SCHOOL SCIENCE AND MATHEMATICS

Research to Practice Article

Metacognitive practice and teacher feedback: Ways to improve teaching and learning

Based on the published SSM Journal Research Manuscript:
The impact of metacognitive practice and teacher feedback on academic achievement in mathematics

Erin Duez
Seattle Pacific University

Nalline Bailram
Seattle Pacific University

Arthur Ellis
Seattle Pacific University

Overview of Study

In the quasi-experimental study conducted by Baliram and Ellis (2018), the researchers sought to examine the effect of student reflection combined with teacher feedback on student achievement in high school geometry classes. The researchers used statistical methods to examine the impact of the treatment. Data included a pretest, posttest administered immediately following the four weeks intervention, and a retention test administered three weeks later. Five intact geometry classes were utilized in this study, two classes were randomly assigned the intervention (n = 33) and three classes (n =42) the comparison groups. The students in the intervention group completed the reflective assessment and two practice problems in the form of an exit ticket during the last 5-10 minutes of each class time while the comparison group used this time to review the learning targets or start homework.

The metacognitive prompts for the reflective assessment included statements such as "Today I learned…", "I can now...", and "I still don't understand…." (Baliram, 2016). In addition to the metacognitive prompts, students completed two application problems that were relevant to the content learned that class period. Another geometry teacher, unaffiliated with the class, provided individual content-specific feedback to the students. Furthermore, a synopsis of misconceptions and common areas of struggle that were prevalent in the exit tickets were disclosed to the classroom teacher. The classroom teacher used this information to provide verbal feedback to the intervention classes at the start of the class while the comparison classes used this time to begin warm-ups.

At the end of the intervention, both groups of students completed a brief survey. The purpose was to understand the students' comfort level related to their preparation for the summative assessment. A Likert-scale from strongly agree to strongly disagree was used in the survey. Students rated themselves on how well prepared they felt for the unit test, how much they enjoyed studying the content, and if they were given an opportunity to reflect on the content learned (Baliram, 2016). The experimental group answered one additional open-ended question about what they liked and disliked about the exit ticket. Finally, three weeks after the post-test, the teacher administered the retention test to both groups.

Research Topic

For decades, researchers have been exploring the effects of metacognitive practice and feedback on student achievement (Flavell, 1979; Zepeda, Richey, Ronevich, & Nokes-Malach, 2015). Both seasoned and novice teachers in science and mathematics would argue for the importance of students reflecting on their learning and teachers providing feedback on student

work. Metacognitive practice and feedback, considered best practices in the role of education have been highly discussed topics among educators, policymakers and education advocates. In fact, Advancement Via Individual Determination, (AVID's) in a recently published handbook, *AVID critical thinking and engagement: A schoolwide approach* focuses on metacognition as a key component in the learning environment (Bendal, Bollhoefer & Koilpillai, 2015). For good reason, teachers are being trained on how to implement metacognitive practices in their classroom.

Similarly, effective feedback noted as a valuable component of instruction, is the core of Hattie and Clarke's new book, *Visible Learning: Feedback* (Hattie & Clarke, 2018). Hattie has cited both constructs, reflection and feedback as powerful strategies and reports large effect sizes; (.79 for feedback and .69 for metacognition) (Hattie, 2012). Both of these effective practices, metacognition and feedback, have documented positive impacts on student achievement as isolated constructs in the research literature. However, this study conducted by Baliram and Ellis (2018) attempted to measure the effects on student achievement by intentionally integrating both approaches in the learning environment. Specifically, the researchers sought to study if students who engage in reflective assessment and receive teacher feedback significantly outperform students who receive the same math instruction without those strategies. Additionally, they examined if there is a statistically significant difference between the post-test and retention test with both the comparison and experimental groups.

