



REMEMBER]>CREATE BLOOM'S TAXONOMY IN SUSTAINABLE ARCHITECTURE PEDAGOGY | MICHEL FRANCIS

REMEMBER]>CREATE BLOOM'S TAXONOMY IN SUSTAINABLE ARCHITECTURE PEDAGOGY

THE LEBANESE AMERICAN UNIVERSITY
SCHOOL OF ARCHITECTURE AND DESIGN

MICHEL FRANCIS

Impression of Biophilic Design using prompt-to-image ai

23-Apr-25

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**BEYOND KNOWING:
CULTIVATING SUSTAINABLE
ARCHITECTURAL THINKERS**

- Bloom's Taxonomy

Anderson and Krathwohl revised Bloom's levels. Source: UIC Center for the Advancement of Teaching Excellence
<https://teaching.uic.edu/cate-teaching-guides/syllabus-course-design/blooms-taxonomy-of-educational-objectives/>

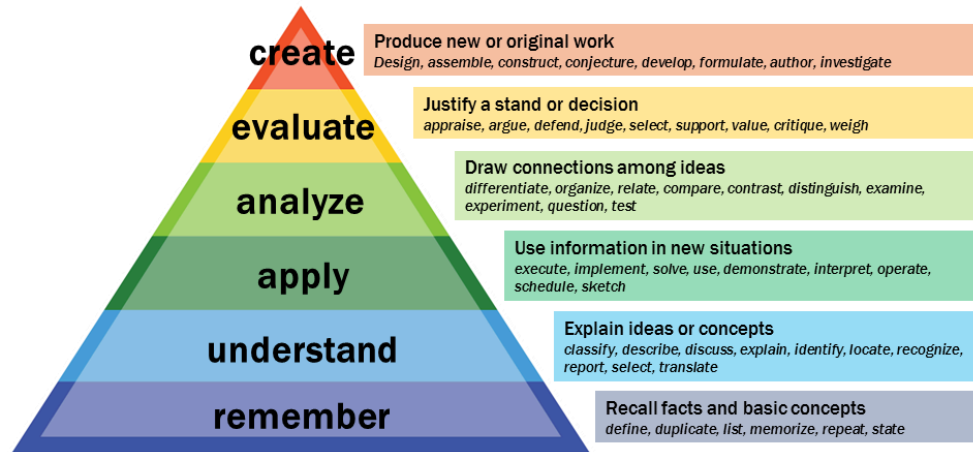
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- **Brief overview of Bloom's Taxonomy:** Originally developed in 1956 by Benjamin Bloom and collaborators and subsequently revised in 2001 by Anderson, Krathwohl, and others, the taxonomy provides a hierarchical classification of cognitive processes.
- The revised taxonomy outlines six levels, progressing from foundational knowledge acquisition to higher-order thinking skills:
 - Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating
- This hierarchical structure, moving **from concrete recall to abstract synthesis and judgment**, appears **particularly relevant for developing the cognitive toolkit needed to tackle the complexities inherent in sustainable design**

Bloom's Taxonomy



"Bloom's Taxonomy." Vanderbilt University Center for Teaching. From "Understanding Bloom's Taxonomy" retrieved from <https://roTEL.pressbooks.pub/>

BLOOM'S TAXONOMY KNOWLEDGE DIMENSIONS



A Model of Learning Objectives—based on A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives by Rex Heer, Center for Excellence in Learning and Teaching, Iowa State University.. From "Understanding Bloom's Taxonomy" retrieved from <https://rofel.pressbooks.pub/>

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The Knowledge Dimension

The knowledge dimension lays out the types of knowledge that professors expect students to acquire.

Factual knowledge includes terms, locations, and other listable knowledge. This kind of knowledge often serves as a base for more advanced knowledge.

Conceptual knowledge includes ways of organizing information and ideas, including knowledge of theories and principles. This type of knowledge helps you structure factual knowledge, as well as understand the relationships among information and ideas.

Procedural knowledge includes knowledge of techniques and methods, as well as when to use those techniques. This type of knowledge tends to be subject-specific, so, for example, different majors will use different procedures for identifying and solving problems.

Metacognitive knowledge is sometimes described as **"thinking about thinking."** This kind of knowledge involves your ability to **take a step back** and understand how you think and learn, which is why it's considered **abstract knowledge**. You will often be asked to do reflective work in college, and every time you are explaining how you know what you know, you're practicing metacognition. You can think about the knowledge dimension as the type of information or ideas that you are supposed to demonstrate and/or work with when you get to the cognitive processes dimension.



