The role of learning outcomes in the EQANIE accreditation process

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Talk Outline

- What are Learning Outcomes?
- Programme LOs (PLOs) and course Intended LOs (ILOs)
- Competences
- Relationship between PLOs and ILOs
- The Euro-Inf Learning Outcomes
- ILOs, syllabus, teaching/learning activities and assessment
- Example course description (ILOs *etc*)

Learning Outcomes

1. provide a structured mechanism for describing degree programmes for the benefit of:
   - students
   - academic staff
   - employers
   - accreditors
2. are normally defined at two levels:
   - programme level - Programme Learning Outcomes (PLOs)
   - course (module) level - Intended Learning Outcomes (ILOs)
3. should be expressed in terms of
   - knowledge
   - competences (skills)

   i.e. what the student should (a) know and (b) be able to do at the end of the programme or course

Competences

- Learning outcomes should be expressed using competence words
  - examples are:
    - state (*e.g.* facts)
    - describe (*e.g.* systems)
    - discuss (*e.g.* facts, systems, techniques)
    - explain (*e.g.* concepts)
    - compare/contrast
    - derive (*e.g.* equations, formulae)
    - design (*e.g.* systems, programs)
    - solve (*e.g.* problems, equations)
    - use (*e.g.* tools, techniques)
- Note the absence of the academically popular word understand
  - How can understanding be assessed?

Understanding

- The UK Engineering Council in

  "The Accreditation of Higher Education Programmes"

  defines understanding as

  "the capacity to use concepts creatively, for example, in problem solving, in design, in explanations and in diagnosis."
- Using this definition, the use of the word understanding becomes acceptable within Programme Learning Outcomes, provided the Course/Module Learning Outcomes elaborate and support this with outcomes such as solve, design, explain, *etc.*
- *i.e.* provided we use understanding at the higher level as an abstraction of directly assessable outcomes at the lower level.

Mapping ILOs to PLOs

	Course A	Course B	Course C	Course D	Course E
PLO 1	x		x		
PLO 2			x		
PLO 3		x			x
PLO 4	x				
PLO 5		x		x	

The Euro-Inf Learning Outcomes - 1^{st} Cycle

- **Underlying Conceptual Basis for Informatics**
  - knowledge and understanding of the key aspects and concepts of their informatics discipline, including some at the forefront
  - an awareness of the wider spectrum of informatics disciplines
- **Analysis, Design and Implementation** - *e.g.*
  - understanding the complexity of informatics problems and the feasibility of their solution
  - select and use relevant analytic and modelling methods
  - describe a solution at an abstract level
  - apply knowledge and understanding to the design of hardware and/or software to meet requirements
  - select and use of appropriate process models and programming environments
  - creation and thorough testing of software systems

The Euro-Inf Learning Outcomes - 1^{st} Cycle

- **Technological and Methodological Skills**
  - an ability to combine theory and practice to complete informatics tasks
  - an ability to undertake literature searches and to use data bases and other sources of information
  - an ability to design and conduct appropriate practical investigations (*e.g.* of system performance), to interpret data and draw conclusions
  - awareness of relevant state-of-the-art technologies and their application
  - recognition of the need for, and engagement in, life-long learning

The Euro-Inf Learning Outcomes - 1st Cycle

- **Other Professional Competences** - *e.g.*
  - an ability to complete tasks from different application areas, taking into account technical, economic and social context
  - consideration of the economic, social, ethical (incl. professional codes of conduct) and legal conditions in informatics practice
  - an awareness of project management and business practices, *e.g.* risk and change management and their limitations
  - an ability to function effectively in a team
    - typically assessed in a software engineering group project
  - an ability to function effectively as an individual
  - an ability to organise their own work independently
  - an ability to communicate effectively
    typically assessed via an individual practical project, written up as a final dissertation and with a presentation

