THE CDIO APPROACH
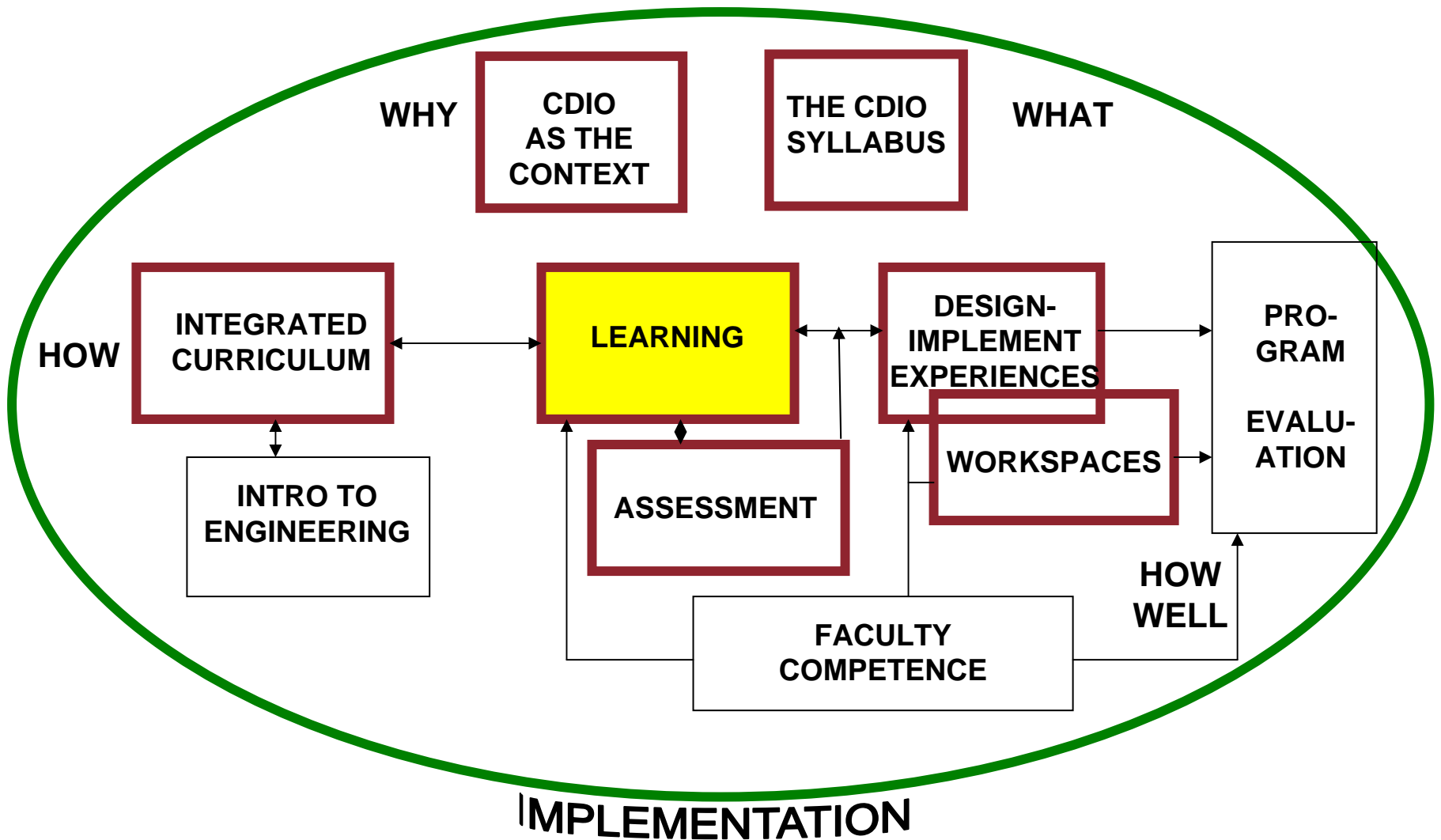# TO ENGINEERING EDUCATION:
3. Engaging Students in Their Learning

