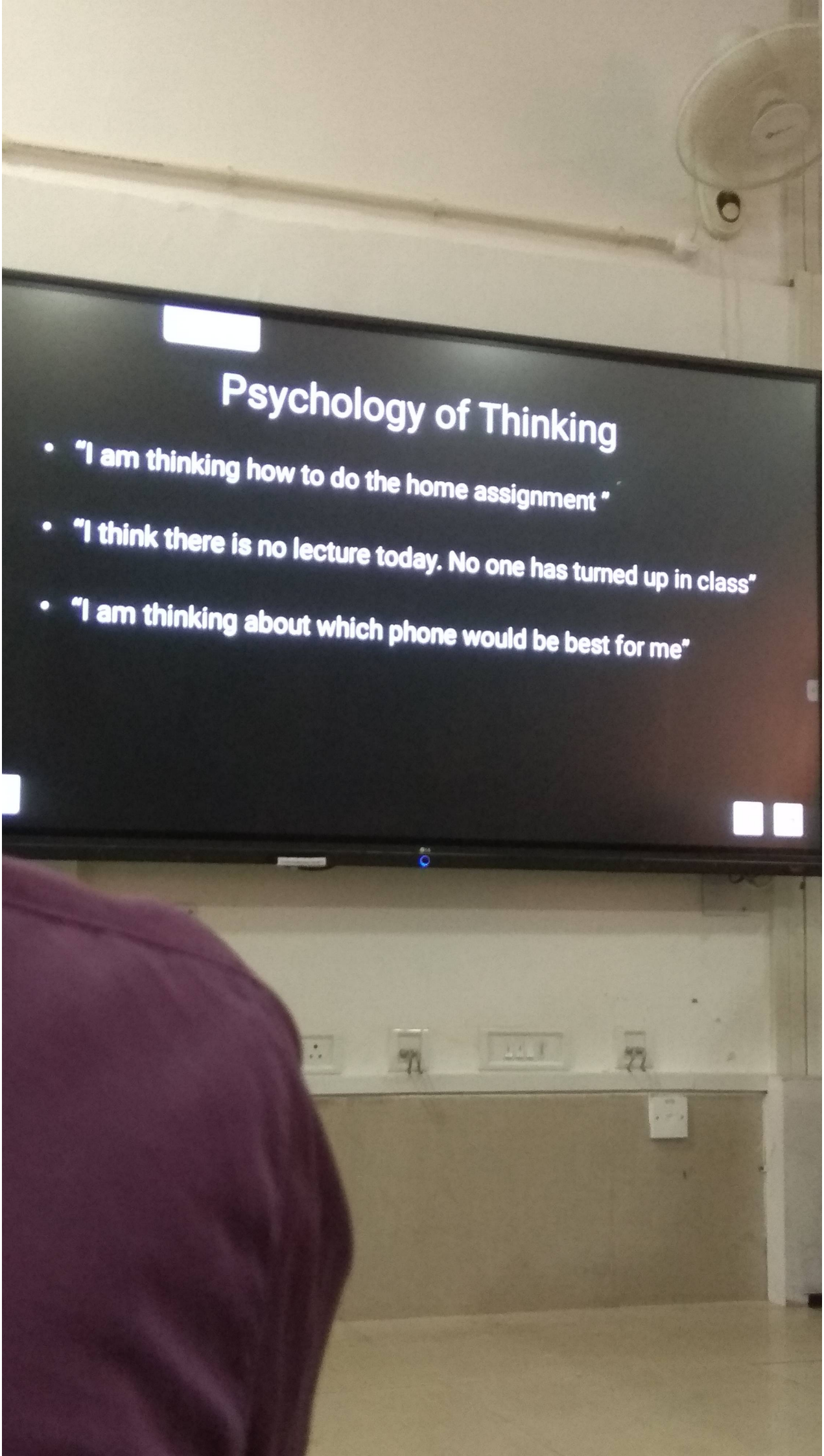
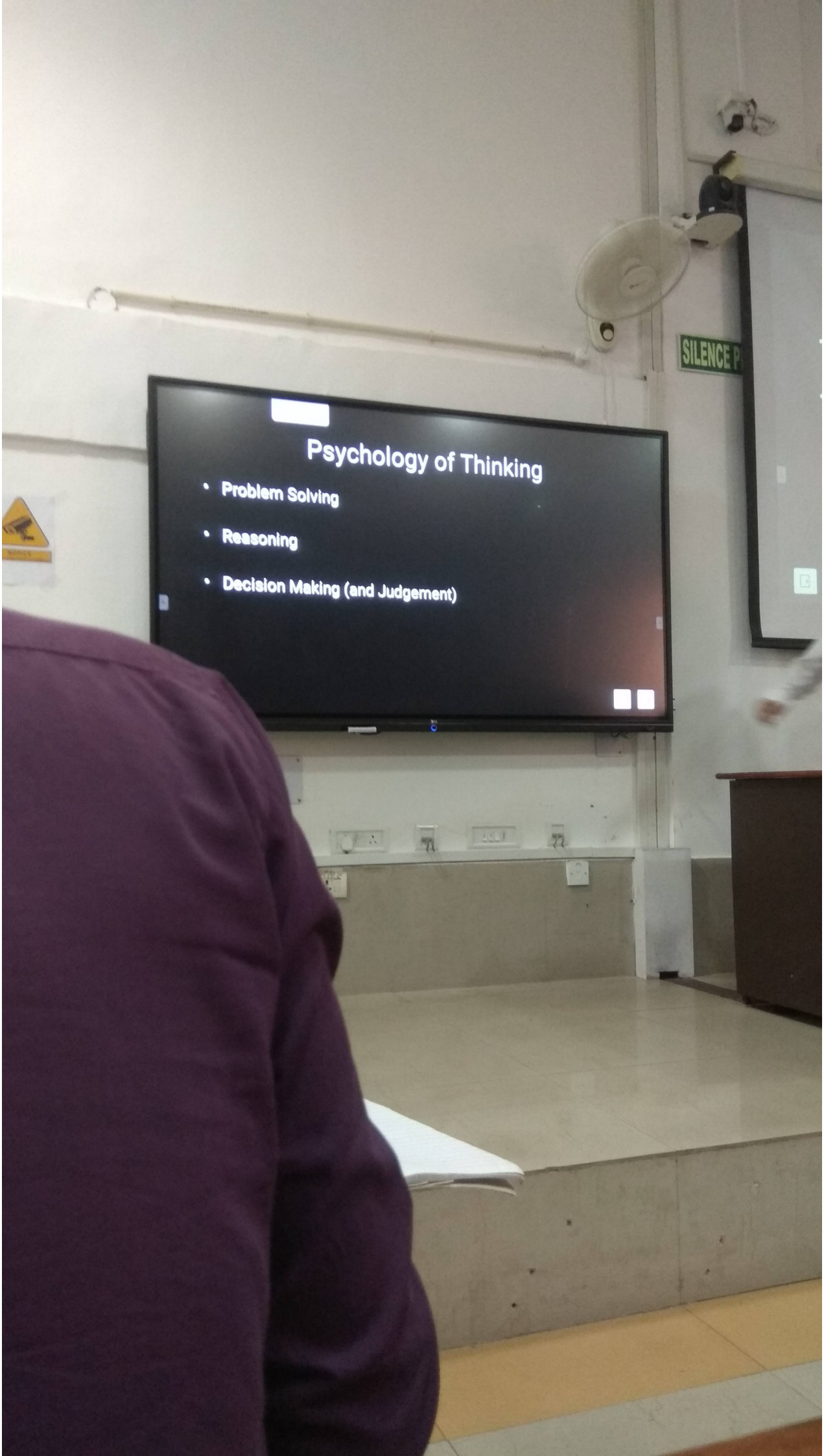
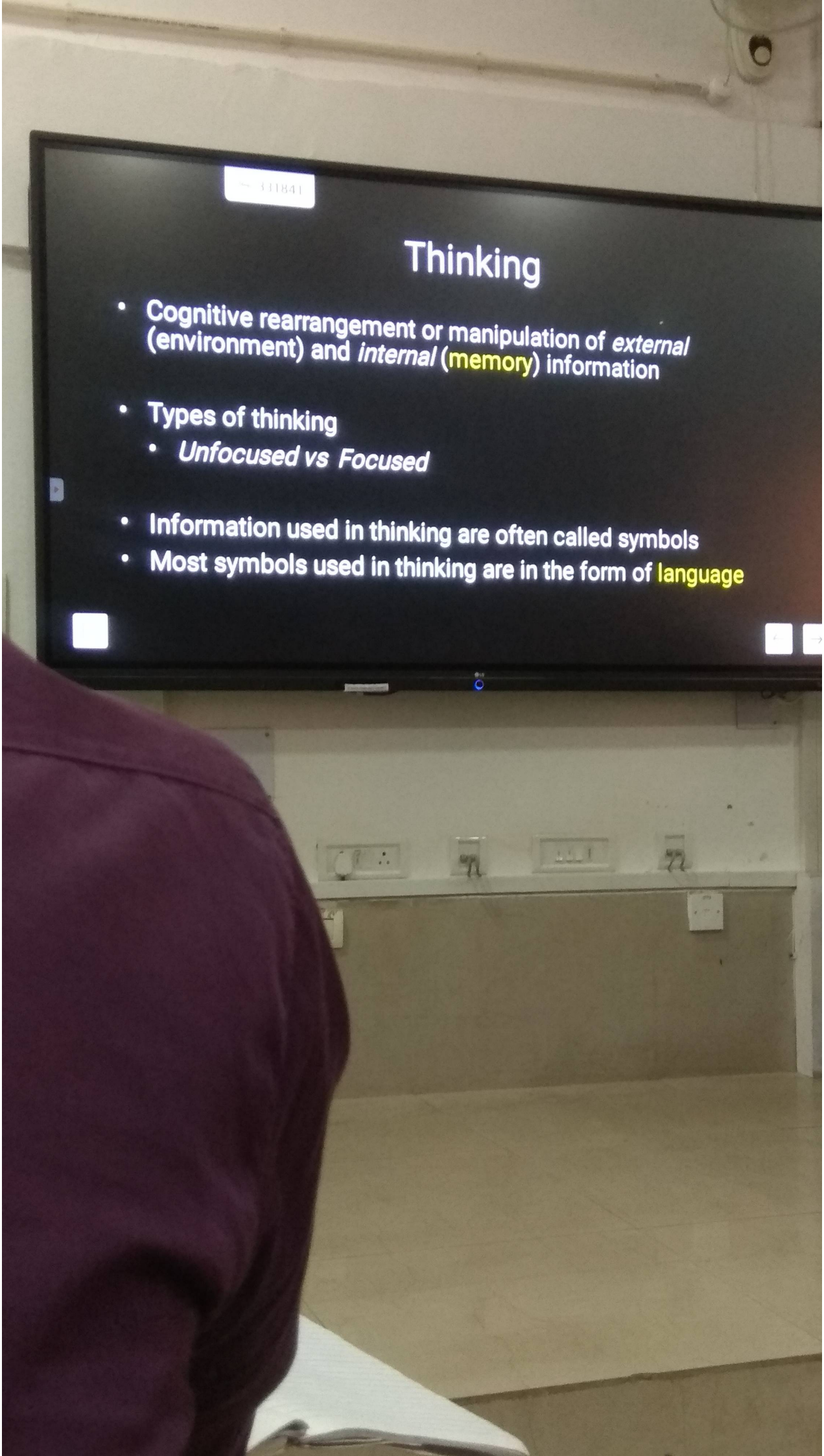
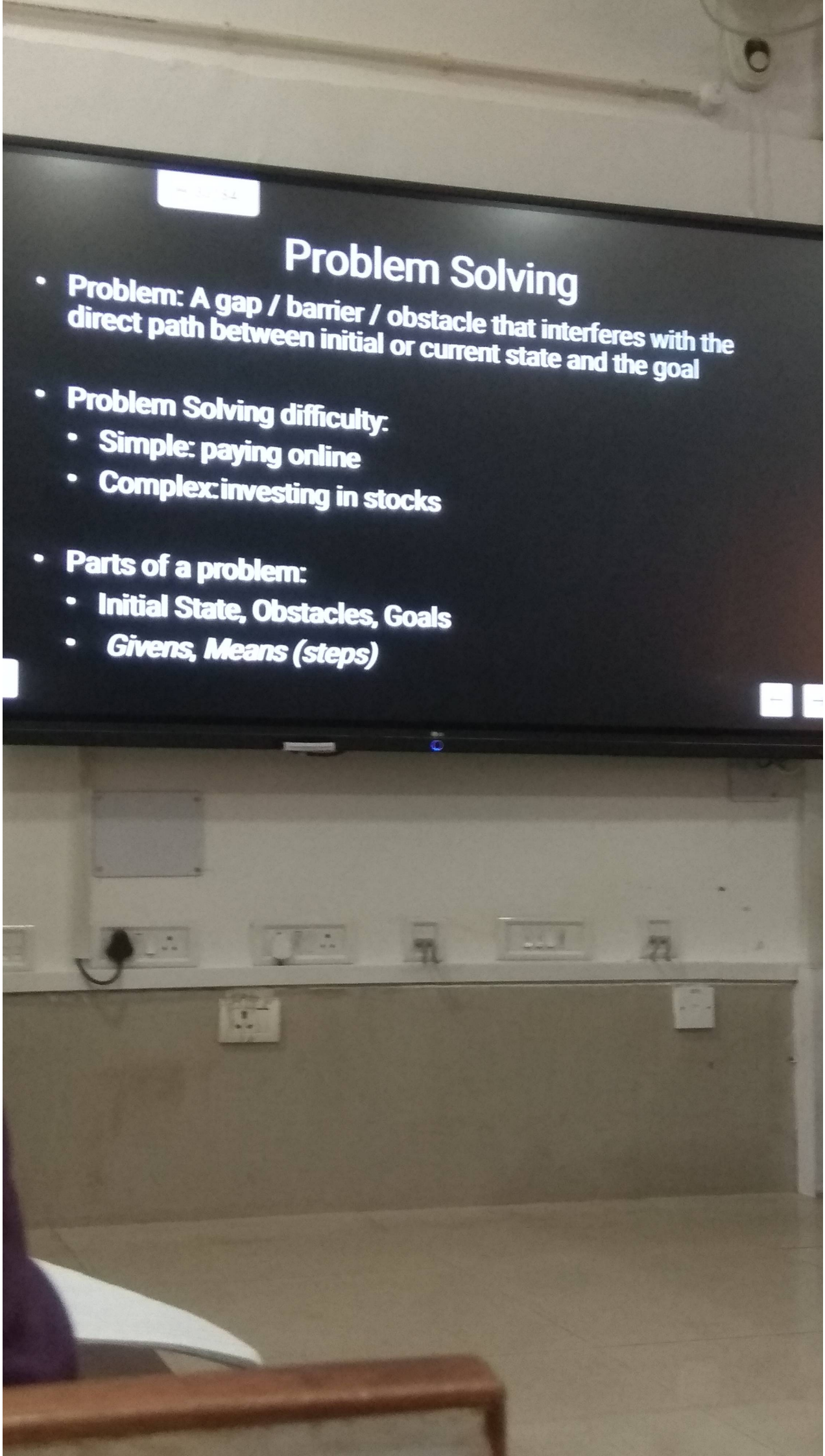

