Coding- and Spreadsheet-Integrated Tasks to Enhance Students' Quantitative Reasoning and Covariational Reasoning for Exponential and Logarithmic Functions

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Quantitative Reasoning (QR) is defined as a conceptualization of quantities as measurable attributes of an object(s), reasoning about and operating on quantities, and quantitative relationships in learning functions (Smith & Thompson, 2008). QR sets a foundation for covariational reasoning (CR); CR is the cognitive process involved in coordinating two quantities that covary while paying attention to how they change with respect to each other (Carlson et al., 2002). Studies have examined students' QR and CR skills across various mathematical domains, including exponential relationships (Castillo-Garsow, 2010; Confrey & Smith, 1995; Ellis, Ozgur, Kulow, Williams, & Amidon, 2012), trigonometry (Moore, 2010), rate of change (Johnson, 2012, 2015a, 2015b), functions (Carlson et al., 2002; Johnson, 2012, 2015a, 2015b), logarithmic-exponential functions (Ferrari-Escolá et al., 2016), the fundamental theorem of calculus (Thompson, 1994), graphs of functions (Carlson et al., 2002; Moore, Paoletti, & Musgrave, 2013), logistic function (Altindis et al., 2024), and differential equations (Castillo-Garsow, 2010). While research highlights the importance of QR and CR across various domains, these skills are complex due to the need to process multiple quantitative relationships simultaneously. Thus, we developed Python-integrated tasks to teach logarithmic and exponential functions.

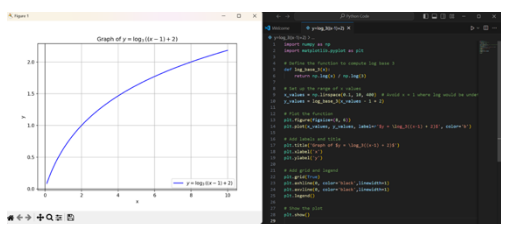

Figure 1. A Logarithmic Function Graph Created with Python Code

This poster will report on the affordances and challenges of coding and spreadsheet-integrated tasks and how these tasks allow students to model and visualize quantities and quantitative relationships. Using multiple representations (symbolic, graphical, numerical) enhances their understanding of function concepts. We will also report on preliminary testing of these tasks with high school students and their open survey responses. Additionally, we will discuss how students engage in multiple representations of mathematical phenomena, using Python codes to simulate and visualize the relationships between varying quantities. Furthermore, we will report that integrating coding into math lessons significantly increased students' engagement with the material, making abstract concepts more tangible and interactive. These findings highlight how Python coding can serve as a tool for enhancing students' quantitative reasoning and covariational reasoning skills, ultimately contributing to a meaningful understanding of logarithmic and exponential functions.

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