**BEYOND KNOWING:
CULTIVATING SUSTAINABLE
ARCHITECTURAL THINKERS**

- Bloom's Taxonomy
- Relevance to Architecture

Anderson and Krathwohl revised Bloom's levels. Source: UIC Center for the Advancement of Teaching Excellence
<https://teaching.uic.edu/cate-teaching-guides/syllabus-course-design/blooms-taxonomy-of-educational-objectives/>

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- **Relevance to Architecture:** Need to move students from basic knowledge to application, analysis, evaluation, and creation.
- architecture is **fundamentally a problem-solving and creative discipline** that requires moving far beyond simple memorization (**technical knowledge, theoretical understanding, practical application, critical judgment, and inventive synthesis**)



BEYOND KNOWING: CULTIVATING SUSTAINABLE ARCHITECTURAL THINKERS

- Bloom's Taxonomy
- Relevance to Architecture

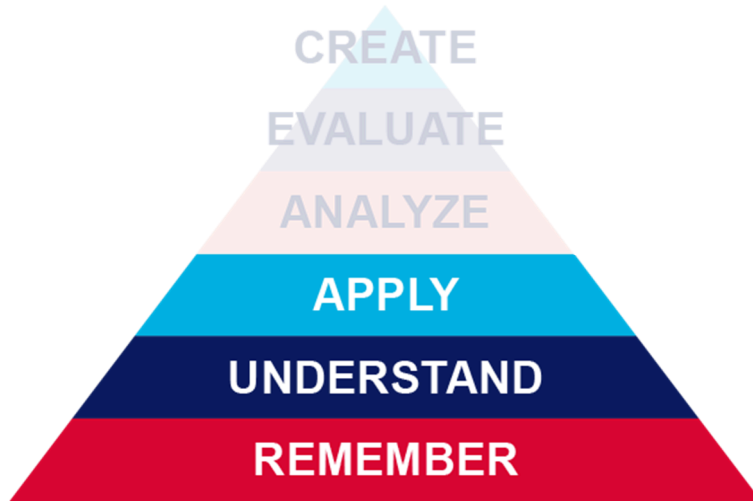
- **Remember:** basic architectural vocabulary, historical precedents, principles of design (like proportion, scale, rhythm), properties of materials, building codes, or basic software commands.



BEYOND KNOWING: CULTIVATING SUSTAINABLE ARCHITECTURAL THINKERS

- Bloom's Taxonomy
- Relevance to Architecture

Understand: (students explain architectural concepts): interpret site analysis data, summarize architectural theories, classify building types, or explain how a particular structural system works. (beyond simple recall.)



**BEYOND KNOWING:
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Applying: This is where design action often begins. Students apply learned principles or rules to specific situations, such as:

- **using CAD or BIM software** to execute a design idea,
- performing basic **structural or environmental calculations**,
- **applying zoning regulations** to a site plan,
- or using knowledge of **passive strategies in a schematic design**.



BEYOND KNOWING: CULTIVATING SUSTAINABLE ARCHITECTURAL THINKERS

- Bloom's Taxonomy
- Relevance to Architecture

Analyzing: Architectural design inherently involves analysis. Students must break down complex problems (like a design brief or a site condition) into manageable parts:

- **compare and contrast** different design options or precedents, analyze the relationship between form and function,
- or **analyze the environmental performance** of a design scheme.

This involves differentiating, organizing, and **attributing significance** to various factors.



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Evaluating: This critical level involves

- **making judgments about the value or effectiveness of design choices based on established criteria (e.g., functional, aesthetic, technical, sustainable, social).**
- Students learn to critique their own work and the work of others, justify design decisions, assess the feasibility of a proposal, or select the most appropriate material or system for a specific context.



BEYOND KNOWING: CULTIVATING SUSTAINABLE ARCHITECTURAL THINKERS

- Bloom's Taxonomy
- Relevance to Architecture

Creating: It involves synthesizing diverse information, ideas, and constraints **to generate a novel and coherent architectural solution.**

- This includes developing design concepts, producing drawings and models, and planning the execution of a design project.



BEYOND KNOWING: CULTIVATING SUSTAINABLE ARCHITECTURAL THINKERS

- Bloom's Taxonomy
- Relevance to Architecture
- Focus on Sustainability Courses

Complexity
requires
structured
learning

- climate change,
- pollution,
- cultural, social political and economical,
- implementation of the SDG's

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Focus on Sustainability Courses: Complexity requires structured learning to tackle challenges like

- climate change,
- pollution,
- cultural, social political and economical,
- implementation of the SDG's



Impression of sustainable architecture design process using prompt-to-image AI

BEYOND KNOWING: CULTIVATING SUSTAINABLE ARCHITECTURAL THINKERS

- Bloom's Taxonomy
- Relevance to Architecture
- Focus on Sustainability Courses

Complexity requires structured learning

- climate change,
- pollution,
- cultural, social political and economical,
- implementation of the SDG's

Challenges

- emissions (40%)
- ecology
- material life cycles
- energy flows
- building technologies
- economic constraints
- social dynamics
- cultural contexts
- policy frameworks
- human behavior

Challenges of sustainability in architecture design:

