

Building Industry-Ready Civil Engineers: Integrating Standards Education into the Civil Engineering Curriculum

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Presentation Outline

- Background and Objective
- Overall Approach and Pedagogy
- Modules Design
- Results and Discussion
- Conclusions



Engineering
Accreditation
Commission

- **Bachelor of Science in Civil Engineering at University of South Alabama (USA)**
 - ABET-EAC Accredited
 - Approximately 230 students in the program
 - Average 35-45 graduates per year



Shenghua Wu



Min-Wook
Kang



John
Cleary



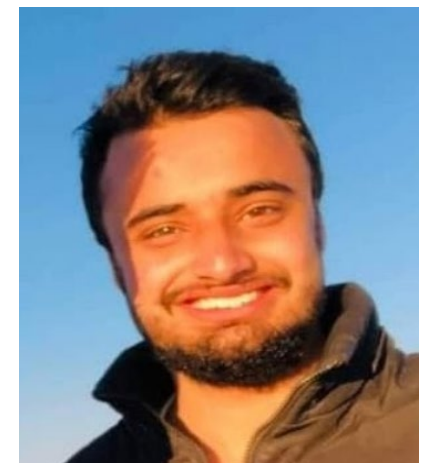
Lisa
LaCross



James P. Van
Haneghan



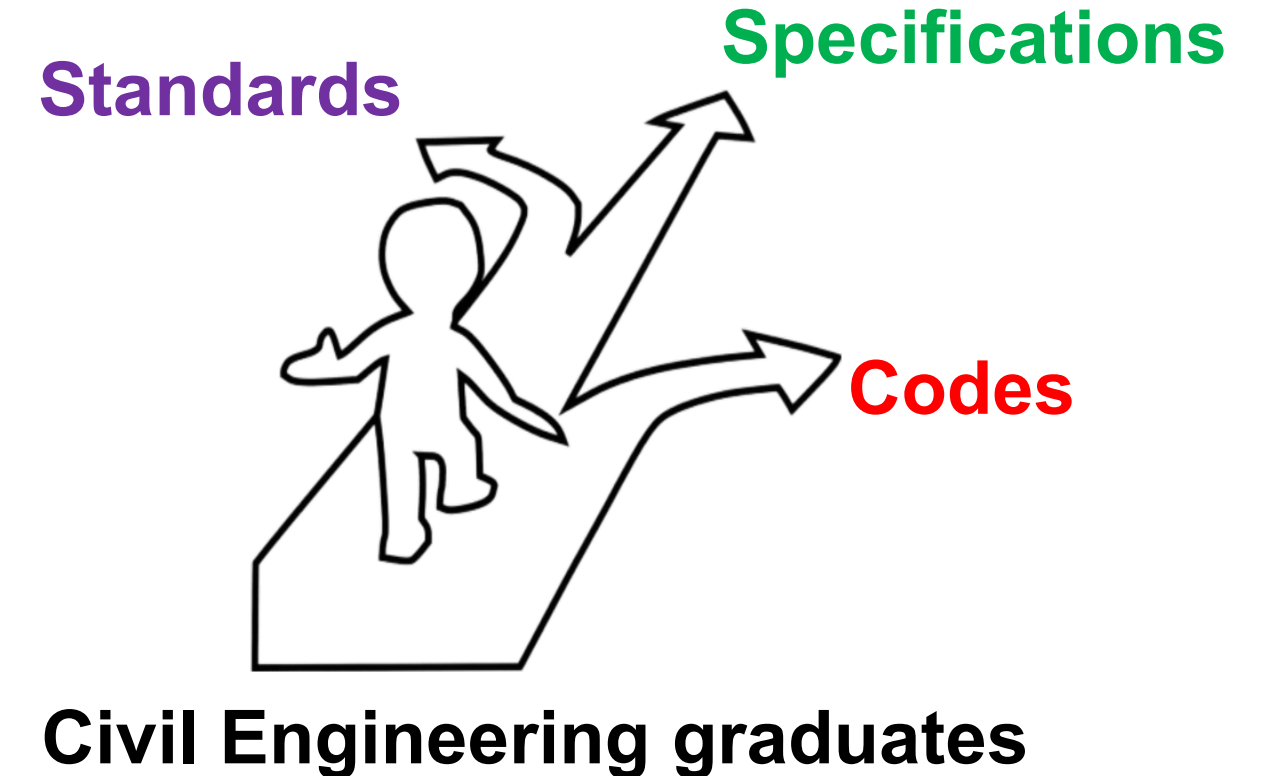
Graduate Student:
Abeeb Oyelere



Former Graduate
Student: Pratik
Neupane

Background

- Civil engineering is a highly dynamic profession with a **wide range of specifications and standards**, such as ASTM, AISC, ACI, AASHTO.
- The ability to **navigate and reference industry specifications** is recognized as a core professional competency.
- Employers expect civil engineering graduates to **demonstrate at least a foundational proficiency in interpreting and applying relevant standards**.



Challenge

Traditional lecture-based instruction **emphasizes memorization**, limiting exposure to real-world specifications.



ACADEMIC THEORY

- Stress & Strain
- Material Properties
- Calculations

THE SKILLS GAP



INDUSTRY PRACTICE

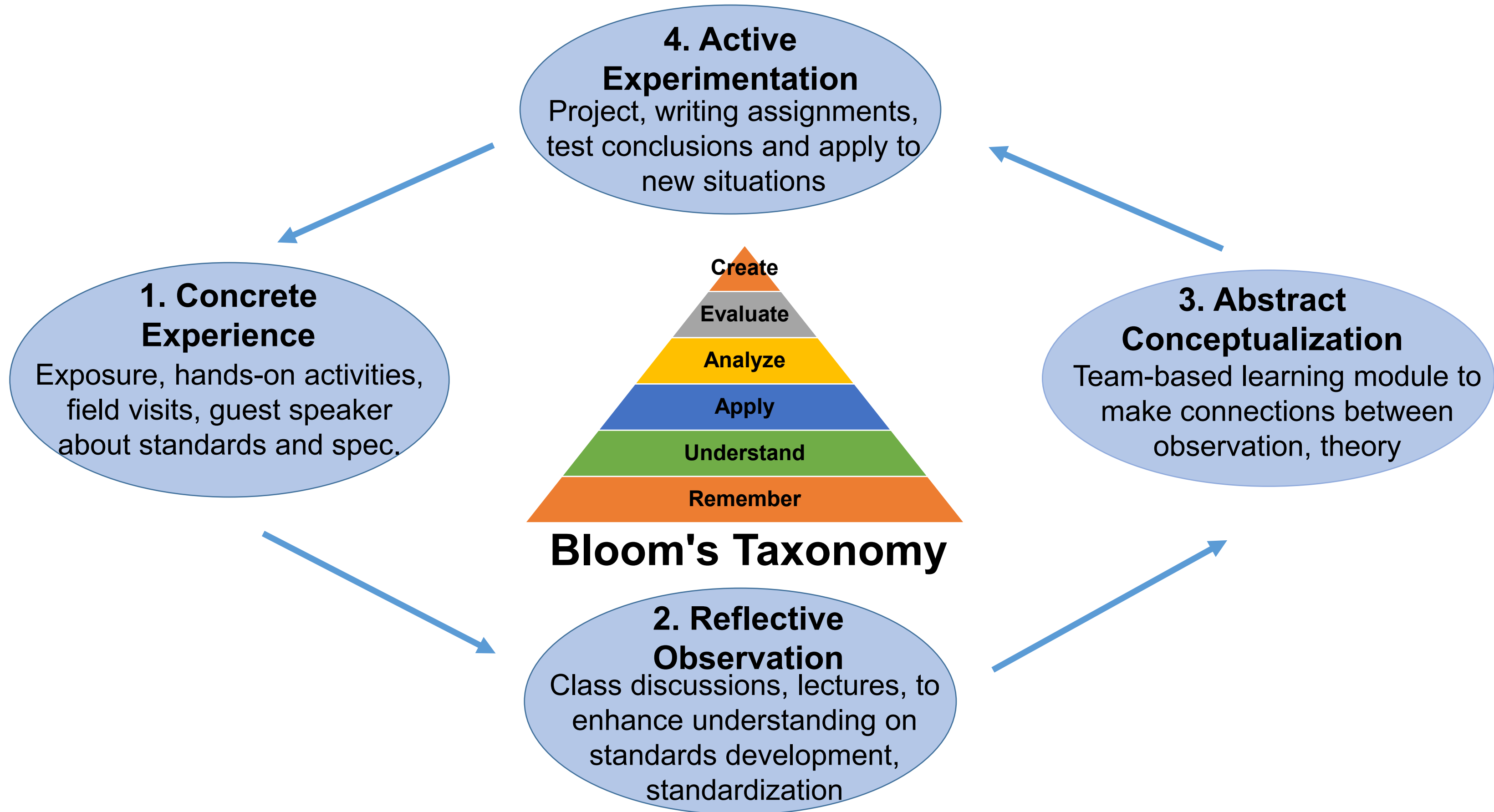
- ASTM/AASHTO Standards
- Regulatory Compliance
- Testing Precision