The Euro-Inf Learning Outcomes - 2^{nd} Cycle

- **Underlying Conceptual Basis for Informatics**
  - deep knowledge and understanding of the principles of informatics
  - either a deepened knowledge of a chosen specialisation or broadened knowledge of informatics in general
  - critical awareness of topics at the forefront of their specialisation
- **Analysis, Design and Implementation**
  - specification and completion of informatics tasks that are complex, incompletely defined or unfamiliar
  - formulation and solution of problems including in new and emerging areas of their discipline
  - application of the state of the art or innovative methods in problem solving, possibly involving use of other disciplines
  - an ability to think creatively to develop new and original approaches and methods

The Euro-Inf Learning Outcomes - 2nd Cycle

- **Technological and Methodological Skills**
  - integration of knowledge from different disciplines
  - comprehensive understanding of applicable techniques and methods for a particular specialisation, and of their limitations
  - awareness of the limits of today's knowledge and the practical application of the state-of-the-art technology
  - knowledge and understanding of informatics to create information models, complex systems and processes
  - ability to contribute to the further development of informatics
- **Other Professional Competences**
  - independent work in their professional field
  - effective communication skills, possibly also in international contexts
  - an ability to apply project management and business practices, *e.g.* risk and change management

ILOs, Syllabus, Teaching and Learning Activities & Assessment

- In each course/module, the syllabus, teaching and learning activities, and assessment tasks should support the achievement of the Intended Learning Outcomes.
  - the syllabus should identify the material that students will need to know about to achieve the learning outcomes
  - the teaching and learning activities should support the students in learning and applying the material in the syllabus
  - the assessment should provide reliable measures of the students' level of achievement of the learning outcomes
- ILOs should not be so numerous and detailed that they cannot all be assessed but not so few and vague as to be meaningless

Example Course: Parallel Architectures

ILOs

After completing the course successfully, students should be able:

1. to describe the various forms of parallelism found in modern computer systems and the techniques used
   - 1.1 to ensure that programs are executed correctly by parallel hardware
   - 1.2 to maximise performance
2. to assess the effectiveness of techniques used to enhance the performance of computer systems
3. to use simulation models of computer systems to investigate their operation and performance
4. to record observations of on-line experiments, present this information in different formats and draw conclusions from it

Example Course: Parallel Architectures

Syllabus

- Introduction
  - Parallelism and Performance, Parallelism in Software
- Uniprocessor Parallelism
  - Parallel Function Units, Simulation Models, Vector & SIMD Instructions, Superscalar and VLIW processors
- Interconnection networks
  - Routing Functions, Static Networks, Dynamic Networks, Combining Networks
- Multiprocessor & Multicomputer Systems
  - Shared Memory Systems, Directory-based Coherence Protocols, Memory Consistency, NUMA Systems, Message Passing Systems
- Performance & Scalability
  - Performance Metrics, Scalability

Example Course: Parallel Architectures

- **Teaching & Learning Activities**
  - Lectures (20 hours)
  - Assignments (25 hours)
    - Use of a uniprocessor simulation model
    - Interconnection network exercise (paper & pencil)
    - Use of cache consistency protocol simulation models
  - Private Study/Other (55 hours)
- **Assessment**
  - Examination 75%
  - Assignments 25%

