatics in Bioengineering: Direct Experience with Interactive Learning, Kathy Luo (CHEM)

To redesign the software and website developed in the original project for students in bioengineering.

Adaption of Podcasting techniques for a postgraduate Computer Science Course, David Rossiter (COMP)

To provide students access to the lecture material via a podcast.

If you are interested to find out more about the projects, please visit *http://celt.ust.hk/cli/*.

Tech Camp 2006 Winter

A new round of **Tech Camp**, aimed at enriching teaching staff's information and communication technology (ICT) skills in a fun and exciting environment, was held again on 11-19 December 2006. With the theme, **Click! Edpedition!**, participants were able to learn a wide range of skills with technologies that support their instruction.

About 40 teaching staff participated in the five mornings and one whole-day session, they learnt techniques in basic image creation and editing, video production, creating interactive presentations, instructional websites and e-portfolio by using built-in tools including MS PowerPoint, MS FrontPage, Adobe Photoshop and Adobe Premiere.

What participants say about Tech Camp?

- "Useful & interesting"

- "It can really provide me more chances to practise."

- "Opportunity to learn more advanced skills, leading to more professional web site design possibilities"

- "The practice session was useful and tailored to our own preferences."

- "Thanks for a good workshop with friendly support from the instruction team."

For more information, please visit *http://celt.ust.hk/instr/MiniTechCamp/home.html*

Recent Events Highlights

- **TA Enhancement Program Spring 2007**: Teaching Assistant Enhancement Program for new or Year 1 TAs at HKUST started on 25 January 2007. For details, please go to *http://celt.ust.hk/ta/*.

- **Tech Camp 2006**: Tech Camp was held from December 11-19, 2006. Learning experience incorporating image editing, video production, creating interactive presentations and building up instructional websites was brought to a group of participants. For more information, please refer to Page 12 of this edition.

- **Seminar: Effects of Problem-based Teaching and Learning Activities on Student Learning**: Conducted by Prof Mike So, ISMT, the seminar was well-received. Please refer to *http://celt.ust.hk/seminar/archive.html* for more information.