

Pedagogy in ML Education: Active Learning & Flipped Classroom

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Talk outline

- Why ML Pedagogy Needs Reconsideration?
- What do we mean by learning?
- Teaching-Learning methodologies
- Limitations of traditional ML pedagogy
- Active Learning
- Active Learning strategies for classroom
- Flipped Classroom
- Challenges in Active Learning/Flipped Classroom

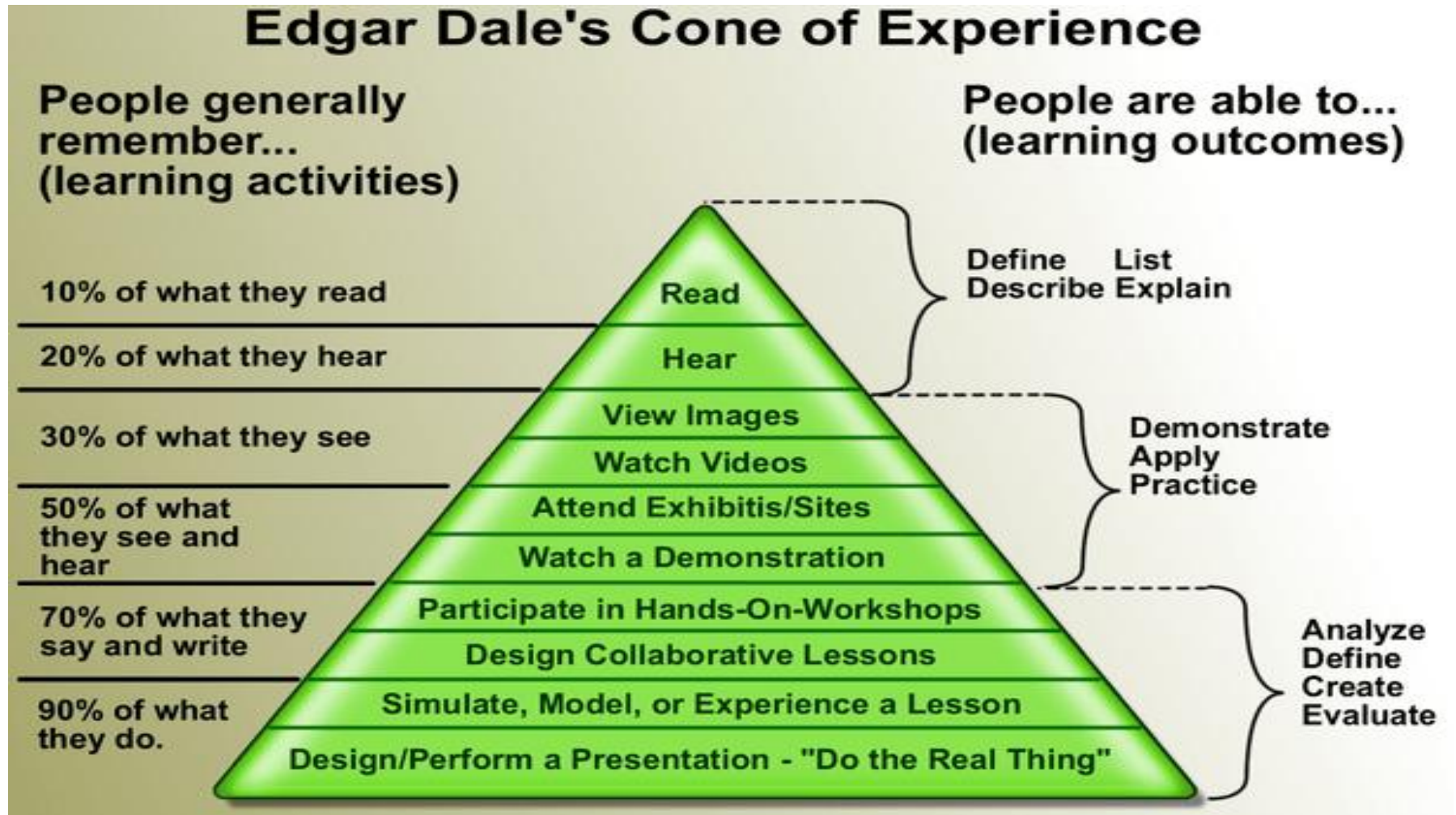
Why ML Pedagogy Needs Reconsideration

- Machine Learning is an interdisciplinary subject combining mathematics, statistics, algorithms, and programming.
 - Undergraduate learners often face cognitive overload due to abstraction and mathematical formulation.
 - Traditional lecture-centric approaches emphasize content coverage rather than conceptual mastery.
 - Industry and research require graduates capable of applying ML to real-world, ill-defined problems.
 - Hence, pedagogy must shift from transmission-based teaching to learning-centered models.