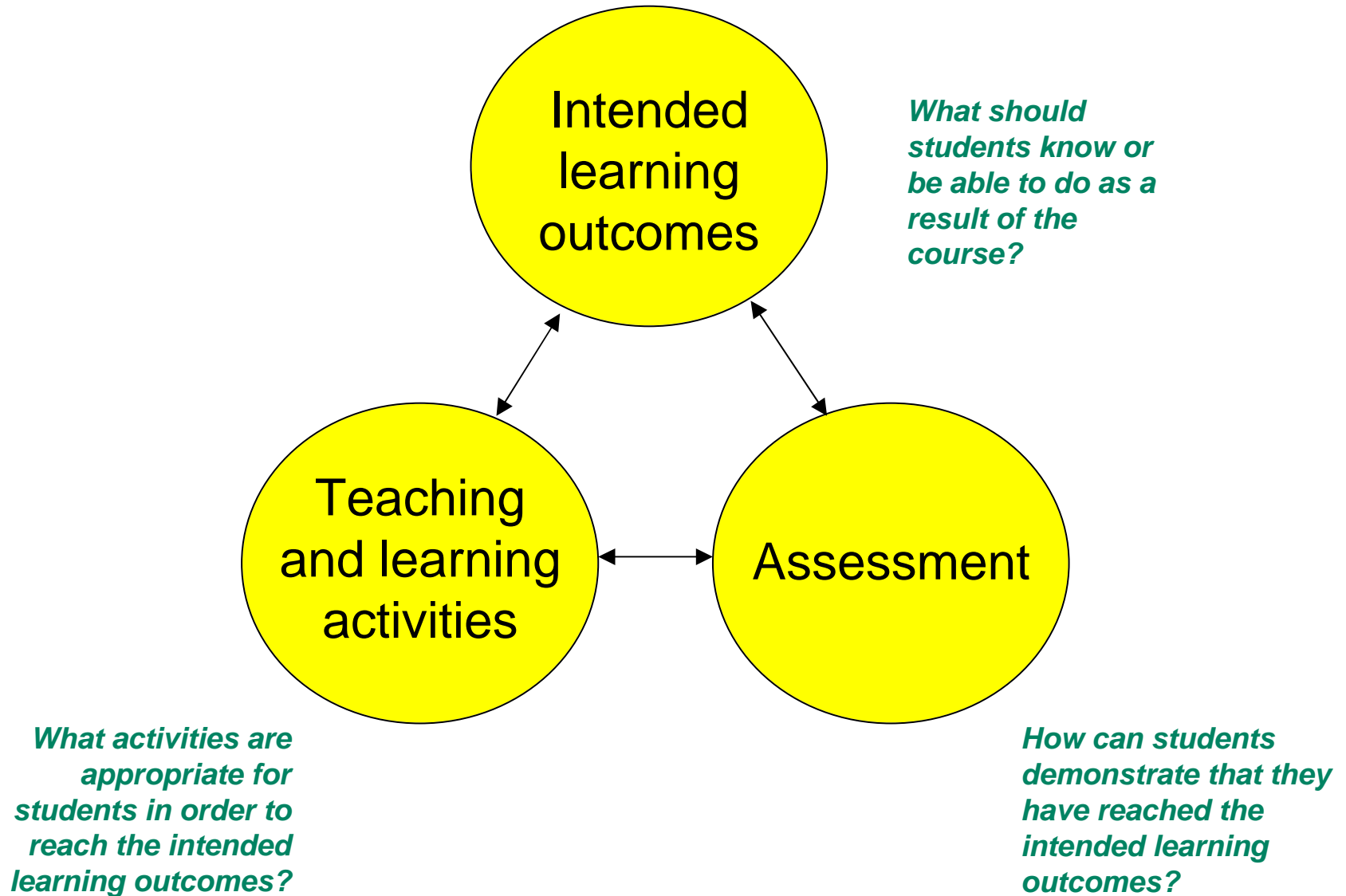**Revised January 2008**

SESSION THREE OBJECTIVES

Recognize the importance of aligning curriculum, teaching, learning, and assessment

Give examples of active and experiential learning methods

Participate in one or more active and experiential learning methods

CONSTRUCTIVE ALIGNMENT

Intended learning outcomes

What should students know or be able to do as a result of the course?