Objectives

To explore a systematic approach, guided by **Kolb's Experiential Learning Model (ELM)**, for designing and incorporating education on standards, codes, and specifications into the Civil Engineering Materials curriculum:

1. Develop **user-friendly learning modules aligned with the ELM framework** that are straightforward to implement and accessible to students;
2. **Integrate** these modules into civil engineering material course and evaluate their **impact on student learning outcomes and overall effectiveness.**

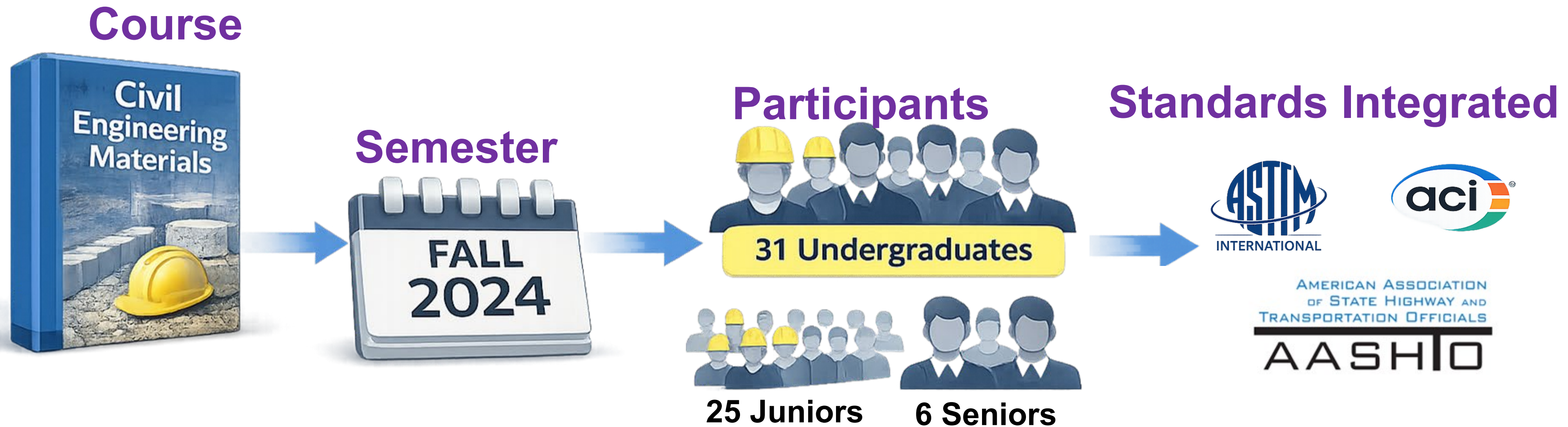
Overall Approach and Pedagogy: Experiential Learning Model



Modules Design

Level	Course Title	Relevance to Experiential Learning Model	Relevance to Bloom's Taxonomy
Freshman	Introduction to Civil Engineering	concrete experience, reflective observation	Remember, Understand, Apply
Sophomore	Mechanics of Materials	concrete experience, reflective observation, active experimentation	Understand, Apply, Analyze, Evaluate
Junior	Civil Engineering Materials and Lab	concrete experience, reflective observation, abstract conceptualization, active experimentation	Understand, Apply, Analyze, Evaluate, Create
Senior	Senior Design	concrete experience, reflective observation, abstract conceptualization, active experimentation	Apply, Analyze, Evaluate, Create
Graduate	Advanced Characterization of Transportation Materials	concrete experience, reflective observation, abstract conceptualization, active experimentation	Apply, Analyze, Evaluate, Create

Course Implementation Example: CE314/315 Civil Engineering Materials and Lab



Stage-by-Stage Implementation



Stage 1: Concrete Experience

- **Classrooms Instruction on Specific Standards:** Guided introduction to reading and interpreting standards
- **Professional Engineering Presentations:** Guest lectures from practicing engineers connecting standards to real-world applications
- **Hands-On Labs:** Material testing following standards and procedures
- **Field Trips:** Direct exposure to industrial production, quality control, and operational environments
- **Assessment:** Participation, data accuracy and procedural adherence

- **Objective:** To engage students in hands-on activities that expose them to real-world material behavior and the practical application of engineering standards.

Stage-by-Stage Implementation

Data Table

	OBSERVED DATA	ASTM STANDARD SPEC
Patameler	3.5°	2.4°
Slumn (In)	3.5°	2.4°
Air Content (%), (1)	42% (Nonr Conformance)	50% - 7.0%
Unit Weight (Itvit°)	183.1	5070%

Compare to ASTM Standard Limits

Results vs Standards?

Parameter	Observed Data
Slump (in)	3.5°
Air Content (%)	4.2% (Non Conformed)

Why? ↗

Below standard limit; Investigate potential causes. eg: improper: improper entrainment, over-mixing.

Analyze test data and compare to ASTM standards

Possible Causes:

- Improper Air Entrainment
- Over-Mixing

Compare to ASTM Standard Limits

ASTM Specification Summary		
Slump (in)	S.S°	2.4°
Air Content	4.2% (Nonconformance)	50% - 7.0%