Psychology of Thinking
• "I am thinking how to do the home assignment "
• "I think there is no lecture today. No one has turned up in class"
• "I am thinking about which phone would be best for me"

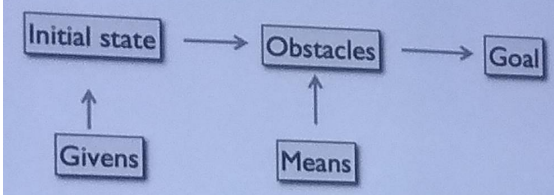

Psychology of Thinking
Problem Solving
Reasoning
Decision Making (and Judgement)
SILENCE P


331841
Thinking
Cognitive rearrangement or manipulation of external (environment) and internal (memory) information
Types of thinking
Unfocused vs Focused
Information used in thinking are often called symbols
Most symbols used in thinking are in the form of language

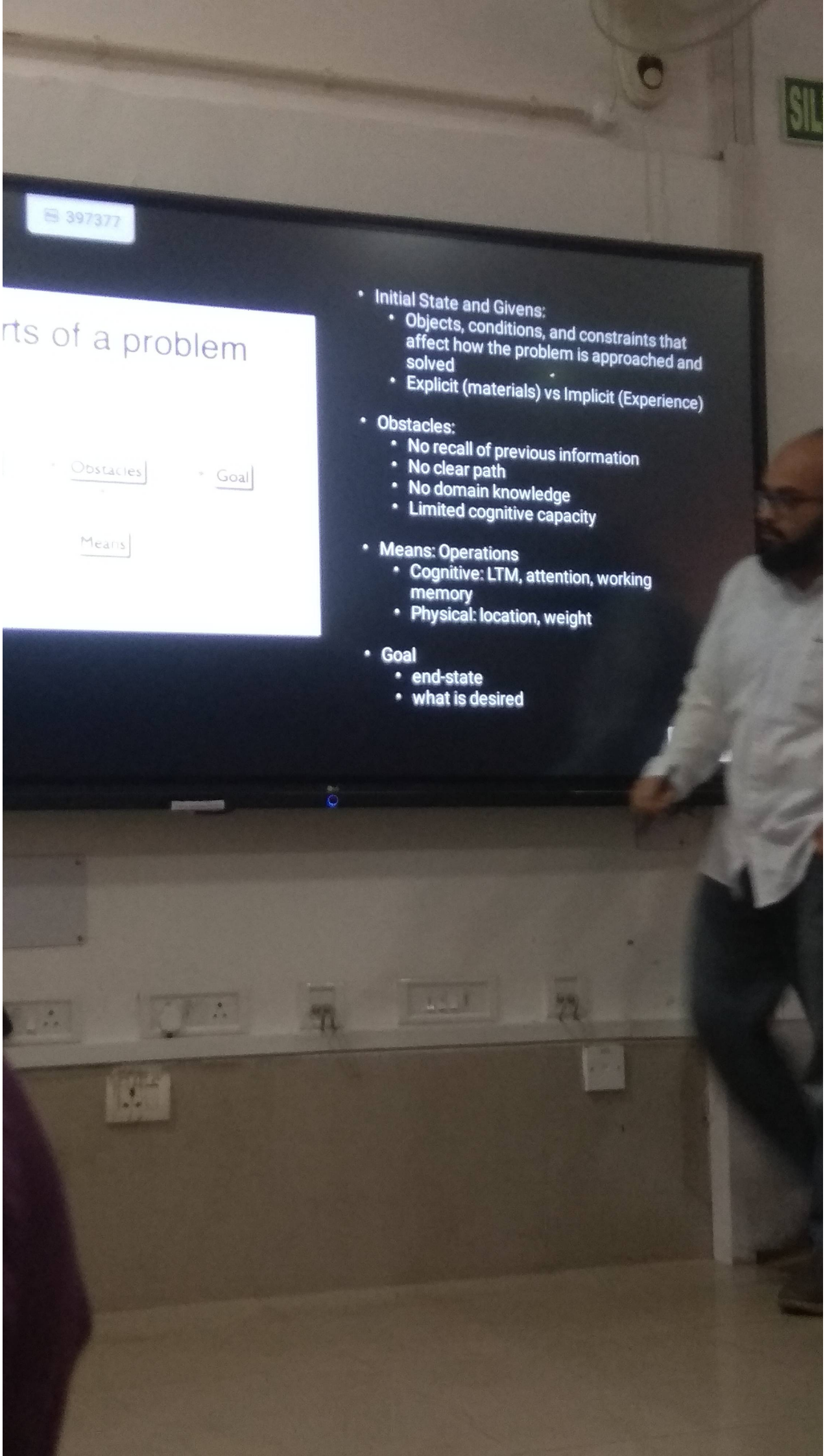

Problem Solving
Problem: A gap / barrier / obstacle that interferes with the direct path between initial or current state and the goal
Problem Solving difficulty:
Simple: paying online
Complex: investing in stocks
Parts of a problem:
Initial State, Obstacles, Goals
Givens, Means (steps)

397377

# Parts of a problem




- Initial State and Givens:
  - Objects, conditions, and constraints that affect how the problem is approached and solved
  - Explicit (materials) vs Implicit (Experience)
- Obstacles:
  - No recall of previous information
  - No clear path
  - No domain knowledge
  - Limited cognitive capacity
- Means: Operations
  - Cognitive: LTM, attention, working memory
  - Physical: location, weight
- Goal
  - end-state
  - what is desired