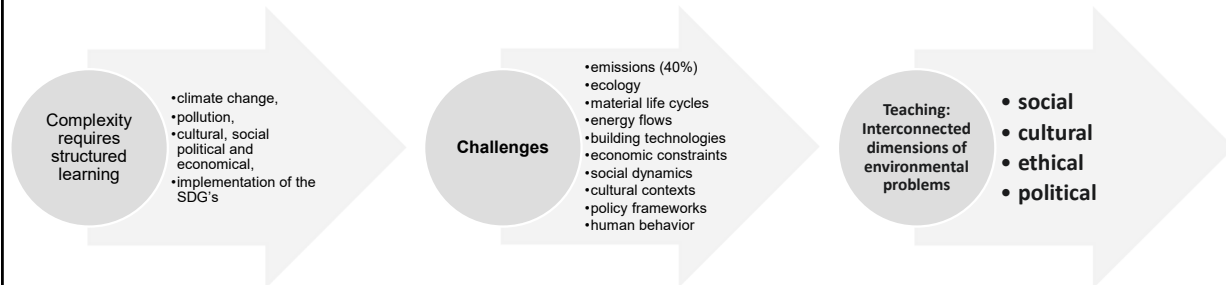
- emissions associated with buildings (40%),
- ecological processes,
- material life cycles,
- energy flows,
- building technologies,
- economic constraints,
- social dynamics,
- cultural contexts,
- policy frameworks,
- and human behavior.



Impression of sustainable architecture design process using prompt-to-image ai

BEYOND KNOWING: CULTIVATING SUSTAINABLE ARCHITECTURAL THINKERS

- Bloom's Taxonomy
- Relevance to Architecture
- Focus on Sustainability Courses



Teaching sustainability effectively requires moving beyond purely technical instruction to encompass the interconnected social, cultural, ethical, and political dimensions of environmental problems.



Impression of sustainable architecture design process using prompt-to-image ai

BEYOND KNOWING: CULTIVATING SUSTAINABLE ARCHITECTURAL THINKERS

- Bloom's Taxonomy
- Relevance to Architecture
- Focus on Sustainability Courses
- Goal



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- **Goal:** Use Bloom's to structure pedagogy for deeper learning and practical, sustainable design skills.



LEVEL 1 & 2: REMEMBERING & UNDERSTANDING - SETTING THE FOUNDATION

ENGAGING LECTURES & VERIFYING COMPREHENSION

- **Level 1**
- **Method:** Active classroom lectures introducing core concepts (climate, energy, services, tools).

Level 1 & 2: Remembering & Understanding - Setting the Foundation (2 mins)

Engaging Lectures & Verifying Comprehension

Level 1 (Remembering):

- **Method:** Active classroom lectures introducing core concepts (climate, energy, services, tools).



**LEVEL 1 & 2:
REMEMBERING &
UNDERSTANDING -
SETTING THE FOUNDATION**

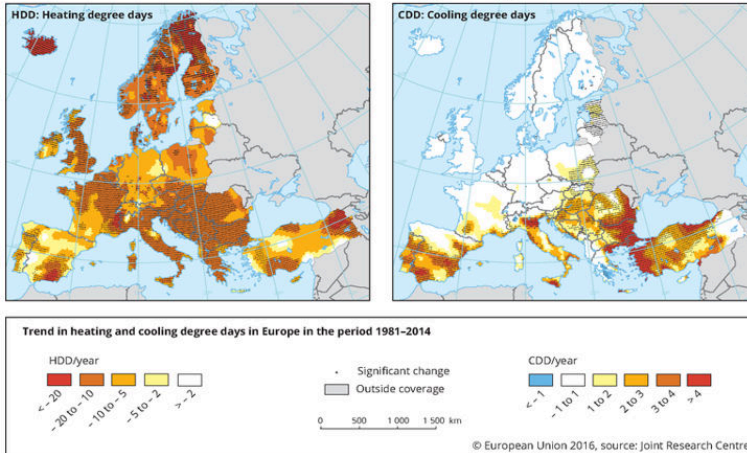
**ENGAGING LECTURES &
VERIFYING COMPREHENSION**

- **Level 1**
- **Activity:** Immediate, short Blackboard quizzes ("Knowledge Checks") after topics to maintain focus and recall basic facts.

Activity: Immediate, short Blackboard quizzes, "**Knowledge Checks**", after topics to maintain focus and recall basic facts.

Climate Responsive Architecture

Heating and Cooling Degree Days



LEVEL 1 & 2: REMEMBERING & UNDERSTANDING - SETTING THE FOUNDATION

ENGAGING LECTURES & VERIFYING COMPREHENSION

- **Level 1**
- **Activity:** Immediate, short Blackboard quizzes ("Knowledge Checks") after topics to maintain focus and recall basic facts.

