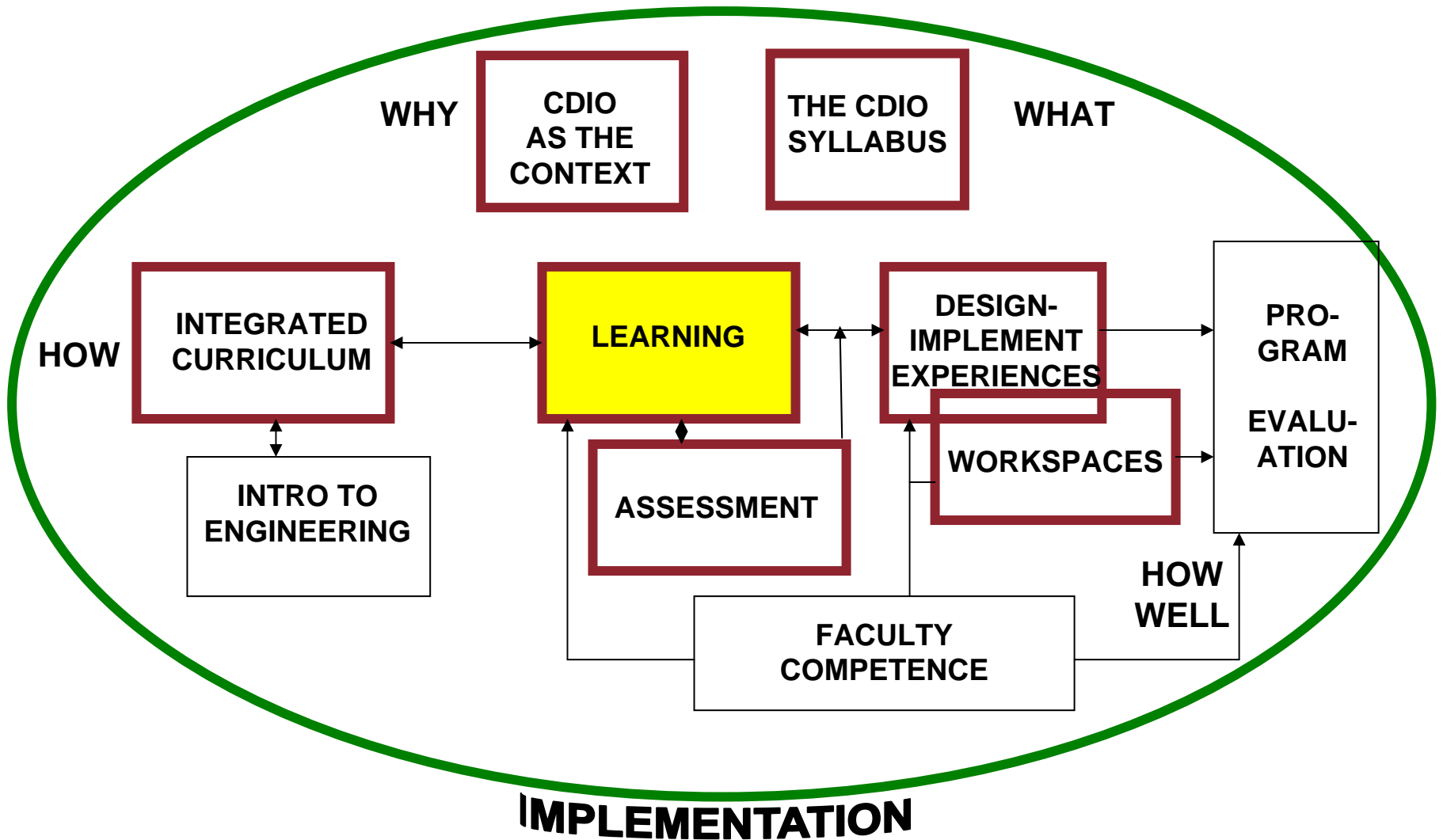**cdio**

CONCEIVE DESIGN IMPLEMENT OPERATE

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

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SESSION THREE OBJECTIVES