Teaching and learning activities

Assessment

What activities are appropriate for students in order to reach the intended learning outcomes?

How can students demonstrate that they have reached the intended learning outcomes?

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"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."

(Courtesy of Queen's University Belfast)

-- Thomas J. Shuell

ACTIVE LEARNING

Engages students directly in thinking and problem solving activities

Emphasis on engaging students in manipulating, applying, analyzing, and evaluating ideas

Examples:

Pair-and-Share

Group discussions

Debates

Concept questions

EXPERIENTIAL LEARNING

Active learning in which students take on roles that simulate professional engineering practice

Examples:

Design-implement experiences

Problem-based learning
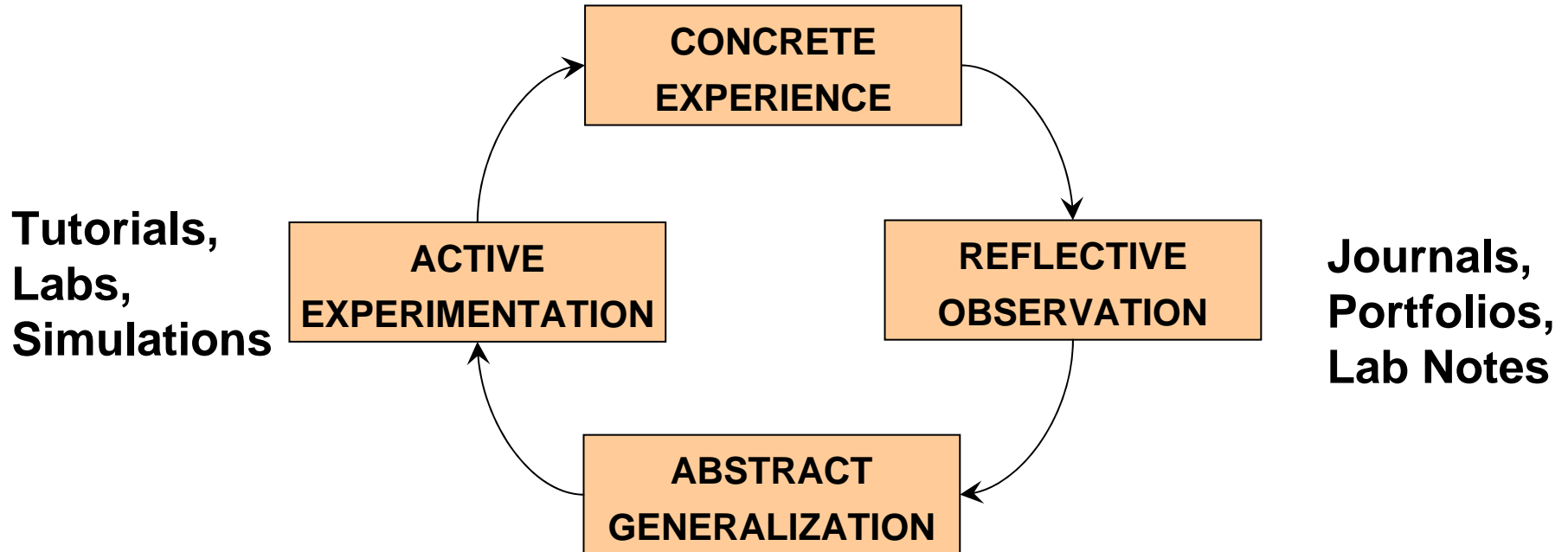
Simulations

Case studies

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CDIO Standard 8 -- Active Learning