- Example of knowledge checks (remembering - test)

08 - Climate Responsive Architecture Knowledge Check 2

Question 1

10 points

On July 2019, Beirut Airport weather station recorded in relation to a baseline of 22 degrees.

Description:	Celsius-based cooling degree days with base temperatures at and around 20 C												
Source:	www.degreedays.net												
Accuracy:	Estimates were made to account for missing data: the "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)												
Station:	Beirut Airport, 18 (3% ASE, 33.87N)												
Station ID:	QLBA												
	(Column titles show the base temperature in Celsius)												
Month starting	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22	22.5	23 % Estimated
01/11/2018	92	79	66	54	43	34	27	20	15	11	8	6	0.6
01/12/2018	25	18	13	9	6	4	2	2	1	0	0	0	0.4
01/01/2019	7	5	3	2	2	1	1	0	0	0	0	0	0.7
01/02/2019	13	11	9	8	6	5	4	4	3	2	2	1	0.4
01/03/2019	11	7	4	2	1	1	1	1	0	0	0	0	1
01/04/2019	50	42	34	28	23	19	16	13	10	9	7	6	0.4
01/05/2019	190	174	159	145	131	118	105	94	82	73	63	55	0.4
01/06/2019	286	271	256	241	226	211	196	181	166	151	136	121	0.3
01/07/2019	342	327	311	296	280	265	249	234	218	203	187	172	0.2
01/08/2019	364	348	333	317	302	286	271	255	240	224	209	193	0.2
01/09/2019	316	301	286	271	256	241	226	211	196	181	166	151	0.2
01/10/2019	266	251	235	220	204	189	173	158	143	128	114	100	0.3

Question 2

10 points

generally, an accumulation of higher degree-days over a comfort baseline means the climate is:

- ☐ A 187 cooling degree days
- ☐ B 187 kwh per day
- ☐ C 187 degrees of cooling
- ☐ D 187 heating degree days

- ☐ A heating dominated
- ☐ B cooling dominated
- ☐ C heating or cooling dominated depending on what hemisphere the project is located.
- ☐ D heating or cooling dominated depending on how much clothing people wear

LEVEL 1 & 2: REMEMBERING & UNDERSTANDING - SETTING THE FOUNDATION

ENGAGING LECTURES & VERIFYING COMPREHENSION

- Level 1
- Activity:** Immediate, short Blackboard quizzes ("Knowledge Checks") after topics to maintain focus and recall basic facts.

- Example of knowledge checks (remembering - test)

08 - Climate Responsive Architecture Knowledge Check 2

Question 1

10 points

On July 2019, Beirut Airport weather station recorded in relation to a baseline of 22 degrees.

Description:	Celsius-based cooling degree days with base temperatures at and around 20 C												
Source:	www.degreedays.net												
Accuracy:	Estimates were made to account for missing data: the "% Estimated" column shows how much each figure was affected (0% is best, 100% is worst)												
Station:	Beirut Airport, LB (35.49C, 33.82N)												
Station ID:	OLBA												
(Column titles show the base temperature in Celsius)													
Month starting	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22	22.5	23 % Estimated
01/11/2018	92	79	66	54	43	34	27	20	15	11	8	6	3 0.6
01/12/2018	25	18	13	9	6	4	2	2	1	0	0	0	0 0.4
01/01/2019	7	5	3	2	2	1	1	0	0	0	0	0	0 0.7
01/02/2019	13	11	9	8	6	5	4	3	2	2	1	1	1 0.4
01/03/2019	11	7	4	2	1	1	1	1	0	0	0	0	0 1
01/04/2019	50	42	34	28	23	19	16	13	10	9	7	6	5 0.4
01/05/2019	190	174	159	145	131	118	105	94	82	73	63	55	47 0.4
01/06/2019	286	271	256	241	226	211	196	181	166	151	136	121	106 0.3
01/07/2019	342	327	311	296	280	265	249	234	218	203	187	172	156 0.2
01/08/2019	364	348	333	317	302	286	271	255	240	224	209	193	178 0.2
01/09/2019	316	301	286	271	256	241	226	211	196	181	166	151	136 0.2
01/10/2019	266	251	235	220	204	189	173	158	143	128	114	100	87 0.3

Question 2

10 points

generally, an accumulation of higher degree-days over a comfort baseline means the climate is:

- (A) 187 cooling degree days Correct answer
- (B) 187 kwh per day
- (C) 187 degrees of cooling
- (D) 187 heating degree days

- (A) heating dominated
- (B) cooling dominated Correct answer
- (C) heating or cooling dominated depending on what them
- (D) heating or cooling dominated depending on how much clothing people wear

- Example of knowledge checks (remembering - answers)



LEVEL 1 & 2: REMEMBERING & UNDERSTANDING - SETTING THE FOUNDATION

ENGAGING LECTURES & VERIFYING COMPREHENSION

- **Level 2**
- **Method:** Facilitated through lectures, short workshops (active discussions), and assigned readings.
- **Outcome:** Students grasp fundamental principles and terminology needed for subsequent levels.

