Welcome to *Better Engineers with CDIO* workshop!

Turku, 2.8.2012

Dr. Juha Kontio
Dean
Faculty of Telecommunication and e-Business

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Agenda

Part 1: more about CDIO

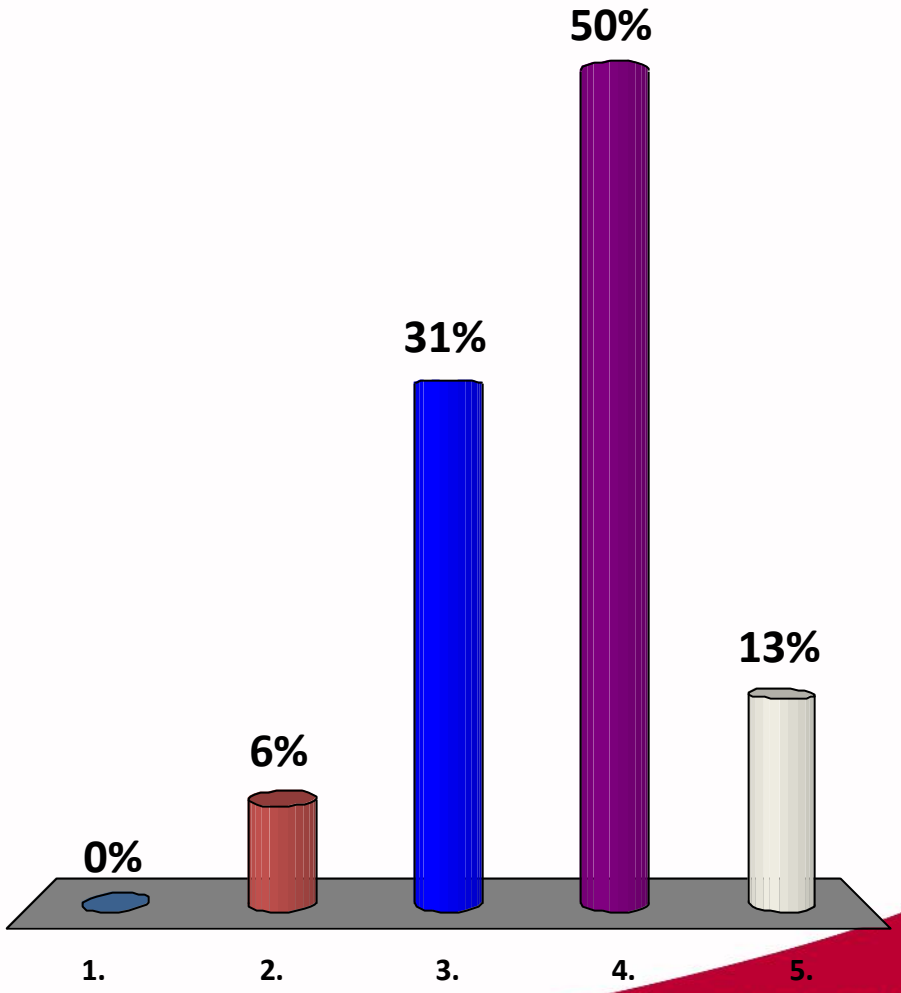
Around 10:00 Coffee break

Part 2: CDIO standards and evaluation

11:30 Workshop ends
11:40 Keynote presentation

Let’s make teams

1. Rectors
2. Deans
3. Program heads
4. Teachers
5. Others



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Warm-up

- Think by yourself, what are the biggest challenges in our program/faculty/university?
  - Make some notes
- Discuss with your neighborough the challenges that you identified ja try to find the key challenge
- Let’s share the challenges to all
- …are there tools/methods to answer these challenges?

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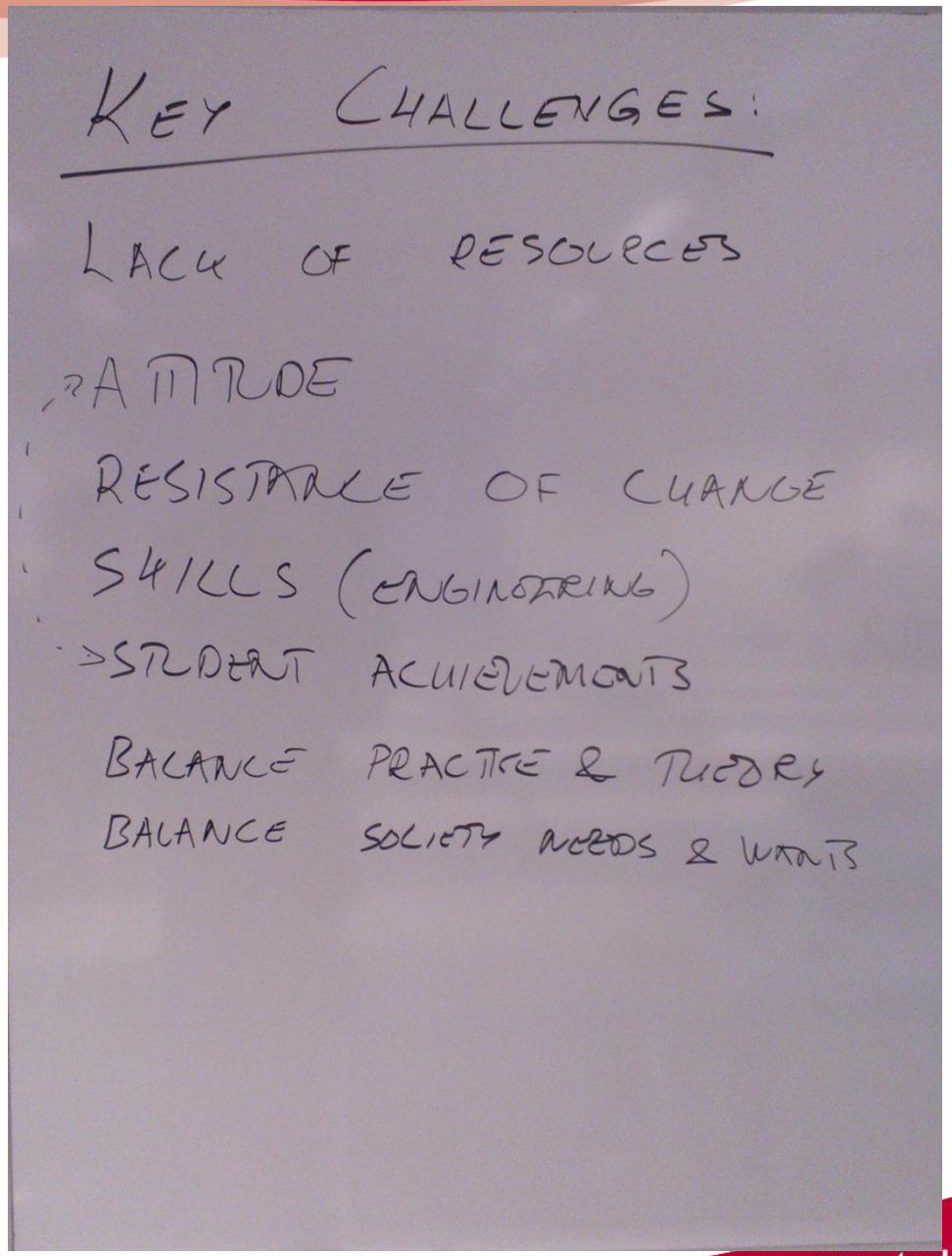
Identified key challenges by the workshop participants



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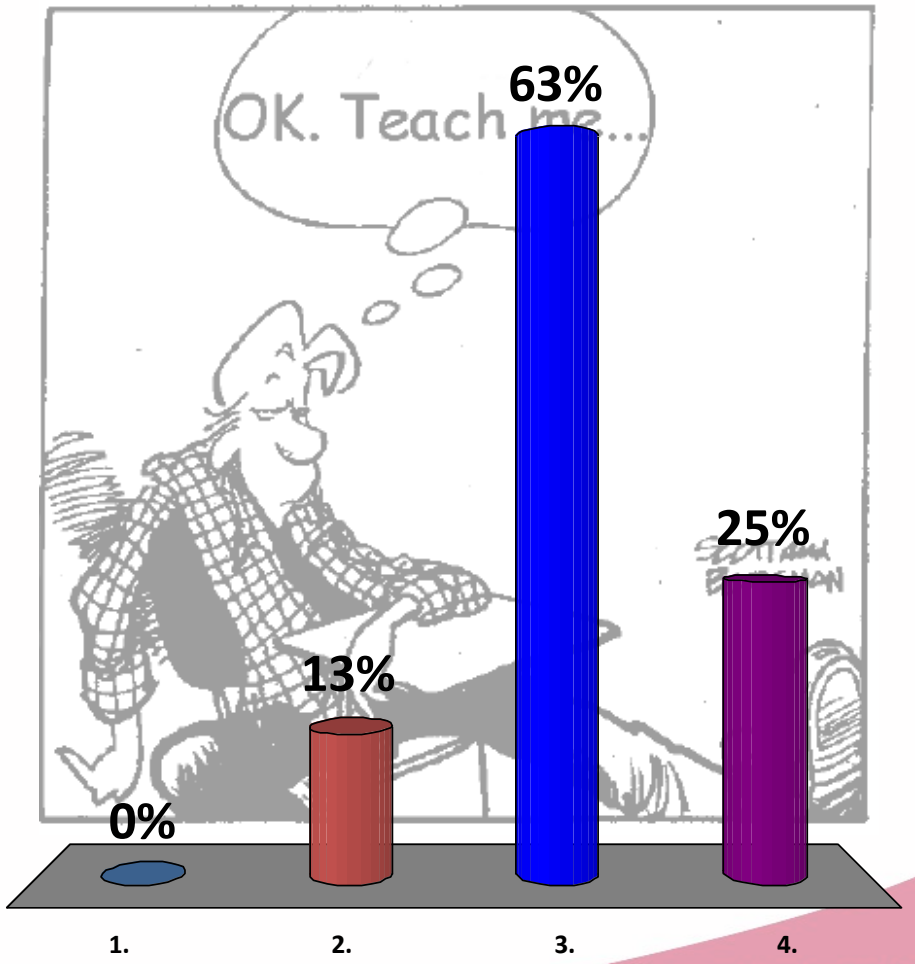
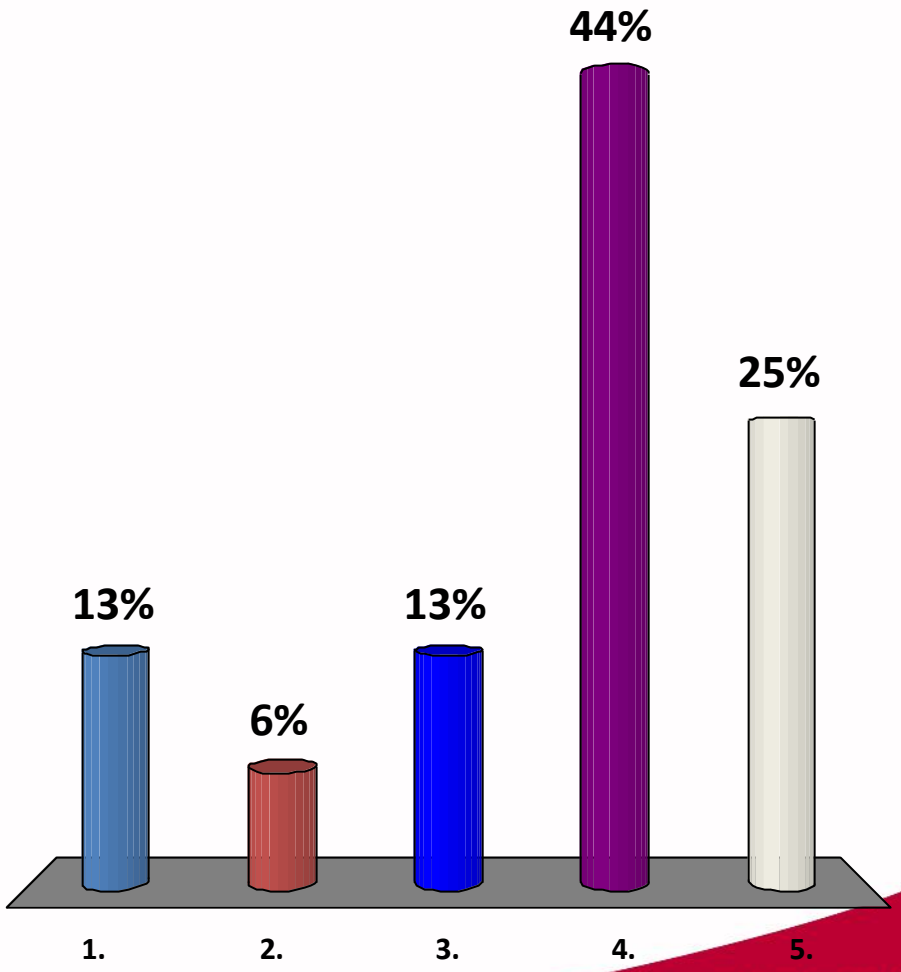
What is happening here?

1. Student becomes an expert
2. Student has active role in learning
3. An important lecture is beginning
4. Student and teacher has agreed on something



According to Glasser most people learn _____ % of what they explain to someone else?

1. 55
2. 65
3. 75
4. 85
5. 95 ✓



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To effective learning….

Several studies (Biggs, 1999) have shown that there is strong correlation between
- **extent of activity** and
- **efficiency of learning**

The 2 key factors that underpin effective learning are (Gibbs, 1982):
- **the learner activity**
- **interaction with others**

Glasser (Biggs, 1999) suggests that most people learn:
10 % of what they read
20 % of what they hear
30 % of what they see
50 % of what they see and hear
70 % of what they **talk over with others**
80 % of what they **use and do in real life**
95 % of what they **explain to someone else**

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Importance of Engaging Learners

"The teacher's fundamental task is **to get students to engage in learning activities** that are likely to result in their achieving the desired outcomes.

Remember that **what the student does is actually more important** in determining what is learned than what the teacher does."

