Learning Together in CBL: Epistemological perspective of students

Introduction

Challenge-Based Learning (CBL) immerses students in real-world, interdisciplinary challenges, emphasizing societal and ethical dimensions. However, engineering students often perceive epistemic concepts (e.g., knowledge certainty, subjectivity, and authority) as separate from technical knowledge. This study examines how epistemic beliefs develop within CBL and how they shape students' ability to integrate ethical and social considerations with technical knowledge in engineering education.

Research Questions

1. How can we assess epistemic beliefs in engineering education?
2. What instruments exist to measure or characterize epistemic beliefs in engineering?
3. How do students negotiate epistemic tensions in CBL?

Significance

Epistemology is the branch of philosophy concerned with the nature of knowledge and knowing.

This includes exploring beliefs about:

- Structure of knowledge (e.g., simple facts vs. interrelated concepts)
- Certainty of knowledge (fixed vs. fluid)
- Sources of knowledge (online, from authority figures, ChatGPT, etc.)
- Justification for knowing (Data, personal experience, etc.)

Importance of Epistemology

Understanding Learning: Students' beliefs about the nature of knowledge and learning affect their mindset, metacognitive practice, and study habits. Ultimately, it also influences their academic performance.

Improving Teaching: Understanding students' epistemic perspectives allows teachers to create better environments for promoting student learning.

Developing Critical Thinking: Understanding the certainty and limits of knowledge, and the evaluation of evidence, enables the critical thinking necessary to solve complex problems.

Informing Educational Goals: Knowing more about the role of epistemological thinking as part of intellectual development can help chart a path toward important educational goals like higher-order thinking and reasoned judgment.

Developing a Philosophy for the Discipline: Epistemology provides a framework for understanding how scientific knowledge is created and justified, and how models function as epistemic tools in engineering and science. It helps analyze what engineers know and how they know it. Understanding what engineering knowledge is and its core epistemological components is necessary for shaping the philosophy of the discipline.

Relating to Ethics: Epistemological beliefs can relate to moral judgment. Judgments about what constitutes a "right opinion" or "knowledge" have epistemological underpinnings.

Future Work

1. Currently developing and validating an instrument for assessing epistemic beliefs for engineering students population
2. Scaling up the assessment tool for broader use in CBL and traditional courses.
3. Comparing epistemic development across disciplines and educational levels.
4. Embedding interventions into CBL course design.

Project phases

Phase 1: Systematic Review of Epistemic Belief Instruments [1]

Objective: Identify reliable tools for assessing epistemic beliefs in engineering students.

🔍 **Database Search → 📚 112 Papers Identified → ❌ Filtered Out (Non-Engineering, General Instruments, Editorials, K-12) → ✅ Final 6 Papers**

Two Identified Instruments:

1- **EBAE** (Epistemological Beliefs Assessment for Engineering) *Carberry et al. (2010)*

Small sample (N=43), low response rate (27%), lacks internal consistency, not truly engineering-specific

2- ERBQ (Engineering Related Beliefs Questionnaire) *Yu & Strobel (2012)*

No pilot validation, unclear interpretation by students, low internal consistency

Key Findings:

- No validated instrument exists for Engineering Epistemology
- General epistemic belief instruments (e.g., Epistemic Belief Inventory) fail to capture engineering-specific knowledge constructs
- Existing Tools Lack Robust Psychometric Validation and theoretical coherence

-> Phase 1 confirms the need for Engineering-specific framework and assessment tools

Phase 2: Empirical Study on Epistemic Tensions in CBL

How do student teams negotiate a common epistemological stance as they interact with faculty, stakeholders, and each other in a CBL environment?

In CBL, epistemic tensions arise when students shift between these modes while working with faculty and stakeholders.

Epistemic Micropractices in Engineering (Isaac, 2021):

The study applies Isaac's (2021) epistemic micropractices framework, which categorizes four facets of epistemological stances in engineering problem-solving:

1. **Absolute Knowing** – Viewing knowledge as fixed and relying on authority figures.
2. **Transitional Knowing** – Recognizing multiple perspectives but seeking a single "best" answer.
3. **Independent Knowing** – Constructing knowledge autonomously through critical thinking.
4. **Contextual Knowing** – Understanding that knowledge is situational, interdisciplinary, and socially constructed.

Classroom Observations

Structured ethnographic observations Hatch (2002) captured real-time epistemic negotiations.

- **Instance 1:** Mid-quarter – initial epistemic tensions emerge.
- **Instance 2:** Late-quarter – negotiation of conflicting perspectives.
- **Instance 3:** End of quarter – decision-making and epistemic resolution.

-> Phase 2 confirms that CBL environments create epistemic tensions that drive student learning

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[1] Abdalla, A., Bombaerts, G., & Houkes, W. (2024, December 11). Assessing Engineering Epistemology: A Systematic Literature Review of Instruments. Proceedings of the 52nd Annual Conference of SEFI. https://doi.org/10.5281/ZENODO.14254724

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