1 ESSAY

In your opinion, what was the most influential event that ultimately led to the green movement in the 20th century? (limit your answer to 50 words).

Answer



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LEVEL 1 & 2: REMEMBERING & UNDERSTANDING - SETTING THE FOUNDATION

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STUDENT "CORRCET" ANSWER

1 ESSAY

In your opinion, what was the most influential event that ultimately led to the green movement in the 20th century? (limit your answer to 50 words).

Answer

After the "glass box" high rise style became an icon in the cities, the 1970s energy crisis became the most influential event that led to the green movement. It highlighted the need for energy efficiency and sustainable practices. The growing environmental awareness from the 1960s, also inspired architects and environmentalists to rethink building designs, which had a big impact on the modern green building movement, especially after being overshadowed by events such as Great depression and world wars.



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Correct student answer, using concepts from the topic.

STUDENT ANSWER – AI

1

ESSAY

In your opinion, what was the most influential event that ultimately led to the green movement in the 20th century? (limit your answer to 50 words).

Answer

The green movement in the 20th century was influenced by the "Silent Spring", a publication by American marine biologist and writer Rachel Carson. As she warned from the dangers of widespread pesticide use on the whole ecosystem from environment to humans, the proliferation of her work enabled a significant change in environmental policies and thus influenced the green movement in 20th century.



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“Blind” LLM ai answer, in this example, the student entered the question as it is, not noting we are talking about “Buildings”

CHATGPT – COPY/PASTE OF THE QUESTION

ChatGPT ▾

In your opinion, what was the most influential event that ultimately led to the green movement in the 20th century? (limit your answer to 50 words).

The 1962 publication of Rachel Carson's *Silent Spring* was the most influential event, exposing the dangers of pesticides and sparking public environmental awareness. It led to policy changes, inspired the modern environmental movement, and laid the groundwork for Earth Day and the establishment of the U.S. Environmental Protection Agency.

↓

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Lebanese American University

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ChatGPT of a copy/pasted question


CHATGPT – ADDED THE WORD BUILDING TO THE QUESTION

ChatGPT ▾

In your opinion, what was the most influential event that ultimately led to the green BUILDING movement in the 20th century? (limit your answer to 50 words).

The 1973 oil crisis was the most influential event, exposing global energy vulnerabilities and sparking widespread interest in energy-efficient design. This catalyzed sustainable architecture, leading to innovations in insulation, passive solar design, and ultimately the green building movement focused on reducing environmental impact and resource consumption.

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ChatGPT answer when adding the word “Building” to the prompt, gives a correct answer.



LEVEL 3: APPLYING - HANDS-ON WORKSHOPS (FOUNDATIONAL COURSES)

FROM THEORY TO PRACTICE:
IN-CLASS APPLICATION

- **Level 3**
- **Method:** Small group or individual workshops immediately following lecture topics for direct application..

Level 3: Applying - Hands-On Workshops (Foundational Courses)

- **Method:** Small group or individual workshops immediately following lecture topics for direct application..

EXAMPLE 1 SAMPLE WORKSHOP (ENERGY AND DAYLIGHT BALANCE)

Tp: Sustainable Archit. Lab

Workshop 2

Work on Revit architecture model you created previously for a small building, create 2 options:

Option 1 with regular windows on all facades.

Option 2 with maximal curtain wall glazing on all facades.

Task 1:

1. Create energy models and optimize them on Insight 360 for both models.
2. Move the 2 models to an Insight folder called **Workshop 1**.
3. Include all options permutations to show the **BIM condition only**.
4. take a screenshot of the insight **model comparison scenarios** and **upload it to the workshop on Blackboard**.
5. Share the Insight with your instructor (add member -> michel.fran@gmail.com to the insight)

Task 2:

1. Create an **illuminance daylight analysis** of both models.
2. take a screenshot of the illuminance analysis results of each model and **upload it to the workshop on Blackboard**.

Upload both Revit models to the BlackBoard.

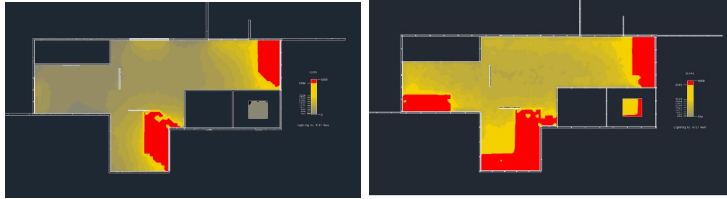
LEVEL 3: APPLYING - HANDS-ON WORKSHOPS (FOUNDATIONAL COURSES)

FROM THEORY TO PRACTICE: IN-CLASS APPLICATION

- **Level 3**
- **Topic:** Passive Strategies & Climate Analysis.
- **Activity:** Analyze climate data, apply passive design principles (e.g., shading, ventilation) to a given building example.