-- Thomas J. Shuell

"I never try to teach my students anything

I only try to create an environment in which they can learn"

-- Albert Einstein

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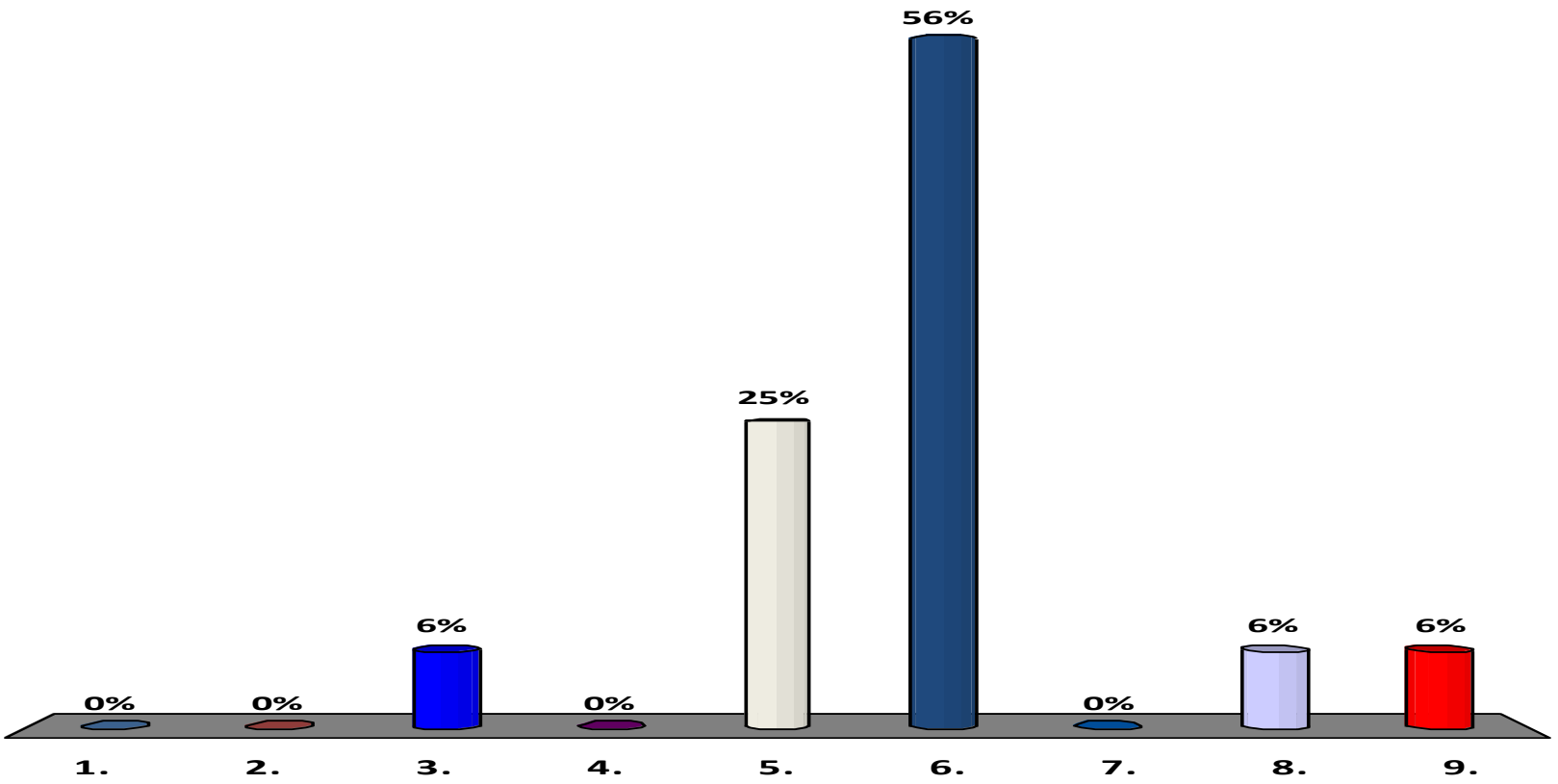
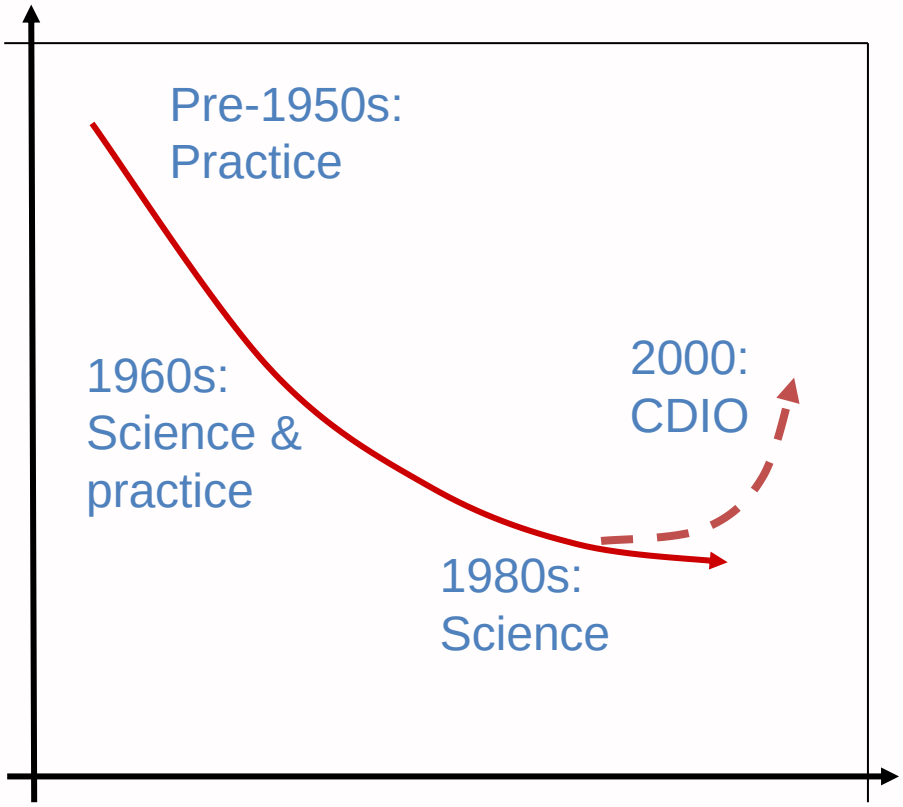
Which field corresponds to your program at the moment?



DEVELOPMENT OF ENGINEERING EDUCATION

Personal, Interpersonal and System Building



Disciplinary Knowledge

Engineers need *both* dimensions, and we need to develop education that delivers both

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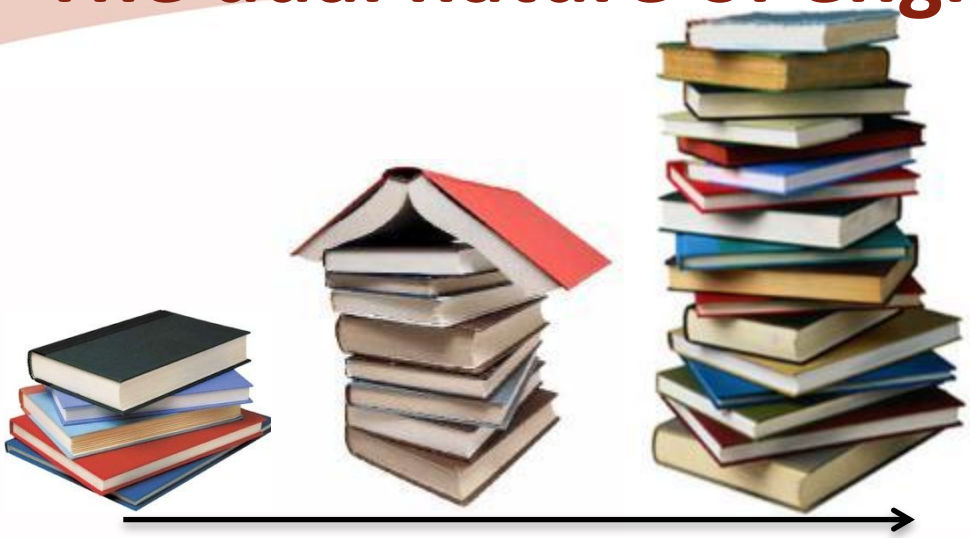
The dual nature of engineering education



Acquisition of technical knowledge

Development of engineering skills

Integrated development of

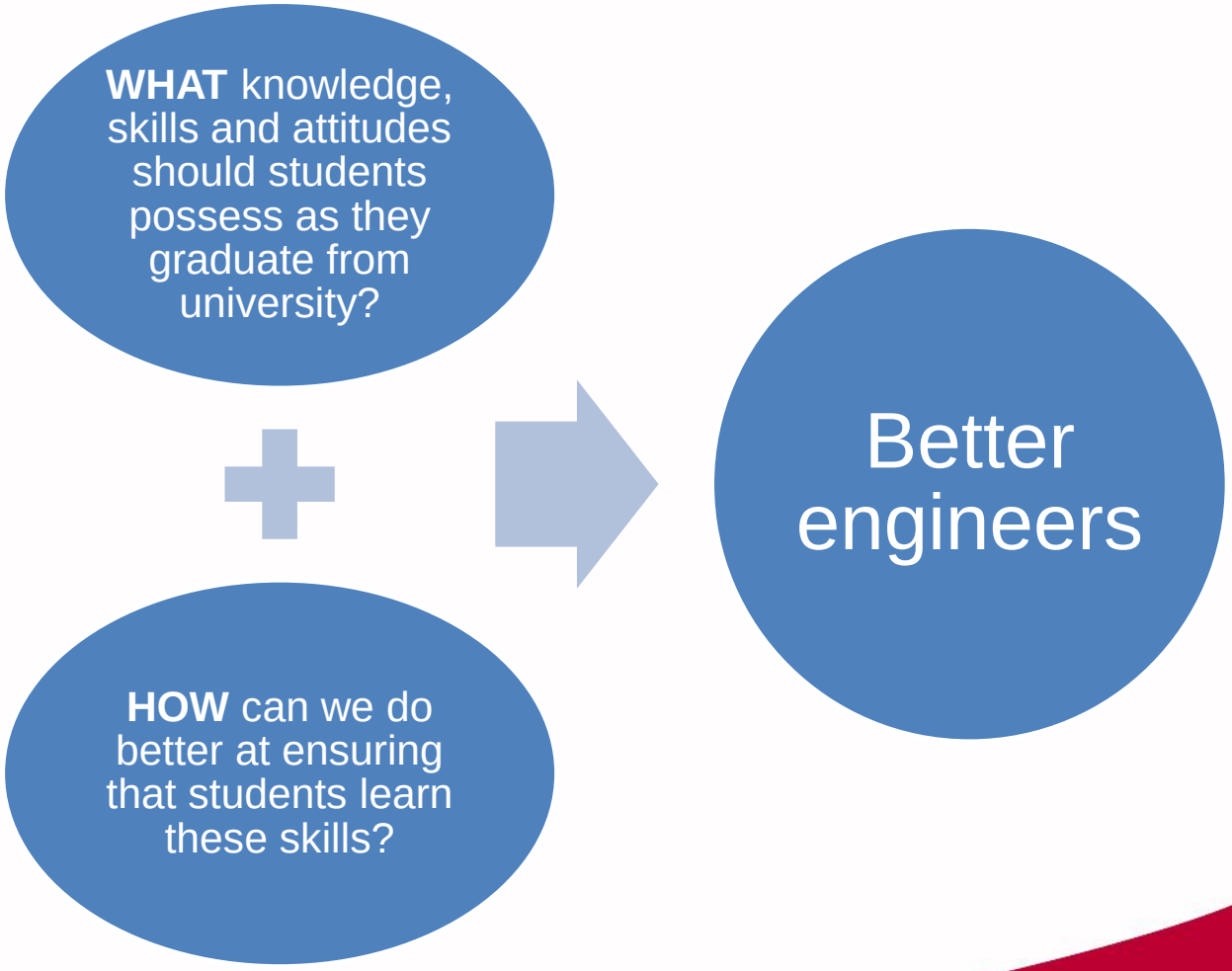
technical knowledge

&

engineering skills

…in meaningful relationship

Central Questions for Engineering Education



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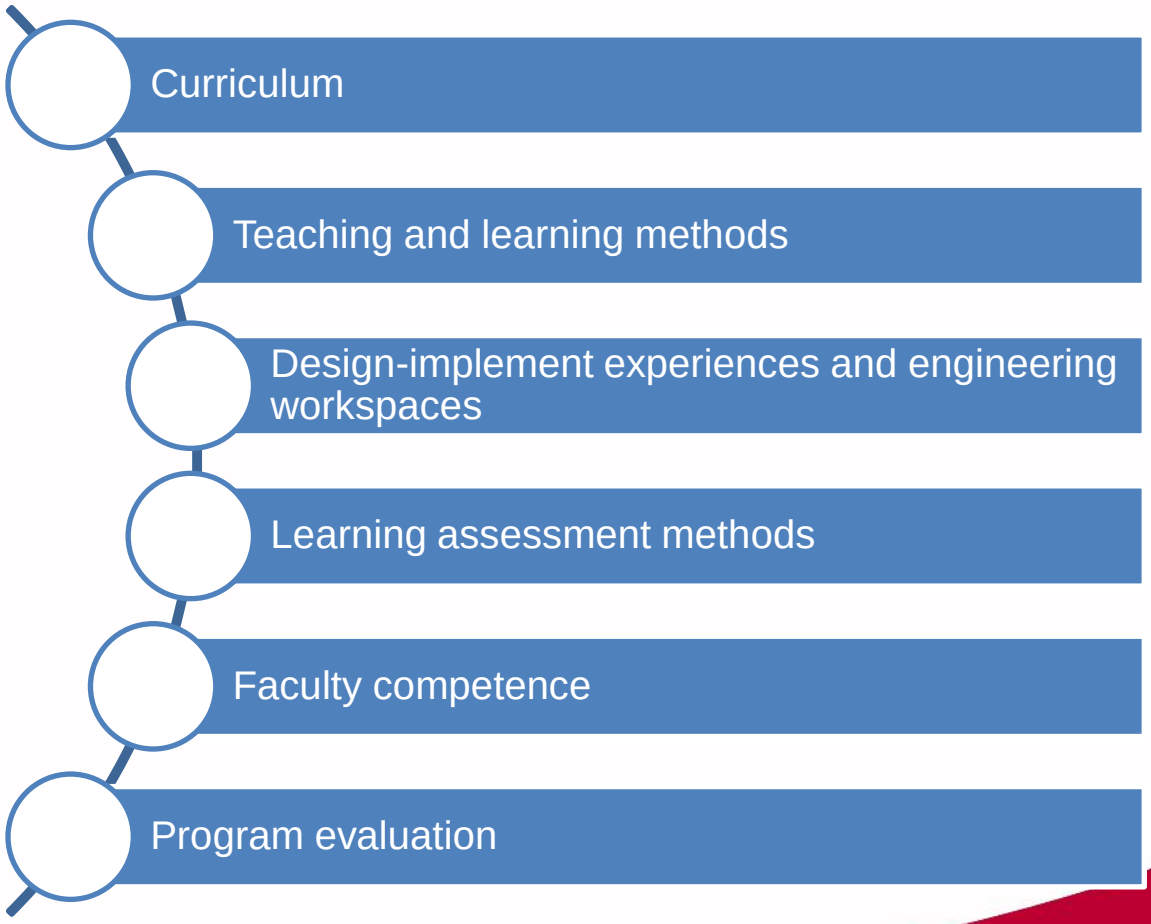
How Can We Do Better?

