

Developmental psychologist, John Flavell, first established the term metacognition in 1976, and metacognitive research in education has spanned the age gamut, focusing on self regulated learning from kindergarten through graduate school (Cromley & Kunze, 2020). Metacognition is defined as the action of reflecting on one's thinking and recognizing approaches for managing novel experiences (Jacobson, 2021). Metacognitive strategies can be subdivided into three categories: planning, monitoring, and evaluation. Planning strategies are utilized prior to a task or unit to encourage goal setting, establish prior knowledge, and identify learning objectives. Monitoring strategies aid students in actively gauging their learning progress. Evaluation strategies nurture student reflection on learning success and assessment preparation techniques. The effectiveness of planning, monitoring, and evaluation metacognitive strategies on assessment performance and perceived learning was investigated within an Alberta Biology 20 class of 19 students.

Background

AR Focus Questions

QUESTION 1: "Can the implementation of metacognitive strategies in the secondary science classroom contribute to an increase in assessment performance?"

QUESTION #2: "Does the incorporation of metacognitive strategies within the curriculum improve the perception of learning, and what types (e.g., planning, monitoring, evaluating, combination) are most effective?"

QUESTION #3: "Do students' perceptions of content understanding correlate with assessment performance?"

Methodologies

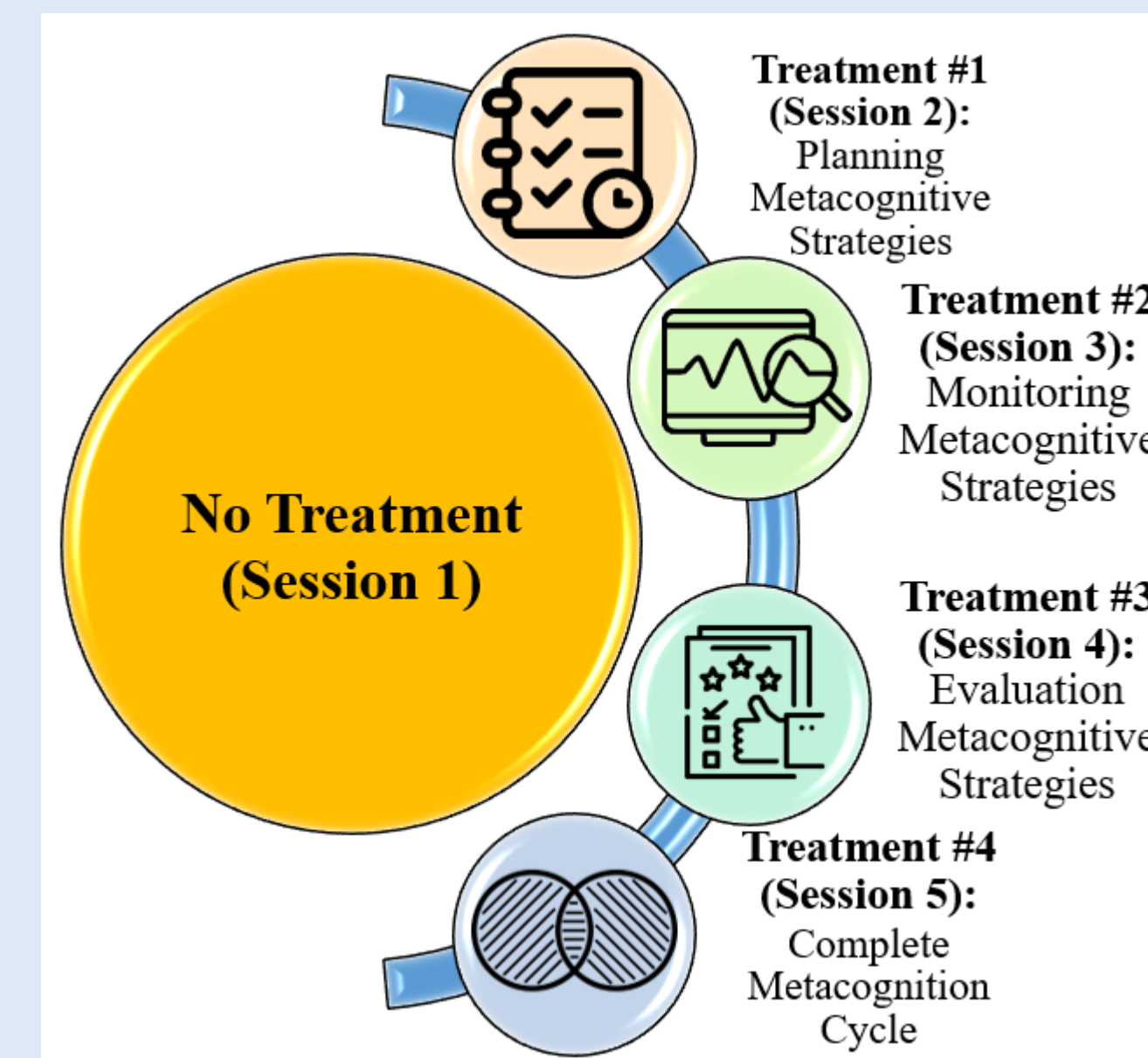


Figure 1. Overview of the implementation of metacognitive strategies throughout the project.

- The project time frame was subdivided into five, approximately two-week sessions, and the first session represented a non-treatment stage.
- Students implemented planning, monitoring, evaluation, and combined strategies for the subsequent four treatment sessions.
- At the conclusion of each session, students were assessed on their recent content knowledge.
- Likert-style surveys with accompanying open-ended questions were provided to participants at the conclusion of each treatment.

Intervention	Time Frame	Curricular Topic	Assessment & Weighting (% of Course Grade)
No Treatment (Session 1)	9 school days (2/1 – 2/11)	Unit 1: Human Systems (Topic: Biochemistry)	Quiz #1 (2%)
Treatment #1 (Session 2): Planning Strategies	9 school days (2/14 – 3/1)	Unit 1: Human Systems (Topics: Enzymes and Digestion)	Quiz #2 (2%)
Treatment #2 (Session 3): Monitoring Strategies	9 school days (3/2 – 3/15)	Unit 1: Human Systems (Topics: Biochemistry, Enzymes, Digestion, Respiratory System)	Unit 1 Assessment (11%)
Treatment #3 (Session 4): Evaluation Strategies	10 school days (3/16 – 4/13)	Unit 1: Human Systems (Topics: Cardiovascular System, Blood, and Immune System)	Quiz #3 (2%)
Treatment #4 (Session 5): Complete Metacognition Cycle	12 school days (4/14 – 5/3)	Unit 2: Energy and Matter Exchange in the Biosphere (Topics: Kidney System and Biosphere Interactions)	Unit 2 Assessment (11%)

Figure 2. Semester timeline of interventions.