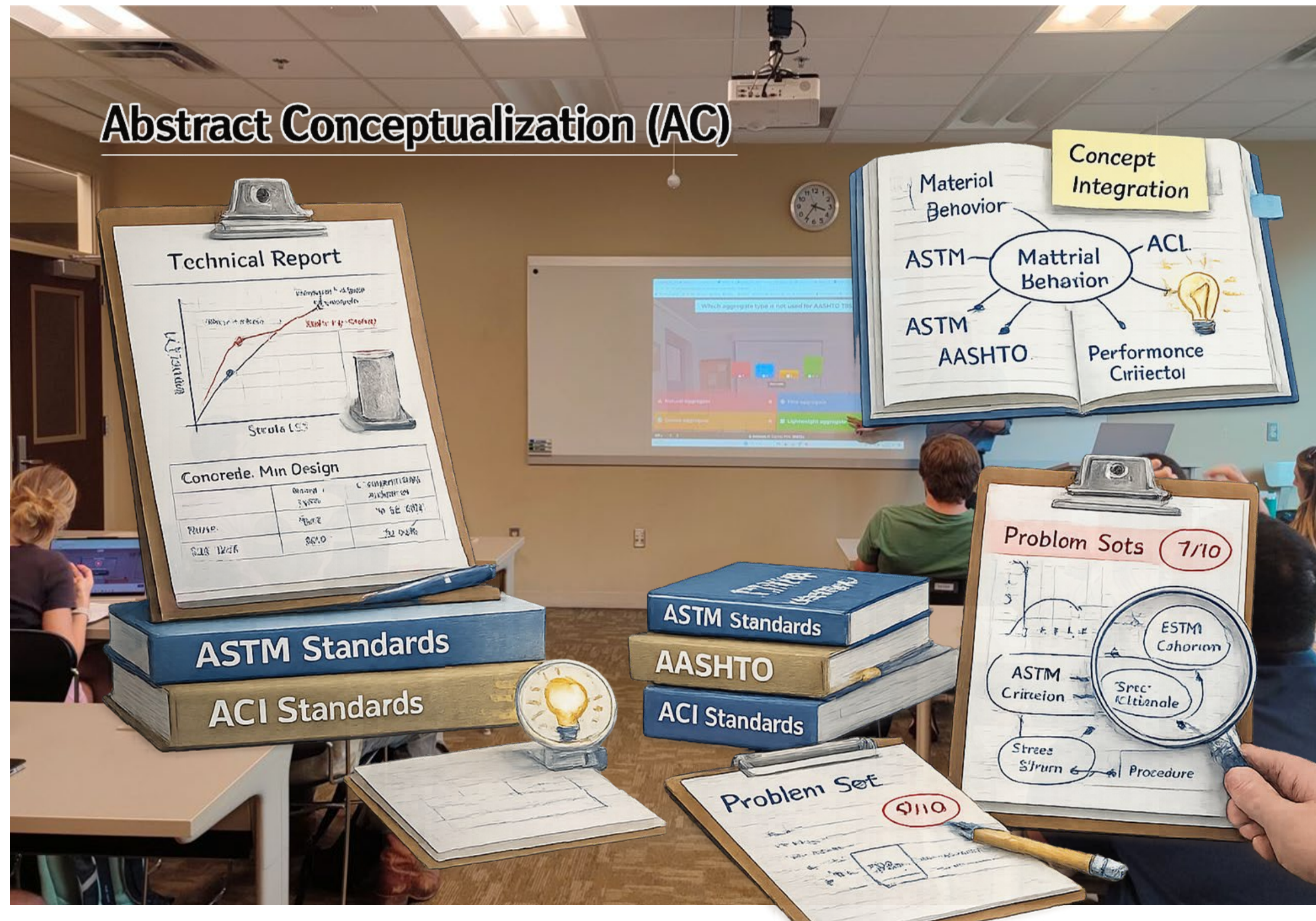
Analyze Discrepancies

Stage 2: Reflective Observation

- **Laboratory Reflection Reports:** Analyze experimental results and compare findings with specification limits and expected outcomes.
- **Guest Lecture Reflections:** Students reflect on how industry professionals apply standards decision-making.
- **Discussion and Journaling:** Structured reflections on challenges, deviations, and compliance.
- **Field Visit Reflection:** Relate plant observations to standards and theory
- **Assessment:** Depth of reflection and accuracy of comparison.

- **Objective:** To encourage students to critically analyze their experiences, compare outcomes with standards, and deepen their understanding of specifications guide engineering practice.

Stage-by-Stage Implementation



Stage 3: Abstract Conceptualization

- **Technical Reports:** Linking laboratory results to fundamental engineering principles.
 - **Concept Integration:** Connecting observed material behavior to performance criteria.
 - **Problem Sets & Quizzes:** Reinforcing theoretical understanding of material properties and specification rationale.
 - **Concept Mapping & Analysis:** Synthesizing data, theory, and standards to explain performance.
 - **Assessment:** Theory–specification alignment
- **Objective:** To develop theoretical understanding by connecting experiential learning to engineering principles and the rationale behind professional standards.

Stage-by-Stage Implementation



Stage 4: Active Experimentation

- **Mini Design Projects:** Designing to meet specified requirements.
- **Asphalt Design Lab:** Modifying materials with additives and evaluating compliance with standards.
- **Group Final Presentations:** Proposing and presenting material solutions with technical justification.
- **Standards-Based Decision Making:** Applying performance criteria to justify technical decision.
- **Assessment:** Problem-solving and technical justification

- **Objective:** To apply theoretical knowledge and specification-based understanding to real-world design challenges, reinforcing problem-solving skills and professional engineering judgment.

Evaluation Framework 1

Guest Speaker Quiz – Industry Knowledge Transfer

Purpose: Measure students' ability to:

- Connect classroom theory to professional practice
- Understand real-world application of ASTM/AASHTO/ACI standards
- Interpret practical examples shared by industry engineers

Assessment Design

- ✓ Administered immediately after lecture
- ✓ Multiple-choice format
- ✓ Quantitative performance analysis

Evaluation Metrics

- ✓ Average score
- ✓ Score distribution
- ✓ Comprehension of: Material testing, Specification compliance, Code interpretation

Evaluation Framework 1 Result

Guest Speaker Quiz – Industry Knowledge Transfer

Selected Questions	Options
1. Which organization does the Speaker work for currently?	A. National Asphalt Pavement Association (NAPA) B. National Center for Asphalt Technology (NCAT) C. Alabama Asphalt Pavement Association (AAPA) D. Alabama Department of Transportation (ALDOT)
2. Which fact about asphalt pavement is incorrect?	A. Asphalt pavement is 100% recyclable. B. Over 94% of the nation’s highways are surfaced with asphalt. C. Asphalt pavement is No. 1 recycled product in U.S. D. Asphalt pavement cannot be placed as a perpetual pavement.
3. Which of the following statement is incorrect about reclaimed asphalt pavement (RAP)?	A. RAP has aged asphalt, which is stiffer than virgin asphalt. B. Aggregate in RAP is the same age as virgin aggregate. C. Use of RAP can save materials cost for asphalt pavement. D. The asphalt content in fine RAP is lower than that in coarse RAP.
4. For an asphalt pavement in Alabama, the maximum RAP content in wearing surface course is?	A. 10% B. 20% C. 35% D. 50%
5. If a contractor chooses to use 100% RAP in a pavement, which location is most appropriate for use?	A. Interstate highway B. Low volume road C. High volume road D. Medium volume road
6. Which of the following statement is correct about the use of reclaimed asphalt pavement (RAP)?	A. For open-graded friction course, no RAP may be used in asphalt mixture. B. RAP is also called “White Rock”. C. Fractionation is not needed for contractor to achieve the uniformity of RAP. D. Adding high content of RAP in asphalt mix will improve low temperature cracking resistance.

- Students achieved an **average score of 96%**, with the majority demonstrating strong comprehension of industry practices and standards application.

Evaluation Framework 2

Laboratory Reports – Applied Specification Literacy

Purpose: Assess students' ability to:

- Apply standards in experimental settings
- Interpret data relative to specification limits
- Cite ASTM/AASHTO/ACI properly
- Communicate findings professionally

Assessment Design

- ✓ Group and individual memos evaluated using a consistent grading rubric.
- ✓ The rubric assessed content accuracy, organization and structure, formatting, grammar and technical clarity, and **proper citation of relevant engineering standards.**

Evaluation Metrics

- ✓ Mean score and standard deviation
- ✓ Group vs. Individual Comparison

Evaluation Framework 2 Result

Lab Reports (Group & Individual)

Type	Content	Average Score ± Standard Deviation	Mean
Group Report	1. Aggregate Property	9.3 ± 0.7	9.3 ± 0.6
	2. Aggregate Gradation	9.0 ± 0.6	
	3. Concrete Mix Design and Batching	9.6 ± 0.2	
	4. Hardened Concrete Testing	9.1 ± 0.7	
Individual Report	1. Concrete Plant Visit	9.5 ± 1.8	9.5 ± 1.0
	2. Asphalt Plant Visit	9.7 ± 0.7	
	3. Asphalt Binder Testing	9.5 ± 0.5	
	4. Asphalt Mixture Testing	9.3 ± 0.6	
Total		9.4 ± 0.9	

- Strong overall performance
- Individual reports slightly higher than group reports
- Highest score: Concrete Mix Design & Batching
- Consistently low variability across most assignments
- Demonstrated solid understanding of standards application

Evaluation Framework 3

Pre–Post Perception Survey – Confidence & Awareness Shift

Purpose:

- To evaluate changes in students' awareness of standards in professional practice, conceptual understanding, confidence in application, perceived curricular coverage, and interest in deeper specification education.

Assessment Design

- ✓ 9 structured questions administered anonymously on the first and last day of the course, analyzed using descriptive statistics.