Retask current assets and resources in:



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CDIO is an approach to improving engineering education

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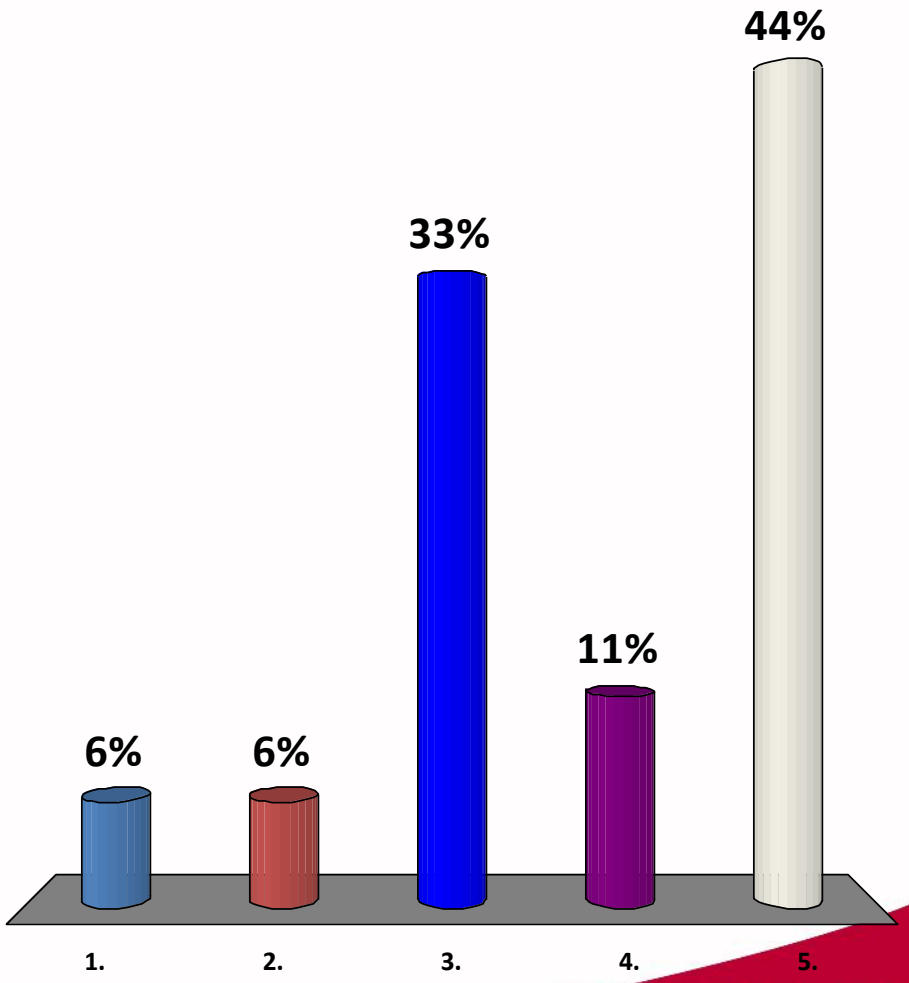
The CDIO initiative has several collaborating universities. How many?

1. <40
2. 41- 55
3. 56 - 70
4. 71 - 85
5. ✓ >85



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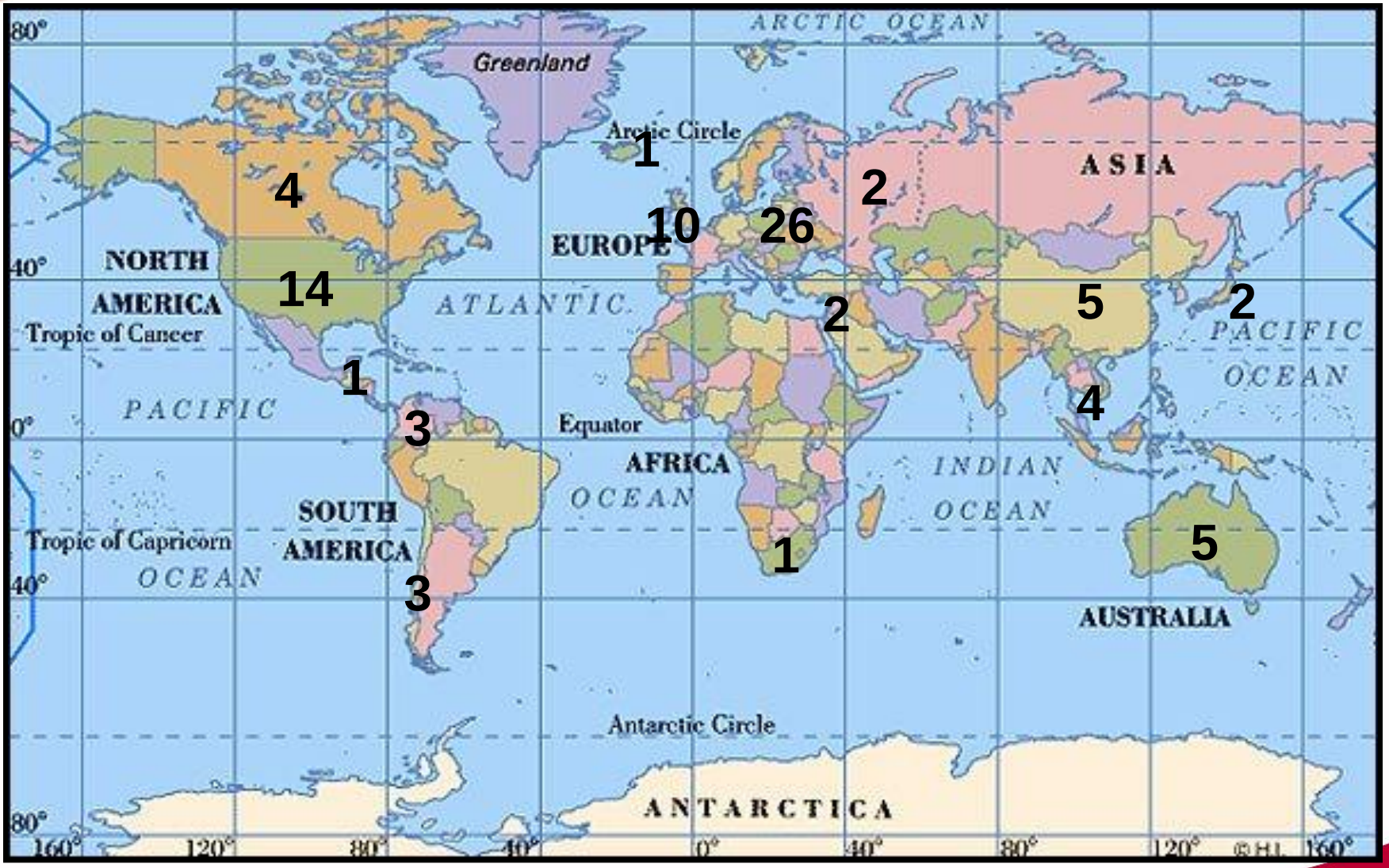
CDIO Collaborators - as of 17 May 2012



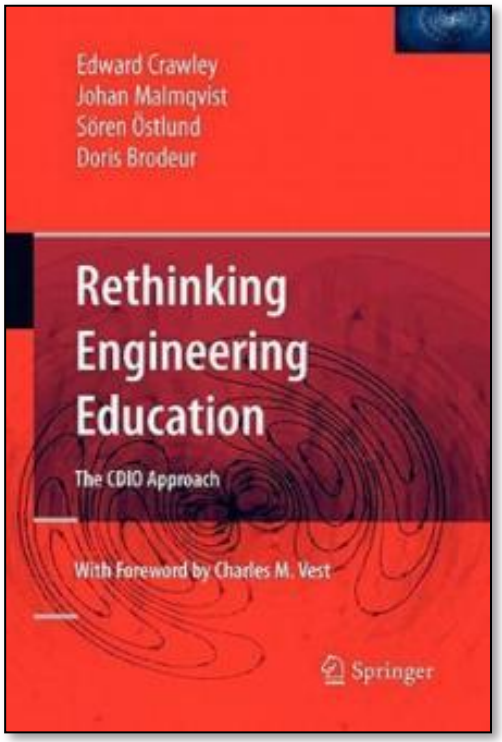
(N = 83)

CDIO partners

- Aalborg University, Denmark
- AFEKA Tel Aviv Academic College of Engineering , Israel
- Arizona State University, US
- Aston University, UK
- Australasian Association for Engineering Education, Australia
- Beijing Jiaotong University, China
- California State University, US
- Chalmers University of Technology, Sweden
- Chengdu University of Information Technology , China
- Chisholm Institute, Melbourne
- Daniel Webster College, US
- Delft University, Netherlands
- Duke University, US
- École Polytechnique de Montréal, Canada
- Embry-Riddle University
- Engineering College of Aarhus, Denmark
- Gdansk University of Technology , Poland
- Group T - International University College Leuven, Belgium
- Hochschule Wismar, Germany
- Hogeschool Gent, Belgium
- Instituto Superior de Engenharia do Porto, Portugal
- Jönköping University, Sweden
- Kanazawa Technical College, Japan
- Kemi-Tornio UAS
- KTH Royal Institute of Technology, Sweden
- Lancaster University, UK
- Lahti AMK
- LASPAU: Academic and Professional Programs for the Americas, US
- Linköping University, Sweden
- Massachusetts Institute of Technology, US
- Metropolia AMK
- Nanyang Polytechnic, Singapore
- Pennsylvania State University, US
- Polytecnico di Milano, Italy
- Pontificia Universidad Javeriana, Colombia
- Purdue University, US
- Queen's University, Canada
- Queen's University, Belfast, UK
- Queensland University of Technology, Australia
- Qinggong College, Hebei United University, China
- RWTH Aachen, Germany
- Savonia University of Applied Science, Finland
- School of Engineering at Taylor's University College, Malaysia
- Seinäjoen AMK
- SCE Shamoon College of Engineering, Ashdod & Beer-Sheva, Israel
- Shantou University, China
- Singapore Polytechnic, Singapore
- Stanford University, USA
- Taylor's University College, Malaysia
- Technical University of Denmark, Denmark
- Telecom Bretagne, France
- Tomsk Polytechnic University, Russia
- Tsinghua University, China
- Turun AMK
- Umeå University, Sweden
- UNITEC Laureate International Universities, Honduras
- US Naval Academy, Annapolis, MD
- US Naval Postgraduate School, Monterey, CA
- Universidad Católica de la Santísima Concepción, Chile
- Universidad de Chile, Chile
- Universidad de Santiago de Chile, Chile
- Universidad Nacional de Colombia, Bogota
- Universitat Politècnica de Catalunya, Spain
- University of Auckland, New Zealand
- University of Bristol, UK
- University of Calgary, Canada
- University of Colorado, US
- University of Leeds, UK
- University of Leicester, UK
- University of Liverpool, UK
- University of Manitoba, Canada
- University of Notre Dame-College of Engineering, US
- University of Michigan, US
- University of Pretoria, South Africa
- University of Strathclyde, UK
- University of Sydney, Australia
- Vietnam National University, Vietnam

