Teaching Script: Sustainable Building Insulation Design

Topic: Sustainable Building Insulation Design
Grade Level: Technical High School (Ages 16-18)
Duration: 90 minutes (Two 45-minute sessions)
Subject Area: Construction Technology
Language of Instruction: Romanian
Key Vocabulary: Thermal conductivity, U-value, R-value, thermal bridge, vapor barrier
Standards Alignment: Romanian Building Code C107/2005

- ✓ Thermal imaging camera
- ✓ Material sample kit
- ✓ TERMO software
- ✓ Calculation templates
- ✓ Technical documentation
- ✓ Infrared images
- ✓ Building section drawings
- ✓ Assessment rubrics

Lesson Opening (0-5 minutes)

[Display thermal imaging photographs on screen]

"Good morning class. Take a look at these images. What do you notice about the heat patterns in these Romanian buildings?"

Opening Hook: Use local building examples to demonstrate energy loss through thermal imaging, making the content immediately relevant to students' experiences.
Engagement Strategies:

- Point out specific heat loss areas in familiar local buildings
- Connect to recent energy bills and costs
- Reference current Romanian energy efficiency regulations

Technical Foundations (5-10 minutes)

"Let's understand how we measure heat loss in buildings. We'll start with thermal conductivity, represented by the symbol λ (lambda)."

Key Concepts to Cover:

- Thermal conductivity (λ): W/mK
- R-value: m²K/W
- U-value: W/m²K

Address Common Misconceptions:

- Higher U-value does NOT mean better insulation
- Thickness alone doesn't determine insulation quality
- Air gaps aren't always beneficial

Material Analysis (10-15 minutes)

[Display physical material samples]

"We'll now examine local insulation materials available in Romania. Each has unique properties and applications."

> **Material Properties Table:**
>
> | Material | λ Value (W/mK) | Cost (RON/m²) | Local Availability |
> |---|---|---|---|
> | Mineral Wool | 0.035-0.045 | 15-25 | High |
> | Hemp Insulation | 0.040 | 30-35 | Medium |
> | Sheep Wool | 0.038-0.042 | 25-30 | Seasonal |

Differentiation Strategies:

- Visual learners: Provide material comparison charts
- Tactile learners: Allow handling of material samples
- Technical learners: Focus on numerical properties

Thermal Bridge Analysis (15-20 minutes)

"Now we'll identify where heat commonly escapes in Romanian buildings. These areas are called thermal bridges."

[Project thermal bridge diagrams]

Common Thermal Bridge Locations:

- Window-wall junctions
- Balcony connections
- Foundation-wall interfaces
- Roof-wall junctions

Demonstration Tips:

- Use TERMO software to show heat flow patterns
- Compare good vs. poor design solutions
- Reference local building examples
- Show before/after renovation cases

Advanced Concepts:

- Linear thermal transmittance (ψ-value)

- Point thermal transmittance (χ-value)
- Temperature factor (fRsi)

Practical Calculations (20-30 minutes)

"Let's work through real calculations for a typical Romanian apartment block renovation."

Sample Problem:

Calculate the total thermal resistance (R-value) for a wall assembly:

- Existing concrete wall: 25cm (λ = 1.7 W/mK)
- Mineral wool insulation: 15cm (λ = 0.04 W/mK)
- Exterior render: 2cm (λ = 0.87 W/mK)

Formula: $R_{total} = R_{si} + \Sigma(d/\lambda) + R_{se}$

Where:

- R_{si} = 0.13 m²K/W (interior surface resistance)
- R_{se} = 0.04 m²K/W (exterior surface resistance)
- d = thickness in meters
- λ = thermal conductivity in W/mK

Group Exercise:

Students work in pairs to:

1. Calculate R-values for each layer
2. Sum the total resistance
3. Convert to U-value (U = 1/R)
4. Compare with Romanian building code requirements

Vapor Control (30-40 minutes)

"Understanding vapor movement is crucial for preventing condensation and mold growth in our climate."

Critical Points:

- Vapor pressure gradients
- Dew point calculation
- Vapor barrier positioning
- Material permeability (μ-value)

Interactive Demonstration:

Using TERMO software to show:

- Winter vapor flow patterns
- Summer vapor flow reversal
- Condensation risk zones
- Effect of different vapor control layers

Case Study Analysis (40-50 minutes)

Case Study: Bucharest Apartment Block Renovation

Building Details:

- Construction year: 1975
- 8 floors, 32 apartments
- Original U-value: 1.8 W/m²K
- Target U-value: 0.20 W/m²K

Renovation Challenges:

- Budget constraints
- Occupant disruption
- Technical limitations
- Historical preservation requirements

Solution Implementation:

- External wall insulation system
- Window replacement
- Balcony thermal bridge treatment
- Ventilation improvements

Analysis Tasks:

1. Calculate energy savings
2. Evaluate cost-benefit ratio
3. Identify potential problems
4. Propose alternative solutions

Technical Documentation (50-60 minutes)

"Professional documentation is essential for compliance and quality control."

Required Documents:

- Technical specifications
- Material certificates
- Installation details
- Compliance certificates
- Quality control procedures

Documentation Exercise:

Students prepare technical documentation for:

- Wall assembly details
- Thermal bridge solutions
- Vapor control strategy
- Installation sequence

Assessment and Evaluation (60-75 minutes)

Evaluation Components:

Component	Weight	Success Criteria
Technical Calculations	30%	Accuracy, methodology, units
Documentation	25%	Completeness, clarity, detail
Case Study Analysis	25%	Understanding, solutions, reasoning
Practical Application	20%	Material knowledge, problem-solving

Required Submissions:

1. Calculation portfolio
2. Technical drawings
3. Case study analysis report
4. Material selection justification

Lesson Closure (75-90 minutes)

Key Takeaways:

- Importance of proper insulation design
- Integration of technical calculations
- Vapor control significance
- Documentation requirements
- Professional standards compliance

Extended Learning:

Students will:

- Complete remaining calculations
- Finalize technical documentation
- Research local case studies
- Prepare for next session on advanced applications

Assessment and Closure (20-25 minutes)

"Let's conclude by applying what we've learned to a real Romanian building scenario."

Final Task:

Students will analyze a local building's insulation design using provided thermal images and calculate potential energy savings using the Romanian Building Code standards.

Assessment Criteria:

- Correct identification of thermal bridges (5 points)
- Accurate U-value calculations (5 points)
- Appropriate material selection (5 points)
- Cost-effectiveness analysis (5 points)

Extended Learning:

Document three examples of thermal bridges in your own home or school building. Calculate the potential energy savings if these were properly insulated.

Additional Resources

- Romanian Building Code C107/2005
- European Insulation Manufacturers Association (EURIMA) guidelines
- Local building material supplier catalogs
- Energy efficiency calculation software