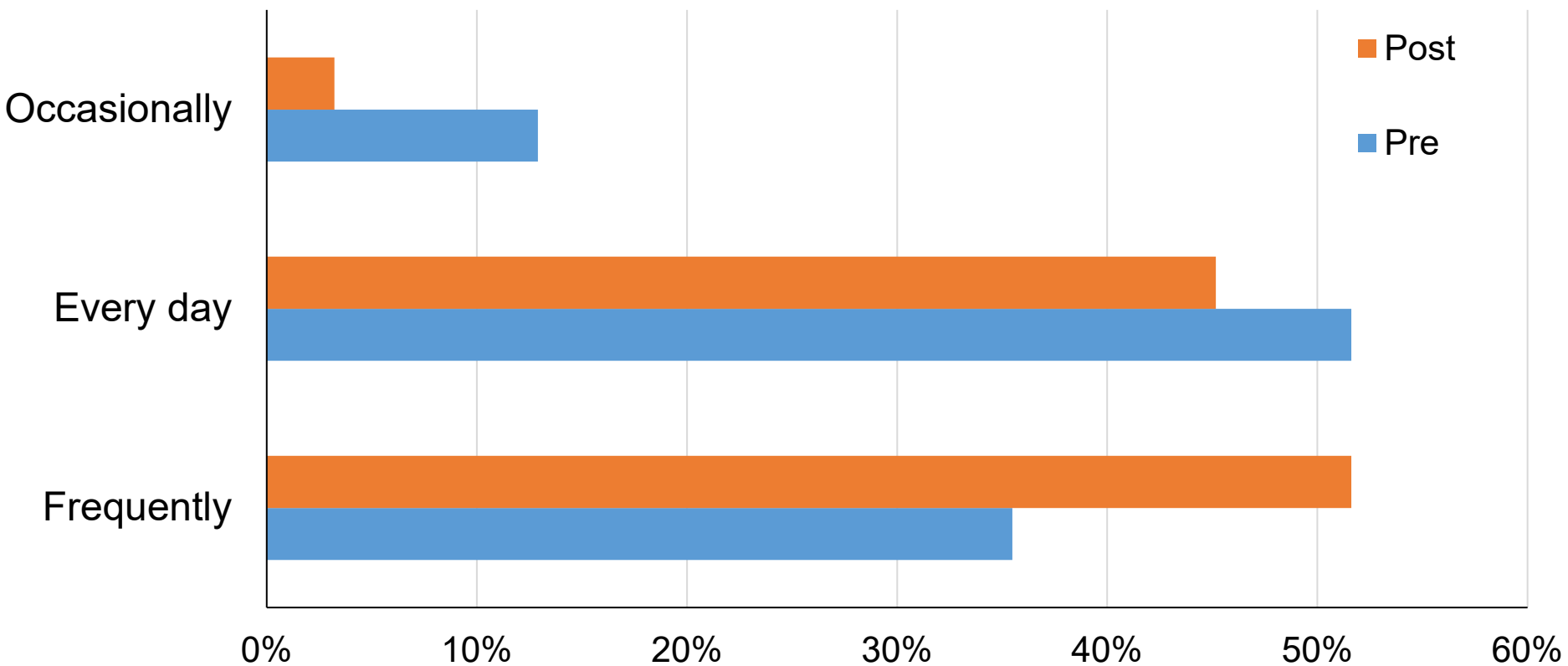
Evaluation Metrics

- ✓ Perceived frequency of code use, self-rated understanding and confidence, concerns about working with standards, instructional preferences, and interest in elective courses.

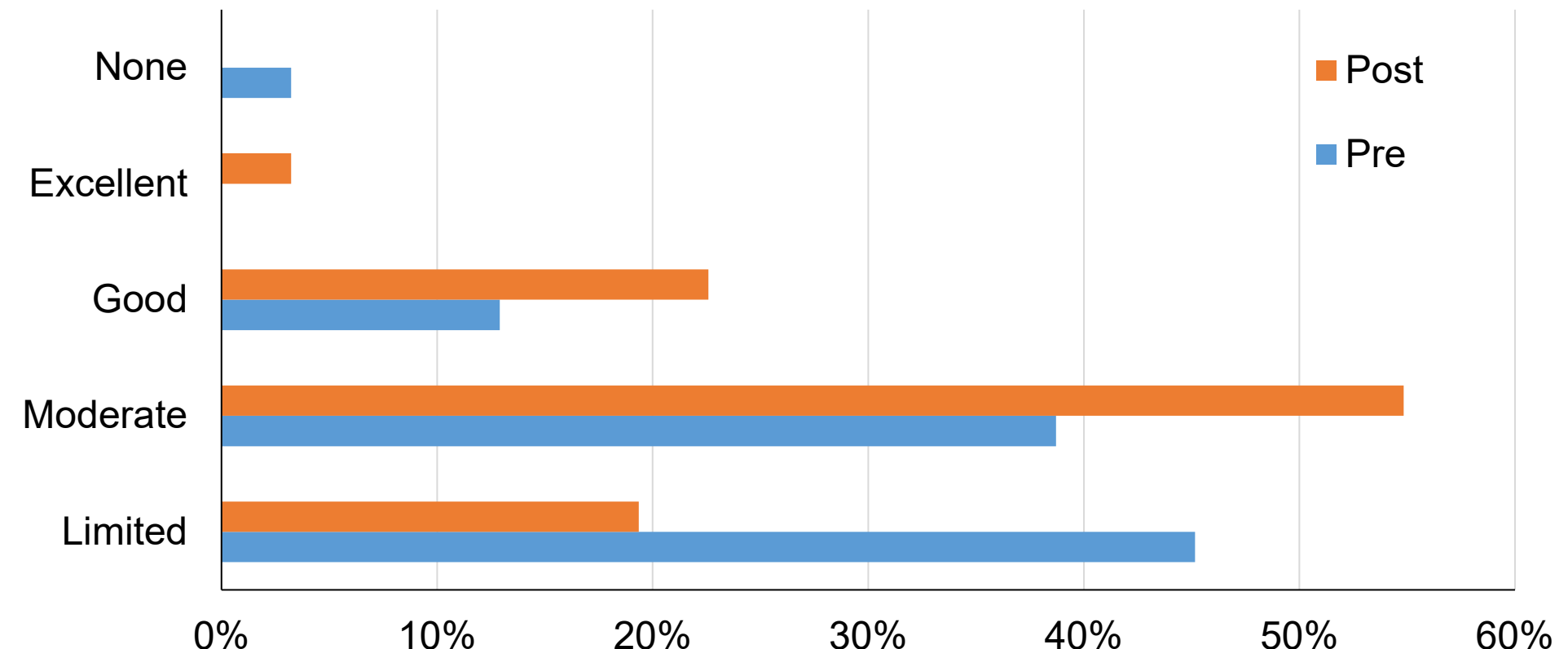
Evaluation Framework 3 Result

Student Survey Results

How often do you think civil engineers reference codes and specifications in their daily work?



What is your current understanding of industry standards and specifications in civil engineering?

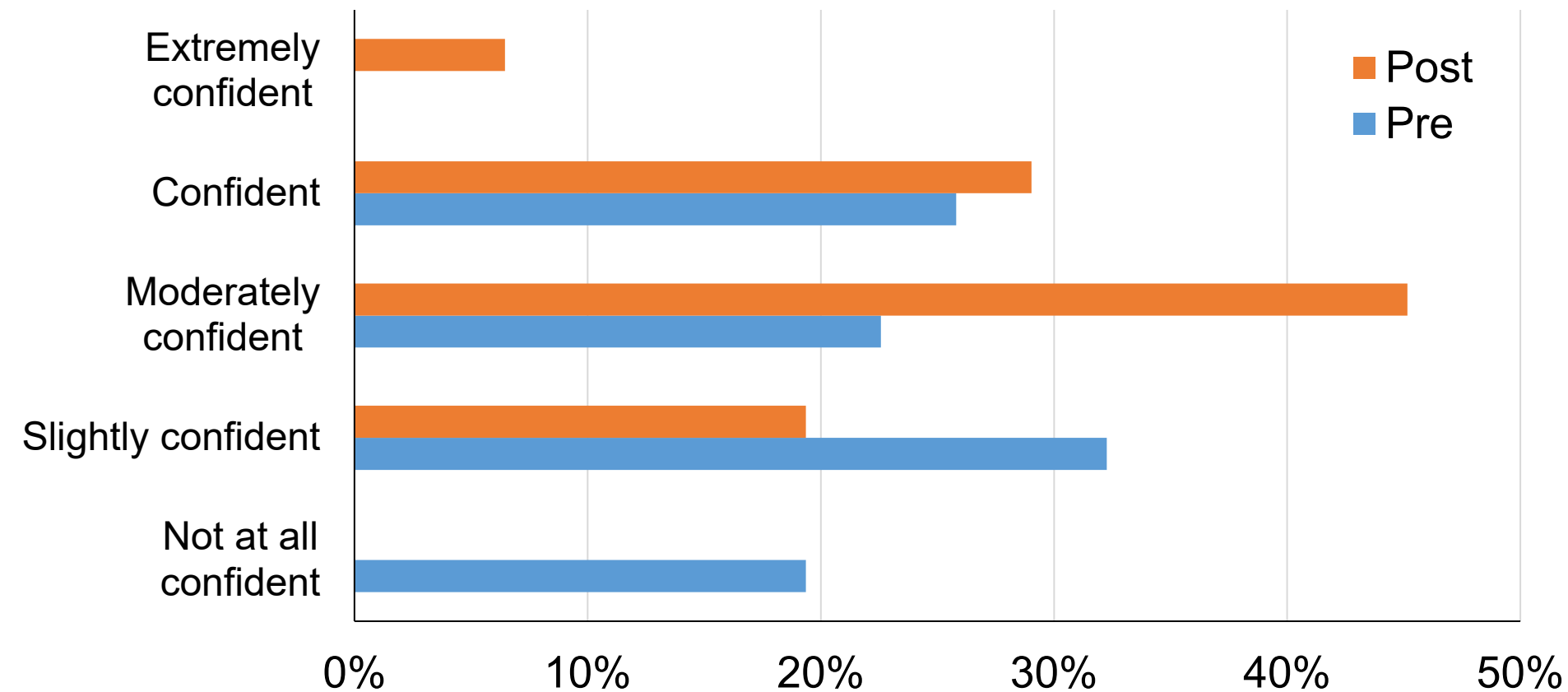


- Students showed increased recognition that **standards are regularly used in professional practice** with **experiential activities** helping students connect coursework to daily professional application.
- Substantial **improvement in self-reported understanding of industry standards** indicating stronger conceptual clarity after structured integration of specifications.