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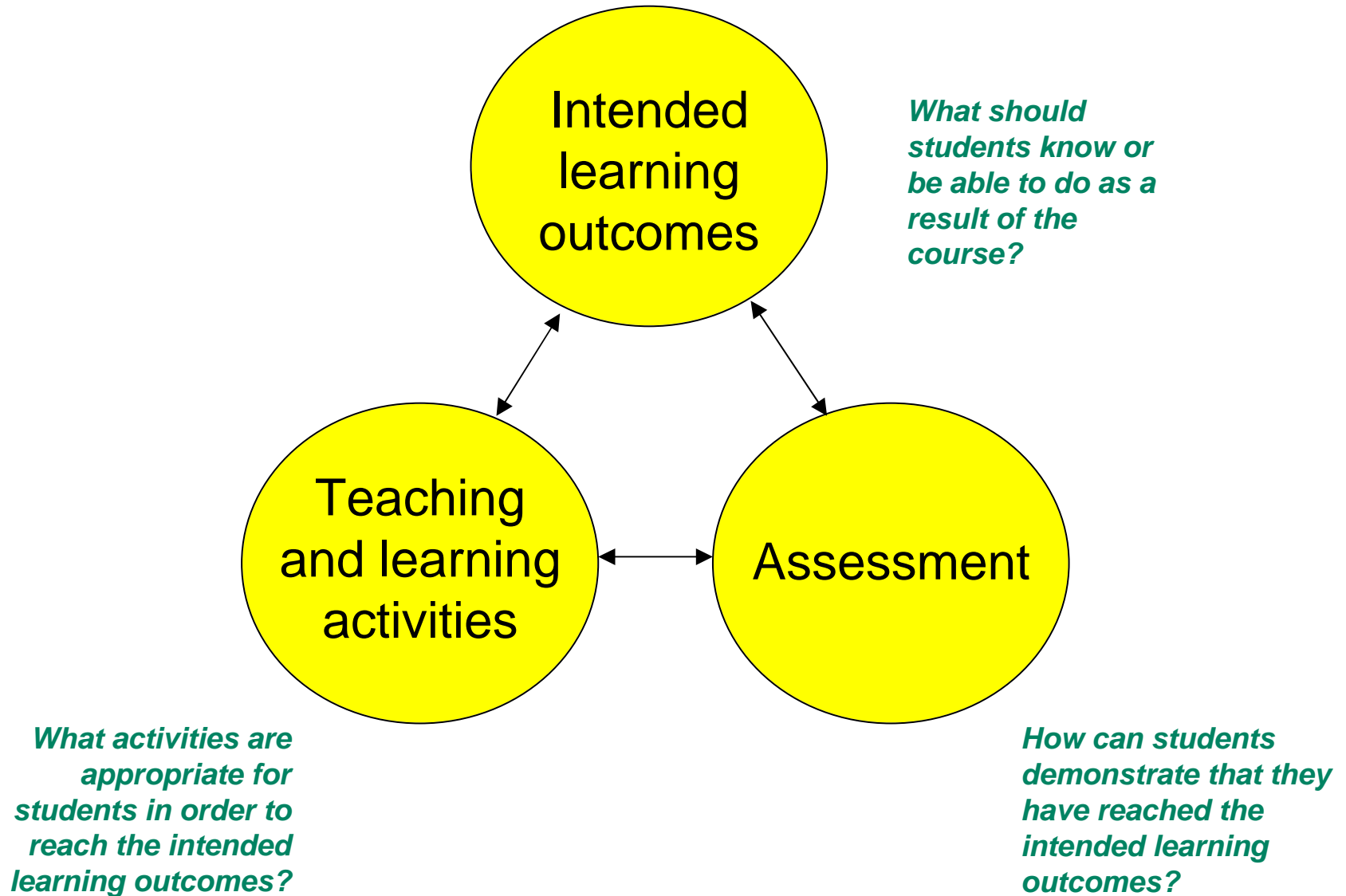
Recognize the importance of aligning curriculum, teaching, learning, and assessment

