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## Transparency and the Big Ideas in Calculus: Using a Write/Feedback/Re-write Cycle to Improve Student Understanding

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Gauss said “Mathematics is the queen of the sciences ... She often condescends to render service to astronomy and other natural sciences, but in all relations, she is entitled to the first rank.” The dual role of queen and servant is keenly felt by STEM students as they progress through the calculus sequence. Many concepts lay the foundation for applications in physics, engineering, and business; however, to be successful, procedural fluency is not sufficient. Students must be able to solve problems, which is a complex task that includes deciphering from a context what is the appropriate tool to use, establishing functions/relations, executing calculus-based procedures, interpreting the results, and communicating and justifying the appropriateness of the solution(s). Each step in this process requires careful thought and metacognitive action by the student.

Writing assignments with the possibility of revision can help students persist in learning difficult concepts, raise the level of student understanding, and improve the quality of student work. Through the write/re-write feedback loop, students learn how to use mathematical notation and language appropriately. Developing writing assignments to address key concepts in a course also helps instructors clarify their expectations to students. This presentation describes how the Calculus 1 teaching team at Western Michigan University developed, utilized, and revised a series of writing assignments to promote and to assess problem-solving skills.