

# GuIDES in Action: Structuring Student–AI Dialogue for Higher-Order Learning in Construction Management

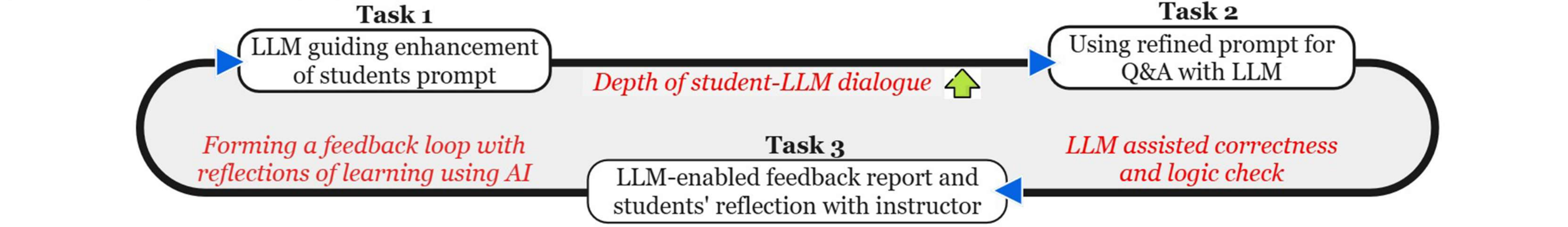
Author(s): Anqi SHI<sup>1</sup>, Hanmo WANG<sup>1</sup>, Jihao LUO<sup>2</sup>, Chris PECAUT<sup>3</sup>, Kaizen LOW<sup>3</sup>, Stephen En Rong TAY<sup>1</sup>, Alexander LIN<sup>1,\*</sup>

- 1. Department of the Built Environment, College of Design and Engineering, National University of Singapore
- 2. Department of Information Systems and Analytics, National University of Singapore
- 3. AI Centre for Educational Technologies, National University of Singapore

\*Corresponding author (A Lin): [bdgal@nus.edu.sg](mailto:bdgal@nus.edu.sg)

**GuIDES** (Guided Inquiry and Dialogue Education System) is a multi-LLM agent–driven module hosted on ScholAistic, an intelligent learning platform developed by the NUS AI Centre for Educational Technologies.

## Part I: Methodology A three-phase scaffolding framework using GuIDES



### Task 1

**Level 2 prompt** Upgraded to **Level 3 prompt**

**(1) Student's prompt:** Is Total Quality Management the best practice in Japan that can be implemented to Singapore's Construction industry for continuous improvement?

**(2) LLM's response:** Your question currently falls at Level 2 (Applying & Analyzing). There are **three levels in total**, and your question reaches the second one.

LLM reports the current level of questioning.

In the refined prompt, student incorporates the LLM's suggestion—adding questions on how to **measure and evaluate the impact** of the managerial approach—and subsequently **hypothesizes about its implications across different countries**.

LLM suggests how to advance to the next level

Moving to the Next Level: To elevate this to Level 3 (Evaluating & Creating), consider making a more critical assessment or proposing a unique perspective. Instead of just asking about its implementation, you might think about measuring its **impact, hypothesizing outcomes**, or comparing it critically to other possible methods.

For example, you might reflect on:

- How would you measure whether Total Quality Management is actually the **best** approach?
- What factors could make it succeed or fail in a different country and industry?

**(3) Student refined the prompt as:** Is Total Quality Management the best practice in Japan that can be implemented to Singapore's Construction industry for continuous improvement? To add on, **how effective is Total Quality Management (TQM) in Japan, and what are the key benefits and modifications required for its successful implementation in Singapore's construction industry?** Indicate some case study as well that proves the **successful** implementations in Japan and make sure all your research are relevantly cited

**(4) LLM's response:** Your question now reaches Level 3 (Evaluating & Creating). This is the highest level, which means your question now prompts **critical evaluation and the creation of new insights based on research**.

What This Means: At this level, you are not just identifying or analyzing the practice, but also evaluating its effectiveness, considering evidence from case studies, and discussing necessary modifications for a different context. This requires forming a well-supported judgment and proposing refined implementations.

LLM acknowledges the upgrading of the prompt

Fig 1. LLM-guided prompt design.

### Task 2

**(1) Refined prompt from students:** Is Total Quality Management the best practice in Japan that can be implemented to Singapore's Construction industry for continuous improvement? To add on, how effective is Total Quality Management (TQM) in Japan, and what are the key benefits and modifications required for its successful implementation in Singapore's construction industry? Indicate some case study as well and make sure all your research are relevantly cited

**(2) LLM's response:** Discussion of **factors influencing the impact**

**Key Success Factors**

- Cultural Alignment:**
  - Japan's emphasis on long-term employment and collective responsibility fostered employee engagement in TQM practices like *Kaizen* (continuous improvement) and QC circles. This cultural foundation enabled sustained commitment to quality[^7][^12].
  - Firms like **Takenaka Corporation** integrated TQM with design-build systems, ensuring quality at every project phase through cross-functional collaboration and iterative feedback loops[^1][^5][^7].
- Process Standardization:**
  - The PDCA (Plan-Do-Check-Act) cycle and data-driven decision-making reduced defects and costs.