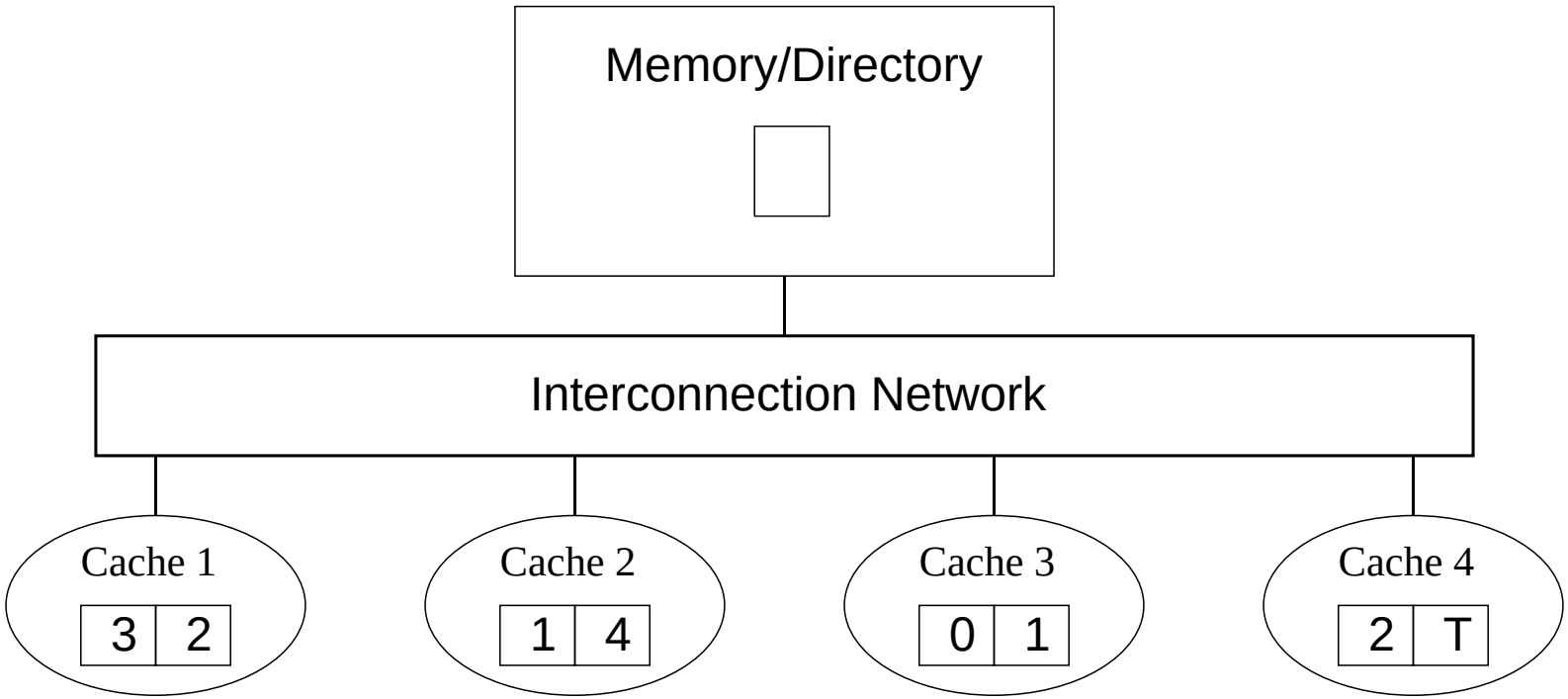
Example Course: Parallel Architectures

- **Sample Examination Question**
  - Compare and contrast *central directory* and *distributed directory* cache coherence protocols.
  - The figure shows the state of the directories for a particular cache line in a distributed directory system that uses the SCI (Invalidate) protocol. 0 = Head of the list, T = Tail.

    List the sequence of events that occur when Cache 2 receives a write request for this cache from its processor. Your list should identify the packets that are sent between the caches and the memory, and should explain the purpose and meaning of each of them.

Example Course: Parallel Architectures

- **Sample Examination Question - Figure**



Reminder: Example mapping to Euro-Inf LOs

2	**Analysis, Design and Implementation**		
	Euro-Inf Learning Outcomes	**Module** contributing to the achievement of the LO	
	Graduates having completed a First Cycle degree should have demonstrated the following capabilities:	Module Title 1	Module Title 2
2.4	formalisation and specification of real-world problems whose solution involves the use of informatics	Requirement Analysis	System Analysis
2.5	understanding the complexity of informatics problems and the feasibility of their solution	Module „Algorithms and Data Structures“	Computational Theory