Results

Focus Question #1 Results

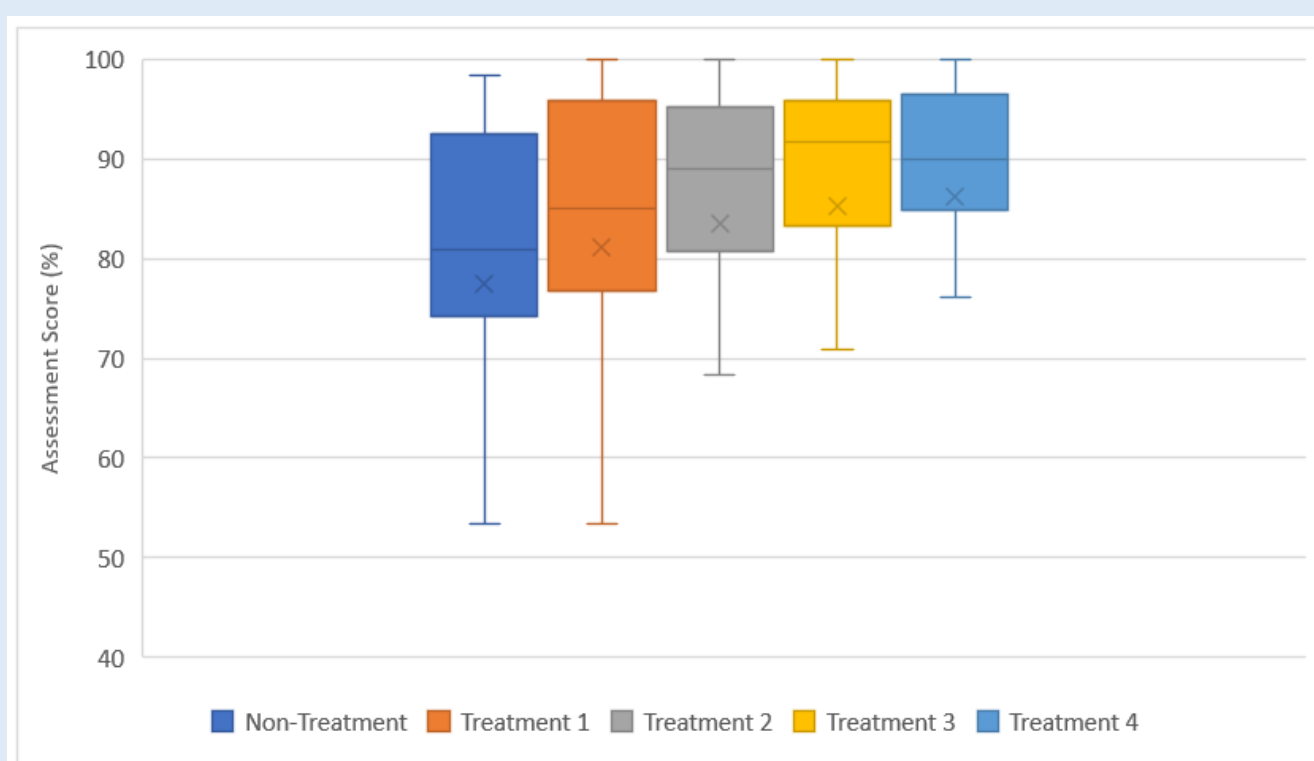


Figure 3. Box and Whiskers Plots for assessment scores.

The **Friedman Two-Way Analysis of Variance by Ranks Test** resulted in a p-value of 0.0018, denoting a statistical significance between assessment scores for the dependent session samples. A **Post-hoc Test for Pairwise Comparisons** indicated that ranks sums were significant between the no treatment sample and treatments 2, 3, and 4 respectively.