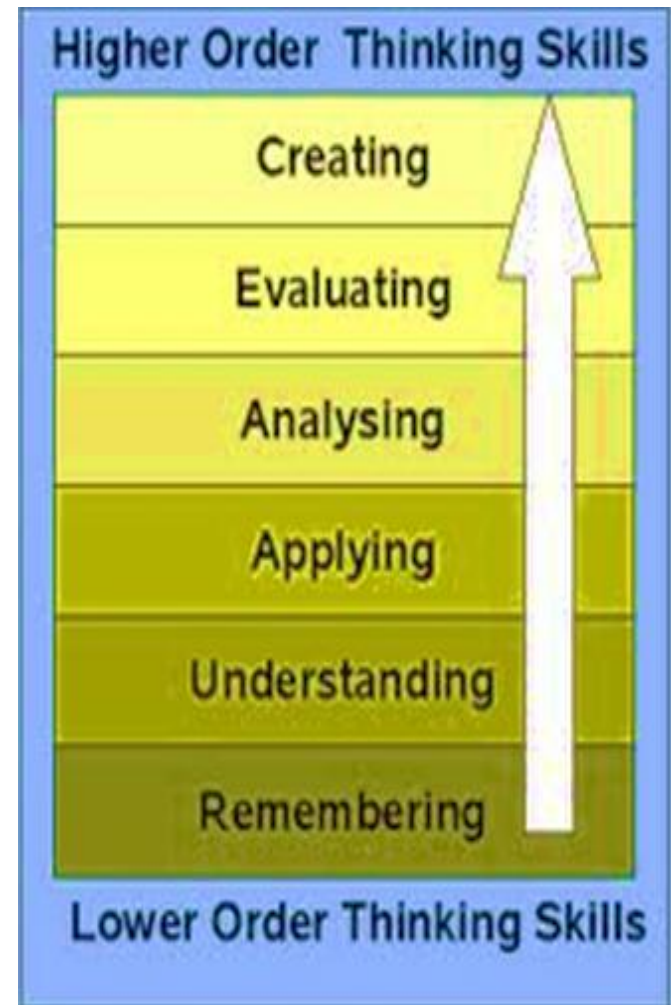
What Do We Mean by Learning?

Learning is an active process of constructing meaning, not passive reception of information.



What Do We Mean by Learning?

- Educational psychology defines learning as a change in understanding, skills, or attitudes.
- Bloom's taxonomy highlights progression from remembering to creating knowledge.
- ML education should emphasize higher-order cognitive skills such as analysis and synthesis.
- Active engagement is essential to move learners beyond rote memorization.



Teaching-Learning Methodologies

- Teacher-centered approaches rely heavily on lectures and demonstrations.
- Student-centered approaches emphasize participation, inquiry, and collaboration.
- Hybrid models blend online resources with in-class interaction.



- Modern ML education benefits from blended and student-centered models.
- Pedagogical choice should align with learning outcomes and learner profile.

Limitations of Traditional ML Teaching

Lectures often prioritize mathematical derivations over intuition and application.

Students struggle to connect algorithms with datasets and real problems.

Limited classroom interaction reduces feedback and misconception correction.

Assessment focuses on exams rather than applied competence.

This results in surface learning and low confidence in ML implementation.



What is Active Learning?

You can remember:

- > 10% of what you read
- > 20% of what you hear
- > 30% of what you see
- > 50% of what you see & hear

You can:

