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**A study of semiotic registers in the development of the definite integral of functions of two and three variables.**

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Summary: Tracing the path from a numerical Riemann sum approximating the area under a curve to a definite integral representing the precise area in various texts and online presentations, we found 3 semiotic registers that are used: the geometric register, the numerical register, and the symbolic register. The symbolic register had 3 representations: an expanded sum, a sum in sigma notation, and the definite integral. Reviewing the same texts, we found that in the presentation of double and triple integrals, not a single textbook continues to present the numerical register and the expanded sum representation of the symbolic register. They are implied and the expectation appears to be that students no longer need them. The omission of these representations is quite ubiquitous and correspondingly affects millions of students. Materials that present the missing numerical register representation and the expanded sum representation of the symbolic register throughout topics associated with double and triple integrals have been created. This paper presents the results of a clinical study on the improvement of student comprehension of multivariable integral topics when these representations are included.

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