Cognitive Engagement Coding framework (adapted from Chi and Wylie, 2014).

ICAP Framework	Adapted framework	Description	Examples
Passive *Receiving*	No or Minimal Engagement	The student gives no response or a very minimal one that doesn't advance the conversation. This corresponds to passive behaviour – little to no cognitive effort is observable.	silence, "yeah", "OK", copying part of the AI question without a real response.
Active *Manipulating*	Basic Active Engagement	The student responds to the AI's query or prompt correctly, but only using the given information. This could be a one-sentence answer or a direct solution with no explanation. It shows the student is participating, but at a surface level.	"C", "Data visualisation", "It's classification." (no reasoning or examples).
Constructive *Generating*	Reflective/ Constructive Engagement	The student not only answers but also elaborates, explains their thinking, or contributes a new idea. For instance, they might justify an answer ("I think the reason is X because…") or connect to something learned earlier. This aligns with the Constructive level of engagement – the message contains original input from the student. Such responses indicate the student is thinking deeply and investing effort in the discussion.	"Data visualisation isn't part of preprocessing because it's used later to explore patterns.", "This reminds me of what we saw in week 2."
Interactive *Dialoguing*	Interactive Engagement	The student actively builds a dialogue with the AI. Their message might ask a follow-up question, seek clarification, or propose a hypothesis, prompting further exchange. They might take the AI's previous answer and extend it. This category mirrors ICAP's Interactive mode, showcasing the highest engagement – the student essentially treats the AI as a learning partner, and their contributions drive a collaborative exploration of the topic.	"Why wouldn't data visualisation be preprocessing?", "Could this apply to time-series data too?", "Okay, so if that's true, could we also say…?".
	Off-Topic or Procedural Talk	Sometimes students stray from the task or engage in meta-conversation. Such messages might be coded separately since they don't reflect engagement with content. (These could be considered non-engaged cognitively, even if the student is active in another sense.)	"What's the point of this?", "I don't want to do this", blank message, joke irrelevant to task.

NOTE: The purpose of this framework is to identify how engaged a learner is and categorise depth

Knowledge Construction process framework (Adapted from Song et al., 2025).

CI-PCD Framework	Adapted Description	Examples
Prior Knowledge (Recall)	Student demonstrates recall of facts, definitions, or previously learned content without further elaboration.	"Data preprocessing involves data cleaning."
Subjective Expression (Personal/Opinion-Based)	The student expresses personal feelings, opinions, or experiences relevant to the task, but without analytical depth or supporting evidence.	"I find preprocessing tricky.", "I prefer classification tasks to clustering."
Elaboration (Explanatory)	Student provides additional detail or clarification about their answer, showing deeper understanding or reasoning.	"Normalisation helps bring features to the same scale, making comparison easier."
Coordination (Integrative)	Student synthesises or explicitly connects multiple concepts, topics, or previous points within their message.	"Both normalisation and standardisation make data comparable, but normalisation restricts data between 0 and 1."
Speculation (Hypothetical)	Student goes beyond provided information, making predictions, posing hypothetical scenarios, or suggesting novel applications.	"I wonder if preprocessing steps differ significantly when handling real-time streaming data."
Construction (Dialogic)	Student actively interacts with AI's previous responses, extending dialogue by challenging, refining, or co-developing ideas.	"If normalisation isn't suitable here, would standardisation be better? Could you explain why?"
Other	When students are not contributing to knowledge construction	"Thank you", "My name is Kevin", "Can I end the quiz?"

NOTE: The purpose of this framework is to understand how a learner builds understanding in dialogue. It focuses on dialogue dynamics and cognitive processes within conversational interactions.