- > Define, list, describe
- > Demonstrate, practice, repeat

**PASSIVE
LEARNING**

- > 70% of what you say & write
- > 90% of what you do

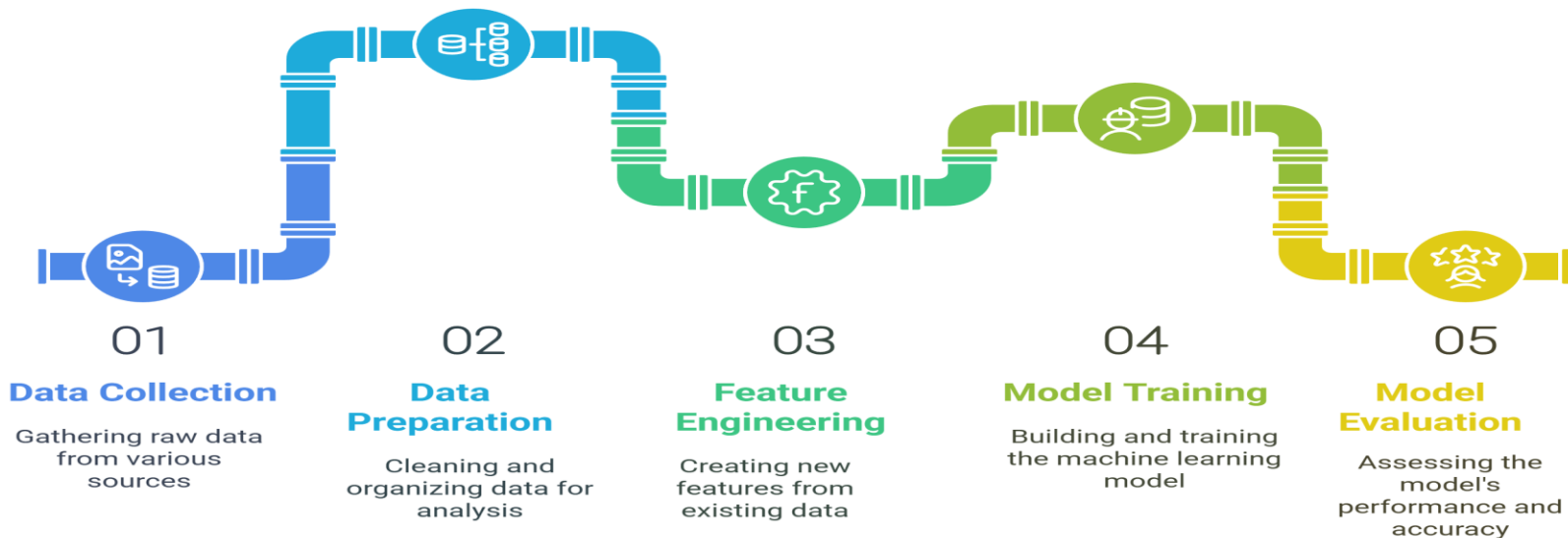
**ACTIVE
LEARNING**

- > Analyse, solve, plan, predict, create, produce, construct, do

Why Active Learning is Suitable for ML

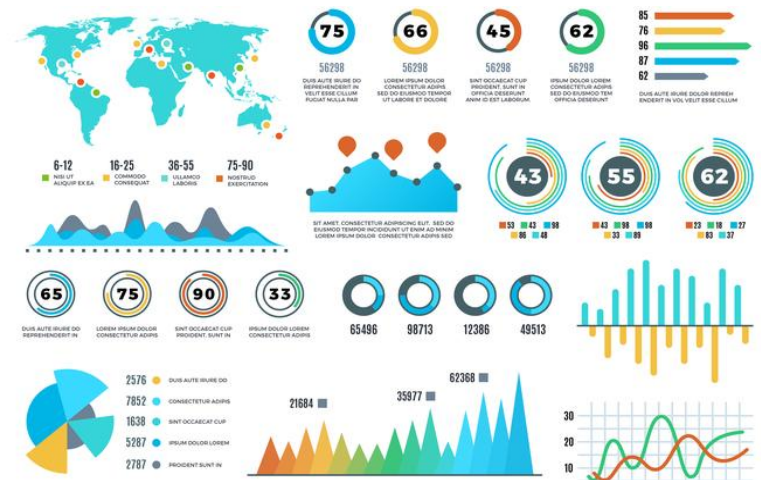
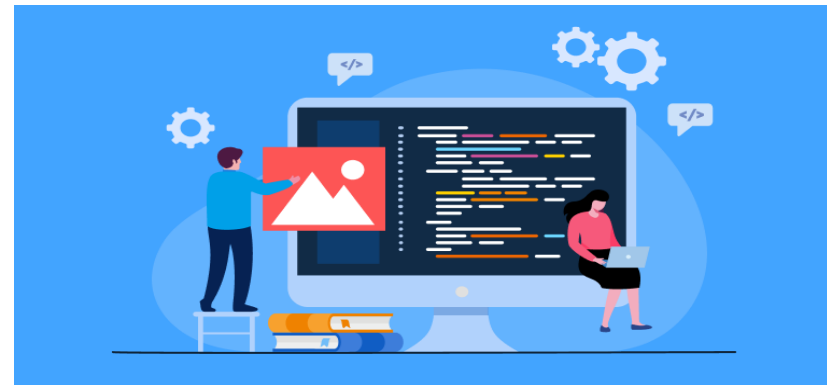
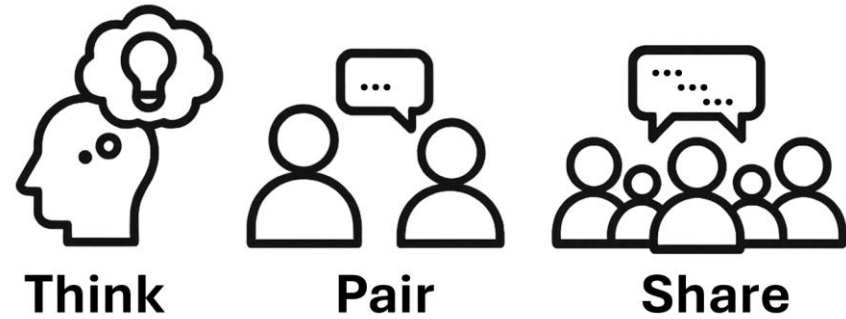
- ML learning inherently involves experimentation and iteration.
- Students learn better by training models, observing errors, and refining solutions.
- Active learning mirrors the real ML workflow used in industry and research.
- It enhances conceptual clarity and transfer of learning.
- It also supports diverse learner backgrounds and pacing.