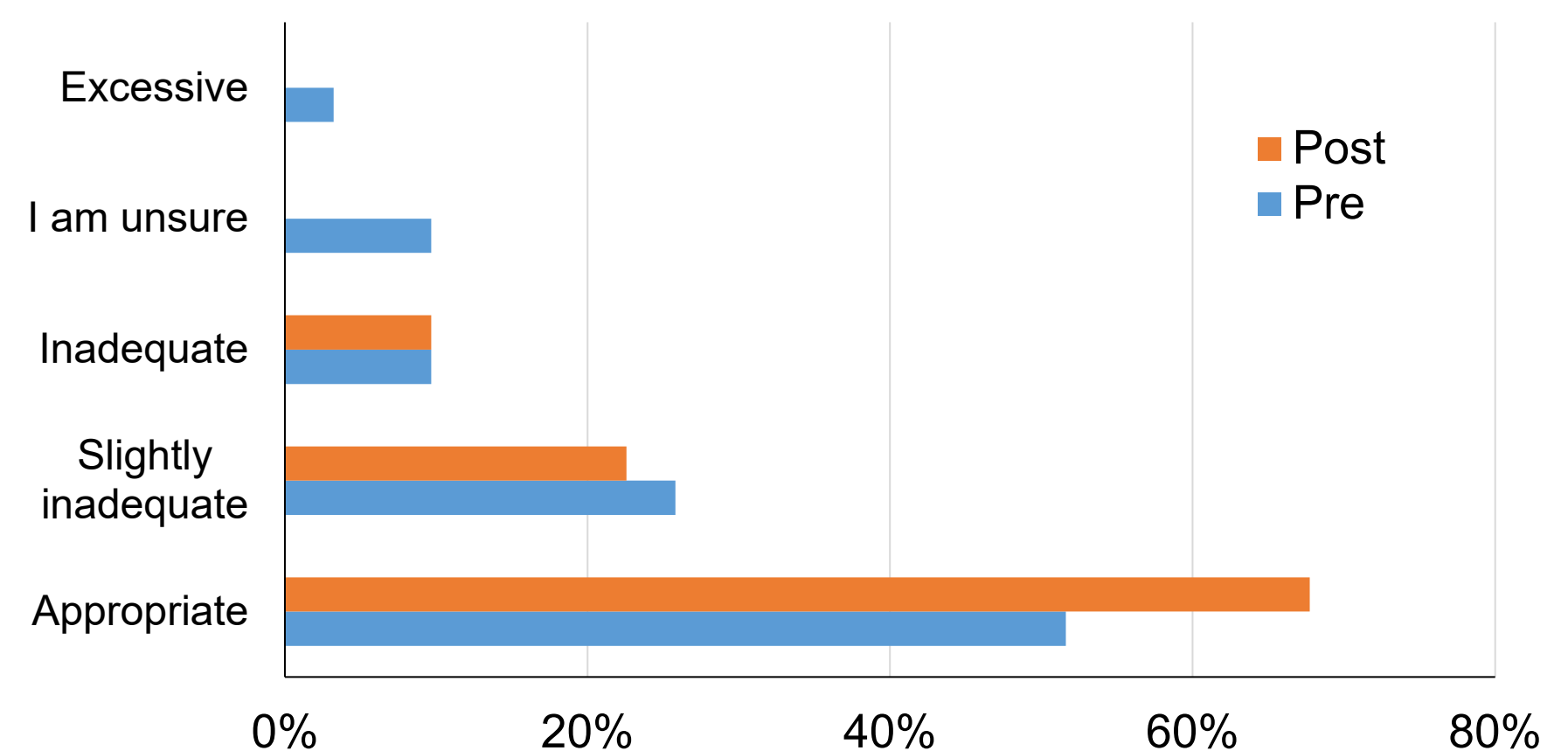
Evaluation Framework 3 Result

Student Survey Results

How confident do you feel in your ability to interpret and apply industry standards to real-world engineering problems?



How would you rate the coverage of codes and standards currently in your civil engineering classes?

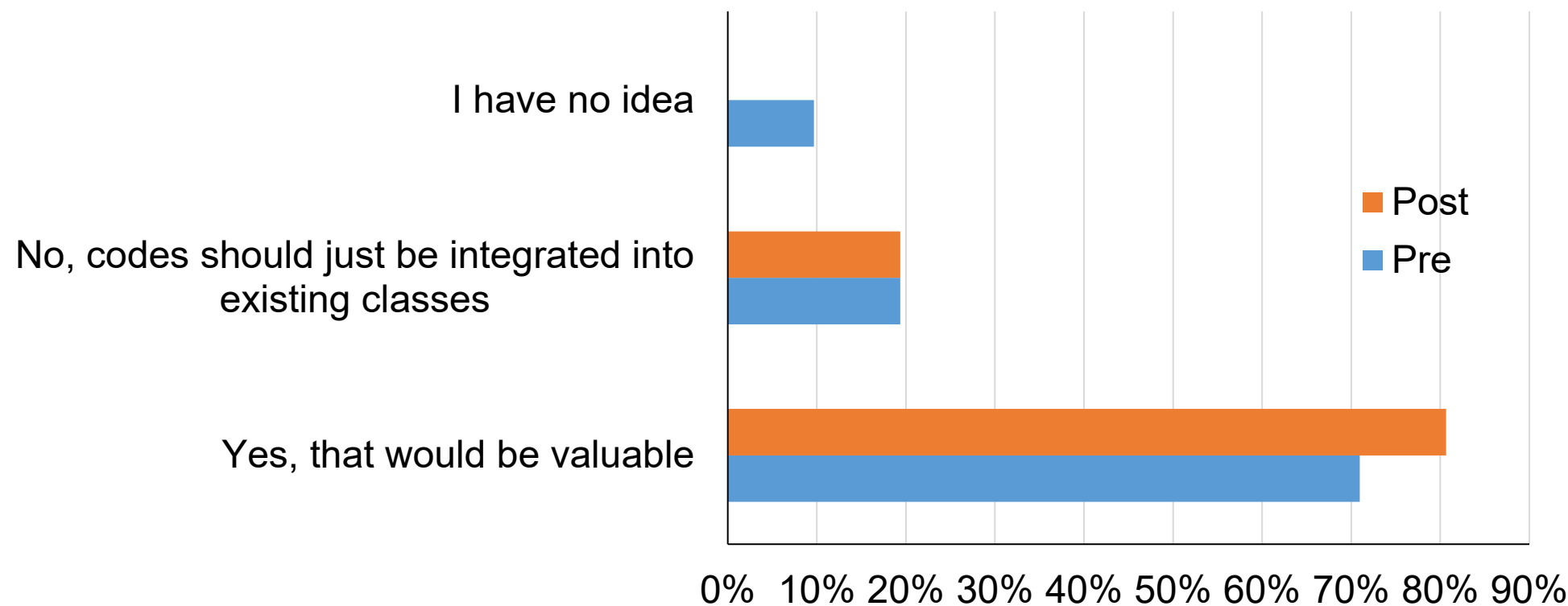


- Students demonstrated a significant **increase in confidence when interpreting and applying industry standards**, reflecting improved readiness to use specifications in laboratory and design contexts.
- Stronger believed that **course coverage** of standards was **appropriate**, with **uncertainty about exposure eliminated** after structured implementation.