Give examples of active and experiential learning methods

Participate in one or more active and experiential learning methods

CONSTRUCTIVE ALIGNMENT

"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 FOR EFFICIENT LEARNING

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The 2 key factors that underpin effective learning are (Gibbs, 1982):

the learner **activity**

interaction with others

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

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**

ACTIVE LEARNING FOR SKILLS DEVELOPMENT

- Central to CDIO is the idea that engineering education should equip graduates with a range of personal, interpersonal and professional skills

- Traditional 'lectures + labs' courses provide few opportunities for students to develop these skills

- Active learning approaches can provide 'integrated learning experiences that lead to the acquisition of disciplinary knowledge, as well as personal, interpersonal, and product and system building skills' (CDIO Standard 7)

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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)

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ACTIVE LEARNING

EXPERIENTIAL LEARNING

Engages students directly in thinking and problem solving activities

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

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

Examples:

Pair-and-Share

Group discussions

Debates

Concept questions

Examples:

Design-implement experiences

Problem-based learning

Simulations

Case studies

VARIETY IN LEARNING METHODS

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Design-Implement Projects, Field Work

Tutorials, Labs, Simulations

CONCRETE EXPERIENCE

ACTIVE EXPERIMENTATION

REFLECTIVE OBSERVATION

ABSTRACT GENERALIZATION

Journals, Portfolios, Lab Notes
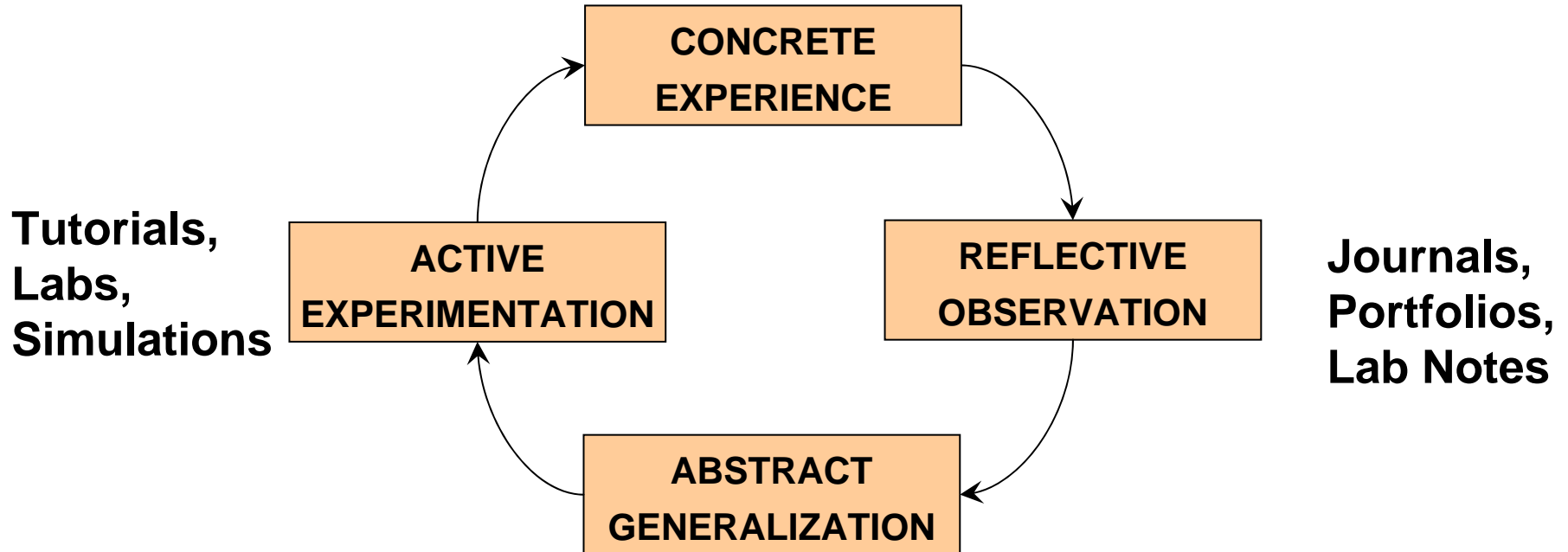
Lectures: Concepts, Models, Laws

Experiential Learning Cycle – From Kolb, 1984

METHODS THAT ENGAGE LEARNERS

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Circle the teaching and learning methods used in your course or program.