the newest ones still missing

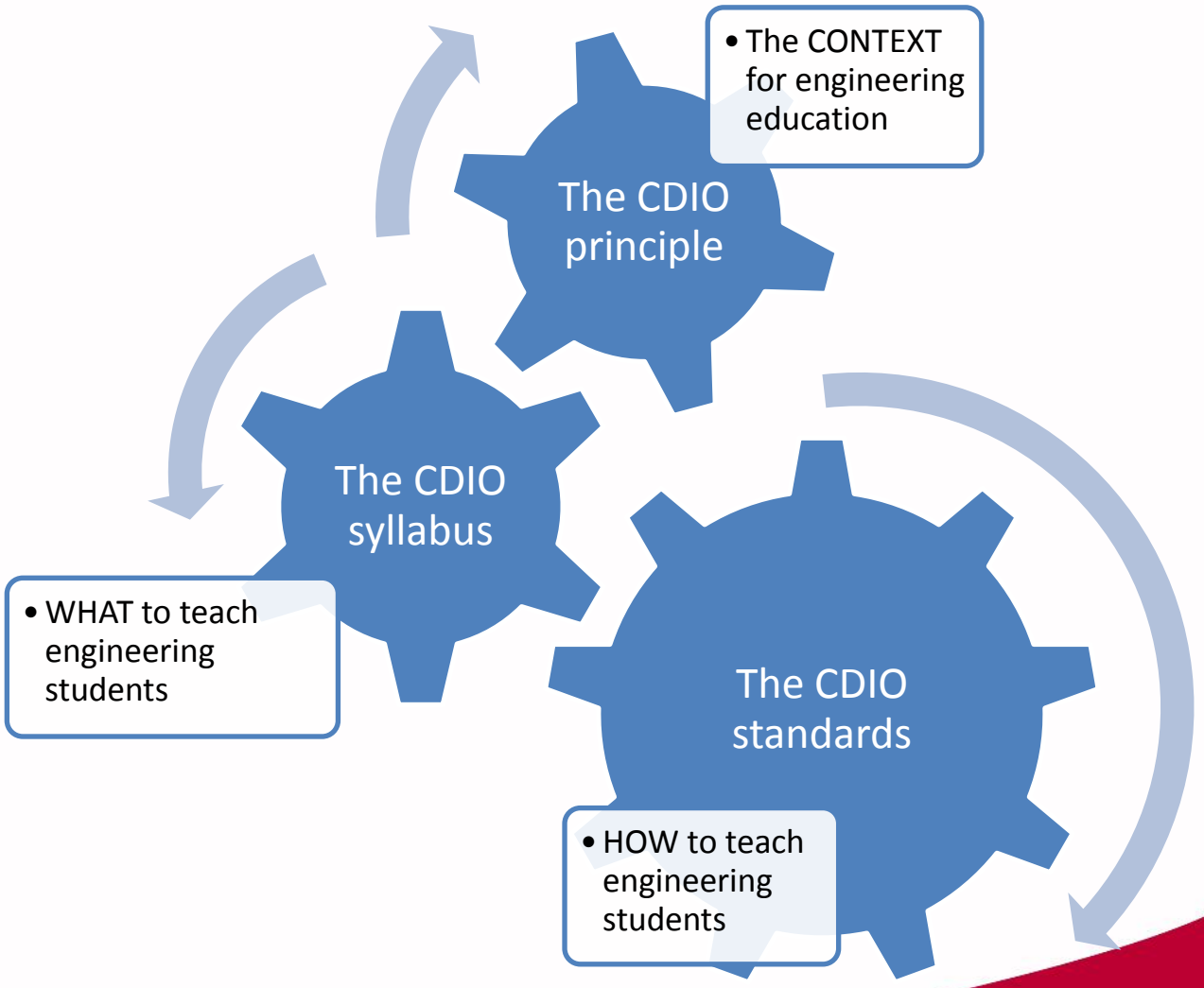
Meet the CDIO community



- **8th International CDIO Conference**
  July 2-5, 2012, Brisbane, Australia
- **Finnish meeting**
  Kemi, September 20th, 2012
- **Fall International CDIO meeting**
  October 22 – 26, 2012, Télécom Bretagne, Brest, France
- **European CDIO meeting**
  January 17-18, 2013, Aarhus School of Engineering, Denmark
- **9th International CDIO Conference**
  June 2013, MIT/Harvard, Cambridge, MA, USA
- **Fall International CDIO meeting**
  Oct 2013, Taylor's College, Malaysia
- **10th International CDIO Conference**
  June 2014, UPC, Barcelona, Spain

- Crawley et al. (2007) *Rethinking Engineering Education: The CDIO Approach,* Springer Verlag. ISBN 0387382879 (2nd edition coming soon)

Main elements of the CDIO approach



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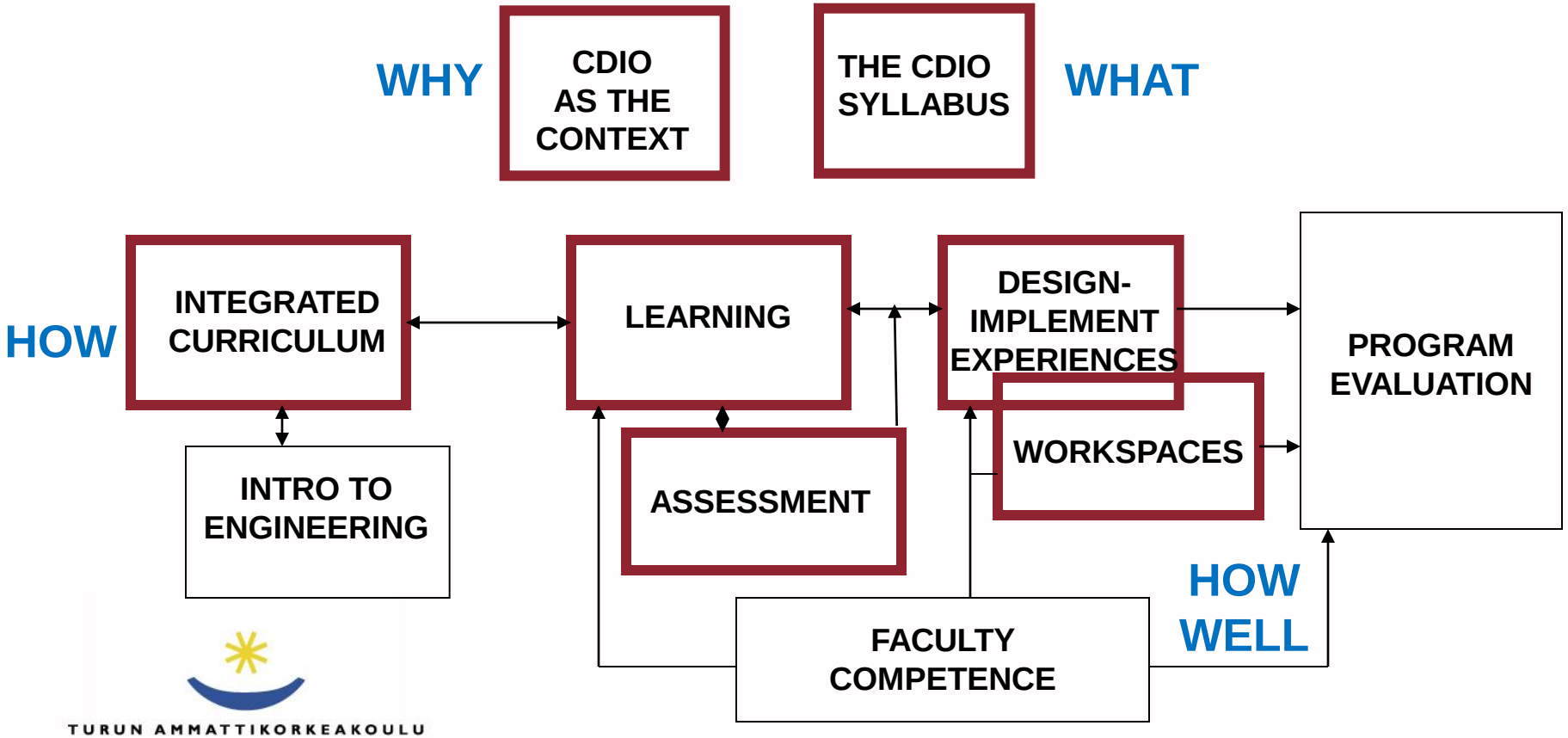
Implementing CDIO



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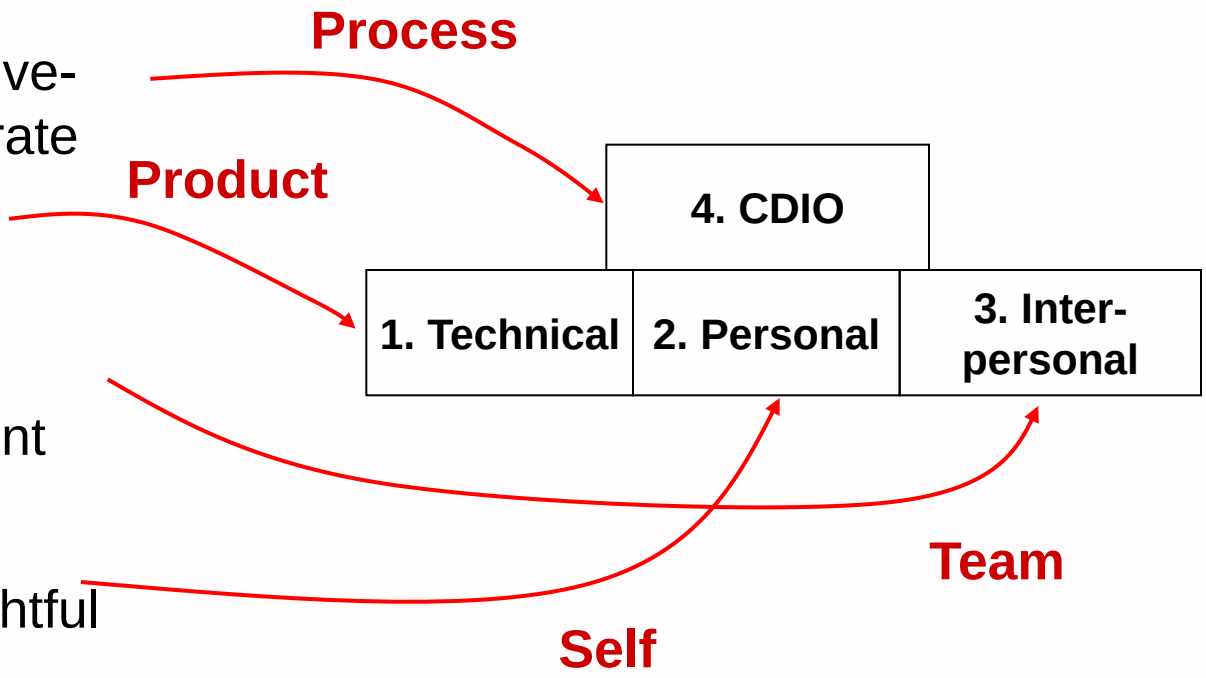
Educate students who…

Understand how to conceive-design-implement-operate

complex value-added engineering systems

in a modern team-based engineering environment

and are mature and thoughtful individuals.



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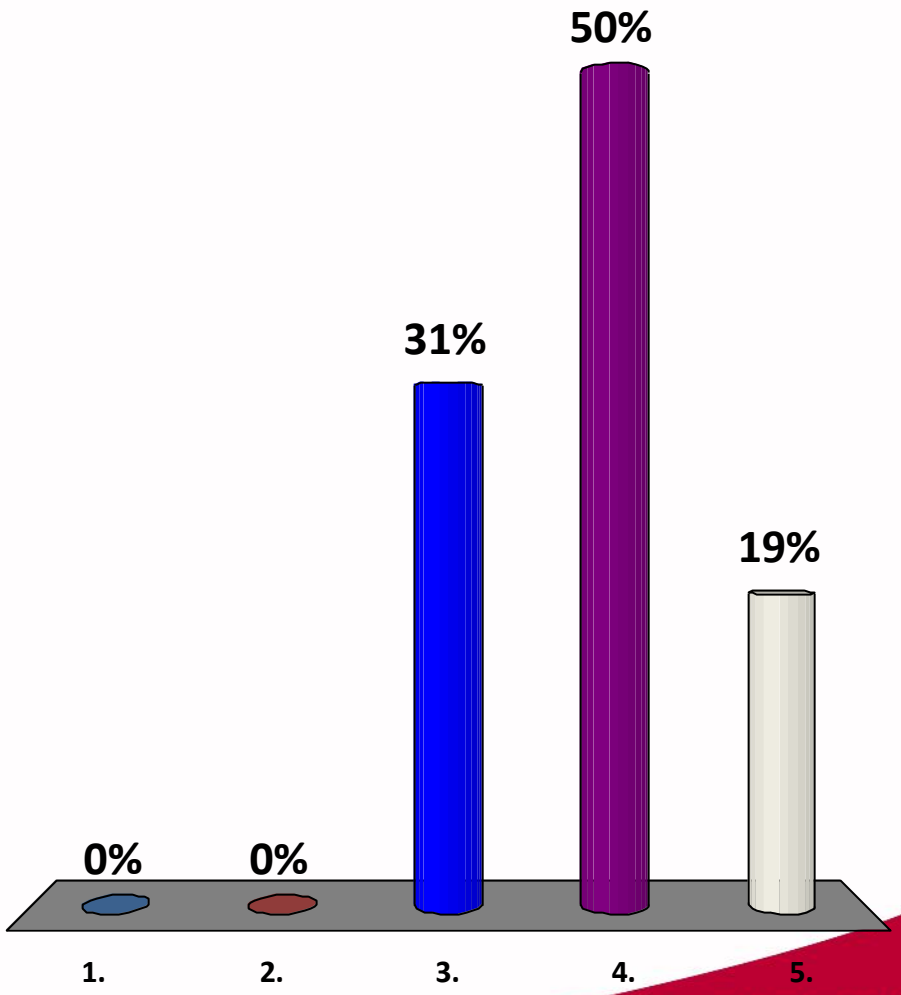
The CDIO Syllabus - a comprehensive statement of detailed Goals for an Engineering Education

How many levels CDIO syllabus has?