Teaching and learning based on active and experiential learning methods

- Engage students directly in thinking and problem solving
- Help students recognize what and how they learn
- Increase student learning motivation
- Help students form habits of lifelong learning
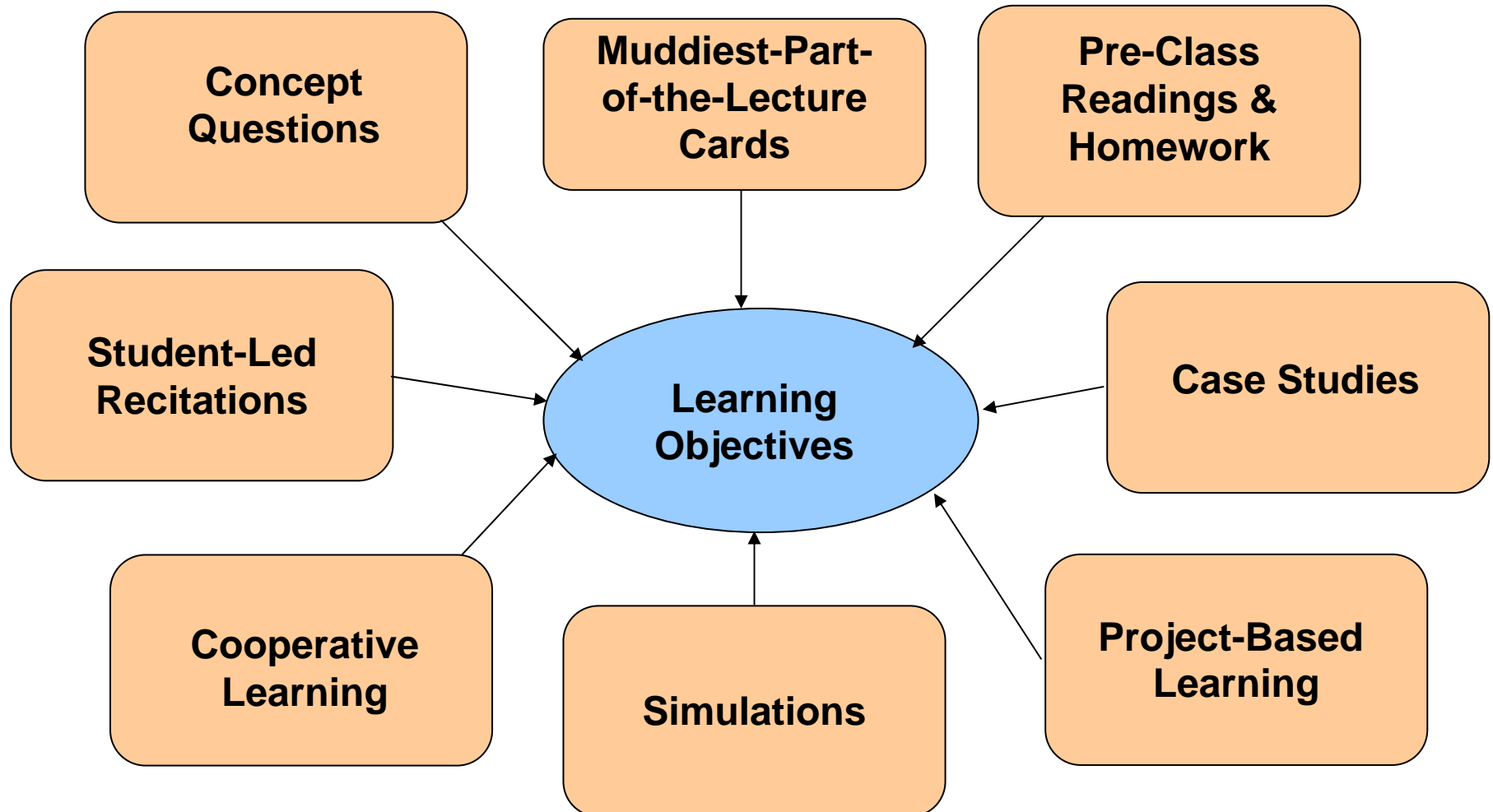
(See Handbook, p.11)

VARIETY IN LEARNING METHODS

CONCEPT QUESTIONS

- Are used in lecture-based courses to check student understanding (about 1 question embedded in lecture every 20 minutes)

- Intended to reveal common difficulties with key concepts

- Focus on a single concept at a time

- Have several plausible answers based on typical student misunderstandings

- Are not solvable by relying solely on equations – should address conceptual understanding

To maximize endurance, an airplane must fly in a manner that

1. Minimizes drag
2. Maximizes drag
3. Maximizes the lift/drag ratio
4. Maximizes power available
5. Minimizes power required

What should instructors do once they have seen student responses?