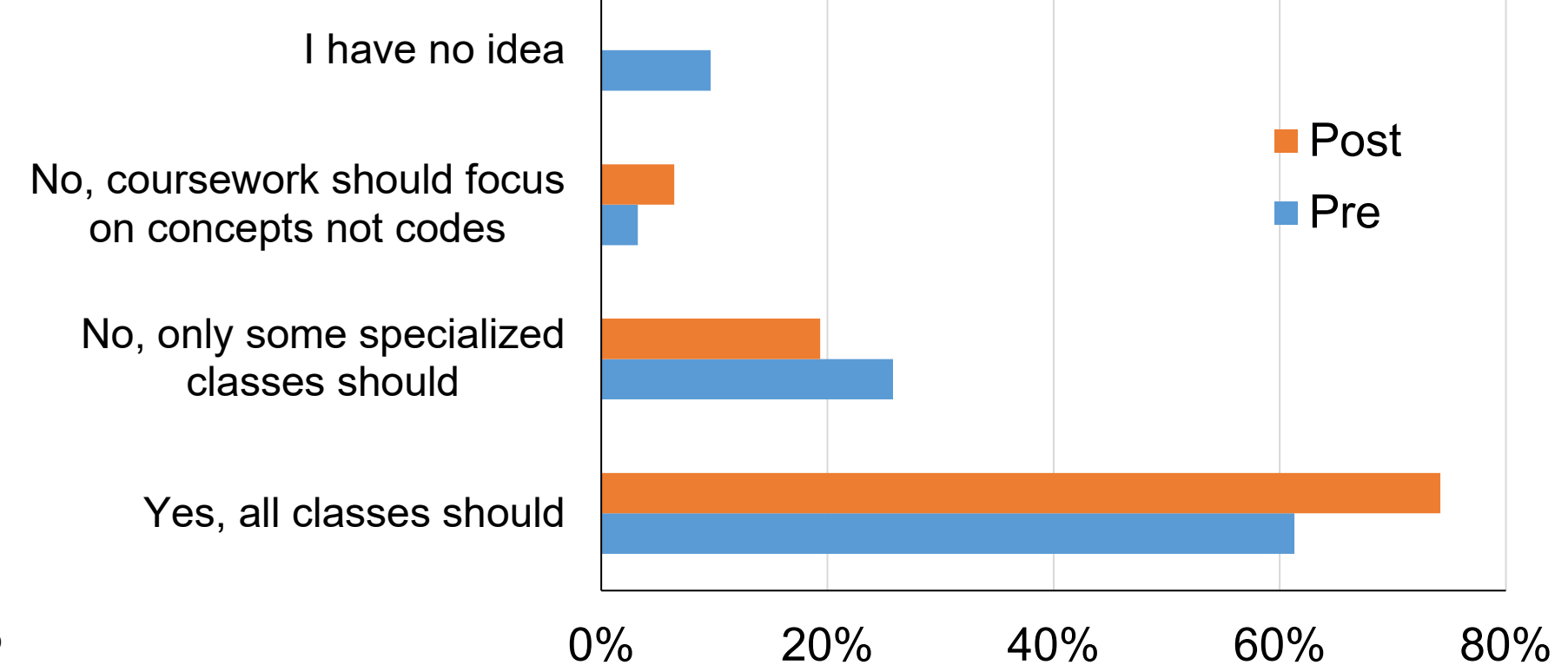
Evaluation Framework 3 Result

Student Survey Results

Do you think colleges should offer elective courses going in-depth on civil engineering codes like AASTHO, ASCE, ACI, etc.?



Do you think all civil engineering classes should incorporate working with relevant codes and standards into projects and assignments?

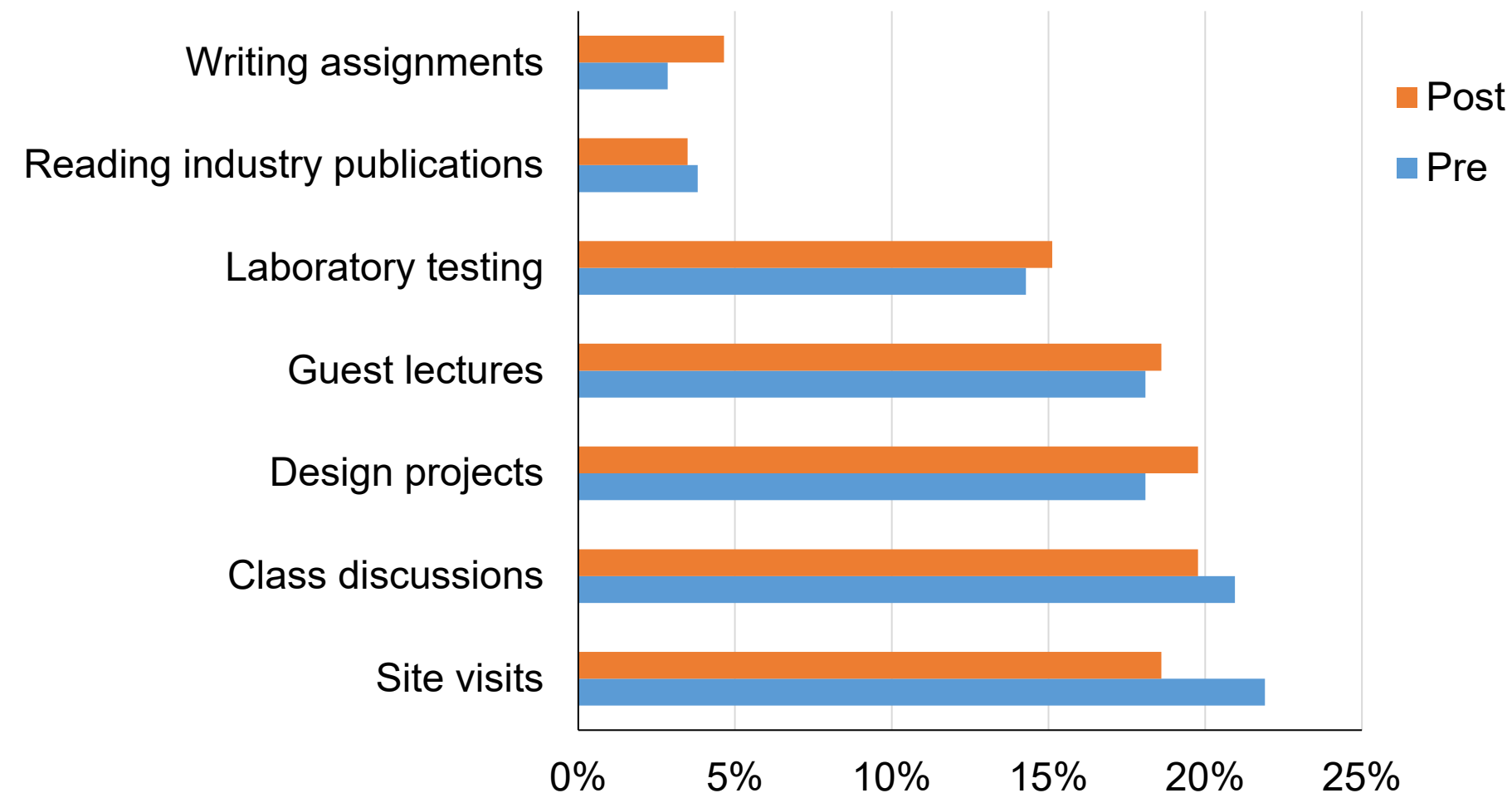


- Interest in **elective courses focused** on AASHTO, ASCE, and ACI standards increased, demonstrating sustained **motivation for deeper specification literacy**.
- Support for **integrating standards across more civil engineering courses increased**, showing growing recognition of their central role in professional preparation.