397377
rts of a problem
Obstacles
Goal
Means
Initial State and Givens:
Objects, conditions, and constraints that affect how the problem is approached and solved
Explicit (materials) vs Implicit (Experience)
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No domain knowledge
Limited cognitive capacity
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Cognitive: LTM, attention, working memory
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end-state
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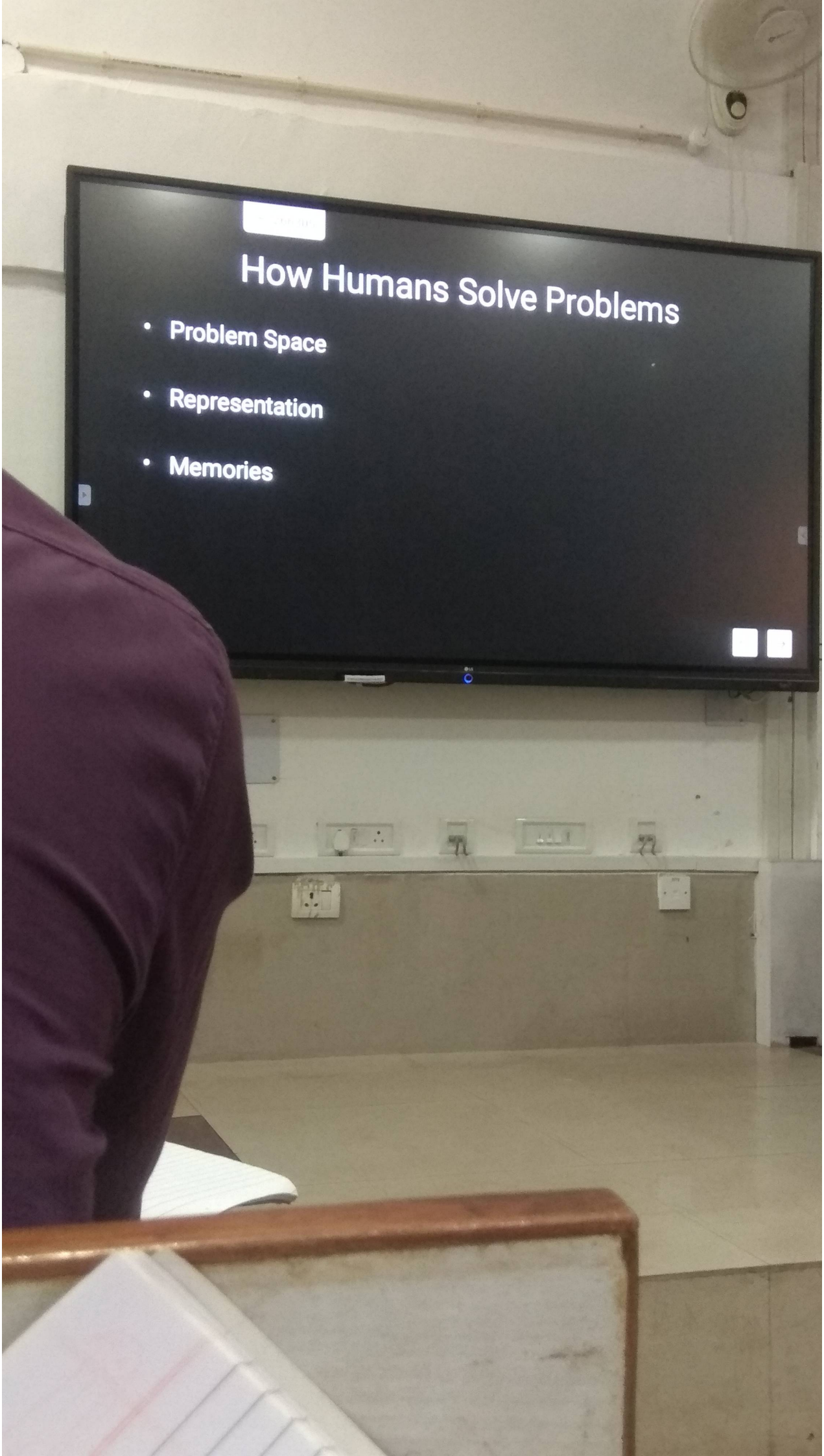
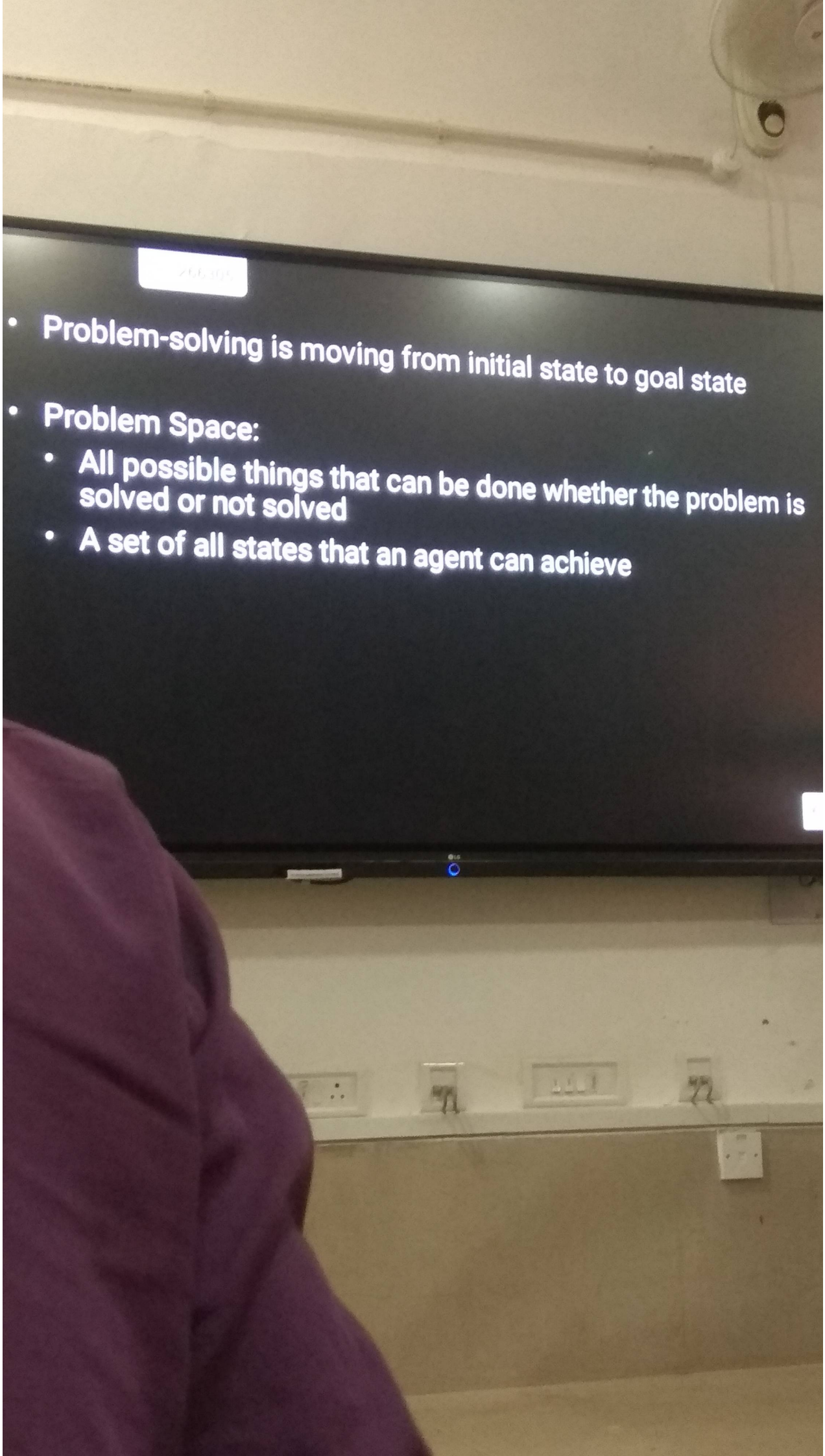
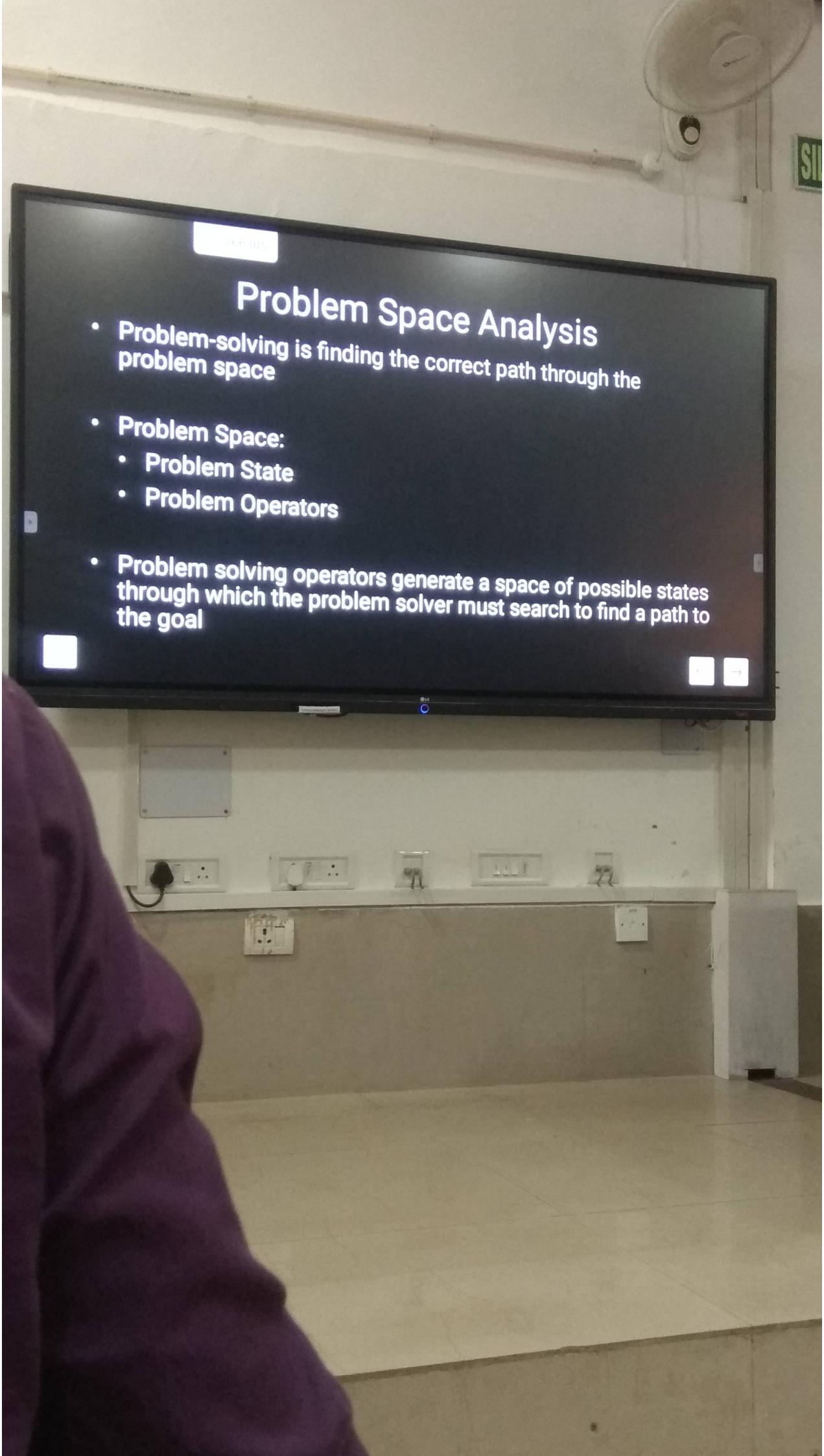
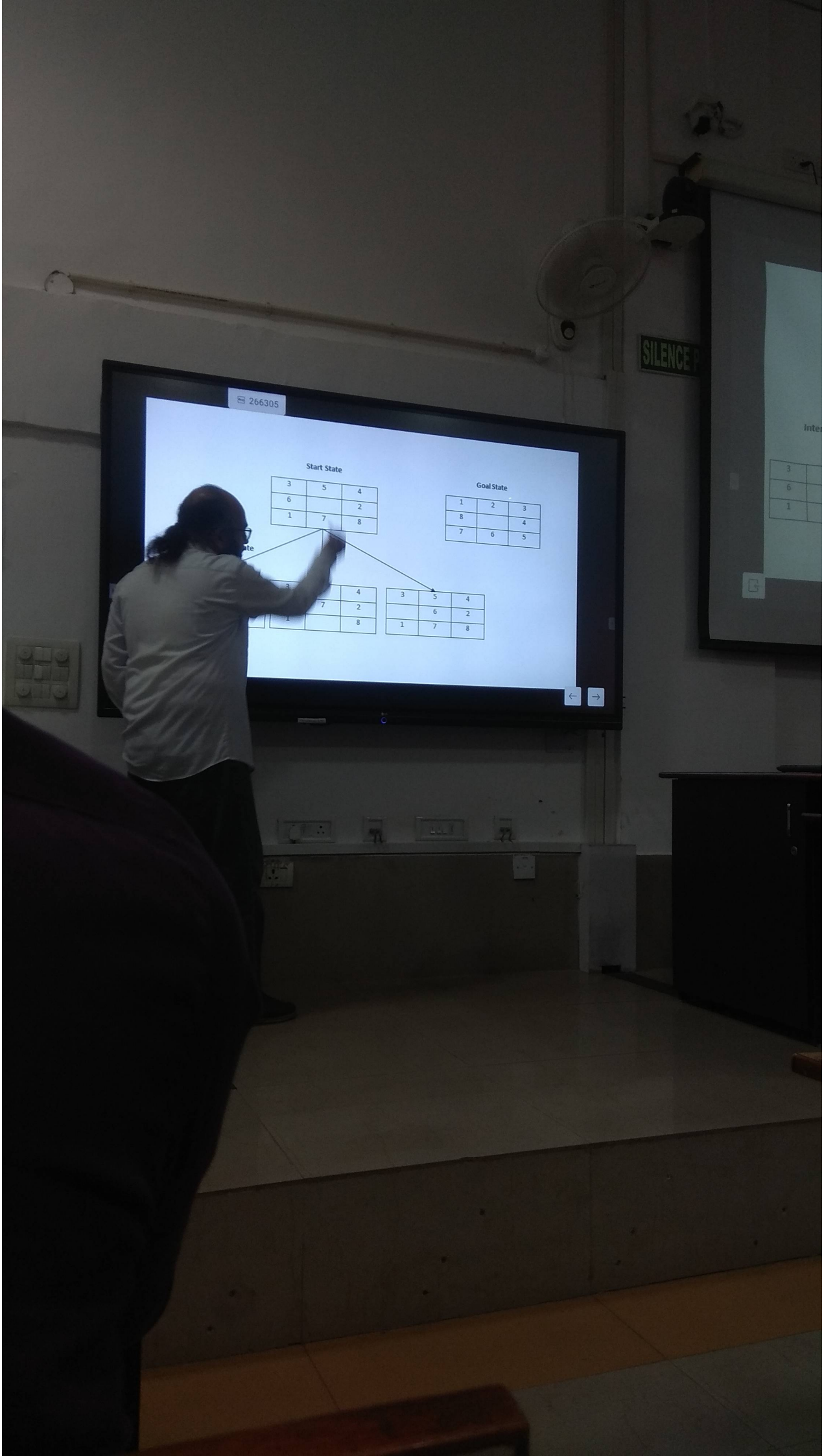
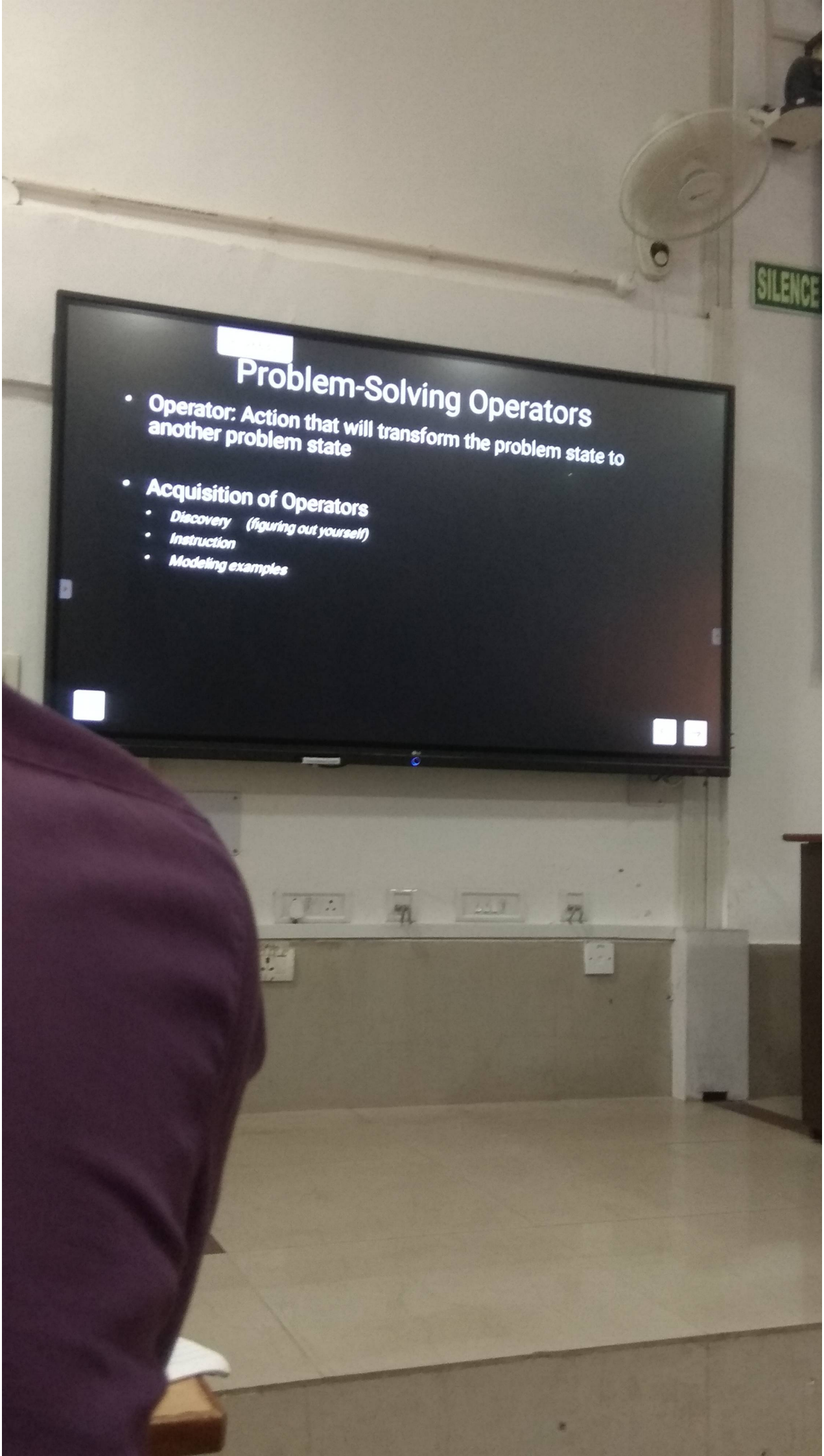
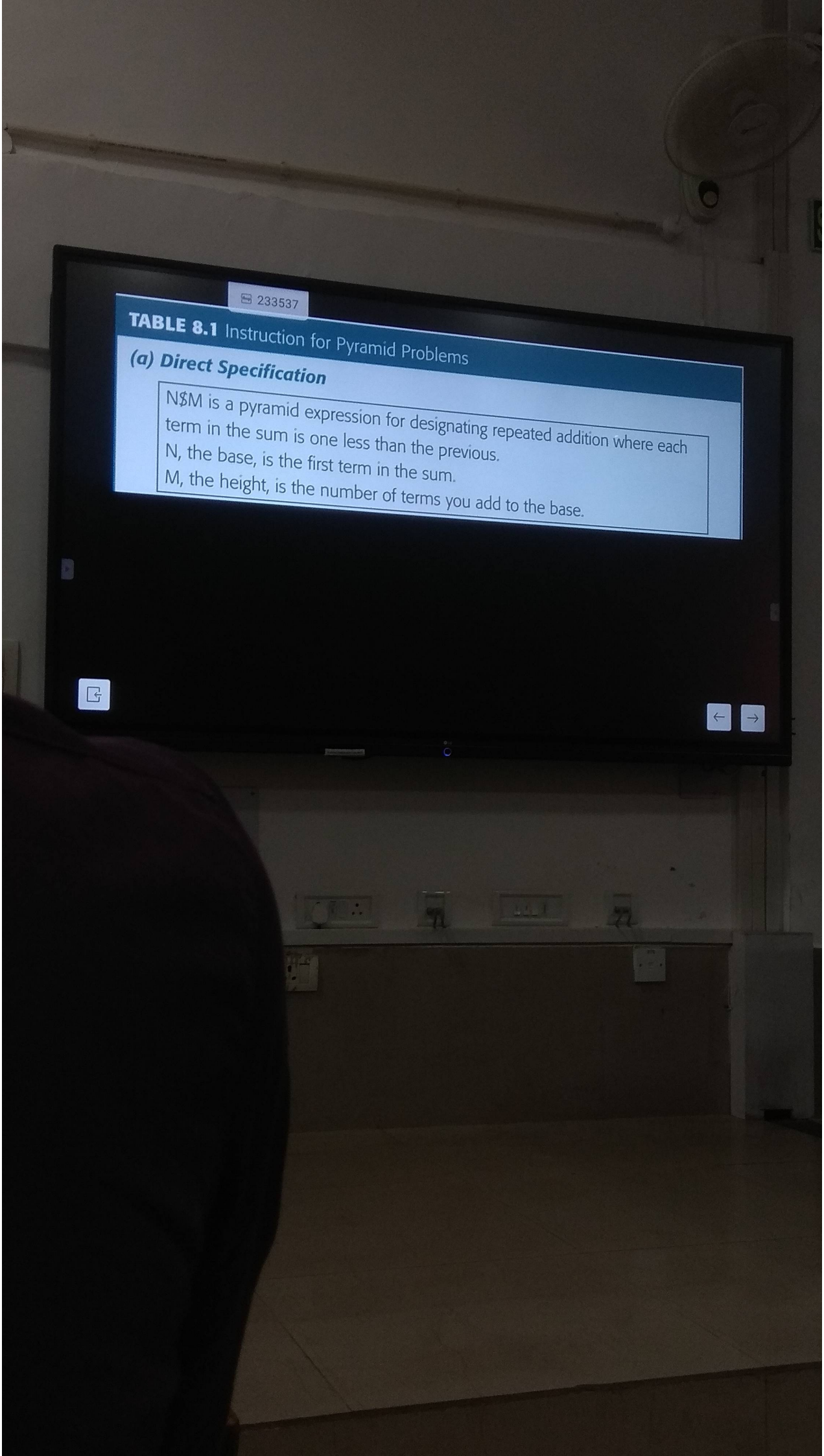