Machine Learning Pipeline Stages



Active Learning Strategies in ML Classrooms

- Think-Pair-Share for algorithm intuition and design choices.
- Live coding sessions where students implement algorithms alongside the instructor.
- In-class dataset exploration and visualization activities.
- Conceptual quizzes followed by peer discussion.
- Group-based error analysis and model comparison.

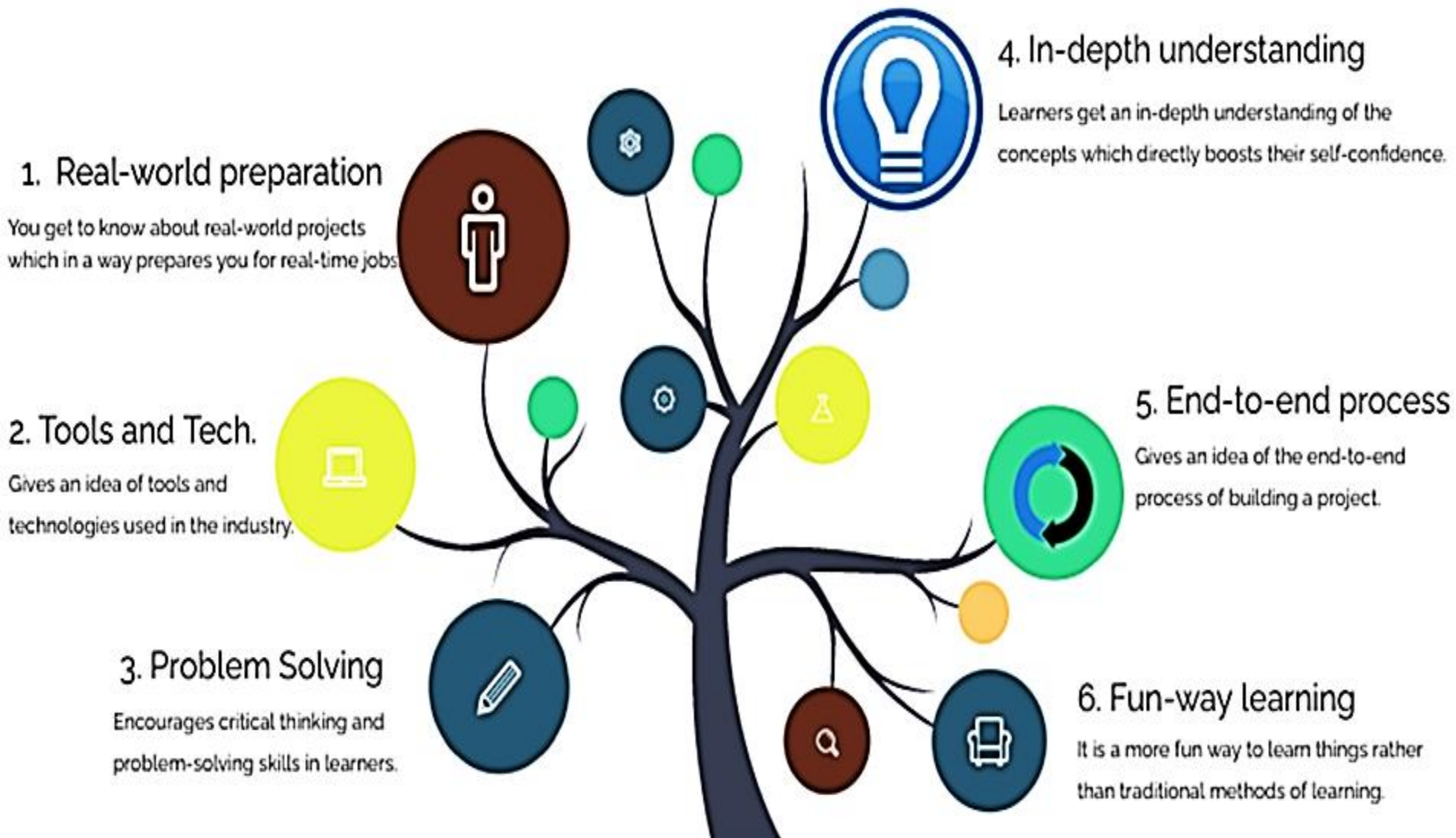


Problem-Based Learning (PBL)