1. One
2. Two
3. ✓ Three
4. Four
5. Five



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CDIO SYLLABUS

- Comprehensive, to select from
- Peer reviewed
- Basis for design of curriculum and assessment of student learning

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1 TECHNICAL KNOWLEDGE AND REASONING
- 1.1. KNOWLEDGE OF UNDERLYING SCIENCES
- 1.2. CORE ENGINEERING FUNDAMENTAL KNOWLEDGE
- 1.3. ADVANCED ENGINEERING FUNDAMENTAL KNOWLEDGE

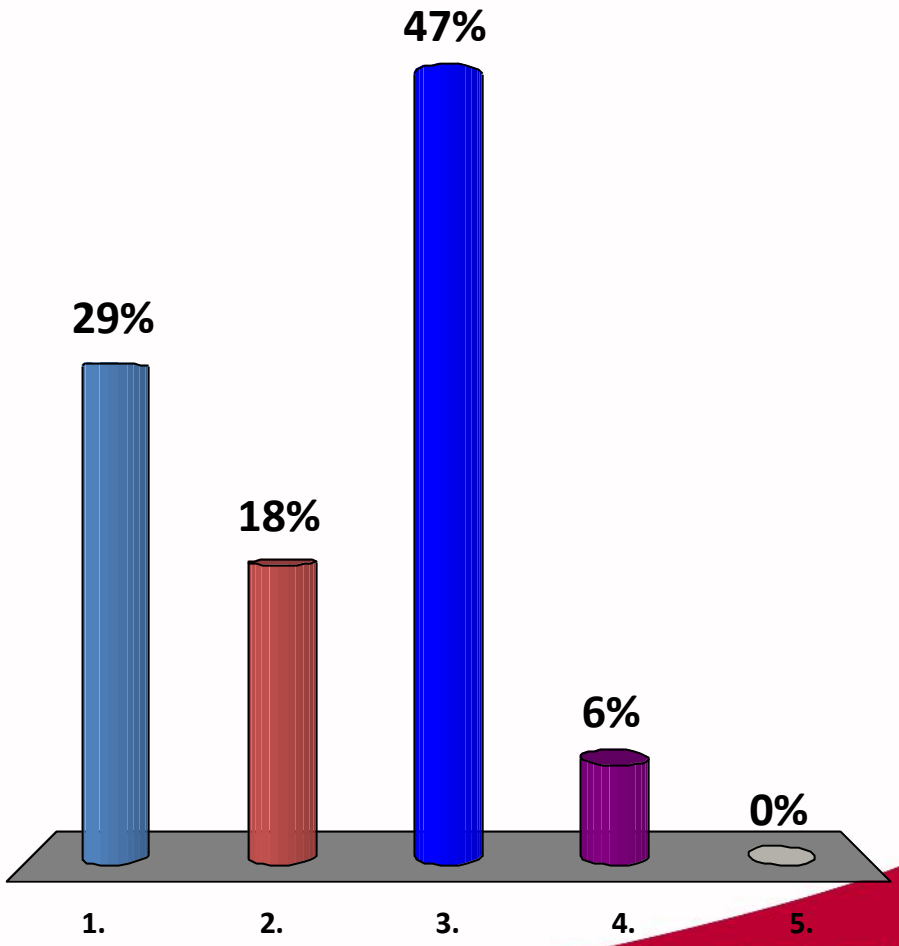
2 PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES
- 2.1. ENGINEERING REASONING AND PROBLEM SOLVING
  - 2.1.1. Problem Identification and Formulation
  - 2.1.2. Modeling
  - 2.1.3. Estimation and Qualitative Analysis
  - 2.1.4. Analysis With Uncertainty
  - 2.1.5. Solution and Recommendation
- 2.2. EXPERIMENTATION AND KNOWLEDGE DISCOVERY
  - 2.2.1. Hypothesis Formulation
  - 2.2.2. Survey of Print and Electronic Literature
  - 2.2.3. Experimental Inquiry
  - 2.2.4. Hypothesis Test, and Defense
- 2.3. SYSTEM THINKING
  - 2.3.1. Thinking Holistically
  - 2.3.2. Emergence and Interactions in Systems
  - 2.3.3. Prioritization and Focus
  - 2.3.4. Tradeoffs, Judgment and Balance in Resolution
- 2.4. PERSONAL SKILLS AND ATTITUDES
  - 2.4.1. Initiative and Willingness to Take Risks
  - 2.4.2. Perseverance and Flexibility
  - 2.4.3. Creative Thinking
  - 2.4.4. Critical Thinking
  - 2.4.5. Awareness of One's Personal Knowledge, Skills, and Attitudes
  - 2.4.6. Curiosity and Lifelong Learning
  - 2.4.7. Time and Resource Management
- 2.5. PROFESSIONAL SKILLS AND ATTITUDES
  - 2.5.1. Professional Ethics, Integrity, Responsibility and Accountability
  - 2.5.2. Professional Behavior
  - 2.5.3. Proactively Planning for One's Career
  - 2.5.4. Staying Current on World of Engineer

3 INTERPERSONAL SKILLS: TEAMWORK AND COMMUNICATION
- 3.1. TEAMWORK
  - 3.1.1. Forming Effective Teams
  - 3.1.2. Team Operation
  - 3.1.3. Team Growth and Evolution
  - 3.1.4. Leadership
  - 3.1.5. Technical Teaming
- 3.2. COMMUNICATION
  - 3.2.1. Communication Strategy
  - 3.2.2. Communication Structure
  - 3.2.3. Written Communication
  - 3.2.4. Electronic/Multimedia Communication
  - 3.2.5. Graphical Communication
  - 3.2.6. Oral Presentation and Interpersonal Communication
- 3.3. COMMUNICATION IN FOREIGN LANGUAGES
  - 3.3.1. English
  - 3.3.2. Languages within the European Union
  - 3.3.3. Languages outside the European Union

4 CONCEIVING, DESIGNING, IMPLEMENTING AND OPERATING SYSTEMS IN THE ENTERPRISE AND SOCIETAL CONTEXT
- 4.1. EXTERNAL AND SOCIETAL CONTEXT
  - 4.1.1. Roles and Responsibility of Engineers
  - 4.1.2. The Impact of Engineering on Society
  - 4.1.3. Society's Regulation of Engineering
  - 4.1.4. The Historical and Cultural Context
  - 4.1.5. Contemporary Issues and Values
  - 4.1.6. Developing a Global Perspective
- 4.2. ENTERPRISE AND BUSINESS CONTEXT
  - 4.2.1. Appreciating Different Enterprise Cultures
  - 4.2.2. Enterprise Strategy, Goals and Planning
  - 4.2.3. Technical Entrepreneurship
  - 4.2.4. Working Successfully in Organizations
- 4.3. CONCEIVING AND ENGINEERING SYSTEMS
  - 4.3.1. Setting System Goals and Requirements
  - 4.3.2. Defining Function, Concept and Architecture
  - 4.3.3. Modeling of System and Ensuring Goals Can Be Met
  - 4.3.4. Development Project Management
- 4.4. DESIGNING
  - 4.4.1. The Design Process
  - 4.4.2. The Design Process Phasing and Approaches
  - 4.4.3. Utilization of Knowledge in Design
  - 4.4.4. Disciplinary Design
  - 4.4.5. Multidisciplinary Design
  - 4.4.6. Multi-objective Design
- 4.5. IMPLEMENTING
  - 4.5.1. Designing the Implementation Process
  - 4.5.2. Hardware Manufacturing Process
  - 4.5.3. Software Implementing Process
  - 4.5.4. Hardware Software Integration
  - 4.5.5. Test, Verification, Validation and Certification
  - 4.5.6. Implementation Management
- 4.6. OPERATING
  - 4.6.1. Designing and Optimizing Operations
  - 4.6.2. Training and Operations
  - 4.6.3. Supporting the System Lifecycle
  - 4.6.4. System Improvement and Evolution
  - 4.6.5. Disposal and Life-End Issues
  - 4.6.6. Operations Management

There are _____ CDIO standards

1. 10
2. 11
3. 12 ✓
4. 13
5. 14



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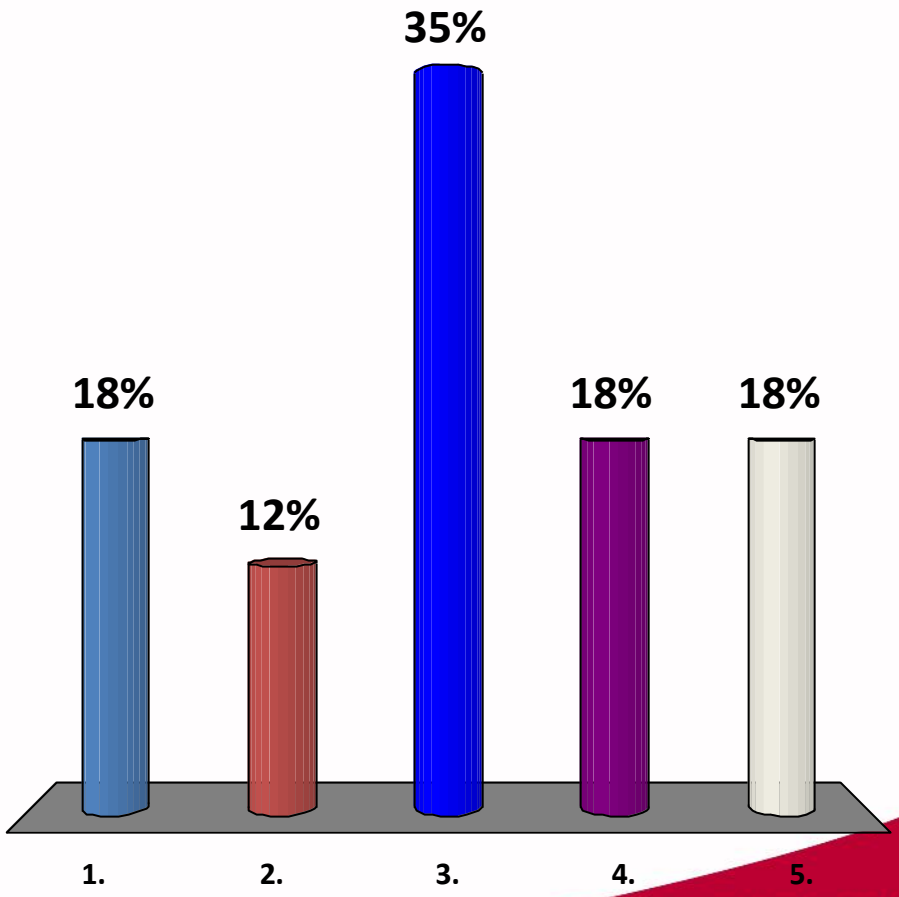
How many standards relate directly to faculty development

1. 0
2. 1
3. 2 ✓
4. 3
5. 4



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CDIO standards – best practises

1. CDIO as Context
Adoption of the principle that product and system lifecycle development and deployment are the context for engineering education

program philosophy

2. CDIO Syllabus Outcomes*
Specific, detailed learning outcomes for personal, interpersonal, and product and system building skills, consistent with program goals and validated by program stakeholders

3. Integrated Curriculum
A curriculum designed with mutually supporting disciplinary subjects, with an explicit plan to integrate personal, interpersonal, and product and system building skills

curriculum development

4. Introduction to Engineering
An introductory course that provides the framework for engineering practice in product and system building, and introduces essential personal and interpersonal skills

5. Design-Build Experiences
A curriculum that includes two or more design-build experiences, including one at the basic level and one at an advanced level

design-build experiences

6. CDIO Workspaces
Workspaces and laboratories that support and encourage hands-on learning of product and system building, disciplinary knowledge, and social learning

and workspaces

7. Integrated Learning Experiences
Integrated learning experiences that lead to the acquisition of disciplinary knowledge, as well as personal, interpersonal, and product and system building skills

methods of teaching and learning

8. Active Learning
Teaching and learning based on active experiential learning methods

9. Enhancement of Faculty CDIO Skills
Actions that enhance faculty competence in personal, interpersonal, and product and system building skills

10. Enhancement of Faculty Teaching Skills
Actions that enhance faculty competence in providing integrated learning experiences, in using active experiential learning methods, and in assessing student learning

faculty development

11. CDIO Skills Assessment
Assessment of student learning in personal, interpersonal, and product and system building skills, as well as in disciplinary knowledge

12. CDIO Program Evaluation
A system that evaluates programs against these 12 standards, and provides feedback to students, faculty, and other stakeholders for the purposes of continuous improvement

assessment and evaluation

9,5	Others		
8,29	Teachers		
6	Deans		
5,85	Program heads		

COFFEE BREAK –
BE BACK AT ….

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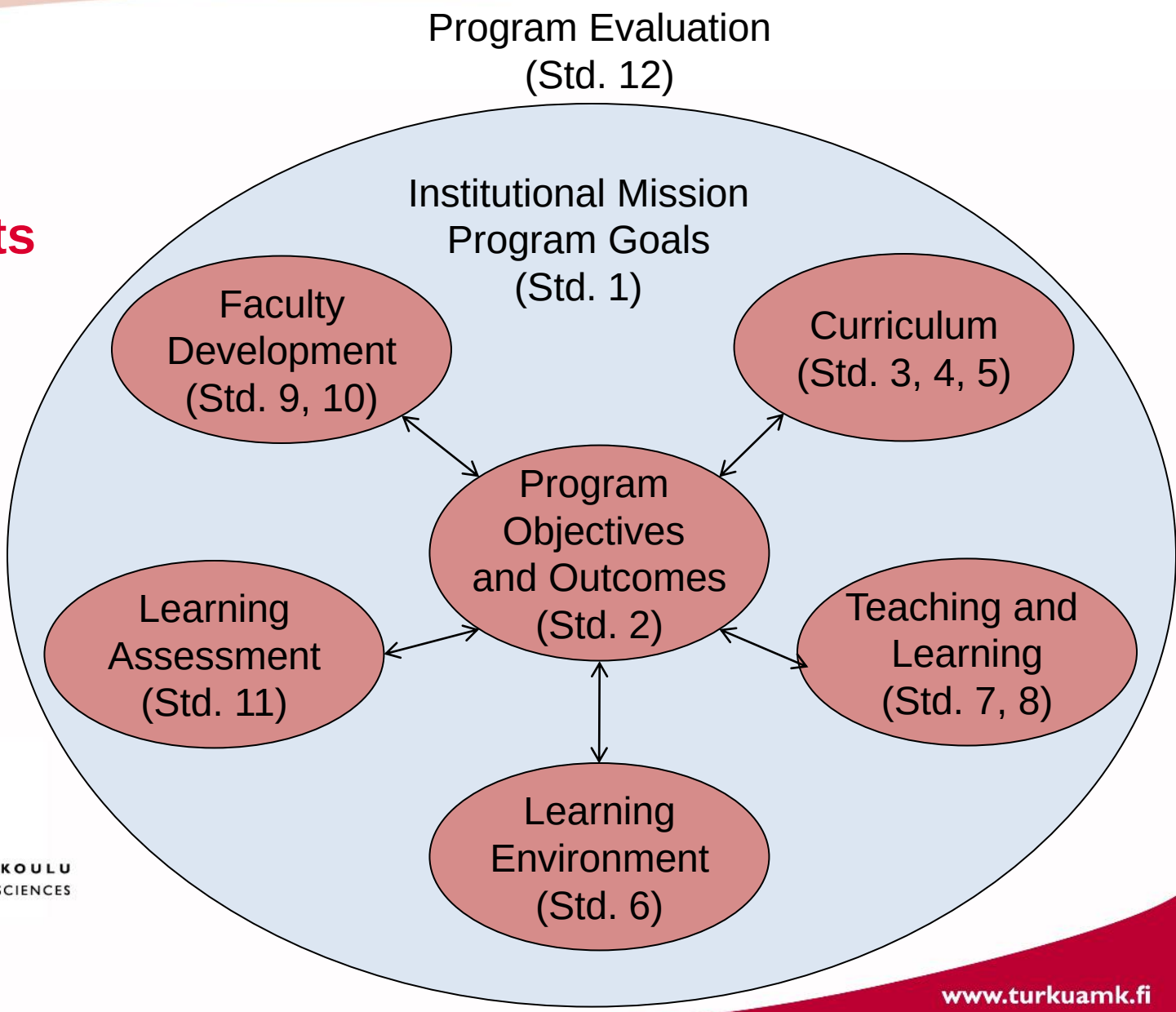
CDIO supports program development



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How?