How Humans Solve Problems
Problem Space
Representation
Memories

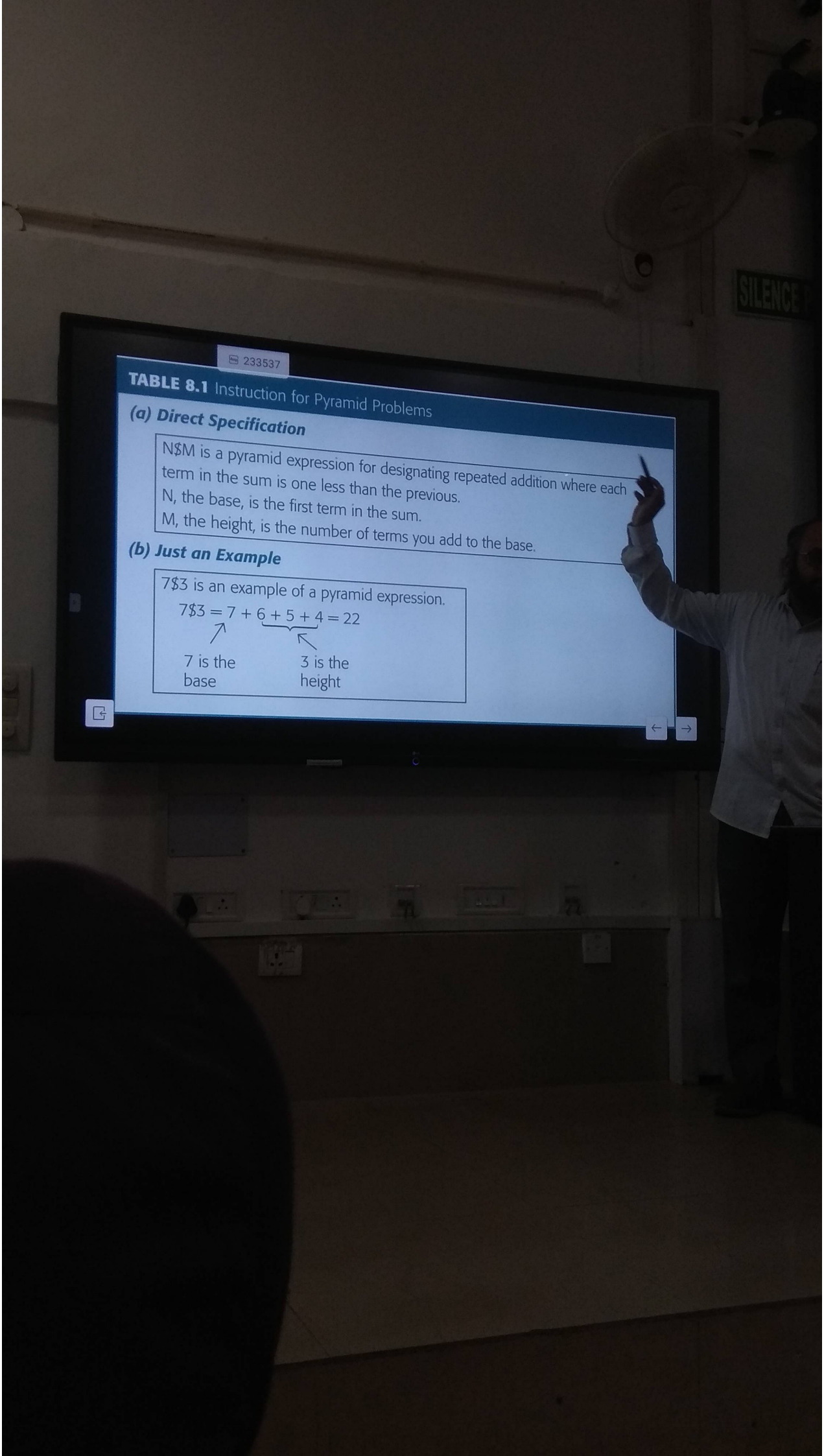

Problem-solving is moving from initial state to goal state
Problem Space:
All possible things that can be done whether the problem is solved or not solved
A set of all states that an agent can achieve

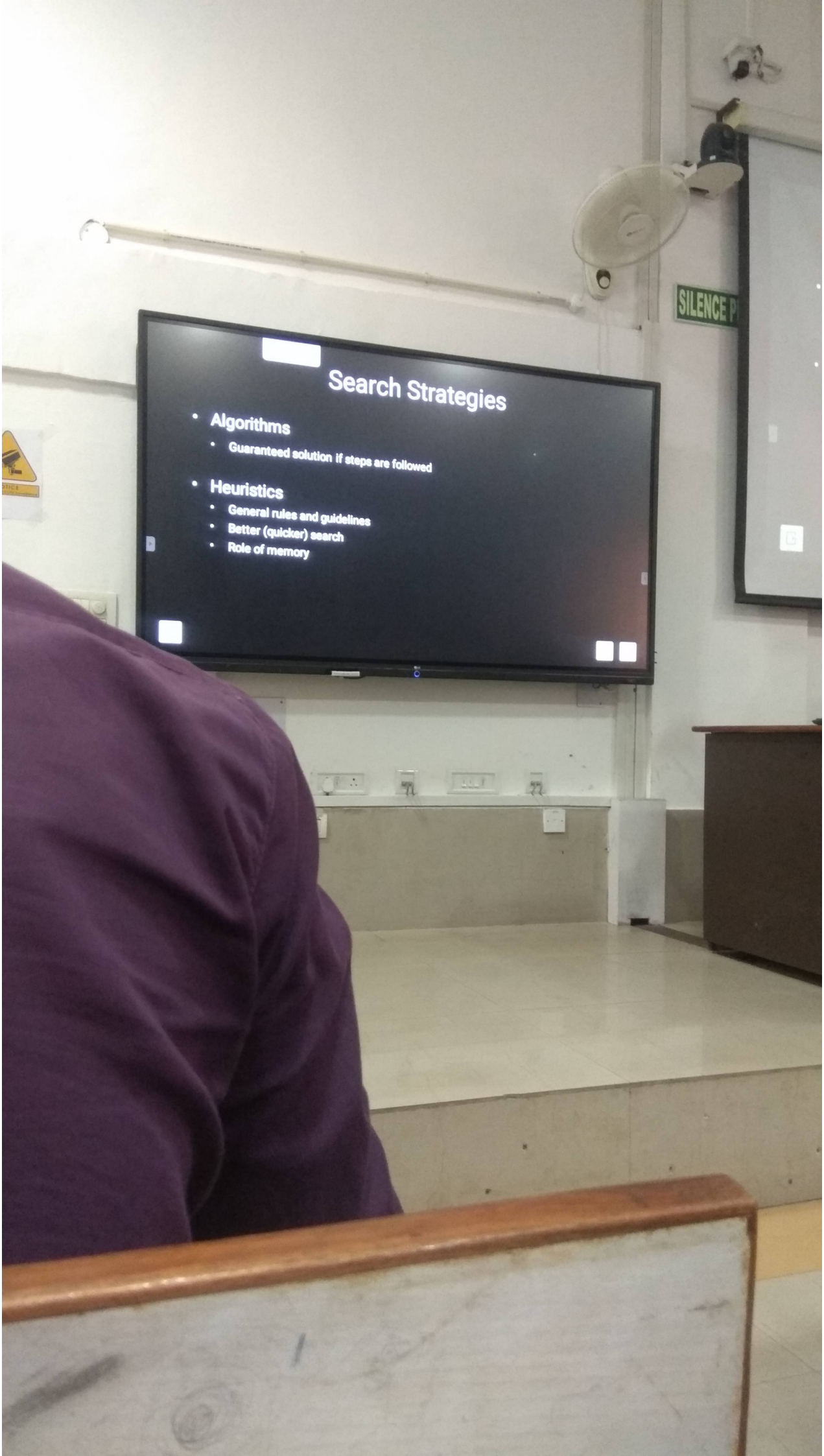

Problem Space Analysis
Problem-solving is finding the correct path through the problem space
Problem Space:
Problem State
Problem Operators
Problem solving operators generate a space of possible states through which the problem solver must search to find a path to the goal