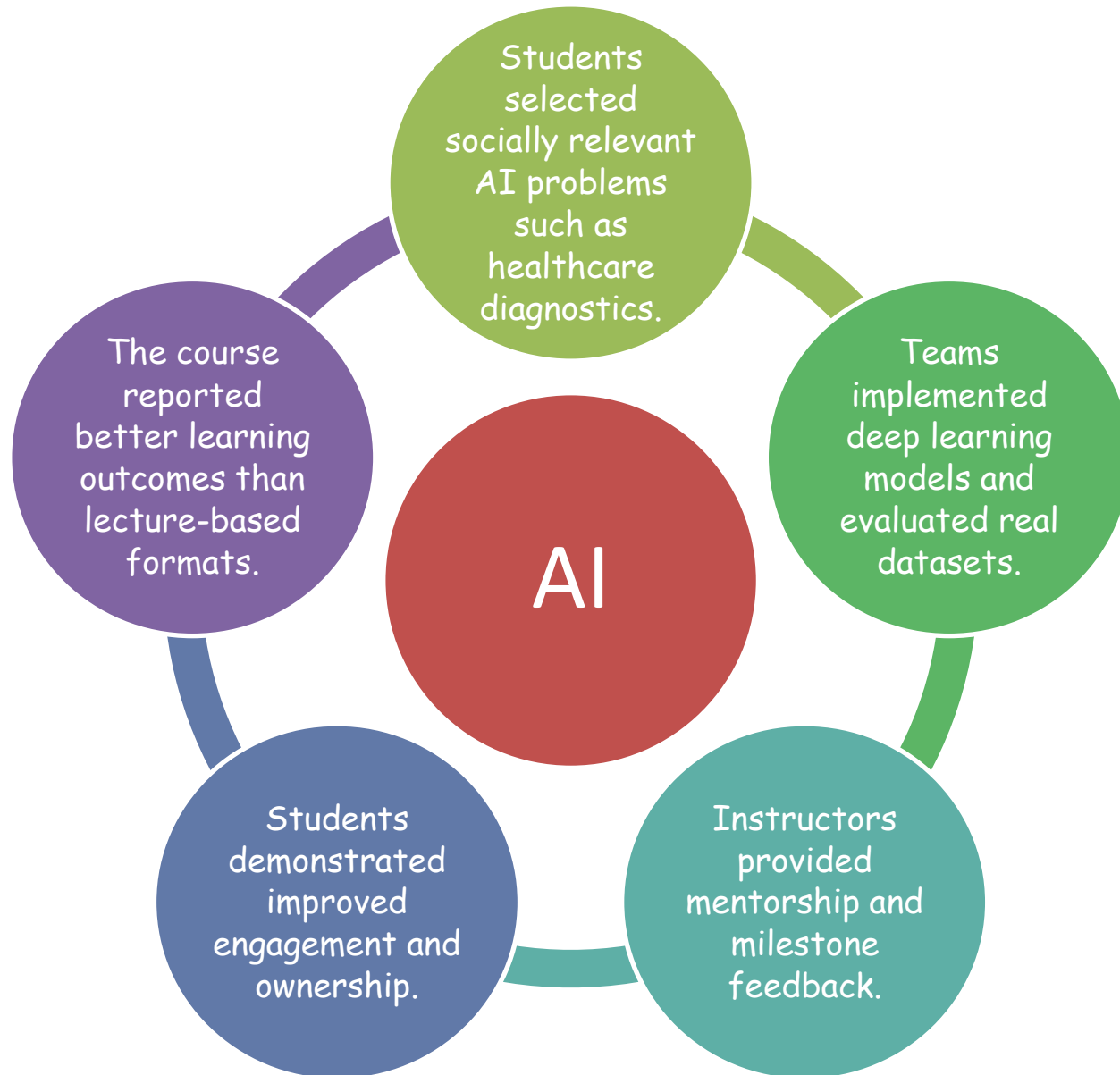
- Students begin learning with an open-ended real-world problem.
- Required theory is learned contextually as needed.
- PBL encourages inquiry, hypothesis formulation, and critical thinking.
- ML problems such as prediction or classification suit PBL well.
- The instructor guides learning rather than prescribing solutions.