Example of activity in Level 3: in-class workshop (brief)

EXAMPLE SAMPLE WORKSHOP (ENERGY AND DAYLIGHT BALANCE)



Lighting Analysis - Results Summary

Custom Analysis

For all Rooms Included in Daylighting

Total Both - 42% Passing

0% either time below threshold
58% either time above threshold

9:00 am - 66% Passing

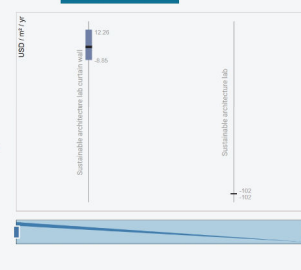
September 21
GHI: 515, DNI: 655, DHI: 81
0% below threshold
34% above threshold w/o shades

3:00 pm - 52% Passing

September 21
GHI: 376, DNI: 570, DHI: 81
0% below threshold
46% above threshold w/o shades

Model Comparison

Scenarios: Custom



Lighting Analysis - Results Summary

Custom Analysis

For all Rooms Included in Daylighting

Total Both - 62% Passing

24% either time below threshold
15% either time above threshold

9:00 am - 65% Passing

September 21
GHI: 515, DNI: 655, DHI: 81
23% below threshold
12% above threshold w/o shades

3:00 pm - 75% Passing

September 21
GHI: 376, DNI: 570, DHI: 81
23% below threshold
3% above threshold w/o shades

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LEVEL 3: APPLYING - HANDS-ON WORKSHOPS (FOUNDATIONAL COURSES)

FROM THEORY TO PRACTICE: IN-CLASS APPLICATION

- **Level 3**
- **Topic:** Passive Strategies & Climate Analysis.
- **Activity:** apply Daylighting strategies and compare results of regular windows with fully glazed facades.

Example of activity in Level 3: in-class workshop (student answer using advanced environmental analysis tools)



LEVEL 4 & 5: ANALYZING & EVALUATE – TECHNOLOGY INTEGRATION AND CONCEPTUALIZATION

LEVERAGING TECHNOLOGY FOR DEEPER INSIGHTS AND CONCEPT APPLICATION

Levels 4

Method: Using advanced simulation tools for application and analysis.

- Students analyze their site/climate using simulation tools.

Level 4 & 5: Analyzing & Evaluate – Technology Integration and conceptualization

Levels 4

Method: Using advanced simulation tools for application and analysis.

- Students analyze their site/climate using simulation tools.



LEVEL 4 & 5: ANALYZING & EVALUATE – TECHNOLOGY INTEGRATION AND CONCEPTUALIZATION

CRITICAL THINKING FOR ADVANCED EVALUATION

Levels 5

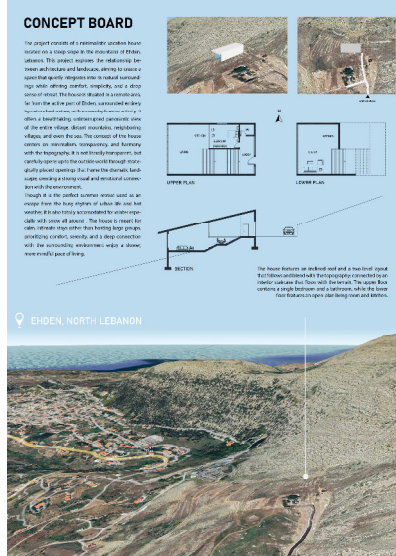
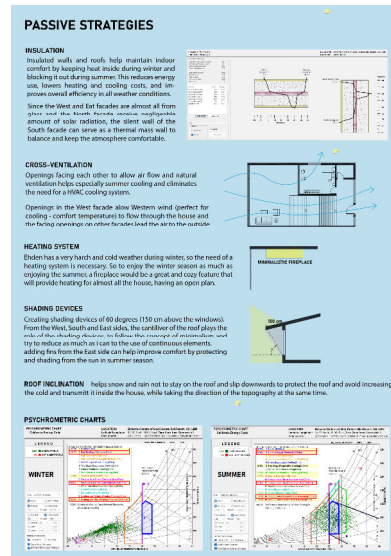
Method: Using critical thinking to conceptualize integration.

- Critically evaluate different design strategies and system choices based on performance data (energy, light, wind, carbon).

Levels 5

Method: Using critical thinking to conceptualize integration.

- Critically evaluate different design strategies and system choices based on performance data (energy, light, wind, carbon).

EXAMPLE: CAPSTONE PROJECT SITE AND ENVIROMENTAL ANALYSIS AND EVALUATION OF PASSIVE STRATEGIES

EVALUATE


Evaluate (environmental site requirements evaluation of proper passive and active strategies) student work



LEVEL 6: CREATING (THE CAPSTONE PROJECT)

SYNTHESIZING KNOWLEDGE: DESIGNING SUSTAINABLE SOLUTIONS

Levels 6


Method:

- Develop a unique architectural design that responds to the analysis and evaluation.
- Integrate systems (e.g., PV, passive strategies) to achieve zero-energy goals.