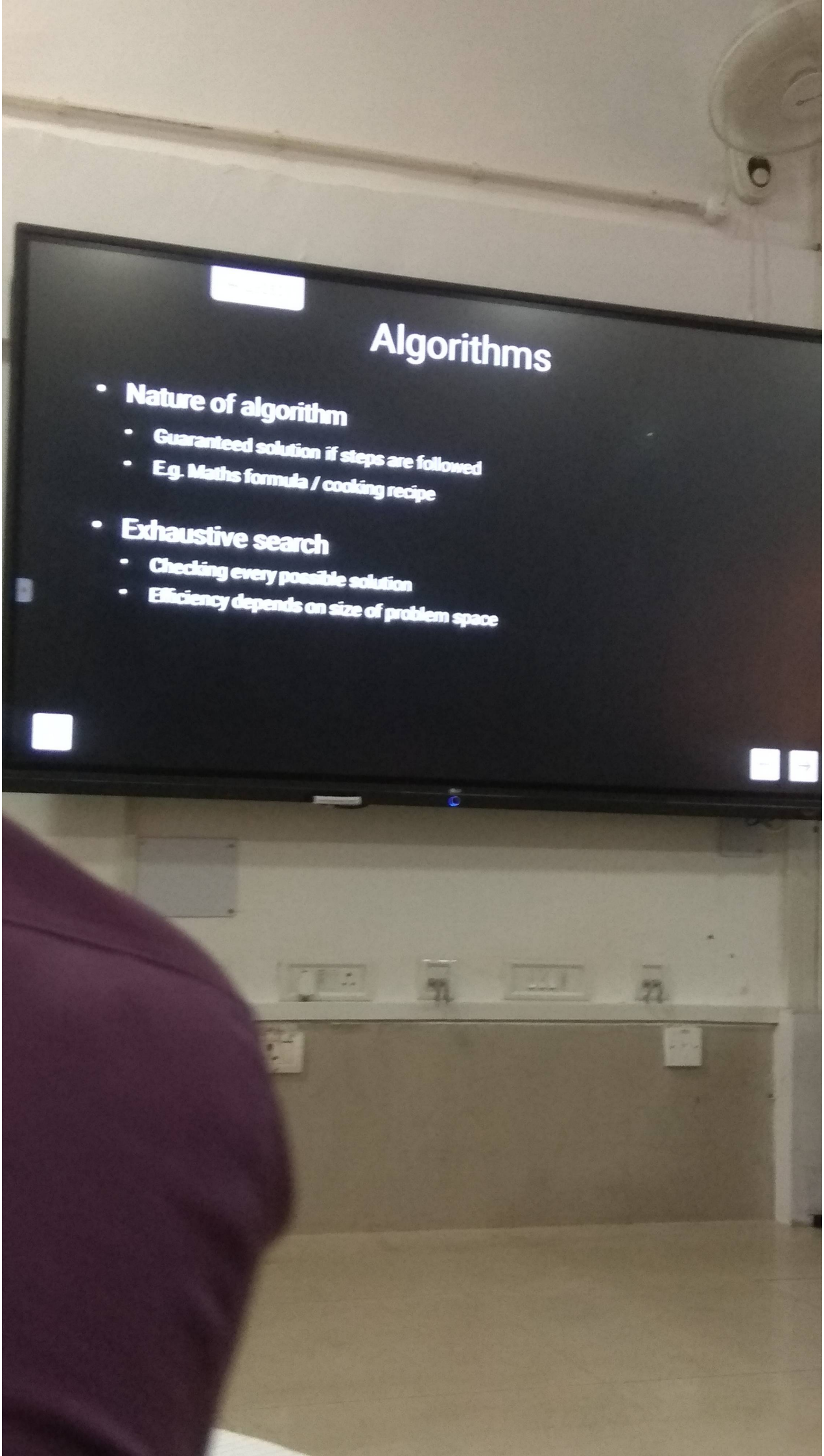

266305
Start State
Goal State
SILENCE

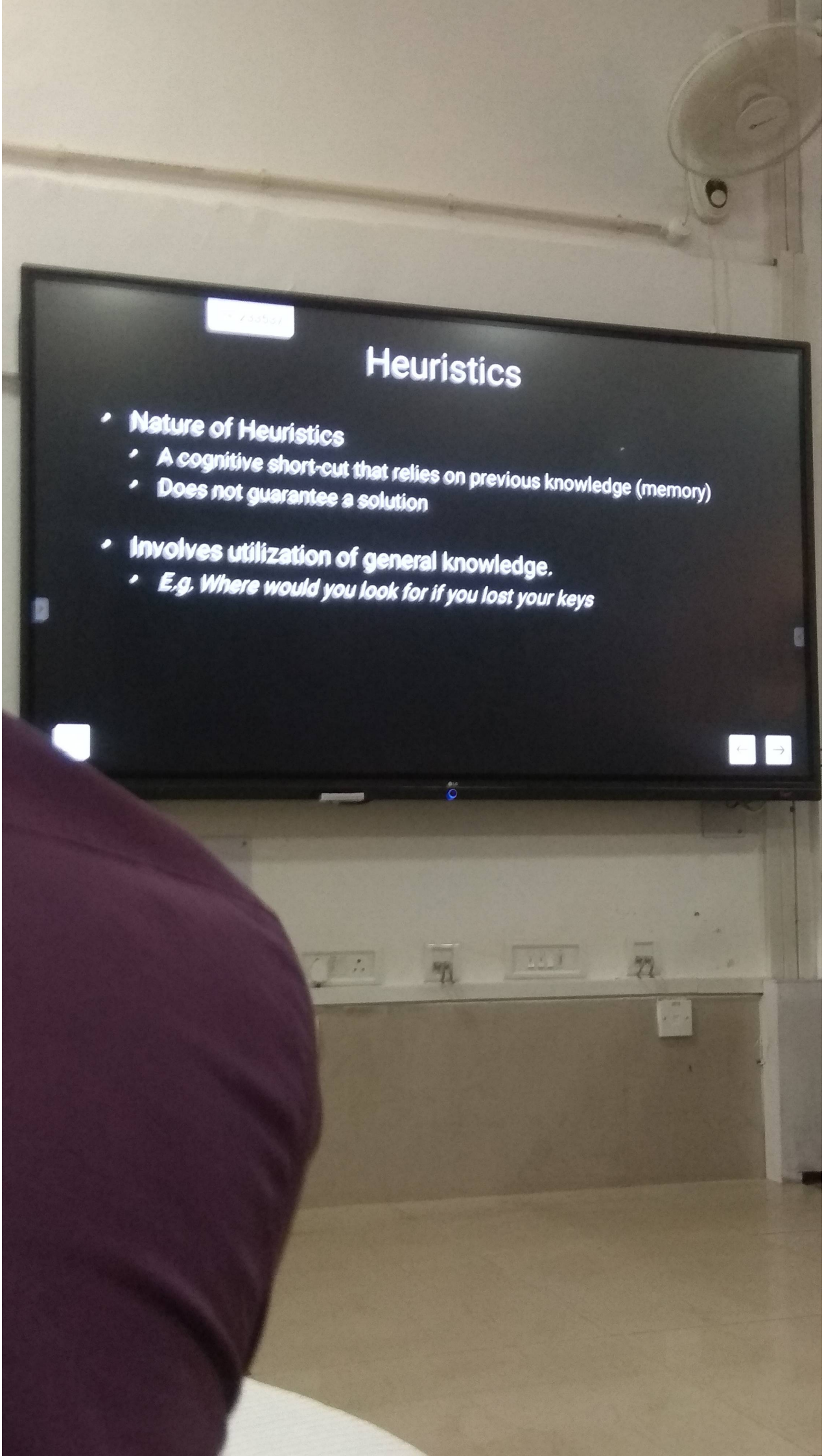

SILENCE
Problem-Solving Operators
Operator: Action that will transform the problem state to another problem state
Acquisition of Operators
Discovery (figuring out yourself)
Instruction
Modeling examples

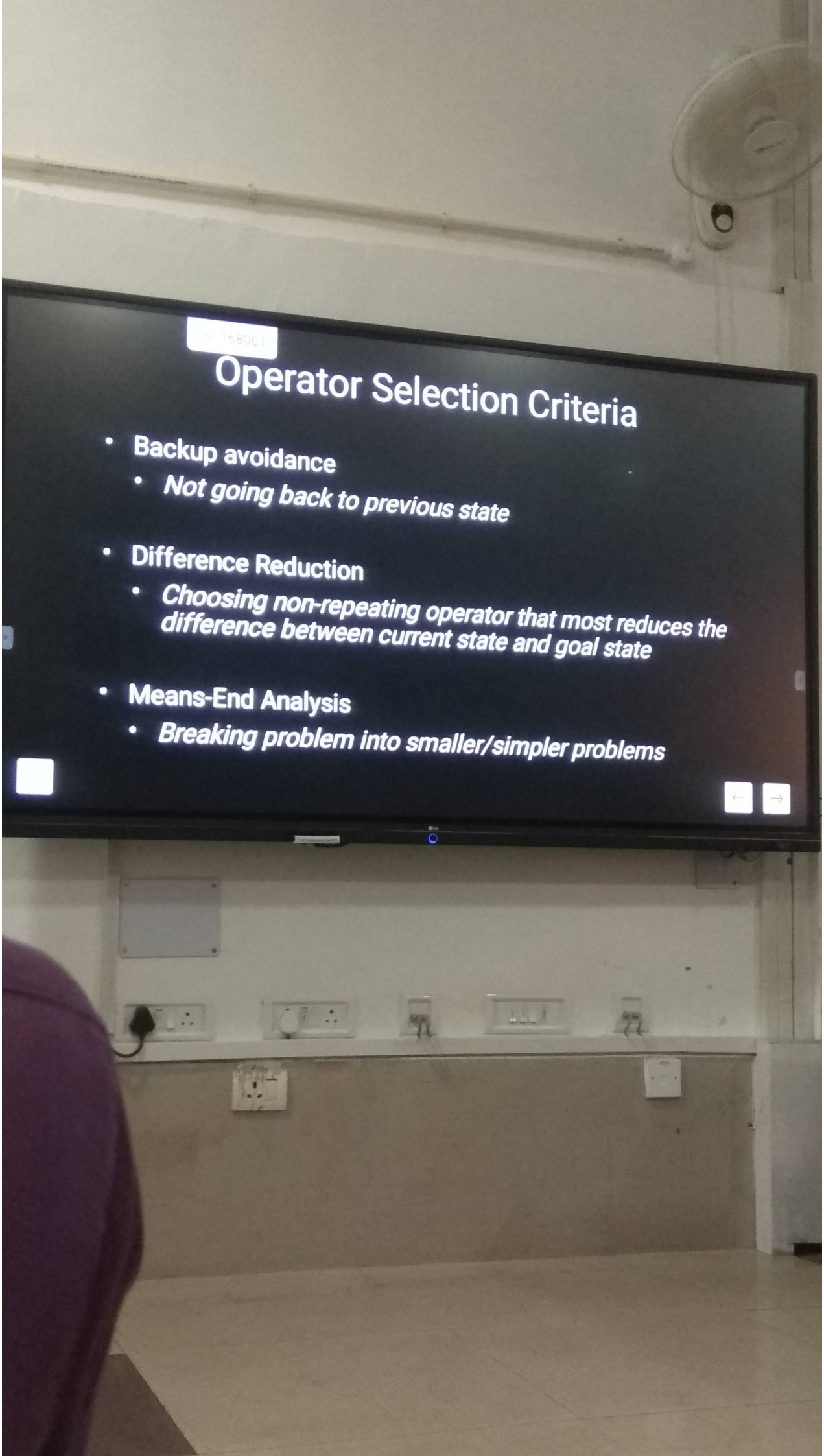

233537
TABLE 8.1 Instruction for Pyramid Problems
(a) Direct Specification
N$M is a pyramid expression for designating repeated addition where each term in the sum is one less than the previous.
N, the base, is the first term in the sum.
M, the height, is the number of terms you add to the base.