Project-Based Learning in ML

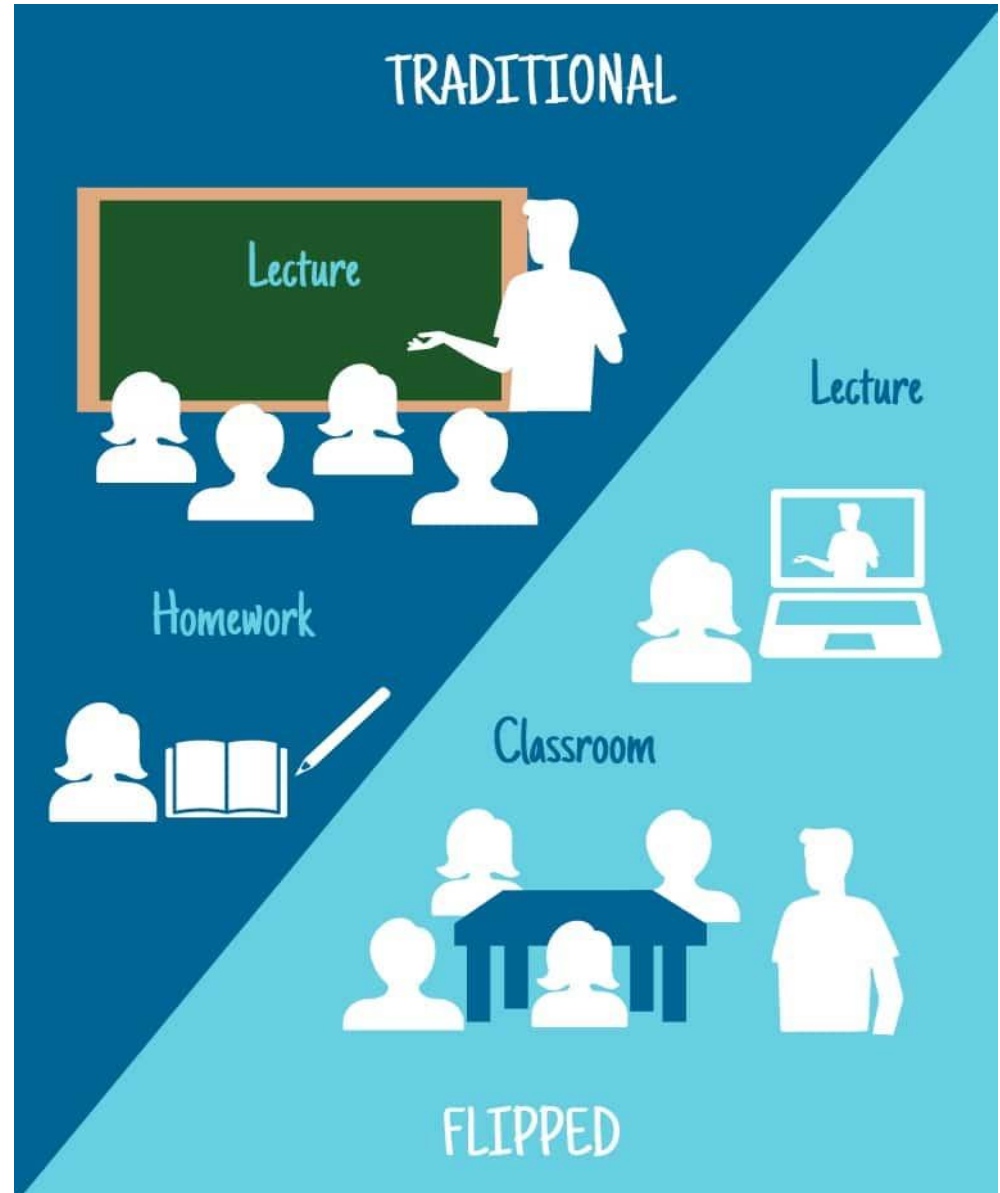


Case Study: PBL in an AI Course



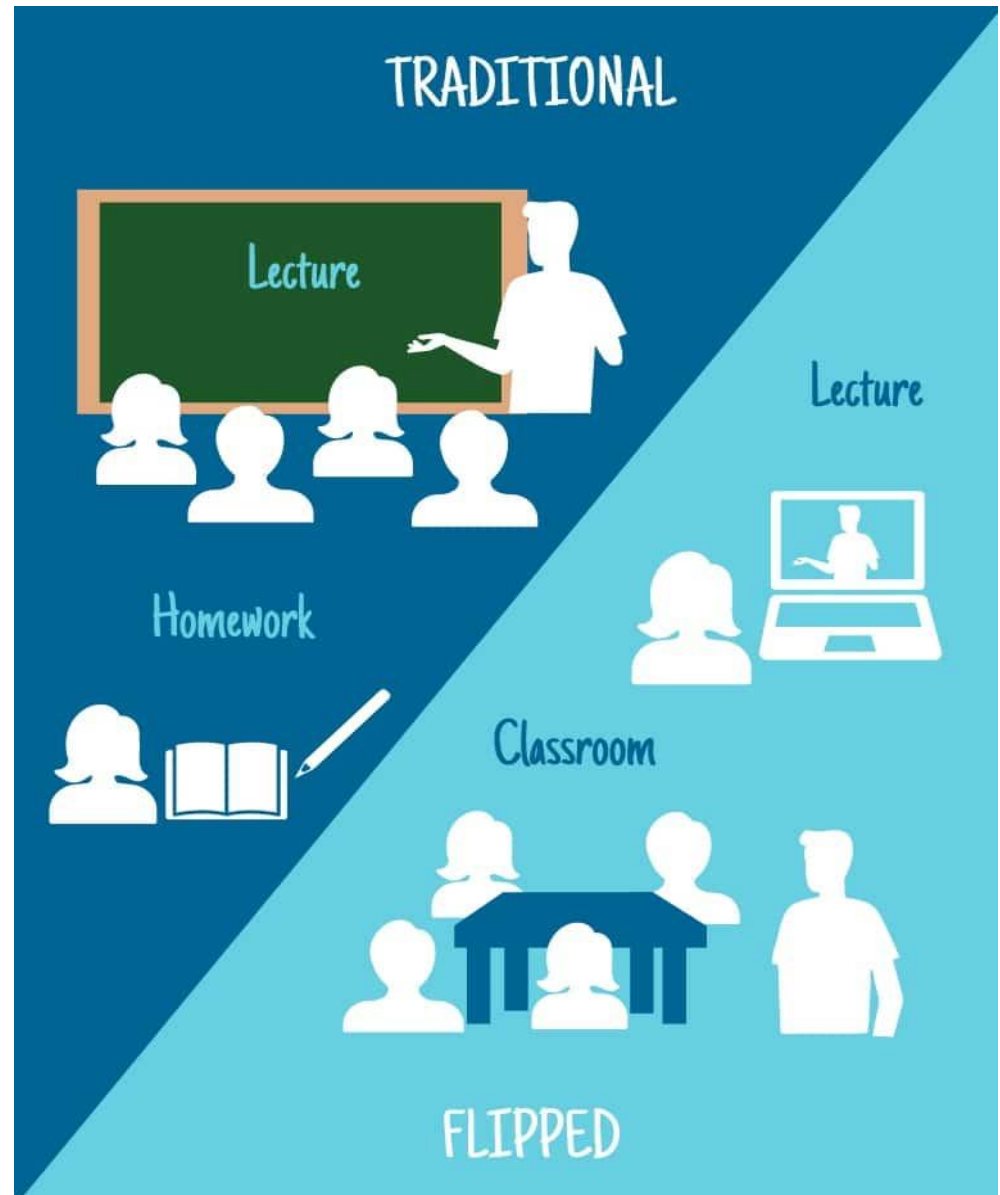
What is a Flipped Classroom?

- Flipped classrooms move content delivery outside class time.
- Students watch videos or read material before coming to class.
- Classroom time is used for problem-solving and discussion.
- This model maximizes instructor-student interaction.
- It supports self-paced learning.



Why Flip an ML Classroom?

- ML concepts often require repeated exposure and practice.
- Pre-recorded content allows students to learn at their own pace.