1. Evaluate performance in each of the 12 standards
2. Provide evidence for the standard ratings
3. Document decisions made for continous improvement

Scale	Criteria
5	Evidence related to the standard is **regularly reviewed** and used to make improvements
4	There is **documented evidence** of the full implementation and impact of the standard across program components and constituents.
3	**Implementation** of the plan to address the standard is **underway** across the program components and constituents.
2	**There is a plan** in place to address the standard.
1	There is an **awareness** of need to adopt the standard and a process is in place to address it.
0	There is **no documented plan** or activity related to the standard.

Standard 12. Program evaluation

A system that evaluates programs against these twelve standards, and provides feedback to students, faculty, and other stakeholders for the purposes of continuous improvement

Description: Program evaluation is a judgment of the overall value of a program based on evidence of a program's progress toward attaining its goals. A CDIO program should be evaluated relative to these 12 CDIO Standards. Evidence of overall program value can be collected with course evaluations, instructor reflections, entry and exit interviews, reports of external reviewers, and follow-up studies with graduates and employers. The evidence can be regularly reported back to instructors, students, program administrators, alumni, and other key stakeholders. This feedback forms the basis of decisions about the program and its plans for continuous improvement.

Rationale: A key function of program evaluation is to determine the program's effectiveness and efficiency in reaching its intended goals. Evidence collected during the program evaluation process also serves as the basis of continuous program improvement. For example, if in an exit interview, a majority of students reported that they were not able to meet some specific learning outcome, a plan could be initiated to identify root causes and implement changes. Moreover, many external evaluators and accreditation bodies require regular and consistent program evaluation.

5	Systematic and continuous improvement is based on program evaluation results from multiple sources and gathered by multiple methods.
4	Program evaluation methods are being used effectively with all stakeholder groups.
3	Program evaluation methods are being implemented across the program to gather data from students, faculty, program leaders, alumni, and other stakeholders.
2	A program evaluation plan exists.
1	The need for program evaluation is recognized and benchmarking of evaluation methods is in process.
0	Program evaluation is inadequate or inconsistent.

EXAMPLE FROM TURKU

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What we have done?

- Four evaluation rounds
  - Sep-06; Jan-08; Apr-09; Sep-10
  - All the time learning more
- Fifth round this autumn

- Understanding has increased
- Documentation has improved
- Evaluation process needs still improvements

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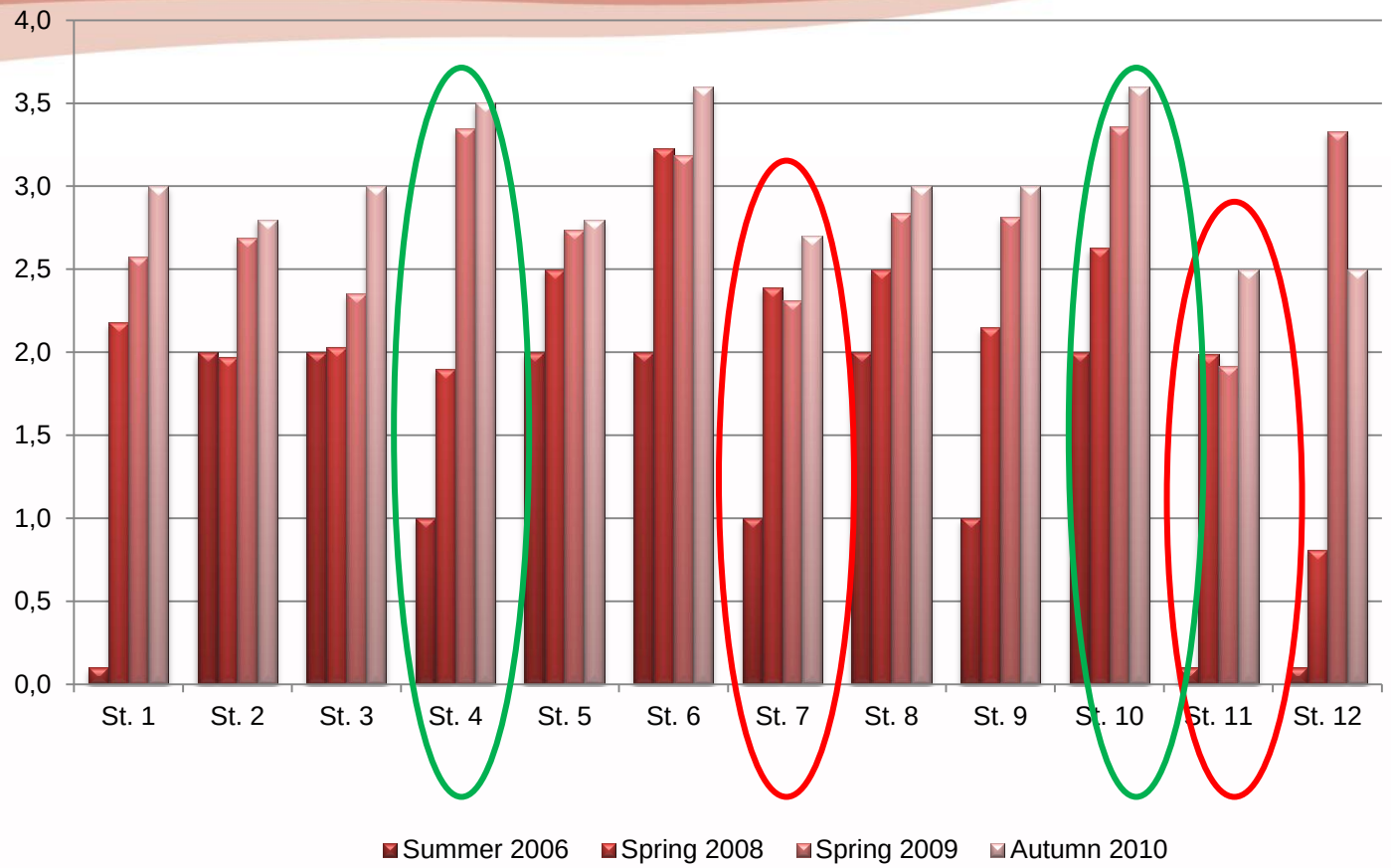
Something has happened (2006-2010)



- Can we say something from this?
- Where have we succeeded?
- Next focus areas for continuous improvement?

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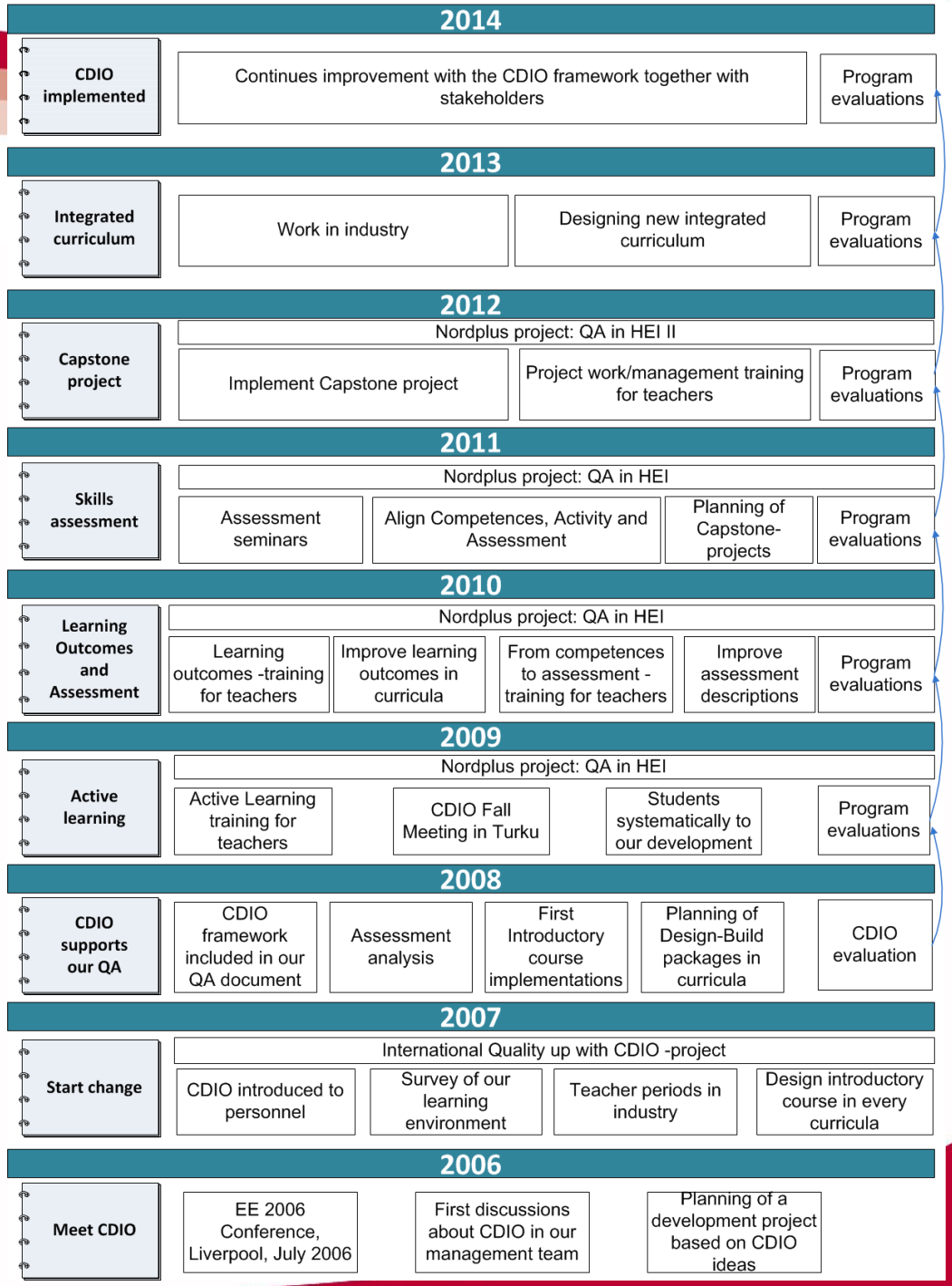
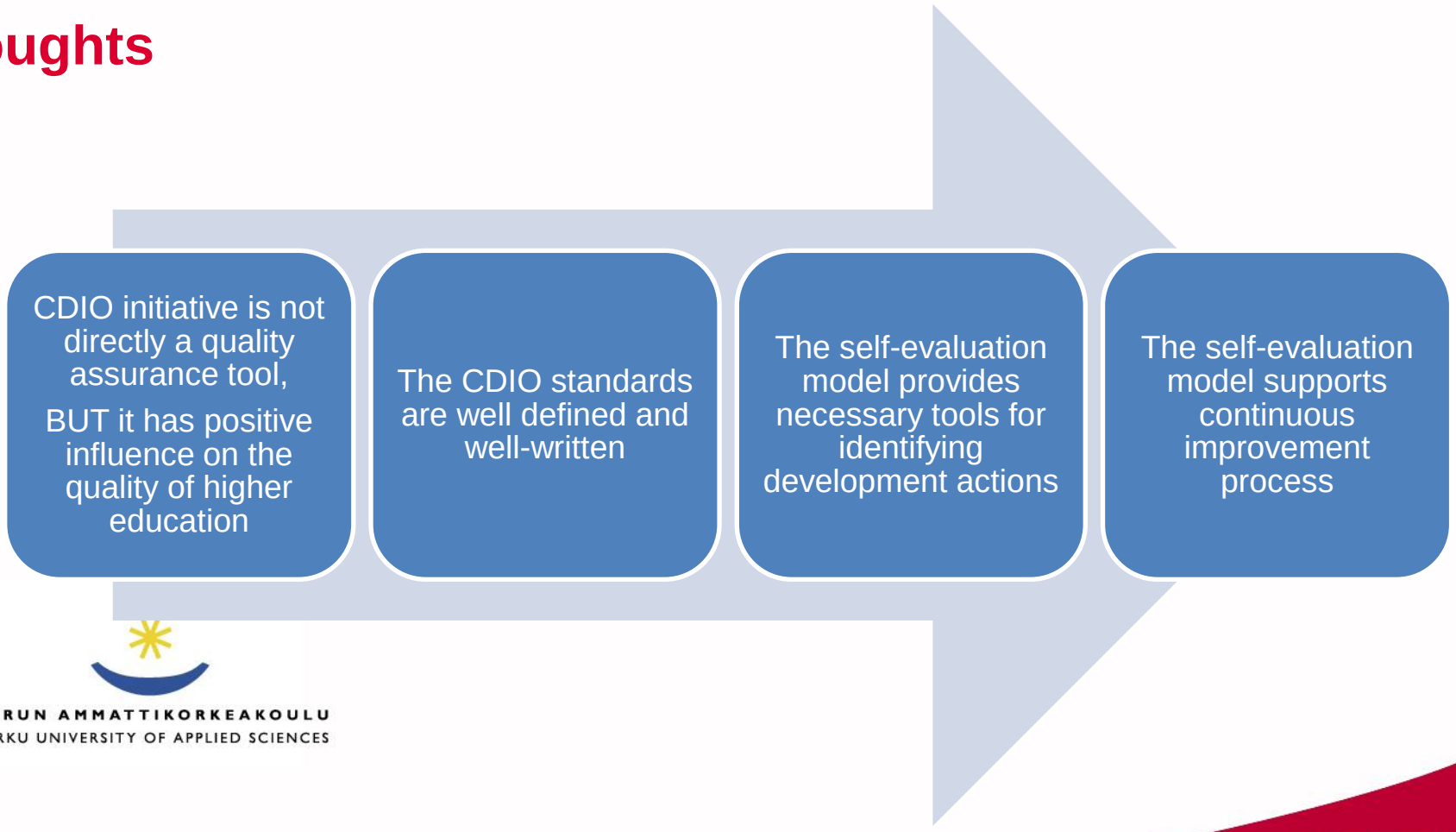
Pedagogical developments

