Metacognitive Strategies in an Earth Science Classroom

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Knowledge → Understand → Apply → Analyze → Evaluate → Synthesize

Background

This research was conducted at Grand Haven High School (GHHS), a public high school in Grand Haven, Michigan. Being able to process at high levels of thinking is an important skill used in school, the workplace, and as a voting citizen. While teaching Earth science to ninth grade students, I noticed their reliance on using low order thinking skills, such as memorization, while trying to learn complex topics. This resulted in students lacking the ability to solve complex problems related to the topic. One major element to develop higher order thinking is metacognition (Kirkland, 2000). Therefore, I decided to focus my research on increasing higher order thinking by explicitly teaching and using metacognitive strategies in the classroom. Metacognition has been shown to increase student confidence, therefore, as a secondary question, I wanted to determine if using metacognition would increase students' confidence in science.

Focus Question	Data Source 1	Data Source 2	Data Source 3
Primary Question 1. Does the use of metacognitive strategies result in students using higher order thinking?	Pre- and Post-Thinking Test	Student Thinking Survey	Student Interviews
Sub Question 2. How will the use of metacognitive strategies influence student confidence in science?	Pre- and post-Confidence Survey	Student Interviews	

Methodology

- Non-treatment and treatment groups were the same
- Research conducted with 30 Earth science students
- Non-treatment unit included pre- and post-tests similar to the treatment phase to determine a baseline for student growth
- Treatment phase included explicit thinking level teaching, reflection that encouraged metacognition, and teacher modeling of metacognition and higher order thinking

Student Performance

Students' ability to answer higher order thinking questions statistically improved with treatment ($p<0.05$).

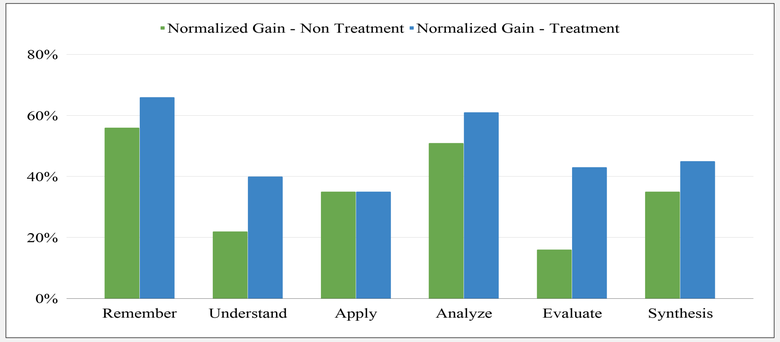

Figure 1. Normalized gains for the thinking levels based on the Thinking Test prior to treatment and post-treatment, (*N*= 30)

Student Confidence

Students' confidence did not appear to have significant differences as a result of using metacognitive strategies.

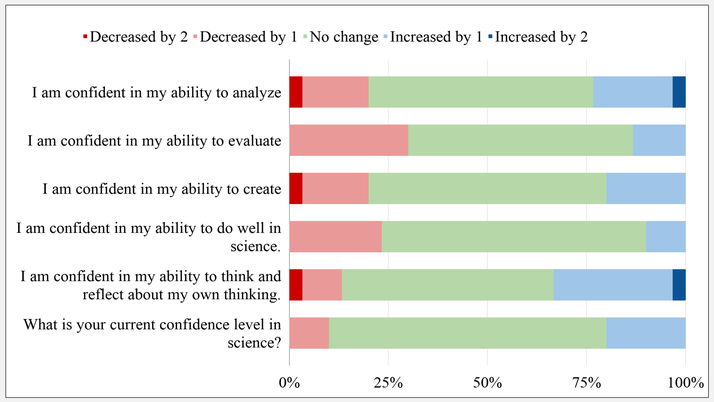

Figure 2. Difference between the pre- and post-Confidence Likert Survey, (*N*= 30).

Student Quotes

- "Before [learning about higher order thinking], I would get really frustrated if I had a problem that I couldn't figure out, [now] it's a lot easier…"
- "[When studying using higher order thinking skills], you have to think more in depth of what you learned, and the reflection helps with that. For low order, you just review your notes."
- "Low [order thinking] is just defining and memorizing which doesn't help in the long run…because it doesn't allow me to think and problem solve as much as high level [thinking]"

Analysis

- Normalized gain for high level questions were medium-low prior to treatment and medium-high post treatment
- Students showed significant growth in correctly answering high level questions ($p<0.05$).
- Likert surveys indicated no significant change in student confidence

Interpretation

Students ability to answer higher level questions increased. From my perspective, their confidence increased as well. However, this does not show in the data. Prior to treatment, students commented that they didn't know what the word *evaluate* means and they didn't know how to answer the question. Therefore, this could indicate that students answered the confidence questions without a good understanding of what the words mean. Students need to not only be taught how to use metacognitive strategies, but they also need to learn about the levels of thinking.

Next Steps

- Continue to teach students about levels of thinking
- Model good answers for different levels of thinking.
- Include reflection, but shorten it and make it more interactive to increase the "buy-in" from students.

References

Kirkwood, M. (2000). Infusing Higher-Order Thinking and Learning To Learn into Content Instruction: A Case Study of Secondary Computing Studies in Scotland. *Journal Of Curriculum Studies*, *32*(4), 509-535.