- In-class time can be devoted to coding and debugging.
- Faculty can address misconceptions immediately.
- Improves engagement and conceptual understanding.



Structure of a Flipped ML Lecture

Pre-class: video lecture on algorithm fundamentals.



In-class: hands-on implementation using datasets.



Group discussion on model performance and errors.



Instructor provides targeted guidance.



Post-class reflection consolidates learning.

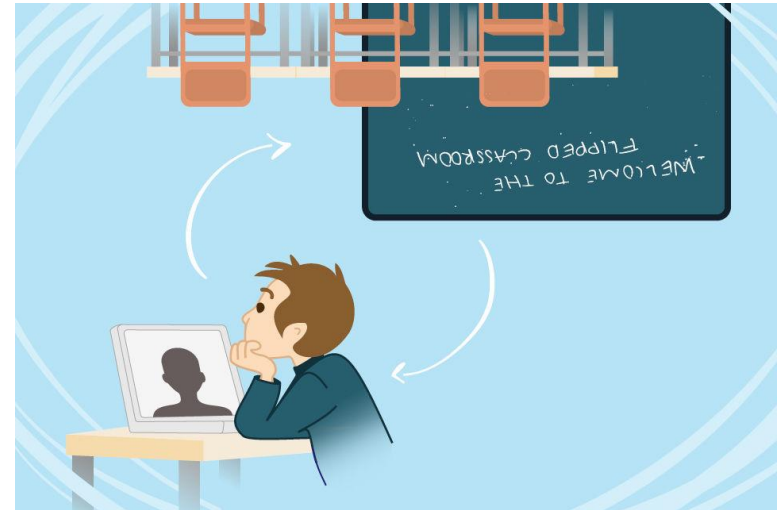
Challenges in Active and Flipped Learning

Table 2

Challenges of the flipped classroom.