- Problem Based Learning
  - PBL cycles integrated in engineering education since 2003.
- Work placements/internships
  - Every student must complete a 30 ECTS work placement as a part of their studies. (20 weeks)
- CDIO –based development since 2006



cdio
CONCEIVE DESIGN IMPLEMENT OPERATE™

Thoughts



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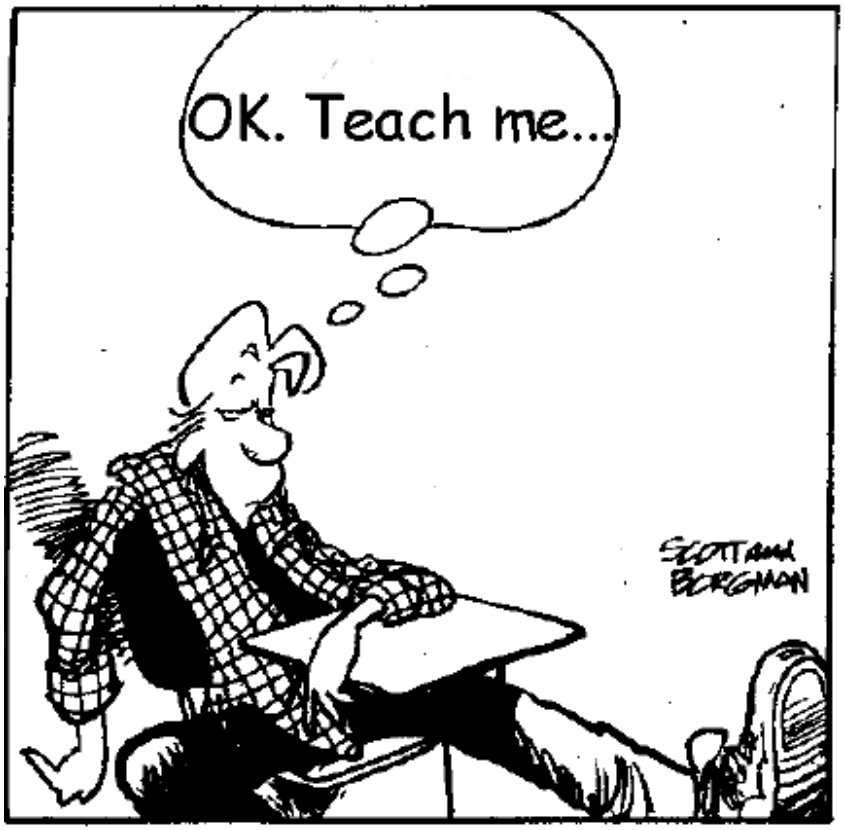
Pedagogical ideology:
We try to avoid this…



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Exercise 1. Learn and teach CDIO standards to your colleagues

1. Divide you in groups of four people
    1. This is your **base group (A, B, C, D, E, F)**
2. Study the standard you received by yourself
    1. Try to understand the ideology behind it
    2. Identify examples from your program that answers these challenges
    3. Estimate the level of your program in the scale
3. Join together with the members of other groups that had the same standards (**expert group – A-F 1, A-F 2,..**)
    1. Exchange your thoughts
    2. Agree on the presentation of your standard to the rest of the people
    3. Create a clip chart
4. Return your base group
    1. Each base groups meets near one flip chart
        1. Half of E with A&B, Half of F with C&D
    2. The expert/s teaches the standard on the flip chart to others
    3. Move to next flip chart and repeat 1-2

Standard 4

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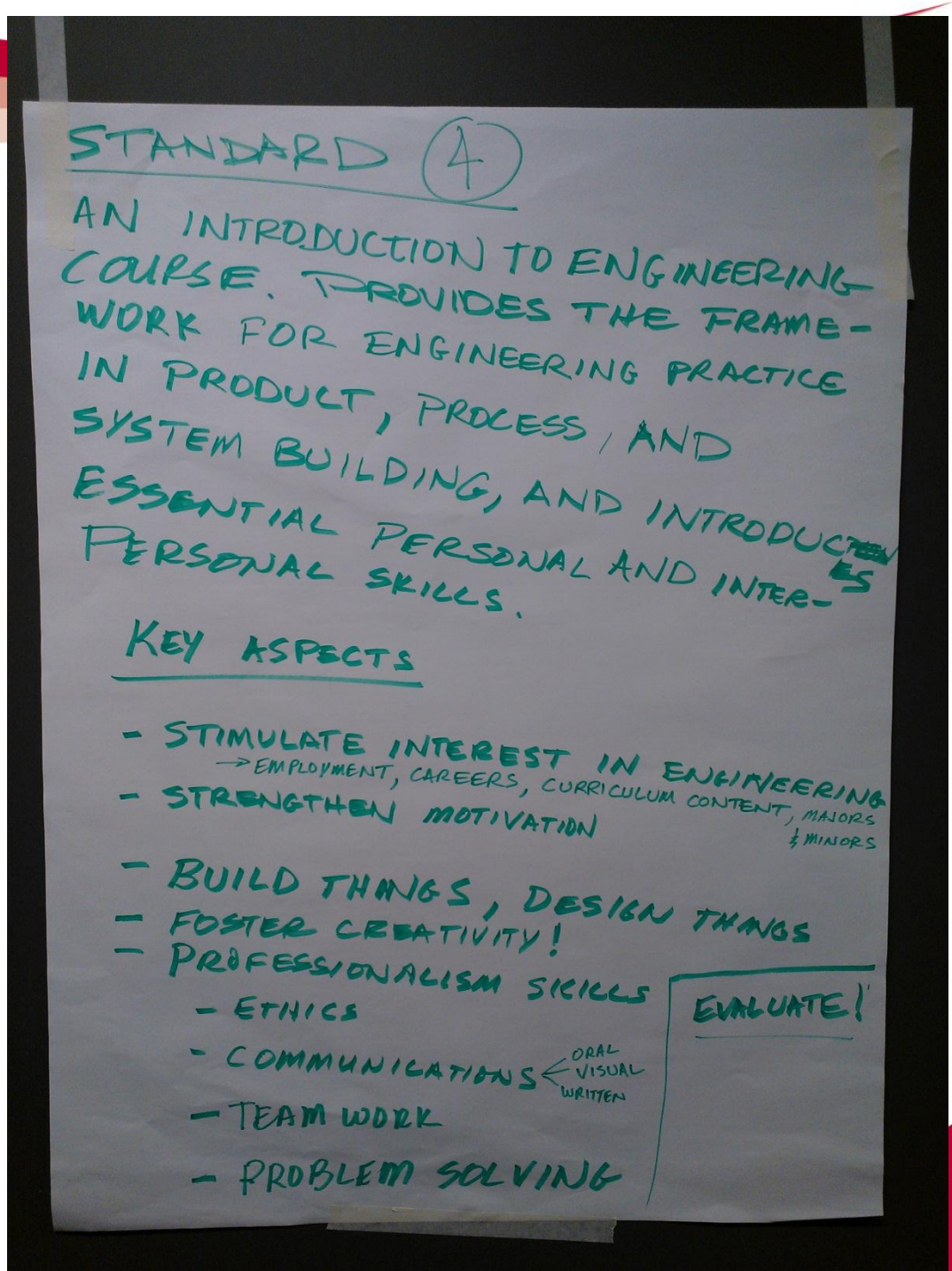
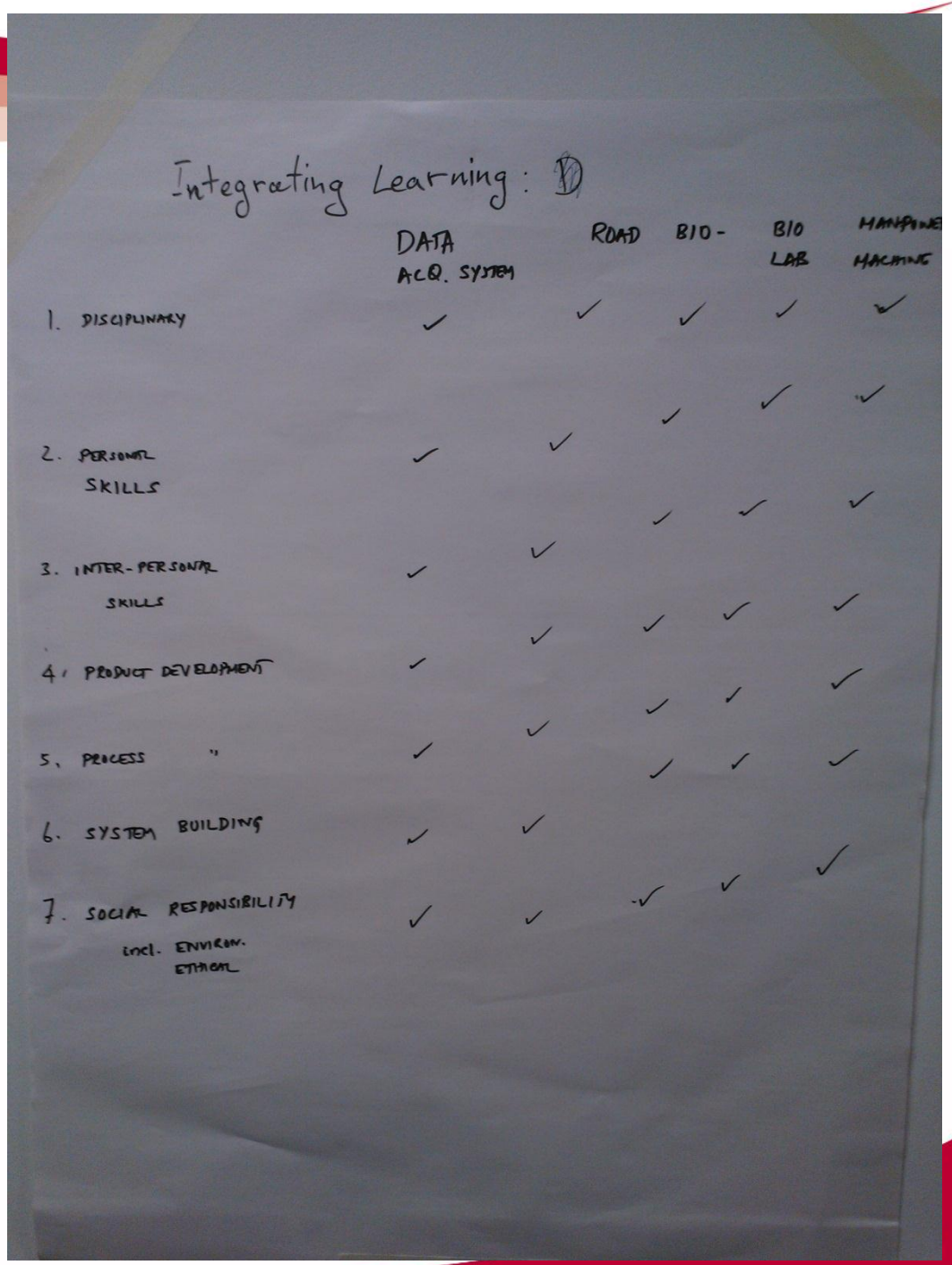


Standard 7



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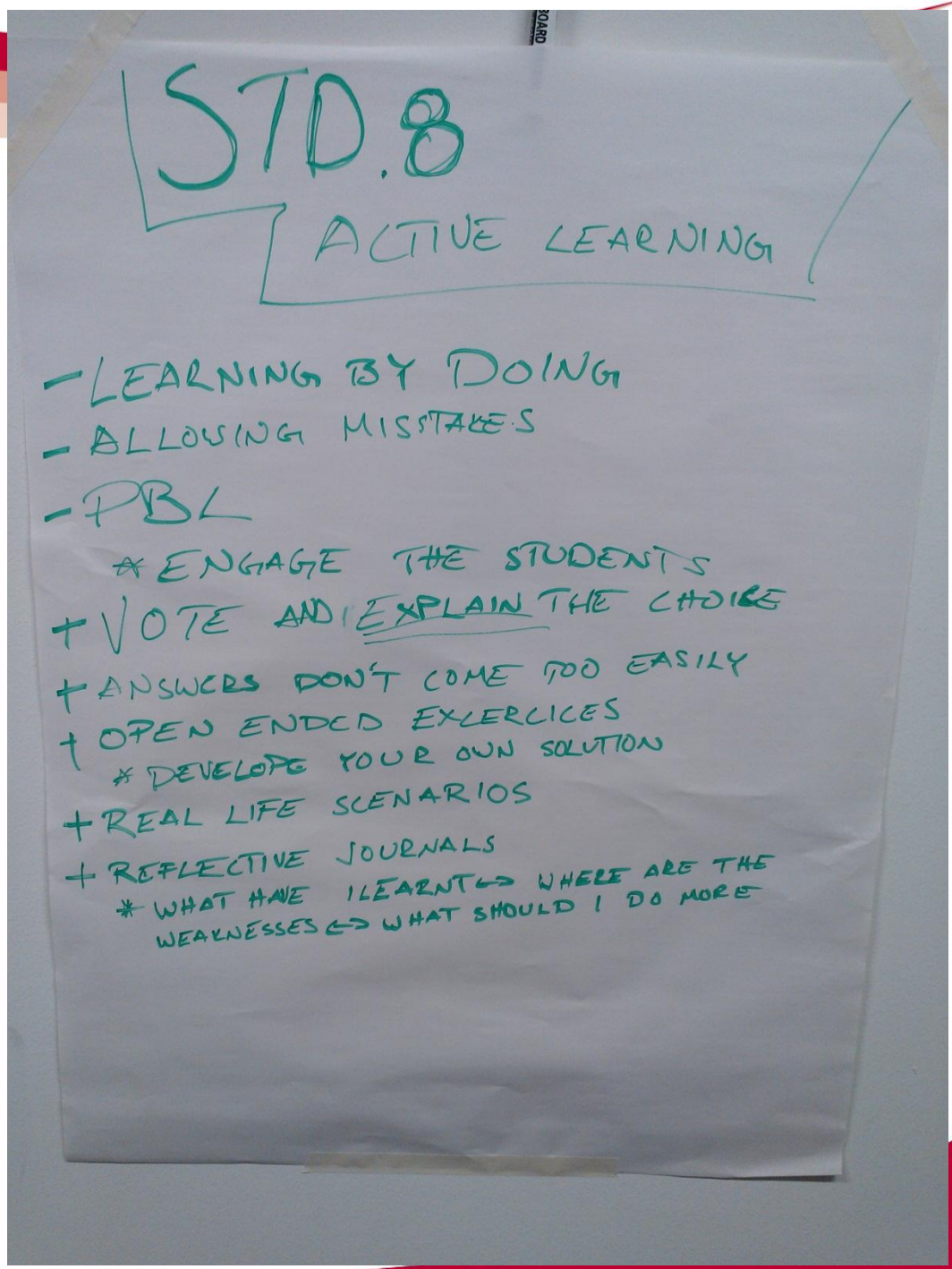
Standard 8



