The Use of Learning Outcomes in Practice

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Imperial College London
Learning Outcomes: What and Why?

- Statements of what students should know, understand or be able to do as a result of following a course
  - Knowledge and understanding
  - Problem solving
  - Skills: experimental, mathematical, design, practical …
  - Communication, teamwork etc.
- Used in defining levels: e.g. 1\textsuperscript{st} and 2\textsuperscript{nd} cycle level descriptors
- Part of Bologna Process and Qualification Frameworks
- Use in Programme Design & QA methodology
- Intrinsic to paradigm shift from professor centred to student centred approach
Example of use in defining levels: Dublin Descriptors for Second Cycle

- Demonstrated knowledge and understanding that is founded on and extends that of the 1\textsuperscript{st} cycle and that provides a basis for originality in developing ideas in a research context.

- Can apply their knowledge and problem solving ability in new environments within a broader context.

- Have the ability to integrate knowledge and handle complexity, reflecting on social and ethical responsibilities.

- Can communicate conclusions to specialist and non-specialist audiences clearly and unambiguously.

- Have the learning skills to continue study autonomously.
Problems in Using Learning Outcomes in Level Descriptors

• Qualitative not numerical so subject to interpretation
• Ultimately matters of opinion so different QA ‘experts’ may give different answers
• Difficult to test
• Tendency to estimate workload needed to achieve Learning Outcomes → Return to counting ECTS!
• Link between learning outcomes and student workload (and hence ECTS) depends on many factors
  – Ability and motivation of students and teachers
  – Course and module design
  – Teaching methods
  – Resources and amount of support (e.g. tutorials)
European Higher Education Qualifications Framework

• Approved by Ministers in Bergen, May 2005
  – *generic descriptors for each cycle based on learning outcomes and competences, and credit ranges in the first and second cycles*
  – 1<sup>st</sup> Cycle credit range: 180 – 240 ECTS
  – 2<sup>nd</sup> Cycle credit range: 90 – 120 ECTS with minimum of 60 ECTS at the 2<sup>nd</sup> cycle level
  – Learning outcomes consistent with Dublin Descriptors

• Learning outcomes need to be refined for each discipline.

• Some variation allowed from country to country and university to university, consistent with harmonisation and comparability, i.e. not a straight-jacket!

• In Engineering, the EUR-ACE proposals are likely to become the standard set of Learning Outcomes.
Hierarchy of Learning Outcomes

- **Top Level:** “By the end of the degree, graduates should be able to …” – i.e. Dublin Descriptors type statements.

- **Intermediate Level:** “At the end of the year, students should be able to …”

- **Module Level:** “At the end of the module, students should be able to …”. This could be a long and detailed list.

- For each level there should also be a set of AIMS, i.e. general purposes. What are we trying to achieve?

- In contrast, Learning Outcomes are specific learning objectives.

- Some Learning Outcomes are contributed by several modules and perhaps by several years of a programme, i.e. holistic approach.

- In principle have a matrix of competences, learning outcomes and modules.
Content versus Competence is a non-diagonal matrix

<table>
<thead>
<tr>
<th>Content</th>
<th>Knowledge</th>
<th>Analysis &amp; Synthesis</th>
<th>Problem Solving</th>
<th>Computing</th>
<th>Practical Applications</th>
<th>Creativity</th>
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<tbody>
<tr>
<td>Mat1</td>
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<td>10</td>
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Academic Level and Learning Outcomes

• Intended Learning Outcomes give a good indication of competence for performing particular tasks, but:
  – Need to be fairly specific
  – E.g. Able to use time dependent perturbation theory to solve problems in atomic and nuclear physics. But:
    • What kind of problems?
    • How difficult?
  – Need to refer to how assessed, e.g. exam questions.

• How do you add up Learning Outcomes? Quantity is relevant to level. Not as easy as ECTS!

