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Daniel L McGee* (mcgeed4@nku.edu). *Extending physical Manipulatives to Visualize Multivariable Calculus Topics into Virtual Reality.*

With help from the NSF, a set of physical manipulatives has been invented that allow students to create 3D representations that help understand the differential and integral calculus. Using student-centered classroom activities to create effective contexts for learning, these physical manipulatives have been used in multivariable calculus classrooms where they have proved very effective with students coming from weaker mathematics backgrounds. This presentation will discuss the underlying semiotic theory behind the manipulatives and activities. It will present samples of the classroom activities that were used and the support that was needed for classroom implementation. It will discuss studies of their effectiveness. And will conclude with an overview of supplemental virtual reality materials that are being used to enhance and broaden the capacity of the physical manipulatives and their associated activities. (Received September 12, 2018)