Metacognitive Levels Obtained in Engineering Students' Reflections on Abilities with Conservation of Mass Problems

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Background

- Reflection on their thoughts, feelings and emotions provides students with motivation to learn and enjoy the process of learning[1]
- Central to reflection is metacognition, through which students express their awareness of and can describe their thinking in a way that allows them to "close the gap" between what they know and what they need to learn.

Methods

Setting: R1 University, process engineering course

Participants:

- Junior and seniors engineering students
- Spring 2021, 28 students, 25% female

Course Assignments:

- 13 Homework (Training) assignments
- Paired with 13 Self-assessment assignments
  - Part A: Students self-grade and commented each homework submission
  - Part B: Students complete structured-reflections with prompts focused on achievement of learning objectives

Data Collection (Part B):

- First three reflections on topic: Conservation of Mass

Research Question

What types of metacognitive strategies are expressed by upper-division engineering students in weekly reflections on their learning?

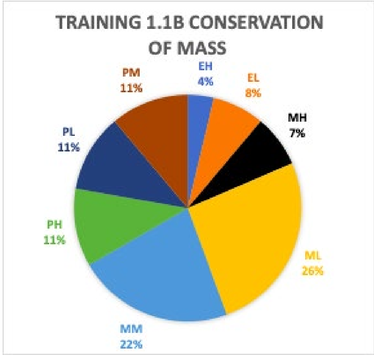
Data Analysis

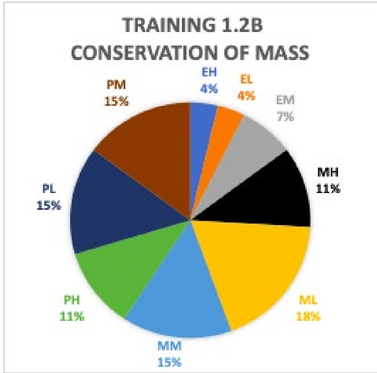
- Three-dimension coding scheme developed based on cognition[3] with levels of low, medium, and high
- Inter-rater reliability established with two coders who reach 90% reliability (simple percent)
- Coding-scheme was used to analyze students' responses to open-ended reflection prompt.

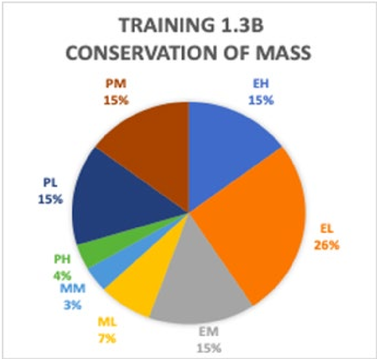
Coding-scheme for metacognitive strategies

Dimension	Description
Planning (P)	Comments on preparation for task execution. The participant inquiries about or identifies procedures and requirements of a task. Low (L), Medium (M), High (H) differentiated based on the awareness of the need of planning.
Monitoring (M)	Comments related to task comprehension. The participant checks or points out own understanding/lack of understanding as well as known/unknown information. Low (L), Medium (M), High (H) differentiated based on if they make some reference to the Learning Objectives
Evaluating (E)	Comments representing assessments of own thoughts and performance in relation to the task goal. The participant indicates recognition of a problem or error. Low (L), Medium (M), High (H) differentiated based on the recognition of a problem and if they attempt to improve it.

Results







Discussion

- Training 1.1B had the most monitoring (55%)
- Training 1.2B had the most planning (41%)
- Training 1.3B had the most evaluating (56%)

What does that mean?

- Students were able to evaluate their own answers
- In the first training, students tended to point out what they were struggling with.
- In the last training, students tended to evaluate and plan more consistently

Conclusion and Future Work

- First look at upper-divisions abilities to reflect on their own learning
- Metacognitive strategies change over the duration of the topic switching from monitoring to higher levels of planning and ultimately evaluation

Future Work

- Analyze students' reflections for remaining assignments
- Relate reflections to self-assessment of work
- Implement and analyze reflections in different courses with different learning objective

References

1. Kember, D., Sinclair, K., & Yuet Wong, F. K. (n.d.). A four-category scheme for coding and assessing the level of reflection in written work. Taylor & Francis.
2. Loo, C. W., & Choy, J. L. F. (2017, August 14). Sources of Self-Efficacy Influencing Academic Performance of Engineering Students. American Journal of Educational Research.
3. Bell, A., Mcdonagh, N., Morrison, K., & Mladenovic, R. (n.d.). A critical evaluation of the usefulness of a coding scheme .