**Outcomes in Japan**

- Enhanced Quality:** TQM reduced rework and defects while improving lifecycle performance of buildings[3][10].
- Cost Efficiency:** Process optimization lowered waste

**Challenges in Adapting TQM to Singapore's Construction Industry**

- Cultural and Workforce Differences**
  - Employee Turnover:** Singapore's reliance on transient foreign labor contrasts with Japan's stable, long-term employment, complicating sustained employee training and engagement[4][9].
  - Hierarchical Structures:** Singapore's top-down

**Citations:**

- <https://www.wcu.edu/pmi/1996/96C007.PDF>
- <https://www.pmi.org/learning/library/japanese-total-quality-management-approach-4863>
- <http://laaturakentaminen.fi/attachments/article/294/TQinConstruction.pdf>

**Proper in-text citation provided by Perplexity, an AI search engine**

Fig 2. LLM-enabled online research.

### Task 3

**Chat evaluation**

**Content**

**1. Extract Key Claims**

**Identified Explicit and Implicit Claims**

The discussion revolves around the applicability of **Total Quality Management (TQM)** from Japan to Singapore's construction industry. The explicit claims include:

- TQM is **highly effective** in Japan's construction industry, especially in **long-term employment and process standardization**.

**2. Assess Factual Accuracy**

**Verification Against Reliable Sources**

- The claims about TQM in Japan (Takenaka Corporation, PDCA cycle, design-build systems) align with documented research and real-world case studies.

**Fig 3. LLM-derived feedback report for student-LLM dialogue in Task 2.**

**Specific Findings and Misalignments:** My initial research assumed that Japan's Total Quality Management (TQM) could be directly transferred to Singapore. However, the AI feedback revealed that certain strategic adaptations would be needed, primarily due to **cultural and structural differences**. Specifically, it highlighted the challenge posed by **Singapore's reliance on foreign labor and hierarchical structures**, contrasting Japan's long-term employment and collective responsibility approach. This was a significant insight not clearly apparent during initial research.

**Trust and Reliability of the AI-generated Report:** Initially, I had reservations about fully trusting the AI-generated feedback report since it was created by another AI system. To address this, I cross-referenced several key points mentioned by the report with external authoritative sources and academic literature. Upon verification, I found the AI-generated claims on cultural alignment, process standardization, and technological integration accurate and consistent with credible external sources.

**The student acknowledged new insights from the AI that deviated from his initial understanding based on his own research.**

**The students initially had reservations about fully trusting the AI-generated feedback, which led them to cross-reference several key points in the report with external authoritative sources as a proactive means of verification.**

Fig 4. Student's reflection write-up..

## Part II: Context and learning targets

### Outlined Challenges

**PF2203 (Quality & Productivity Management)**

"While LLMs can guide inquiry and enhance problem-posing and knowledge integration, **unguided use risks superficial learning, overreliance, and unmanageable review workloads for educators.**"

### Intended Learning Outcomes

*GuIDES have been incorporated to students' group project to:*

- Cultivate critical thinking** and integrate interdisciplinary knowledge in quality & productivity management for the construction.
- Use GenAI-assisted learning** to develop higher-order questioning, conduct targeted research, and reflect using AI-generated feedback.
- Effectively work with GenAI on meaningful research questions**, integrate cross-context knowledge, and critically assess AI-generated content for real-world problem-solving.

## Part III: Implementation and feedback

### Besides of students' write-up improvement:

1. Definition and Scope		2. Policy and Regulation	
Aspect	UK MMC	Aspect	Singapore DfMA
<b>Core Focus</b>	Broad spectrum of off-site and on-site innovations, including modular construction, 3D printing, and process improvements[1][5].	<b>Government Role</b>	NHS mandates <b>70% MMC for new builds</b> and 50% for refurbishments[2].
<b>Categories</b>	7 categories: 3D/2D structural systems, additive manufacturing, non-structural assemblies, and site/productivity innovations[5].	<b>Procurement</b>	Encouraged through frameworks like the <b>Transforming Infrastructure Performance</b> program[1].
	Focuses on technologies like <b>Advanced Precast Concrete Systems (APCS)</b> and <b>Mass Engineered Timber (MET)</b> .	<b>Standardization</b>	Emphasis on aligning stakeholders

(a) what is the differences between UK MMC and Singapore Dfma

(b) WHY SINGAPORE CAN BENEFIT FROM UK

This is made worse with:

- Committee of Supply 2024 (Foreign Workforce policy)
  - Raising the Local Qualifying Salary (LQS) threshold
- Increased competition from the Middle East in hiring foreign labour for mass projects (eg. The Line-Saudi Arabia, Qatar Post World Cup construction boom)

WHY SINGAPORE CAN BENEFIT FROM UK

Singapore's adoption of MMCs

- Likely increase in short term costs on companies investing more towards AI and robotics driven offsite technological methods
- Long term higher cost savings and a reduced strain on demand for foreign labour

Fig 5. Student's work illustrating (a) Use of GuIDES and (b) take-away from case study.

GuIDES significantly enhances the quality of presentations, as shown in a student presentation where the comparison results of prefabrication systems in the UK and Singapore (Fig 5a), based on insights from GuIDES, were used to support an analytical slide (Fig 5b). In this collaborative effort, the student first reviewed the consulting information provided by GuIDES and then created the presentation slides, highlighting potential improvements to Singapore's prefabrication construction system based on UK practices.

## Part IV: Reflections and key learning points

**Students:** With structured prompts and reflective feedback loops, LLMs foster **deep learning** over passive consumption.

**Teachers:** AI-generated feedback enables teachers to guide students' reflections without the need for exhaustive manual monitoring; offers a **scalable, transferable AI model** in education.

3 min introduction video



Questionnaire