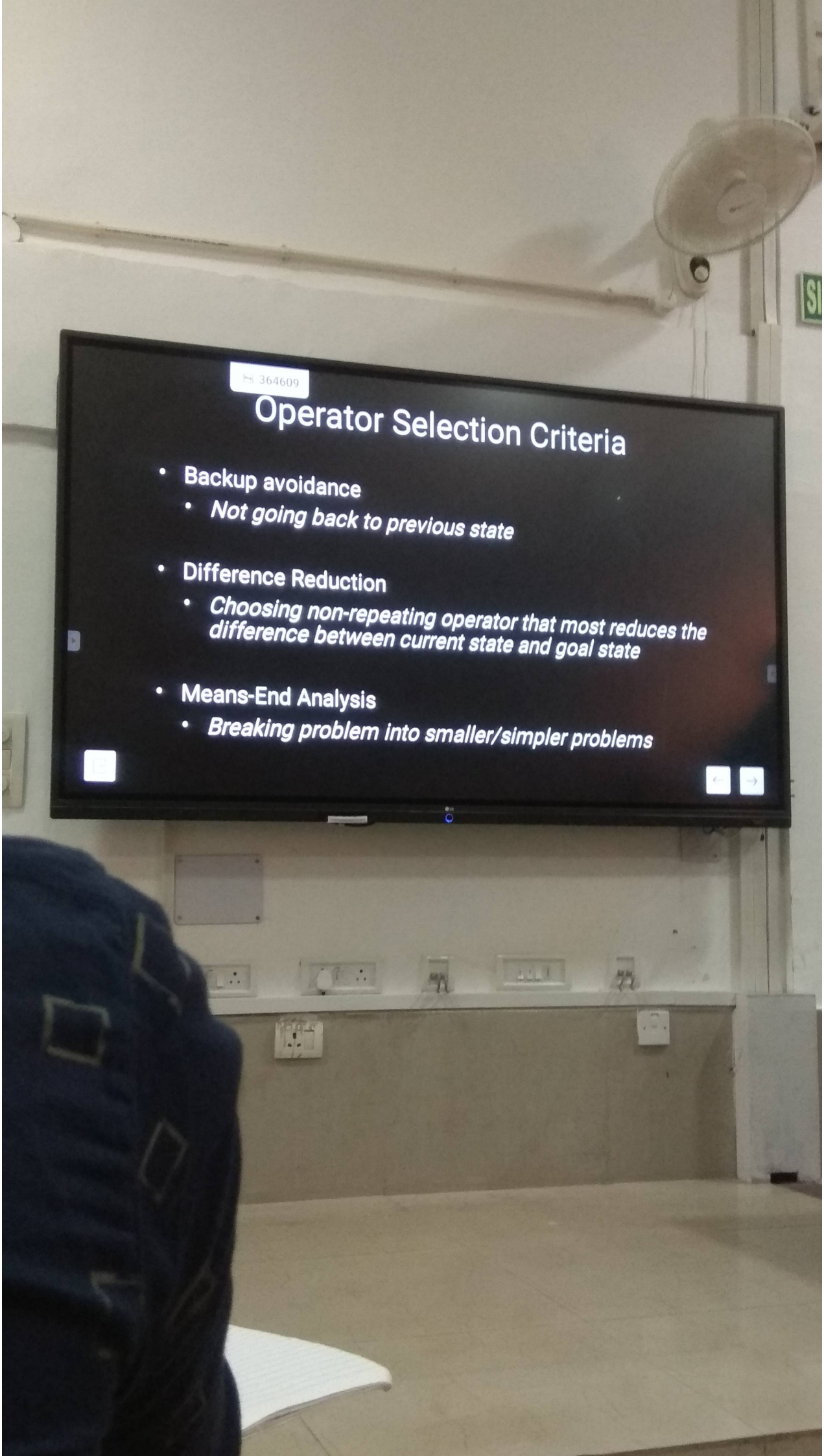

233537
TABLE 8.1 Instruction for Pyramid Problems
(a) Direct Specification
N$M is a pyramid expression for designating repeated addition where each term in the sum is one less than the previous.
N, the base, is the first term in the sum.
M, the height, is the number of terms you add to the base.
(b) Just an Example
7$3 is an example of a pyramid expression.
7$3 = 7 + 6 + 5 + 4 = 22
7 is the base
3 is the height
SILENCE


Search Strategies
Algorithms
Guaranteed solution if steps are followed
Heuristics
General rules and guidelines
Better (quicker) search
Role of memory
SILENCE P


Algorithms
Nature of algorithm
Guaranteed solution if steps are followed
E.g. Maths formula / cooking recipe
Exhaustive search
Checking every possible solution
Efficiency depends on size of problem space


Heuristics
Nature of Heuristics
A cognitive short-cut that relies on previous knowledge (memory)
Does not guarantee a solution
Involves utilization of general knowledge.
E.g. Where would you look for if you lost your keys


168001
Operator Selection Criteria
Backup avoidance
Not going back to previous state
Difference Reduction
Choosing non-repeating operator that most reduces the difference between current state and goal state
Means-End Analysis
Breaking problem into smaller/simpler problems


364609
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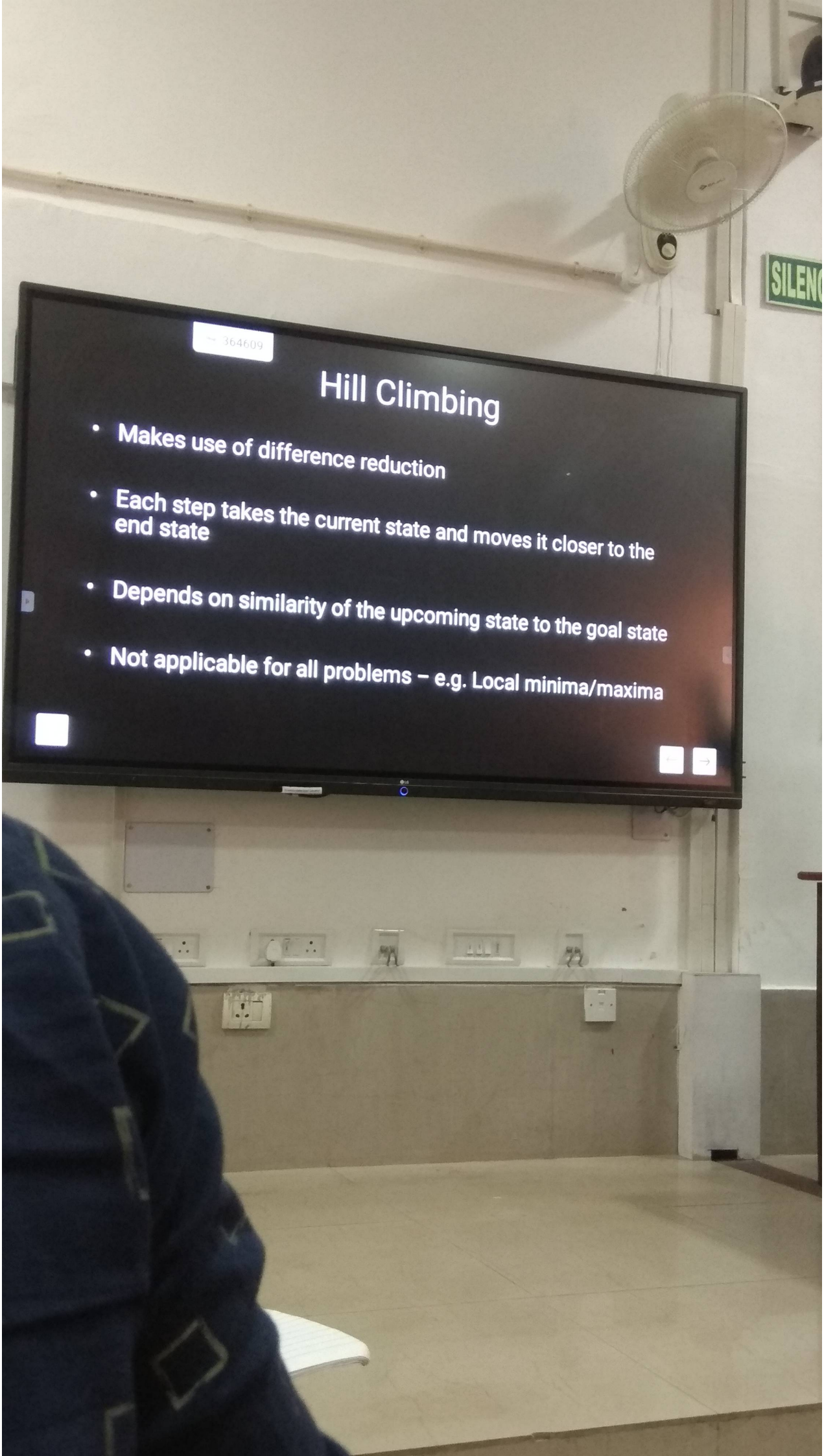
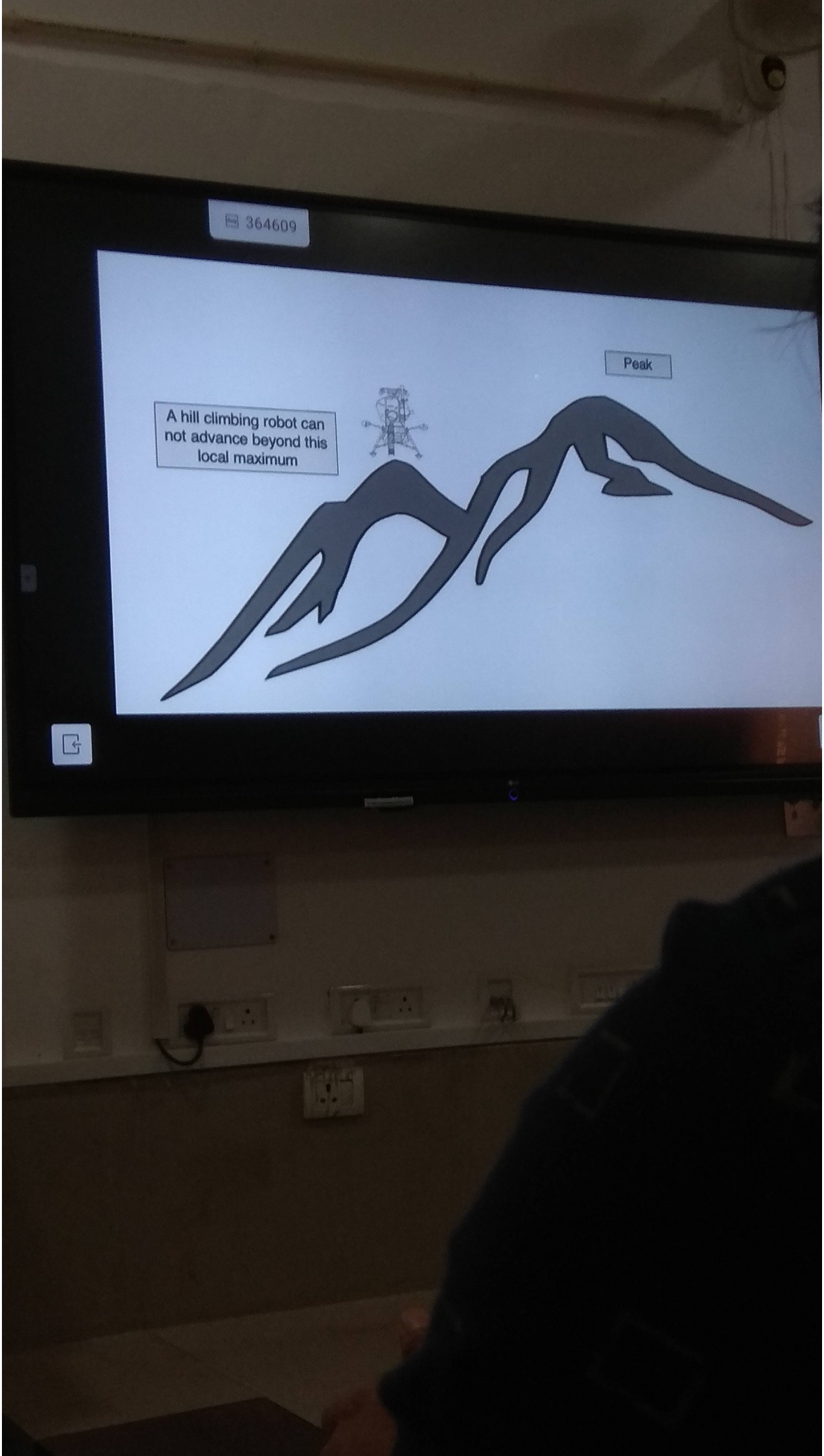
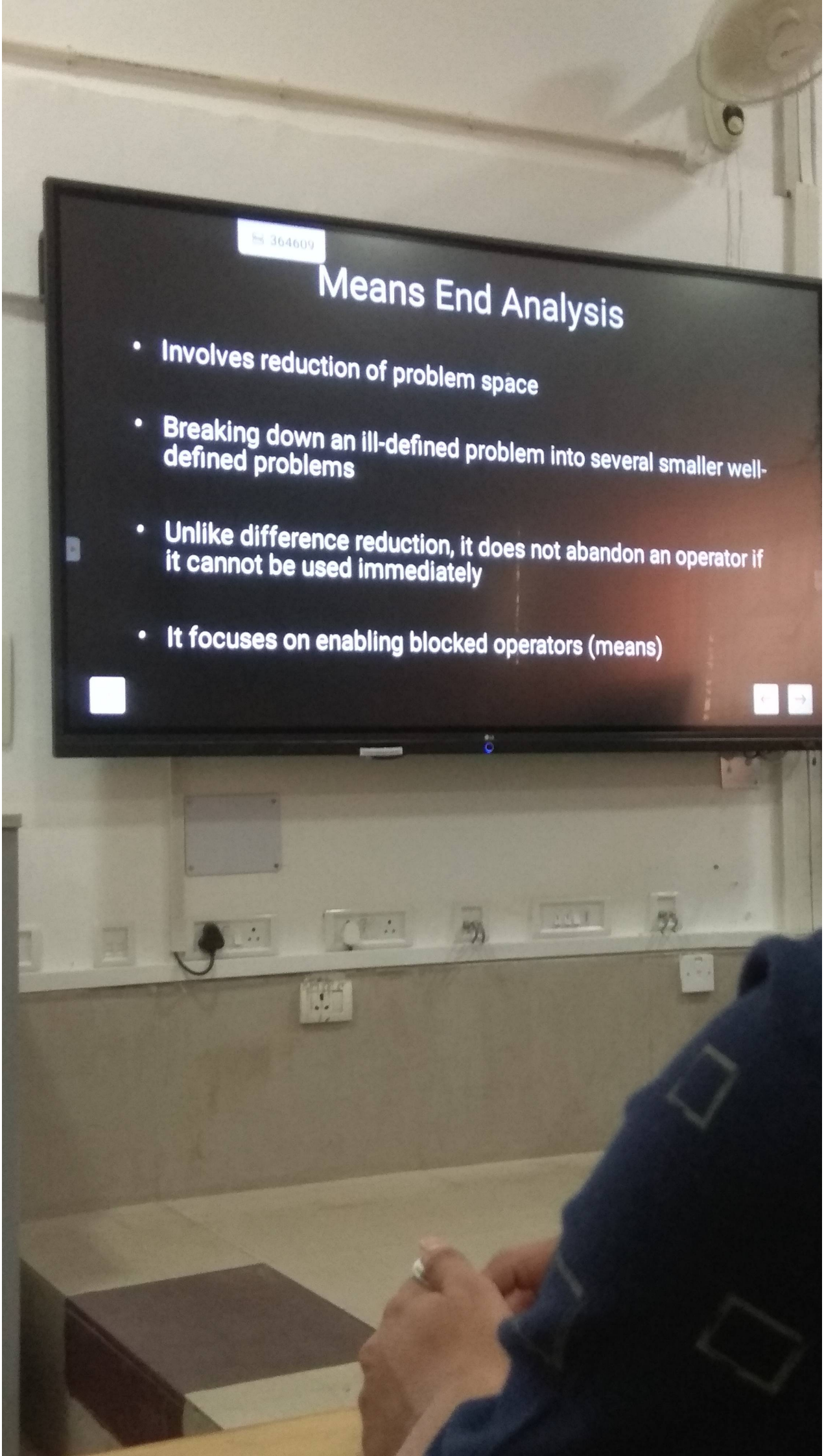
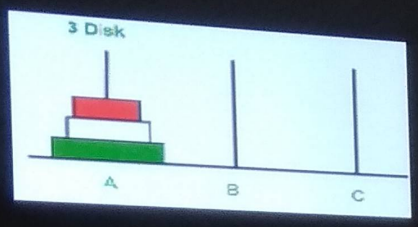