Focus Question #2 Results

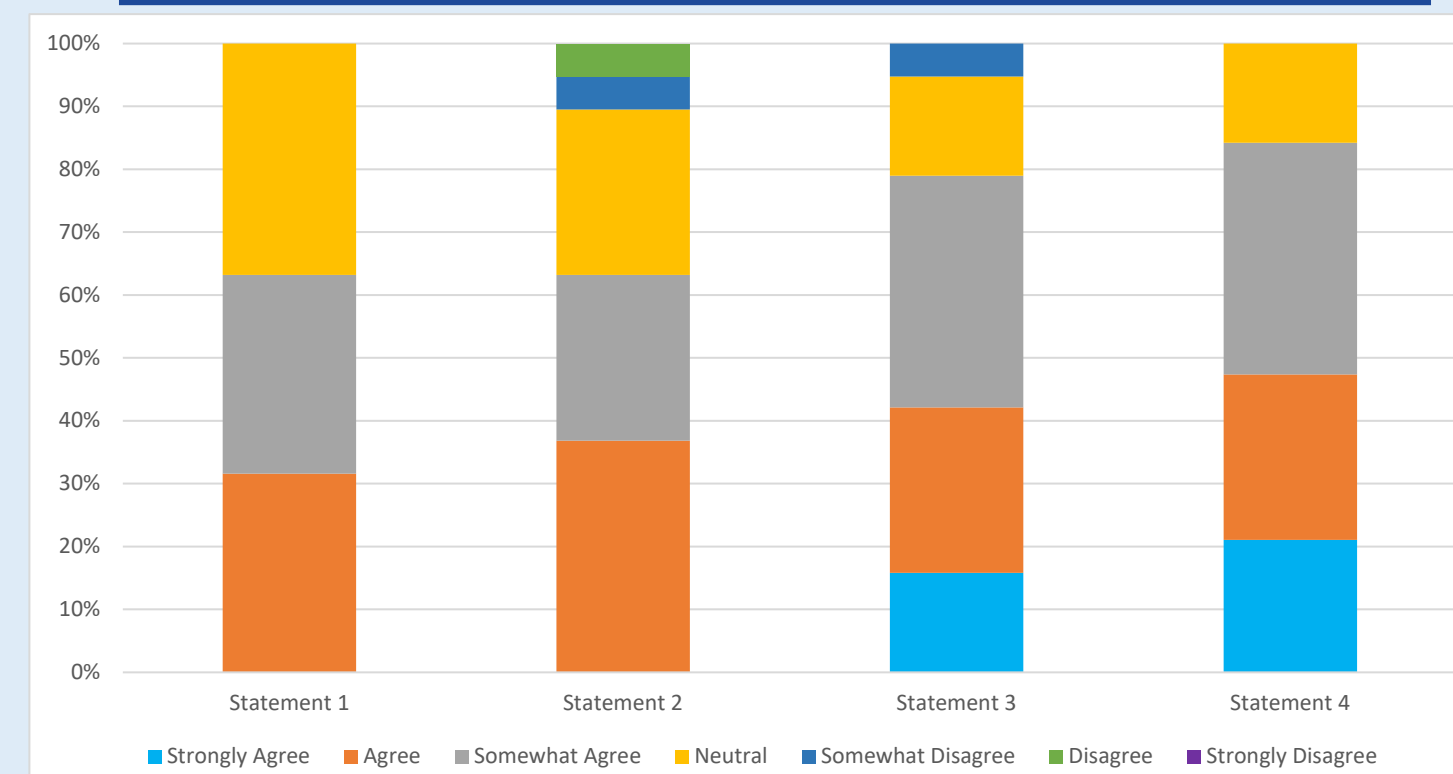


Figure 4. Post-Treatment Combination Metacognitive Strategies Student Survey results, (N=19). Statement 1: Using a combination of strategies in the planning-monitoring-evaluation cycle increased my understanding of the content in comparison to when I did not use any metacognition strategies at the beginning of the semester. Statement 2: Using a combination of metacognitive strategies in the planning-monitoring-evaluation cycle increased my understanding of the content in comparison to when I used one type of metacognition strategy at a time. Statement 3: Overall, I enjoyed this process of learning about metacognition strategies. Statement 4: Overall, I recognize the importance of metacognition strategies in improving learning.

Focus Question #3 Results

Table 1. Spearman Rank-Order Correlation Analysis, (N=19).

Session	Spearman Correlation Coefficient, ρ	t statistic	p-value
No Treatment	0.42	1.88	0.08
Treatment 1	0.49	2.31	0.03
Treatment 2	0.47	2.21	0.04
Treatment 3	0.45	2.05	0.06
Treatment 4	0.45	2.10	0.05

The results of the **Spearman Rank-Order Correlation Analysis** demonstrated that the ranked variables of assessment score and learning confidence were correlated for Treatments 1 and 2. The results of the **Learning Confidence Reflection Surveys** disclosed that students on average perceived their initial learning confidence rankings as very accurate 12.3% of the time, following a thorough review of their assessment.

Conclusions

Quantitative data supported the claim that the implementation of metacognitive strategies in the secondary science classroom augmented assessment performance. Statistical significance resulted after only two treatments of metacognitive strategies. Students may have needed an adjustment period to gain familiarity with the routine of implementation.

Quantitative data from the Likert scales and qualitative remarks from students supported the claim that the incorporation of metacognitive strategies within the curriculum improved the perception of learning. Students retained a favorable opinion of metacognition strategies throughout the study.

Quantitative and qualitative data supported the claim that students' perceptions of content understanding did not correlate with assessment performance consistently throughout the semester. Learning confidence was included in this study because accurate rankings require self-awareness, which is a foundational skill for metacognition and learning motivation.



References