Level 6: Creating (The Capstone Project)

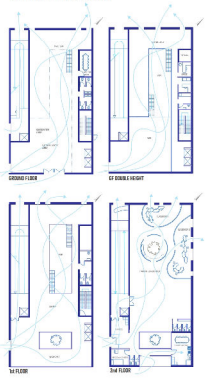
Method:

- Develop a unique architectural design that responds to the analysis and evaluation.
- Integrate systems (e.g., PV, passive strategies) to achieve zero-energy goals.



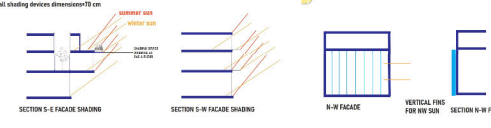
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CROSS VENTILATION

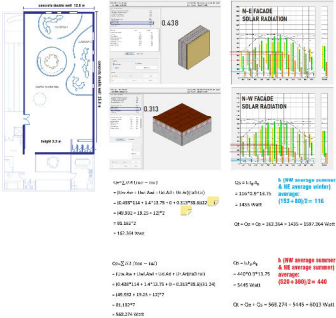


SHADING DEVICES FOR SUN PROTECTION

all shading devices dimensions in cm



HEAT FLOW ANALYSIS



CARBON EMISSIONS IMPACT

Category	Material	Quantity	Unit	CO2e (kg)
Structure	Concrete	100	m³	10000
	Reinforcement	1000	kg	100
	Brickwork	500	m³	5000
	Plaster	100	m³	1000
Envelope	Insulation	50	m³	500
	Windows	10	m²	1000
	Doors	5	m²	500
	Furniture	100	kg	1000
Services	Electrical	100	kg	1000
	Plumbing	100	kg	1000
	Mechanical	100	kg	1000
	Other	100	kg	1000
Total				20000

The difference on carbon emissions between recycled and virgin material is almost negligible, so maybe we should maybe use more recycled material or reconsider the way of recycling to have a bigger impact

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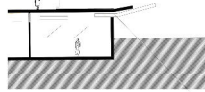
Example of Student creative architecture work integrating sustainable architecture requirements

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Passive integrations

Light well strategy :



Since the underground level is now an addition to my design, the integration of the light well strategy can provide light access for underground levels and also acts as a ventilation mechanism

In order to enhance the light well performance, high canopies are placed on the same level of the light well as placed to reduce energy consumption for artificial light on the underground level

The strategy can also take care in the upper level where the display in the right of the board unit, this is directly to the ground level well not being affected by the artificial light (being) looking the ceiling light



part of the ground floor

Construction cost: 100,000,000 L.L.

Energy use

Energy use: 100,000,000 L.L.

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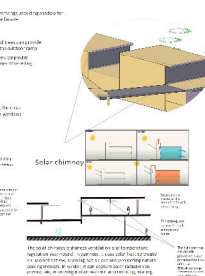
Energy use: 100,000,000 L.L.

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Energy use: 100,000,000 L.L.

General Quantity Schedule for the building	
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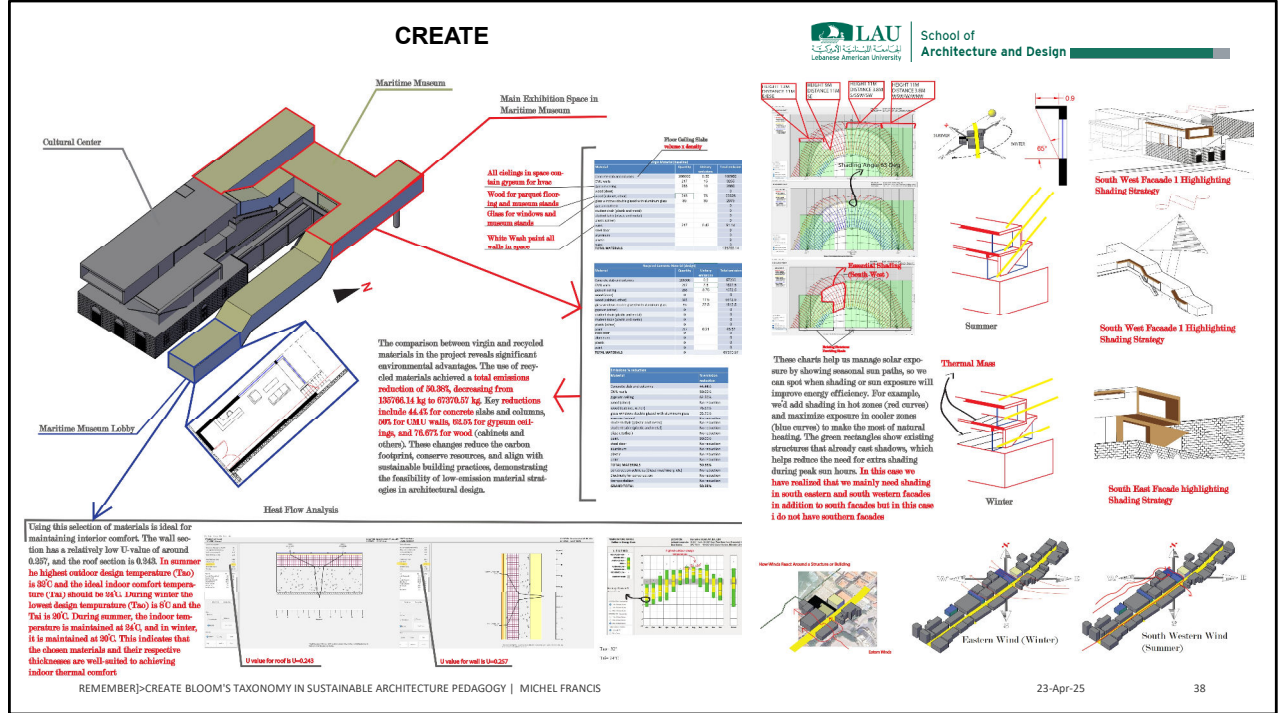
Solar chimney