STUDENT-LED RECITATIONS

Simplest example of integrated learning of disciplinary knowledge, problem solving, and communication skills

- At the end of one class. all students are asked to prepare solutions to the same set of problems

- At the start of the next class, students **tick** (check) on a list the problems they are willing and prepared to present

- Students are chosen *at random* to present the problems on the board - one student per problem

- The student must demonstrate an honest effort to answer the problem, and be able to lead a classroom discussion to a satisfactory solution. Should they fail in this, their **ticks** (checks) are cancelled for that session

- **Ticking** at least 75% of the problems is required, or rewarded with bonus points, or similar

- Note that the reward is given for the **ticks**. As the purpose is purely formative, the quality of presentations does not affect the grade

COMMENTS ABOUT STUDENT-LED RECITATIONS

WHAT STUDENTS SAY:

"I now realize that in every course before this, I have only solved problems to get them done, without thinking really."

"This gave me motivation to prepare for class, because I did not want to stand up and say that I couldn't do it."

This is the first time I have seen friends, who are generally weaker students, really "get it".

WHAT INSTRUCTORS SAY:

"Suddenly, students don't want to leave! They stay and work after class, discussing alternative solutions. During all my years as a teacher I have never seen anything like this."

"This raised the level of the whole course. The lectures, as well, have become interesting to students, now that they have the basis for understanding them."

(Courtesy of KTH-Royal Institute of Technology)

KEY PRINCIPLES

It's about improving what the **student** does.

- Generating time on task
- Generating appropriate learning activities
- Providing prompt feedback
- Providing feedback that the students pay attention to
- Helping the students internalize criteria for quality

(based on Gibbs, 1999)

See Handbook, pp. 29-30

PROJECT-BASED LEARNING

- Student-centered and self-directed
- Organized around real-world problems
- Focused on authentic skills
- Collaborative
- With faculty as facilitators

COOPERATIVE LEARNING (JIGSAW)

PROCEDURE – to teach 4 concepts

❑ The instructor prepares study notes on 4 concepts

❑ The class is divided into groups of 4, where students are numbered 1 to 4. These are students' *Base Groups*

❑ Each student is assigned a single concept, corresponding to his/her number, from the notes provided. They can study on their own or with others who have the same number

❑ Students then form *Expert Groups* with all the 1's together, the 2's together, etc.

❑ In the *Expert Group*, students discuss the assigned concept and identify the key points. They decide how they will *teach* this concept to the other members of their *Base Group*

❑ Students return to their *Base Group* and teach their concept to the other members

❑When all groups have learned all the concepts, the instructor checks understanding

THIS IS AN ACCELERATED VERSION

❑ Divide into **Base Groups** of 4, and number yourselves 1 to 4
❑ Refer to the Handbook, pp. 31-34 for four teaching methods
❑ Person 1 studies <u>only</u> Method 1, Person 2 studies <u>only</u> Method 2, etc.

5 minutes

❑ Form **Expert Groups** – all 1's, all 2's, all 3's and all 4's
❑ Discuss what you have learned and how to explain to others

5 minutes

❑ Rejoin **Base Groups** and share your new knowledge – teach each other what you have learned

10 minutes

CHECKING FOR UNDERSTANDING

- In the Jigsaw method, the role of the instructor is not to lecture but is to facilitate student learning

- In the Jigsaw method the students teach each other

- The instructor must check appropriate student learning has occurred

How might instructors check for understanding?

What is still "clear as mud" to you?

What methods for engaging students can you introduce or improve in your courses?