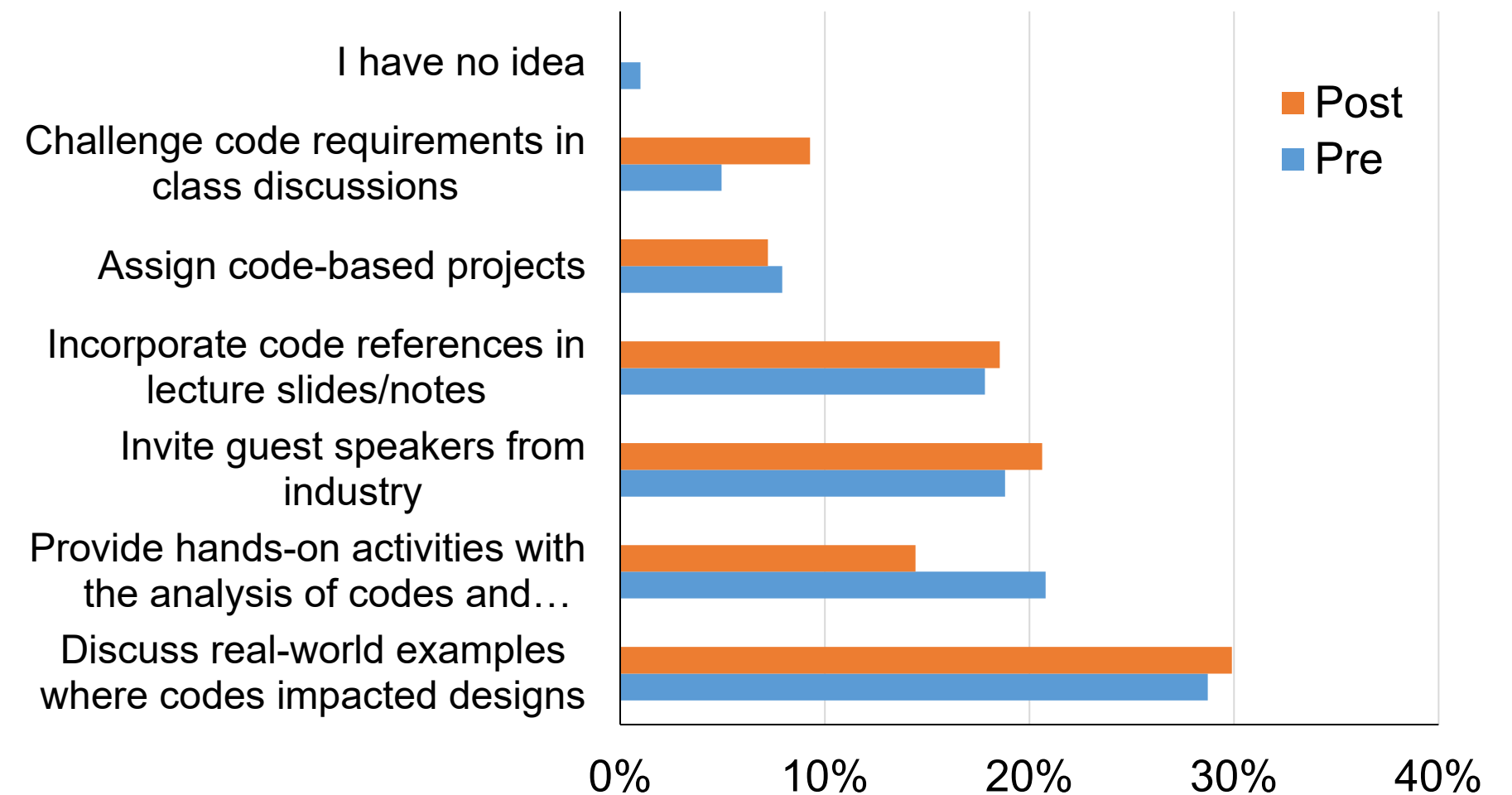
Evaluation Framework 3 Result

Student Survey Results

What methods or activities do you think would help you better understand civil engineering standards, codes, and specifications? Select your top 3 choices.



What should civil engineering instructors do to help students better understand the importance of codes and standards? Select all that apply.

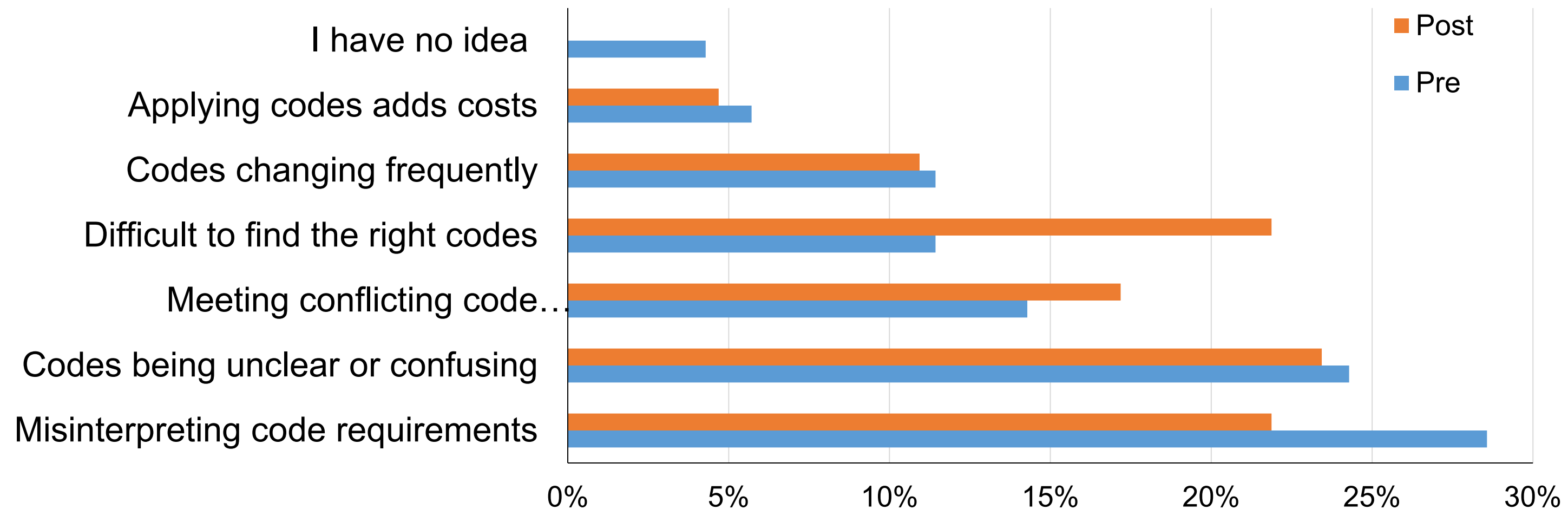


- Students showed increased preference for **experiential learning methods** such as **real word example**, **site visits**, **design projects**, and **guest lectures**, reinforcing the effectiveness of the ELM-based approach.

Evaluation Framework 3 Result

Student Survey Results

What are your biggest concerns when it comes to working with codes and standards for civil engineering projects or tasks? Select all that apply.



- Students demonstrated significantly **higher confidence in interpreting and applying standards**, reflecting the effectiveness of hands-on labs, reflection, and design-based assignments.

Dissemination

- ASEE Southeastern Conference 2026, ASEE Annual Conference 2025, ASEE Southeastern Conference 2025, ASEE Annual Conference 2024
- Conference of Teaching and Learning (CoTL), 2026, 2025, 2024
- Class Demonstration at California State University Chico, 2025
- Microplastic and Nanoplastic Workshop (2026), Plastic Circularity Education Workshop (2026)
- 1 Paper to ASCE Journal of Civil Engineering Education (Under Review)

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ENGINEERING EDUCATION

Paper ID #45501

Case Study of Integrating Standards, Codes, and Specifications into Engineering Curricula: Various Pathways to Professional Readiness

Dr. Shenghua Wu, University of South Alabama

Dr. Shenghua Wu is an Associate Professor in the Department of Civil, Coastal, and Environmental Engineering at the University of South Alabama. His research areas include civil engineering materials characterization, pavement performance evaluation and modeling, design, and maintenance, multidisciplinary approach to address complex engineering issues, as well as STEM education. He holds multiple leadership roles, including the Director for Interdisciplinary Center for Sustainable Engineering (ICSE), Executive Director for Gulf Coast Environmental Equity Center (GCEEC), Director for the Solid Waste Sustainability Hub, Director for the Gulf Coast Center for Addressing Microplastics Pollution (GC-CAMP), and Director for the Sustainable Asphalt Materials Laboratory, as well as the founding faculty advisor for the Society of Sustainable Engineering. He teaches a mixture of undergraduate and graduate engineering courses. Dr. Wu is a committee member for Transportation Research Board (TRB) AJE35 and AKM 90, a member of American Society of Civil Engineer (ASCE), American Society for Testing and Materials (ASTM), and Academy of Pavement Science and Engineering (APSE), as well as an editorial member for Journal of Testing and Evaluation and International Journal of Pavement Research and Technology. He serves panel member for several NCHRP and ACRP projects. He is also a registered professional engineer in Alabama and LEED AP.