Concept Questions	Recitation	Muddy Cards	Jigsaw Classroom

ACTIVE LEARNING

Formulate Share Create Revise		Pre-Class Reading

EXPERIENTIAL LEARNING

Problem Based Learning	Case Studies	Project Based Learning	Simulations

METHODS THAT ENGAGE LEARNERS

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Concept Questions

Recitation

Muddy Cards

Jigsaw Classroom

Formulate
Share
Create
Revise

Pre-Class Reading

Problem Based Learning

Case Studies

Project Based Learning

Simulations

ACTIVE LEARNING TECHNIQUE

CONCEPT QUESTIONS

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

- Audience Response Systems are useful in concept questioning

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?

ACTIVE LEARNING TECHNIQUE

JIGSAW CLASSROOM

JIGSAW CLASSROOM

- **A cooperative learning approach in which:**
  - the role of the instructor is not to lecture but is to facilitate student learning
  - the students form 'learning teams' in which they teach themselves and each other

- **A 'learning contract' is formed between team members**
  - Students are motivated to take responsibility for their own, and each others, learning
  - Enhances student engagement with material
  - Facilitates interaction between students
  - Develops communication and teamwork skills

- **An efficient way to cover content**

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 study notes provided. They first study their notes individually

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 consider 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

STAGE 1

❑ Divide into **Base Groups** of 3, and number yourselves 1 to 3

❑ Refer to the Additional Handout for three teaching methods

❑ Person 1 studies <u>only</u> Method 1, Person 2 studies <u>only</u> Method 2, etc.

5 minutes

STAGE 2

❑ Form **Expert Groups** – all 1's, all 2's, and all 3's

❑ Discuss what you have learned and consider how best to explain to others

Skip this today for time

❑ This stage can be carried out during the lecture

❑ Often better between lectures – allowing more discussion & background research

STAGE 3

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

10 minutes

- 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 themselves and each other

- The instructor must check appropriate student learning has occurred

How might instructors check for understanding?

Which active learning technique clarifies and reinforces independent learning through peer-peer discussion?

1. **Formulate – Share – Create - Revise**
2. **Mud Cards**
3. **Recitation / Ticking**

Most people learn 70% of what they talk over with others (Biggs, 1999)

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- Independent learning clarified and reinforced through discussion with peers
    - the F-S-C-R approach structures and focuses the discussion

- Student engagement is increased because they have a responsibility / accountability to their partner

- Lecturer has EVERYONE thinking about the question posed
    - different from asking a question and then calling on an individual student, which leads some to gamble they won't be the one who gets called on and therefore they don't think much about the question.

- Students get to try out their answers in the private sanctuary of the pair, before having to "go public" before the rest of their classmates.
    - Unconfident students are at least giving an answer to SOMEONE this way

- The approach often stimulates valuable group discussion

Which active learning technique motivates students to spend more time in private study by requiring them to explain their learning to the class?

1. **Formulate – Share – Create - Revise**
2. **Mud Cards**
3. **Recitation / Ticking**

Most people learn 95% of what they explain to others (Biggs, 1999)

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

- Generating time on task
  - The prospect of being called upon in the recitation session motivates students to spend more time on problems

- Generating appropriate learning activities
  - Because they must not only solve the problems, but also be prepared to present them in class, students are encouraged to reflect on how to explain their methods and decisions
  - This leads to deeper learning

(based on Gibbs, 1999)

- Providing prompt feedback that students pay attention to
    - Students have prepared exactly the same problems that others present - they are able to follow the problem-solving presented in class
    - This provides immediate feedback for all students, and often leads to good discussions on alternative solutions.

- Helping the students internalize criteria for quality
    - Students will observe recitations of differing quality, and will begin to notice what makes a good solution and a good presentation

See Handbook, pp. 29-30

(based on Gibbs, 1999)

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".

(Courtesy of KTH-Royal Institute of Technology)

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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)

Which active learning technique encourages students to reflect on their learning and provides immediate feedback to the instructor?

1. **Formulate – Share – Create - Revise**
2. **Mud Cards**
3. **Recitation / Ticking**

What is still "clear as mud" to you?

What methods for engaging students might you now introduce to your teaching?