Category	frequency
Time consuming (teachers' perspective)	14%
Limited student preparation	13%
Poor video quality	13%
Time consuming (students' perspective)	11%
Increased workload (students' perspective)	10%
Inability to get immediate help/feedback	10%

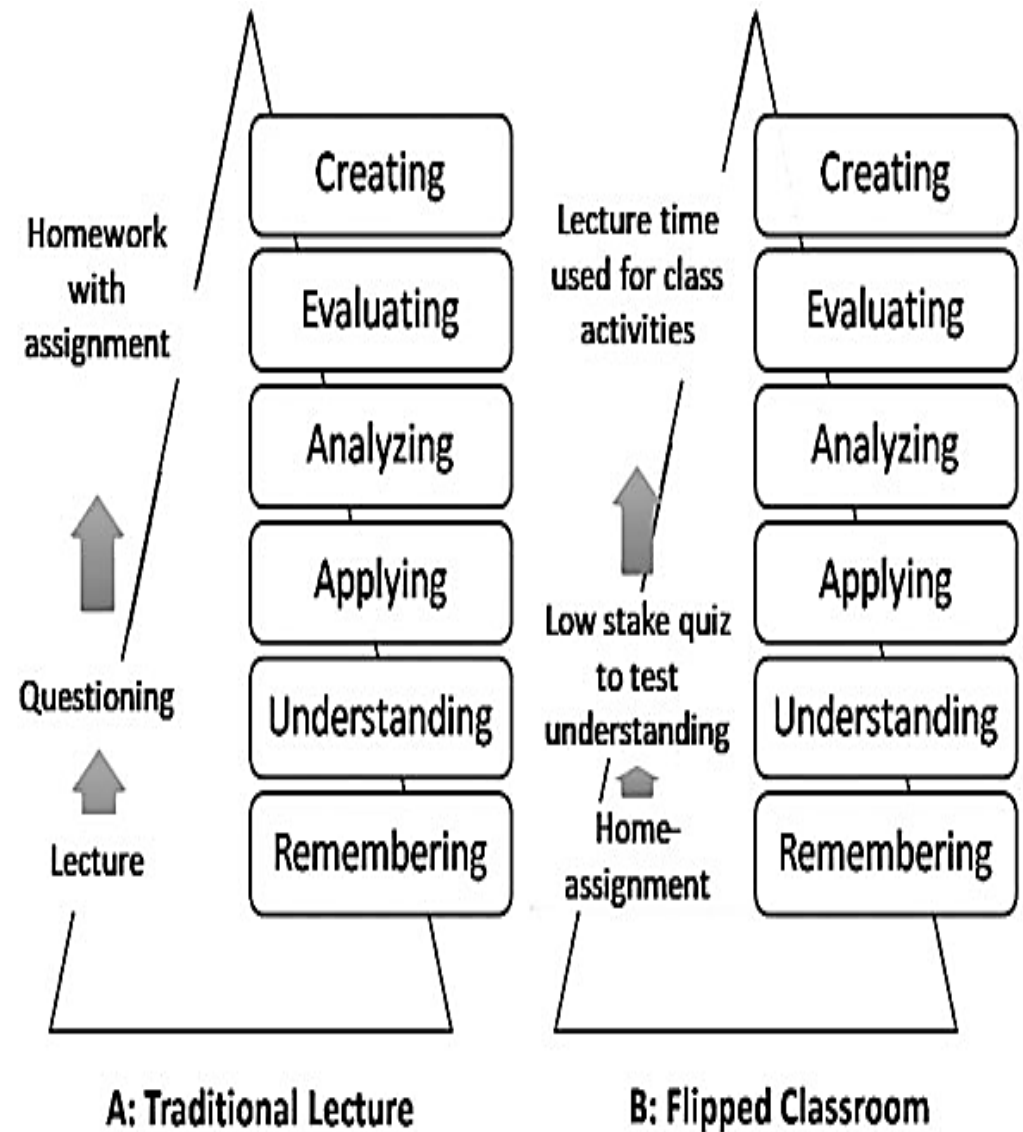
Table adapted from Akçayir and Akçayir, 2018



- Initial resistance from students accustomed to lectures.
- Increased preparation effort for instructors.
- Managing large classes can be challenging.
- Ensuring students complete pre-class work.
- Assessment design requires careful planning.

Alignment with Outcome-Based Education

- Active & Flipped learning supports achievement of higher-order outcomes.
- Facilitates attainment of NBA program outcomes.
- Evidence-based assessment supports accreditation.
- Encourages continuous improvement.
- Aligns teaching, learning, and assessment.



*Thank
you!*

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