Dr. Min-Wook Kang, University of South Alabama

Dr. Kang is a professor of Civil, Coastal, and Environmental Engineering at the University of South Alabama

Dr. John Cleary, University of South Alabama

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Paper ID #45500

Fast-Track to Research Writing Mastery: A 9-Week Intensive Course for Graduate Students

Dr. Shenghua Wu, University of South Alabama

Dr. Shenghua Wu is an Associate Professor in the Department of Civil, Coastal, and Environmental Engineering at the University of South Alabama. His research areas include civil engineering materials characterization, pavement performance evaluation and modeling, design, and maintenance, multidisciplinary approach to address complex engineering issues, as well as STEM education. He holds multiple leadership roles, including the Director for Interdisciplinary Center for Sustainable Engineering (ICSE), Executive Director for Gulf Coast Environmental Equity Center (GCEEC), Director for the Solid Waste Sustainability Hub, Director for the Gulf Coast Center for Addressing Microplastics Pollution (GC-CAMP), and Director for the Sustainable Asphalt Materials Laboratory, as well as the founding faculty advisor for the Society of Sustainable Engineering. He teaches a mixture of undergraduate and graduate engineering courses. Dr. Wu is a committee member for Transportation Research Board (TRB) AJE35 and AKM 90, a member of American Society of Civil Engineer (ASCE), American Society for Testing and Materials (ASTM), and Academy of Pavement Science and Engineering (APSE), as well as an editorial member for Journal of Testing and Evaluation and International Journal of Pavement Research and Technology. He serves panel member for several NCHRP and ACRP projects. He is also a registered professional engineer in Alabama and LEED AP.

Min-Wook Kang, University of South Alabama

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Dr. John Cleary, University of South Alabama

The Future of
Engineering Education
2024 Annual Conference & Exposition Oregon Convention Center
Portland, OR - June 23 - 26, 2024

Fostering Student Ownership and Active Learning through Student-Led Lectures in a Civil Engineering Materials Course

Dr. Shenghua Wu, University of South Alabama

Dr. Shenghua Wu is currently an Associate Professor in the Department of Civil, Coastal, and Environmental Engineering at the University of South Alabama. His research areas include civil engineering materials characterization, pavement performance evaluation and modeling, design, and maintenance, multidisciplinary approach to address complex engineering issues, as well as STEM education. He is the Director for Solid Waste Sustainability Hub, Gulf Coast Center for Addressing Microplastic Pollution (GC-CAMP), and the founding faculty advisor for the Society of Sustainable Engineering. He teaches a mixture of undergraduate and graduate engineering courses. Dr. Wu is a committee member for Transportation Research Board (TRB) AJE35 and AKM 90, a member of American Society of Civil Engineer (ASCE), American Society for Testing and Materials (ASTM), and Academy of Pavement Science and Engineering (APSE), as well as an editorial member for Journal of Testing and Evaluation and International Journal of Pavement Research and Technology. He serves panel member for several NCHRP and ACRP projects. He is also a registered professional engineer in Alabama and LEED AP.

Basant Bhatt, University of South Alabama

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Paper ID #49864

Bringing Specifications to Life: Integrating Standards, Codes, and Hands-On Learning in Civil Engineering Materials Education

Dr. Shenghua Wu, University of South Alabama

Dr. Shenghua Wu is an Associate Professor in the Department of Civil, Coastal, and Environmental Engineering at the University of South Alabama. His research areas include civil engineering materials characterization, pavement performance evaluation and modeling, design, and maintenance, multidisciplinary approach to address complex engineering issues, as well as STEM education. He is the Director for Interdisciplinary Center for Sustainable Engineering (ICSE), Gulf Coastal Environmental Engagement Center (GCEEC), and Gulf Coast Center for Addressing Microplastic Pollution (GC-CAMP), and the founding faculty advisor for the Society of Sustainable Engineering. He teaches a mixture of undergraduate and graduate engineering courses. He is also a registered professional engineer in Alabama and LEED AP. Dr. Wu has received recognition for his teaching and research through awards such as Mobile Area Engineering Educator of the Year, the Recognizing Academic Research Excellence (RARE) Award, Tau Beta Pi Professor of the Year, and Mortar Board Top Prof.

Abeeb Gbolahan Oyelere, University of South Alabama

Dr. John Cleary, University of South Alabama

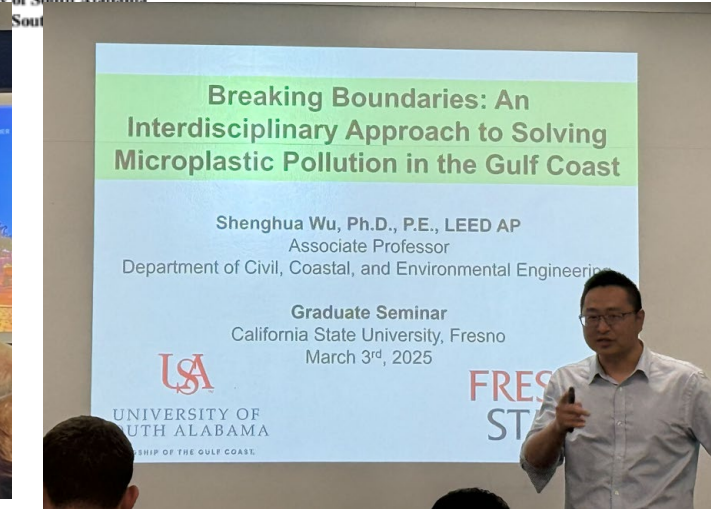
Min-Wook Kang, University of South Alabama

Dr. Kang is a professor of Civil, Coastal, and Environmental Engineering at the University of South Alabama

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Xiaojun Li, California State University, Fresno

Julie M. Estis, University of South Alabama



Review on Asphalt and PG Specification

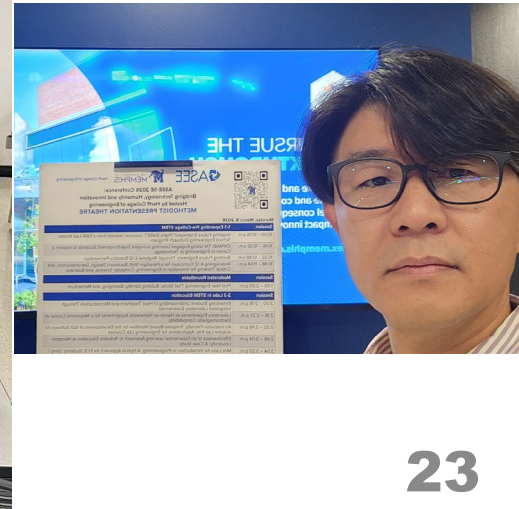
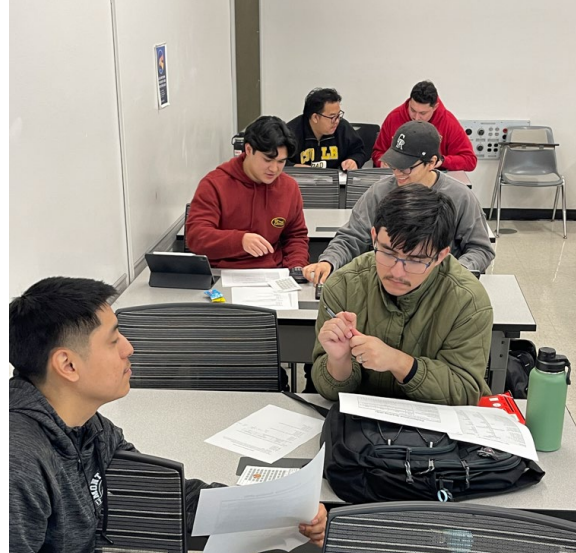
Learning Objectives

- Review standard asphalt binder testing, properties and application
- Determine asphalt binders' PG following standards and specification

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STATE



Summary

- The study employed **Kolb's Experiential Learning Model**, informed by **Bloom's taxonomy**, to **design flexible modules** that were systematically integrated into **Civil Engineering Materials curriculum**.
- The structured integration of specification-based instruction **significantly enhanced student engagement, conceptual understanding, and professional readiness**.
- Students demonstrated **increased confidence, stronger technical writing with consistent citation of standards, and improved ability to interpret and apply** ASTM, AASHTO, and ACI requirements.
- Survey findings confirmed **measurable gains in awareness, understanding, and motivation**, while strong guest lecture and laboratory performance reinforced the effectiveness of the experiential framework.
- Overall, the approach offers a **scalable and adaptable model for strengthening specification literacy** and bridging the gap between theory and professional practice in civil engineering education.

Moving Forward

- **Enhance Experiential Learning Opportunities**

- Continue modules implementations
- Continue collaboration with industry partners
- Explore the use of AI tools in students' learning

- **Disseminations**

- Website: <https://sites.google.com/southalabama.edu/standards-education>
- Final Report
- Journal Articles and Conferences



Acknowledgements

- National Institute of Standards and Technology (NIST)
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- LevelUP program, USA
- Innovation in Learning Center, USA

Thank you! Questions?

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