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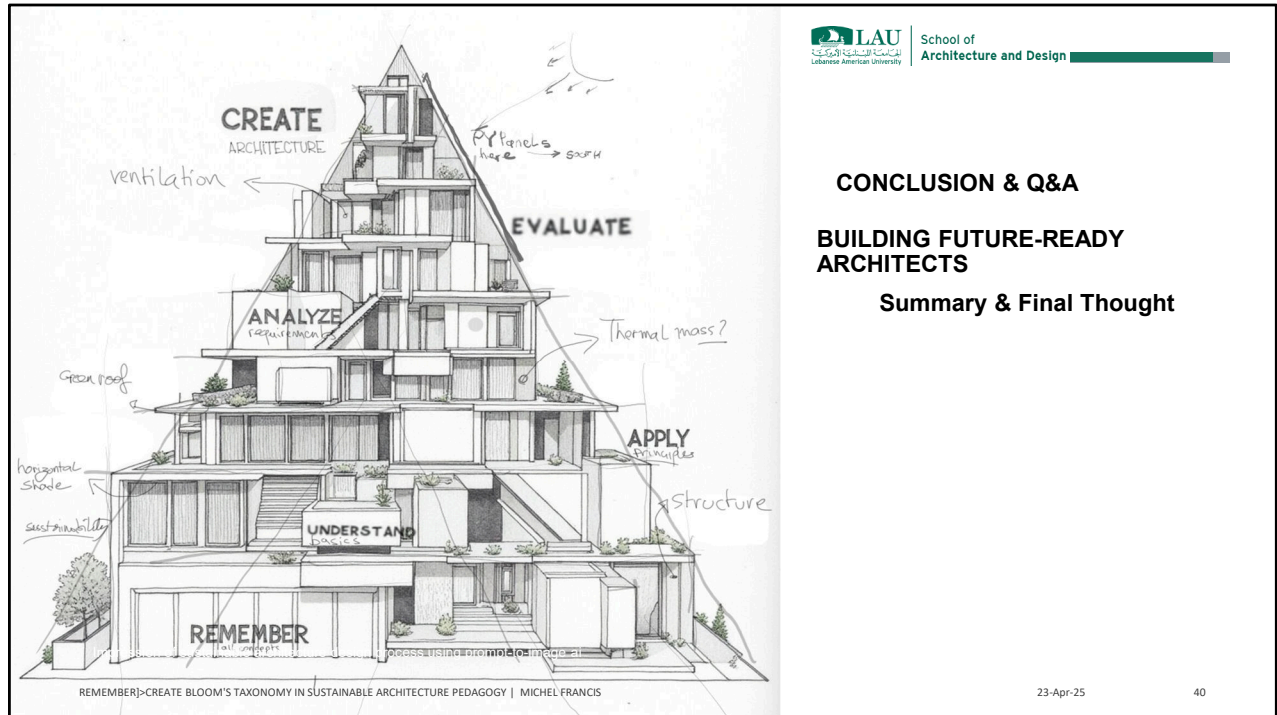
Solar chimney

Solar chimney

Example of Student creative architecture work integrating sustainable architecture requirements



Example of Student creative architecture work integrating sustainable architecture requirements



- Bloom's Taxonomy provides a valuable framework for structuring architecture pedagogy, especially in complex fields like sustainability.
- This approach helps move students progressively up the cognitive ladder, from remembering basic facts to creating innovative solutions.

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