• Problem of “inappropriate” learning outcomes, e.g. excessively detailed knowledge.
Traditional Programme Design

• (Professor)_i → (Course)_i
  – “I will teach them what I know”

• Programme = ∑ (Course)_i

• Leads to content and professor dominated curriculum

• Danger of
  – Content overload and excessive ‘derivations’
  – Obscurity of purpose: “Why are we doing this?”
  – Little increase in competence

• Advantages:
  – Good for producing future professors!!!
  – Produces deep understanding for best students
Design via ‘reverse engineering’ from desired Learning Outcomes

- Start with Objectives expressed as Learning Outcomes
- Define academic level and general competences
- Produce Matrix of competences vs modules
- Define learning outcomes for each module
- Decide how to assess achievement of learning outcomes
- Decide how to integrate (holistic approach) & how to test overall aims
- Advantages:
  - More effective graduates for labour market & research
  - Reduced content and time
Steps in Programme Design Based on Learning Outcomes

- Aims - General Purposes
- General Competences to be developed
- Subject Specific Competences ““ “
- Define Structure in terms of Modules or Units
- Define overall learning outcomes
- Define individual module learning outcomes
- Decide on content of each module (syllabus)
- Decide how they can be assessed
- Monitor results obtained by students
- Iterate above steps to improve!
QAA and Learning Outcomes
(QAA is the English Quality Assurance Agency)

• What do you want the students to achieve by the end of the programme?

• How do the learning outcomes link to the College Mission and Strategic Aims?

• How do the learning outcomes enable the subject benchmarks to be met?

• How do they enable the level descriptors in the Qualifications Framework to be met?

• Programme Specifications must contain learning outcomes and teaching/learning methods
### Example of Programme Specification

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Teaching/Learning Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge &amp; Understanding</td>
<td>Lectures</td>
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<td></td>
<td>Tutorials</td>
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<td>Analysis &amp; Synthesis</td>
<td>Lectures</td>
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<td>Tutorials</td>
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<td>Practical Skills</td>
<td>Laboratory Courses</td>
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<td></td>
<td>Project Work</td>
</tr>
<tr>
<td>Design Skills</td>
<td>Project Work</td>
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</tbody>
</table>
Example 1: Physics, Imperial College London

• 1st Year Mechanics Learning Outcomes (selection)
  – Understand the concept of conservative force and its relation to the potential function
  – Be able to solve single particle motion from a given potential function in two dimensions
  – Be able to use angular momentum and energy conservation in central force problems

• Academic in nature but related to competences
• Can be tested by answers to exam questions
• Problem: How to interpret exam marks
  – Not just “Yes or No” but partial “Yes”
  – Index of “cleverness” or speed of working
Example 2: Business & Finance, Liverpool John Moore’s University (courtesy Beryl Shannon)

• VERY small extract from the full set of Learning Outcomes provided for the students for just one particular module.

• 1\textsuperscript{st} Year Module on Business Mathematics & Statistics
  – Aims:
    • To develop an awareness of the scope and limitations of quantitative analysis
    • (6 other aims)
  – Learning Outcomes: After completing the module, students should be able to
    • Formulate, test and interpret hypotheses using suitable significance tests
    • Undertake regression and time series analysis to provide simple forecast data
    • Produce a statistical report
    • Analyse and present business data using appropriate packages
    • (5 other learning outcomes)
Are Learning Outcomes Helpful?

- Problem of assessing whether or not they are achieved?
  - Exams OK for academic problem solving but not so good for realistic problem solving
  - The difficulty of questions is crucial for standards but is hard to control and interpret
  - Mark Scale: Raw data for testing hypothesis “Has this LO been achieved?” but what is threshold mark?
  - Can pass even if only a sample of LOs have been achieved
  - Practical tasks easier to test
- Can be very helpful for programme design
- Can improve teaching and the output competences of graduates
The Reality!