364609
Hill Climbing
• Makes use of difference reduction
• Each step takes the current state and moves it closer to the end state
• Depends on similarity of the upcoming state to the goal state
• Not applicable for all problems – e.g. Local minima/maxima
SILENC

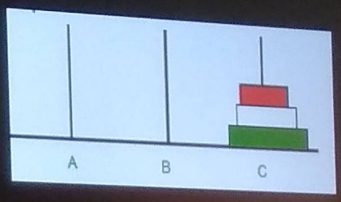

364609
Peak
A hill climbing robot can not advance beyond this local maximum


364609
Means End Analysis
Involves reduction of problem space
Breaking down an ill-defined problem into several smaller well-defined problems
Unlike difference reduction, it does not abandon an operator if it cannot be used immediately
It focuses on enabling blocked operators (means)

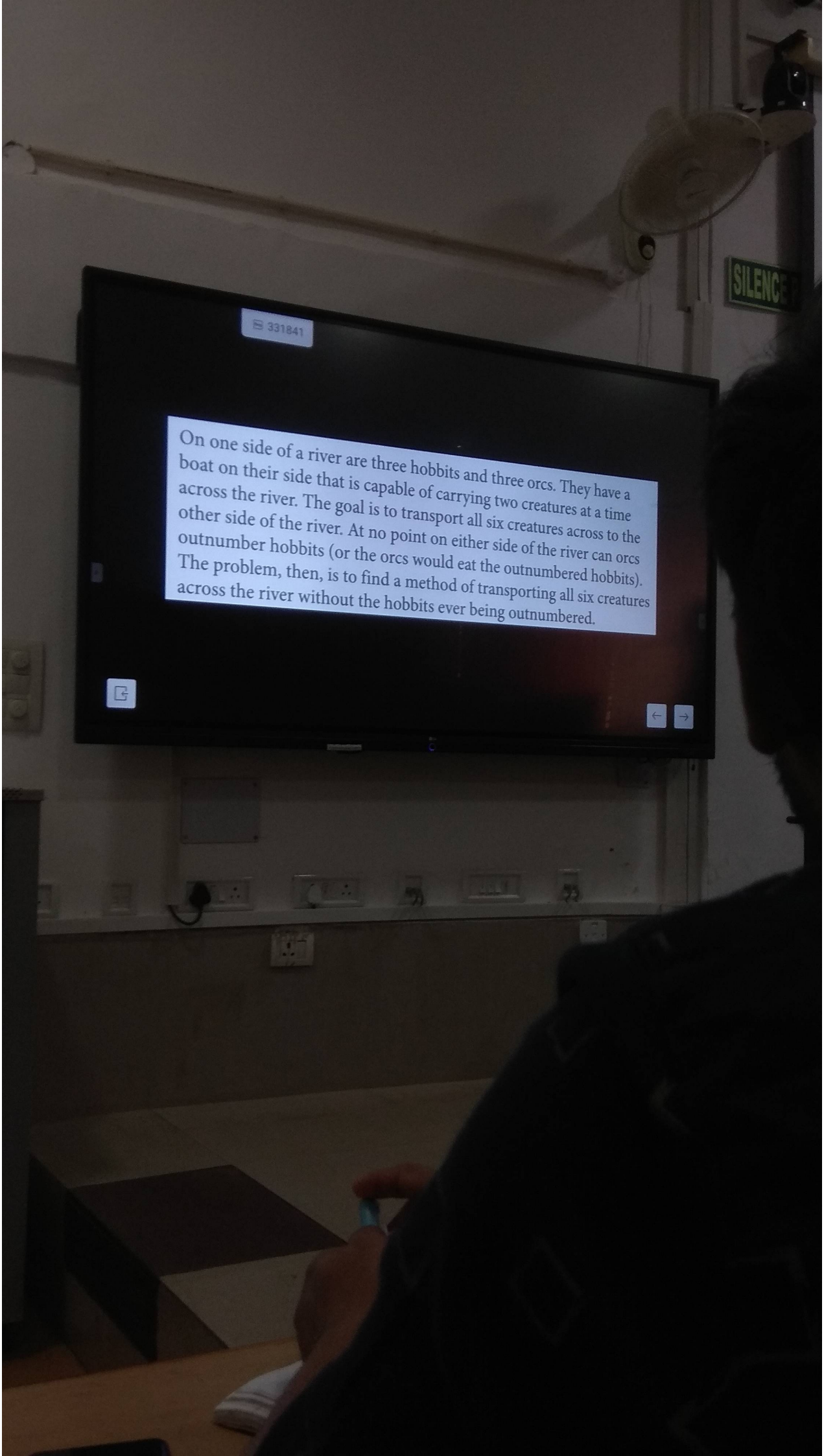
364609

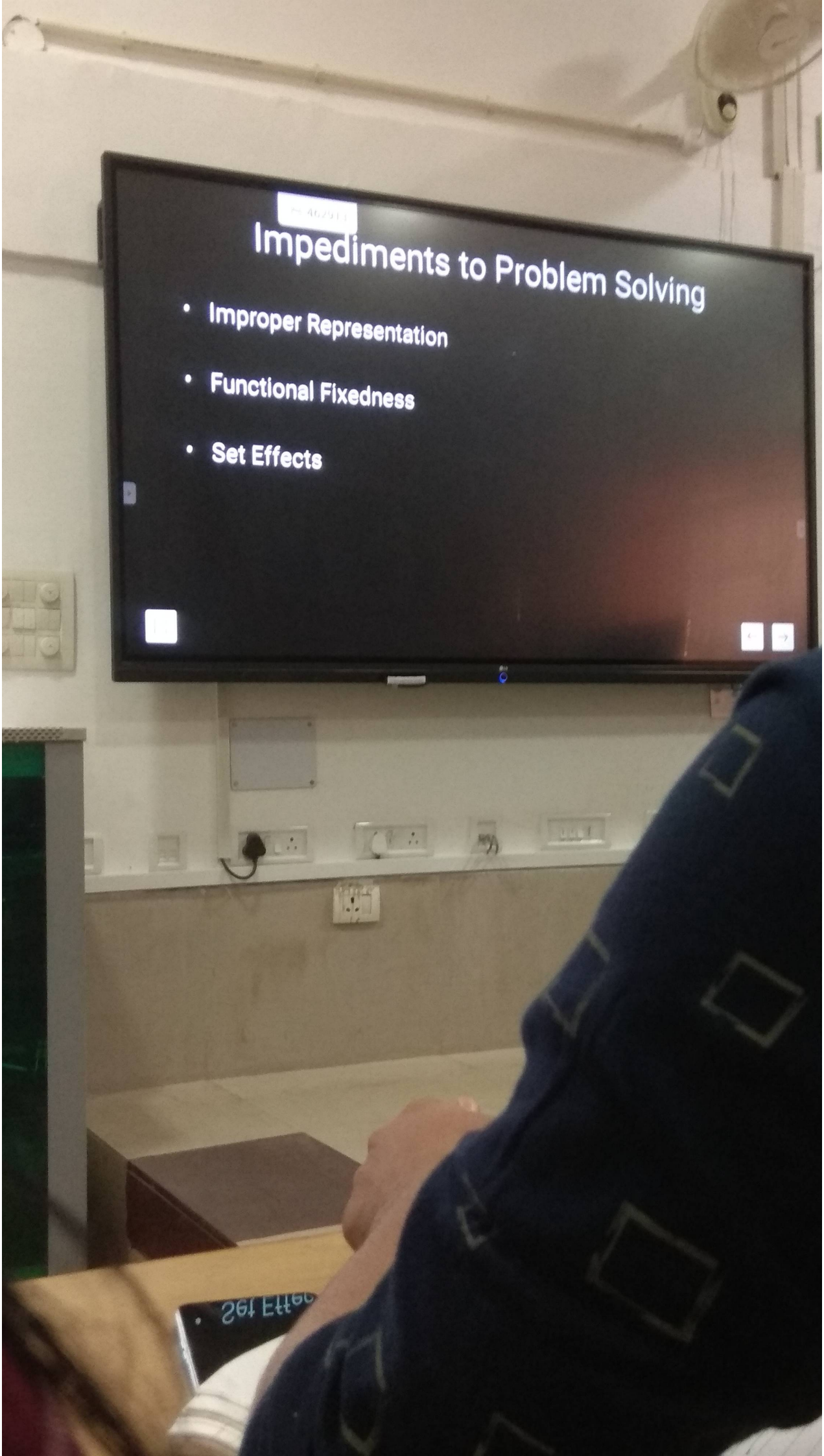
# Tower of Hanoi Problem

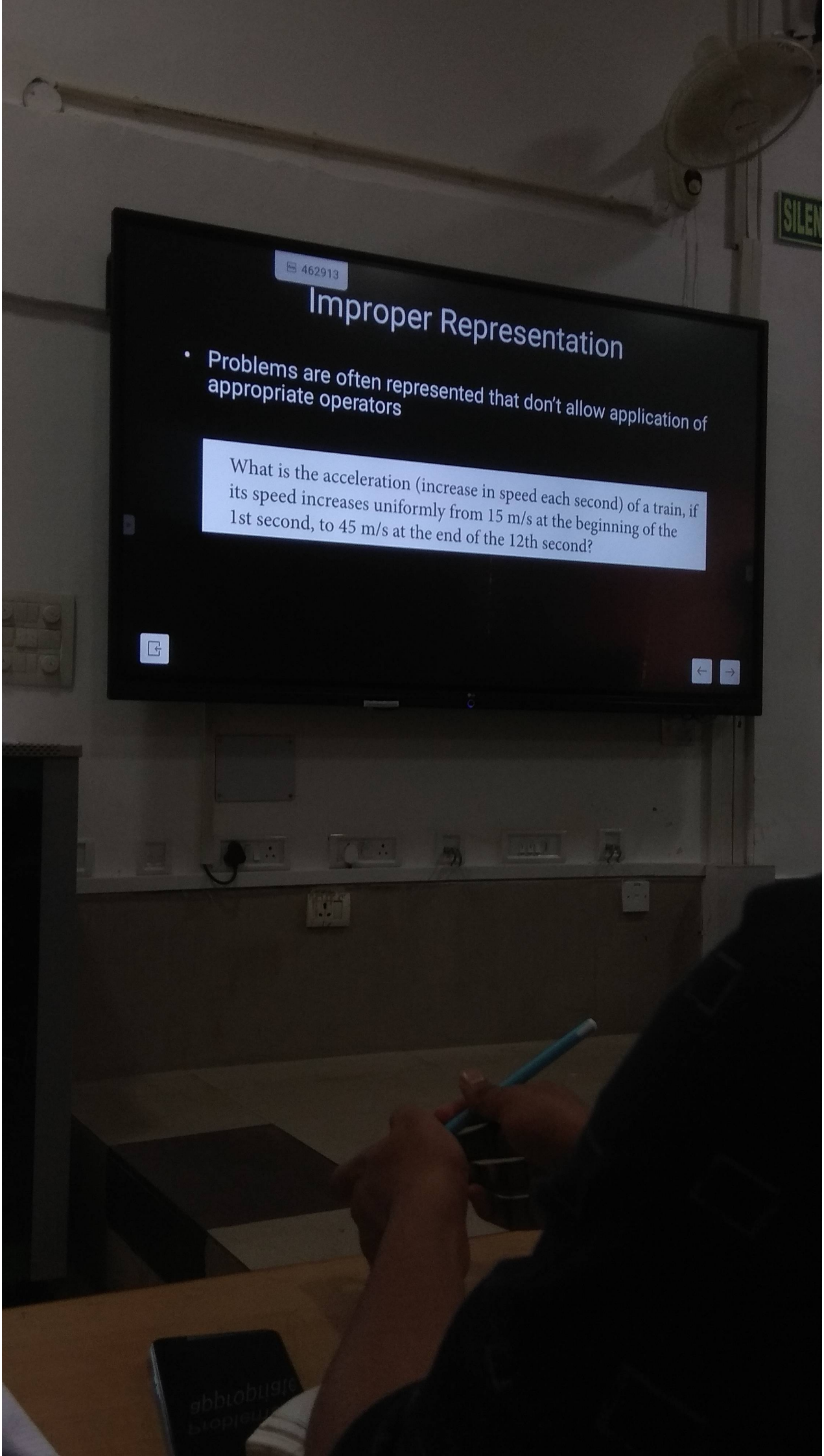



- Only one disc can be moved at a time
- larger disc must never be on top of the smaller disc


331841
On one side of a river are three hobbits and three orcs. They have a boat on their side that is capable of carrying two creatures at a time across the river. The goal is to transport all six creatures across to the other side of the river. At no point on either side of the river can orcs outnumber hobbits (or the orcs would eat the outnumbered hobbits). The problem, then, is to find a method of transporting all six creatures across the river without the hobbits ever being outnumbered.


Impediments to Problem Solving
Improper Representation
Functional Fixedness
Set Effects


462913
Improper Representation
Problems are often represented that don't allow application of appropriate operators
What is the acceleration (increase in speed each second) of a train, if its speed increases uniformly from 15 m/s at the beginning of the 1st second, to 45 m/s at the end of the 12th second?

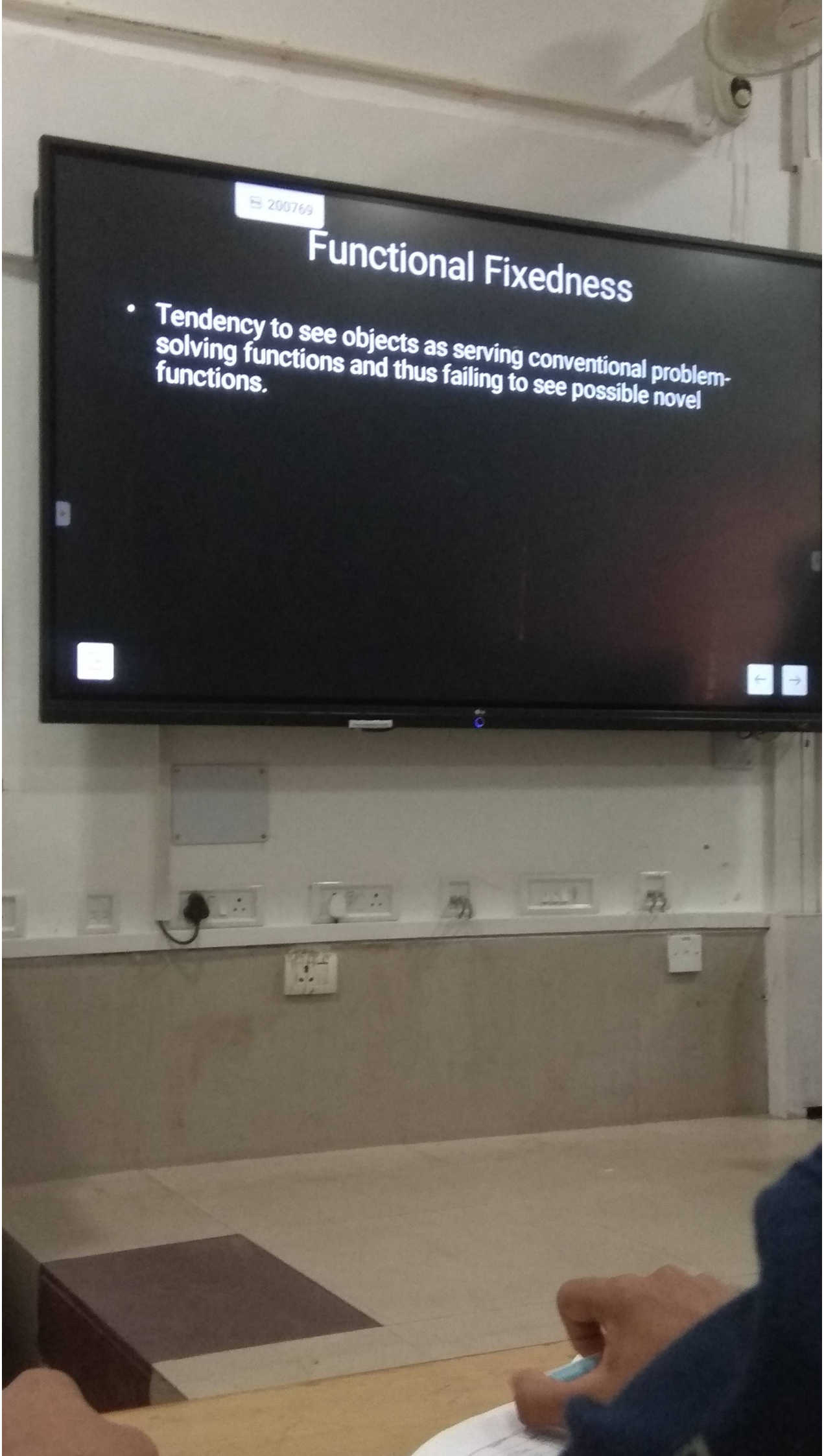
462913

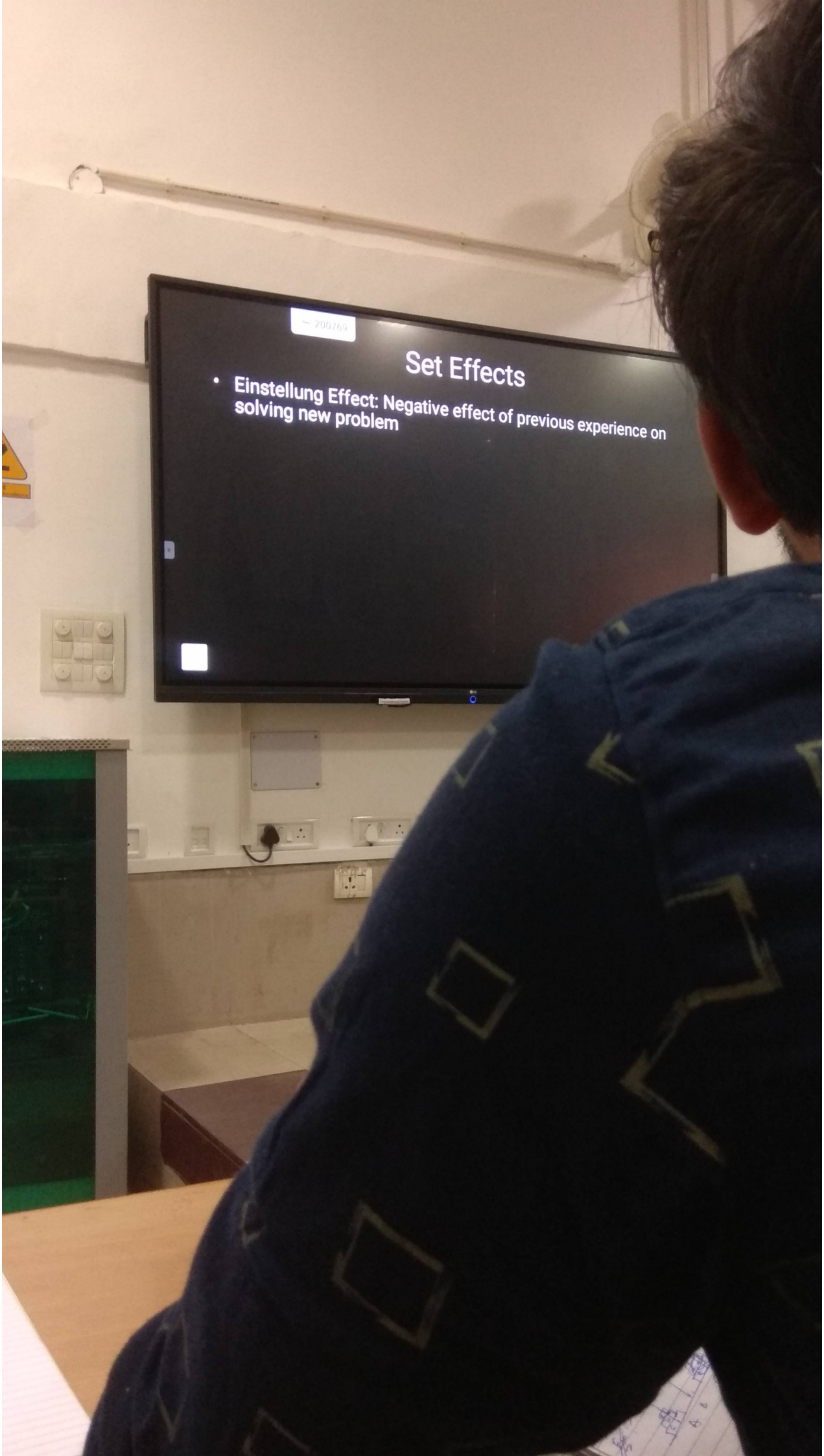
# Improper Representation

- Problems are often represented that don't allow application of appropriate operators

What is the acceleration (increase in speed each second) of a train, if its speed increases uniformly from 15 m/s at the beginning of the 1st second, to 45 m/s at the end of the 12th second?

Juanita went to work as a teller in a bank at a salary of $12,400 per year and received constant yearly increases, coming up with a $16,000 salary during her 13th year of work. What was her yearly salary increase?


200769
Functional Fixedness
Tendency to see objects as serving conventional problem-solving functions and thus failing to see possible novel functions.


200769
Set Effects
Einstellung Effect: Negative effect of previous experience on solving new problem

200769

**TABLE 8.3** Luchins's Water Jug Problems Used to Illustrate the Set Effect

| Problem | Capacity (cups) | | | |
|---|---|---|---|---|
| | Jug A | Jug B | Jug C | Desired Quantity |
| 1 | 21 | 127 | 3 | 100 |
| 2 | 14 | 163 | 25 | 99 |
| 3 | 18 | 43 | 10 | 5 |
| 4 | 9 | 42 | 6 | 21 |
| 5 | 20 | 59 | 4 | 31 |
| 6 | 23 | 49 | 3 | 20 |
| 7 | 15 | 39 | 3 | 18 |
| 8 | 28 | 76 | 3 | 25 |
| 9 | 18 | 48 | 4 | 22 |
| 10 | 14 | 36 | 8 | 6 |