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

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| **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).

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| **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.