Discussion of Findings

Parametric methods, more specifically, an ANOVA with repeated-measures suggested that students in the experimental group (M = 89.38) significantly outperformed the students in the control group (M = 81.38, p = .02, Cohen's d = .57). Furthermore, the results using a pair-wise comparison suggested a decrease in mean scores of 9.39 between the post-test and the retention test. However, the mean score for the students in the experimental group remained statistically significantly higher than the control group on the retention test (p = .01, d = .59).

The brief survey completed by the students in the experiment disclosed a positive outlook regarding the feedback they received in their exit tickets. Some positive comments made by the students included "I liked being able to apply what I learned. It helped me to realize what I fully understood and what I didn't. The feedback that I was given back was very helpful and I used it to study." The negative comments referenced the amount of time it took to complete the exit ticket and a feeling of being rushed, such as this one "I did not like how sometimes I would not have enough time to finish the ticket."

Implications for Practice

This study conducted by Baliram and Ellis (2018) is of significance because it measures the effects of two interventions merged in the learning environment. Classroom teachers have limited time, making it imperative that we explore ways to streamline our practice. Empirical research has demonstrated the positive effects of teacher feedback and reflective assessment in the science and math classroom. It is not common for math and science teachers to utilize reflective writing and practice problems as exit tickets in their classroom similar to the method used in this study (McDonald & Dominguez, 2009). Consequentially, it is not difficult to imagine teachers adding a feedback component to this practice. One student wrote in the open-ended question "I really like getting a second way of teaching through the note cards. It was useful to see it on a notecard right next to our work" (Baliram, 2016).

Students are acknowledging the effectiveness of combining metacognitive reflective assessment with teacher feedback. However, as many students wrote in their comments, we need to make sure we allow them enough time to reflect and engage in metacognition when trying out this strategy in our classroom. Similarly, it is essential to recognize the overwhelming demands already placed on teachers to ensure success among their students. Therefore,

further research is warranted to explore attainable models for teachers to effectively apply feedback to students' reflective writing.

Resources

There are multitude resources available for teachers to access for support in both reflective assessment and providing feedback. One such valuable resource is *Teaching, learning, and assessment together: Reflective assessments for middle and high school mathematics and science* by Ellis and Denton (2010) which provides concrete examples ready to be implemented. For teachers that want to explore giving meaningful specific feedback, Hattie and Clarke (2018) recently released an updated their book, *Visible learning: Feedback.* Both of these books provide both the theoretical background and instruction strategies for classroom implementation.

References

Baliram, N. (2016). *Reflective assessment, feedback, and academic achievement in high school mathematics* (Doctoral issertation). Available from ProQuest Dissertations and Theses database. (No. 10157333)

Baliram, N. & Ellis, A.K. (2018). The Impact of Metacognitive Practice and Teacher Feedback on Academic Achievement in Mathematics. *School Science and Mathematics.* pending publication

Bendal, P., Bollhoefer, A., & Koilpillai, V. (2015). *AVID Critical Thinking and Engagement: A schoolwide approach*. San Diego, CA: AVID Press.

Ellis, A. K., & Denton, D. (2017). *Teaching, learning, & assessment together: Reflective assessments for middle & high school mathematics & science*. New York, NY: Routledge

Flavell, J.H. (1979) Metacognition and cognitive monitoring: a new area of cognitive-developmental inquiry. *American Psychologist, 34(10)*, 906-910.

Hattie, J., (2012) *Visible learning for teachers: Maximizing impact on learning*. New York, NY:Routledge.

Hattie, J., & Clarke, S. (2018). *Visible learning: Feedback*. London: Routledge, Taylor & Francis Group.

McDonald, J., & Dominguez, L. (2009) Reflective Writing. *The Science Teacher,* March 2009, 46-49.

Zepeda, C.D., Richey, J.E., Ronevich, P., & Nokes-Malach, T.J. (2015) Direct instruction of metacognition benefits adolescent science learning, transfer, and motivation: An in vivo study. *Journal of Educational Psychology, 107*(4) 954-970.