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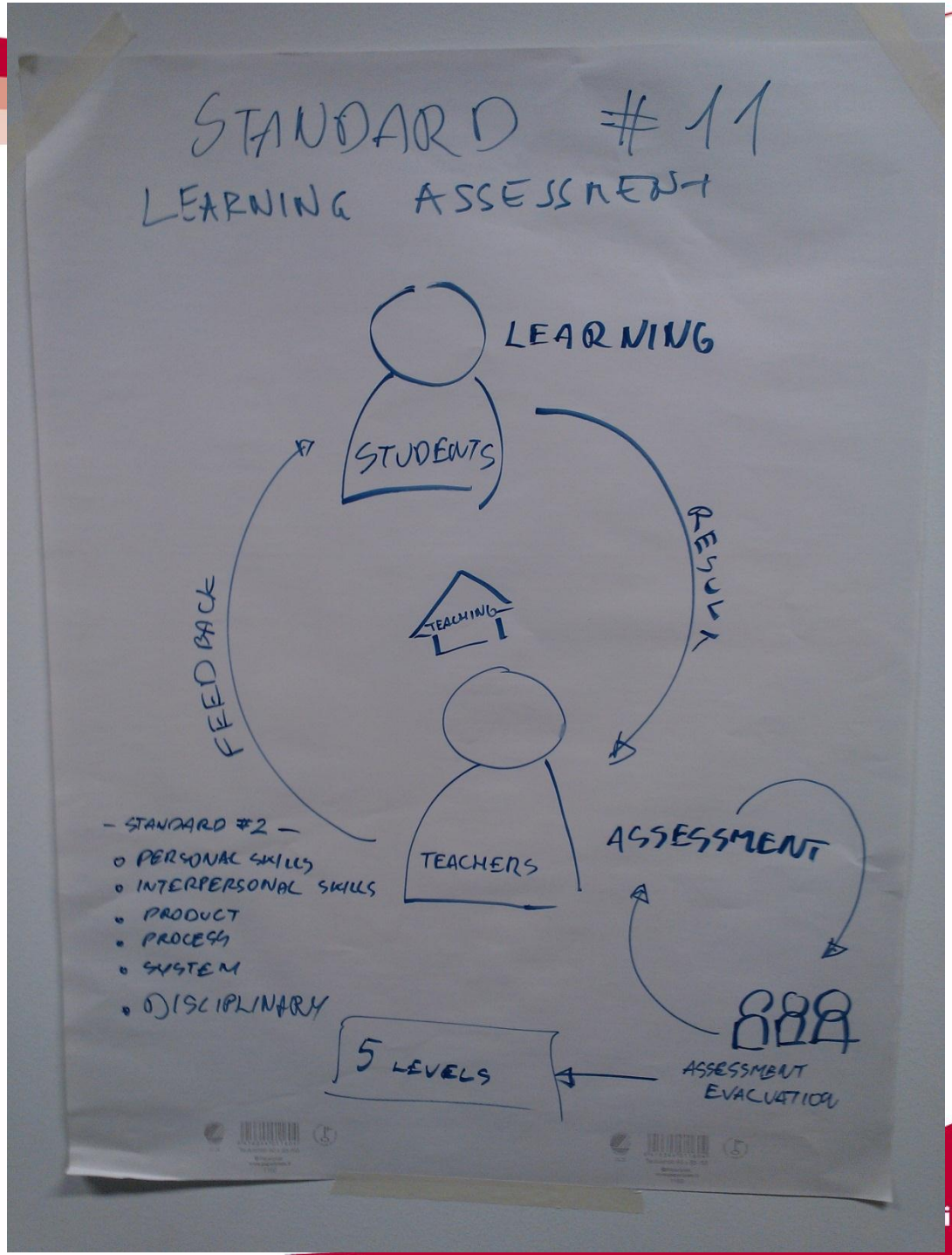
Standard 11



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FEEDBACK

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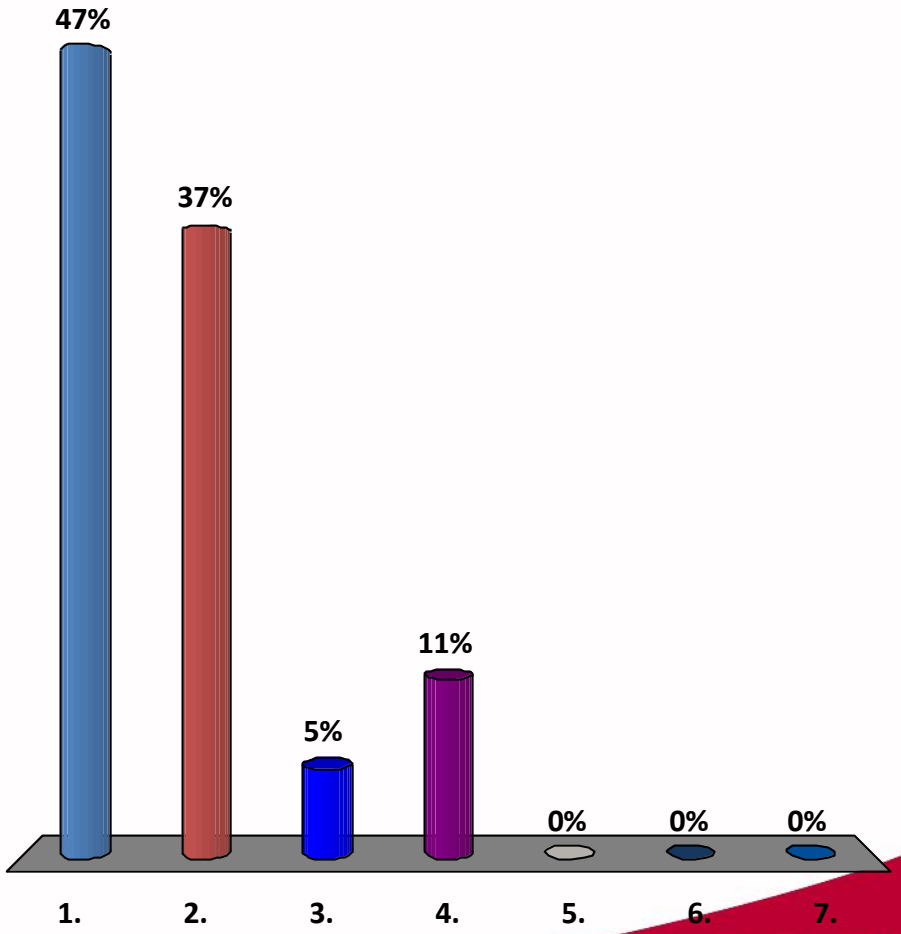
Feedback – how you liked the workshop?

1. Very useful
2. Useful
3. Somewhat Useful
4. Neutral
5. Somewhat not useful
6. Not useful
7. Totally not useful



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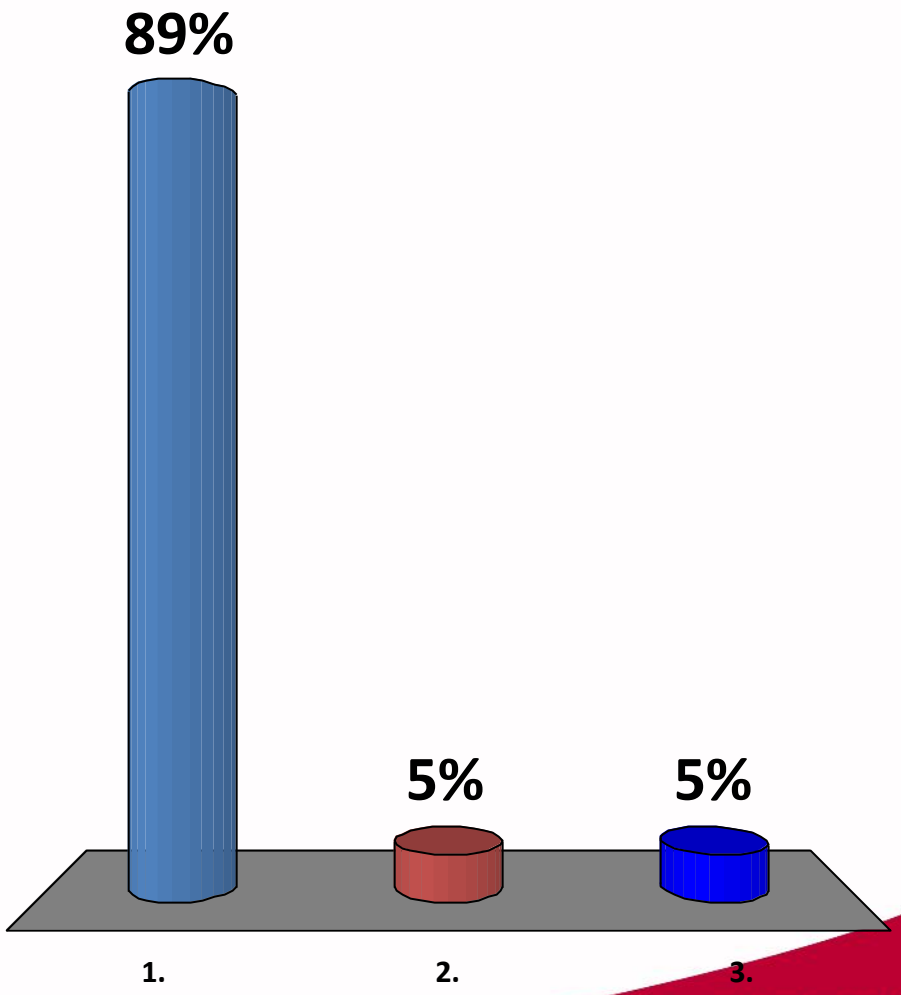
I would recommend this kind of workshop to my colleagues?

1. Yes
2. No
3. Maybe



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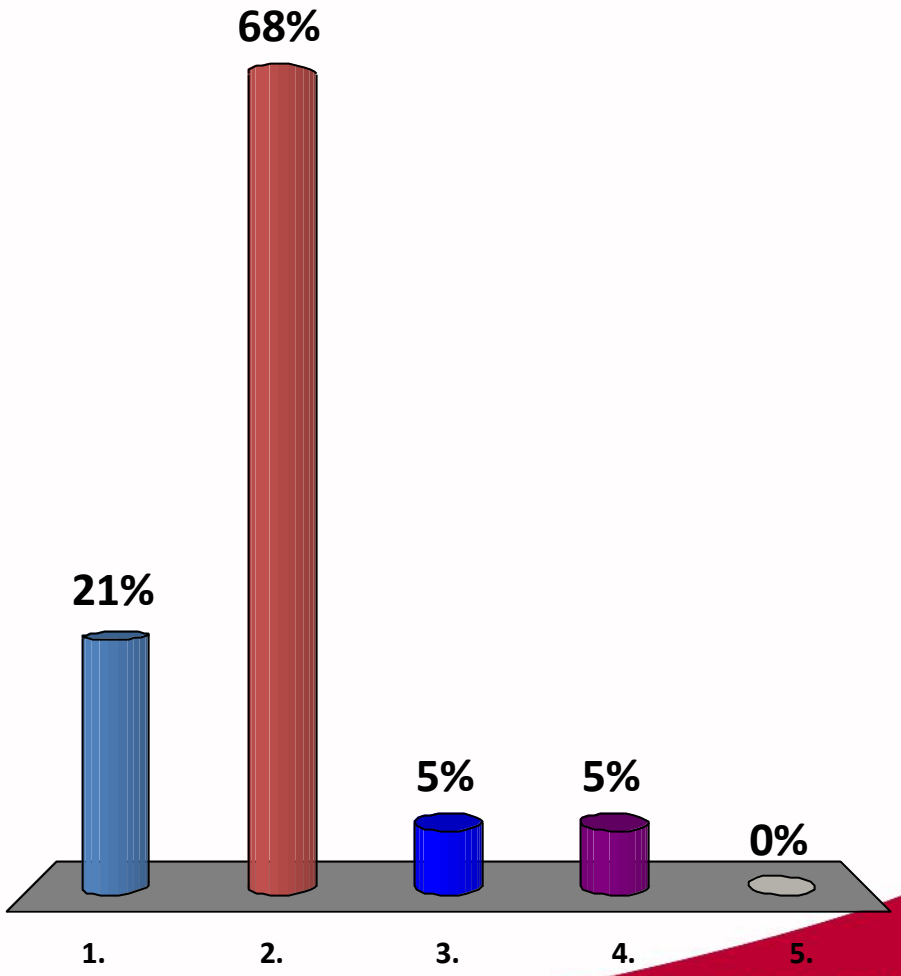
I got something that I can start using already tomorrow…

1. Strongly Agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree



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Thank you!

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