- Main point of defining and using Learning Outcomes is that they focus the minds of the teachers on what they are trying to achieve in terms of students’ knowledge and competences.
- For students, the main advantage is to make clear what they are supposed to learn and be able to do at the end of the module
  - Helps preparation for exams
  - Helps motivate and produces sense of purpose
- Must be realistic
  - Mainly useful at course design and assessment phases.
  - Students rarely think about them; they just think about getting a good mark in exams.
  - Teachers think about them but then get on with good teaching as before, which has more to do with human relations and personal understanding of difficult concepts.
TC = Teaching Committee
ScSC = Science Studies Committee (or Eng. Stud. Com)
SEQ = Student Evaluative Questionnaire
External References include: Accreditation requirements, national and international discussions on curricula, etc.
The shaded boxes represent the key processes.
Resources allocated to teaching are determined by the Head of Department in consultation with the Director of Studies.
Imperial College - Individual Course Level Processes

TC = Teaching Committee
SSC = Staff-Student Committee
SLEQ = Student Lecturer Evaluation Questionnaire
DUGS = Director of UG Studies
The shaded boxes represent the key processes
Aims -> Design -> Delivery -> Exam -> Results
The key feedback loops are represented by thick arrows
Imperial College - Review Processes

TC = Teaching Committee
DUGS = Director of UG Studies
LOs = Learning Outcomes
USC = Undergraduate Studies Committee
QAA = Quality Assurance Agency
The USC Review involves 3 external experts chosen by IC
The QAA Review involves about 5 external experts chosen by QAA. Both operate on a 5-6 year cycle.
Tuning Survey of Physics Graduates: Highest Ranked General Competencies

Score (max = 4.00)

Competence

Analysis & Synthesis  Problem solving  Capacity to learn  Practical Application  Computing skills  Work autonomously  Creativity  Concern for quality  Will to succeed  Adapting to new situations

Importance
Achievement

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Importance
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Expected advantages of outcomes orientation
(courtesy Gunter Heitman)

1) increase of transparency for different groups,

2) emphasis on student learning,

3) facilitation of recognition and mobility, including recognition of prior and experiential learning,

4) better alignment of teaching, learning and assessment and of education and practice,

5) improvement of quality assurance,

6) increase of accountability
Potential Disadvantages of Outcomes orientation  
(courtesy Gunter Heitman)

1) too detailed regulation of teaching and learning,  
2) thereby loss of a university type of education and study,  
3) additional workload on faculty and administration;  
4) difficulties in implementation,  
5) lack of a shared understanding of the concept and of a common language.
ASIIN (Germany): Minimum content standards for bachelor programs (input requirements)

(courtesy Gunter Heitman)

- Math. and Nat. Sciences: 15 - 25 %
- Engineering specific fundamentals: 15 - 20 %
- Subject related specialisation: 40 - 45% 
- Interdisciplinary components: 10%
- Bachelor thesis (maximum 12 ECTS credits ) and Internship: 5 – 15 %

- Additional specifications are made with regard to subject areas
UK-SPEC Competence Statements
(courtesy Gunter Heitman)

- Using knowledge and understanding to apply and develop technology
- Applying appropriate theoretical and practical methods
- Providing technical and commercial leadership and management
- Demonstrating effective interpersonal skills
- Recognising obligations to society, the profession and the environment
Output Standards of the Eng. Professors Council (UK)
(courtesy Gunter Heitman)

• Defines 26 generic abilities (ability to ...) in 7 groups, which are in the core of engineering:

şiAbility to exercise Key Skills,
şiAbility to transform existing systems into conceptual models,
şiAbility to transform conceptual models into determinable models
Output Standards of the Engineering Professors Council (UK)
(courtesy Gunter Heitman)

4. Ability to use determinable models to obtain system specifications in terms of parametric values,

Ability to select optimum specifications and create physical models,

Ability to apply the results from physical models to create real target systems,

Ability to critically review real target systems and personal performance.
EUR-ACE Programme Outcomes

- Knowledge and Understanding;
- Engineering Analysis;
- Engineering Design;
- Investigations;
- Engineering Practice;
- Transferable Skills,

All 6 outcomes are specified in generic terms for the First and the Second Cycle Degree level.