Use of Real-Time Sensors to Teach Statistical Graphing to Home-Schooled Children

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EXECUTIVE SUMMARY

Conceptual understanding plays a critical role in mathematics. However, traditional methods are predominantly focused on procedural knowledge and are insufficient to help students develop this understanding. Therefore, to ensure that students understand mathematical concepts comprehensively, it is necessary to explore alternative, innovative teaching methods that go beyond established practices. In this light, this chapter introduces an informal yet potent approach for teaching statistical graphing in the context of elementary arithmetic with the use of real-time sensors. This approach aligns with the need for teachers to comprehend the rationale behind mathematical concepts deeply as well as encourages students to foster a spirit of inquiry, explore mathematical concepts outside the traditional classroom setting, and question established procedures. By using real-time sensors appropriately with adequate instruction and guidance, students will be able to build a meaningful connection between mathematical concepts and real-life experiences and find mathematics learning more engaging.

INTRODUCTION

A noticeable issue in mathematics education in the United States is an overemphasis on procedural fluency at the expense of conceptual understanding (Perry & Len-Rios, 2019). Many teachers focus on improving students' calculation abilities through rote learning and formula memorization rather than guiding them to understand the underlying concepts. This can be attributed to insufficient support in the teaching environment and inadequate pre-service teacher preparation (Stohlmann et al., 2015). Consequently, even when instructors recognize the importance of both conceptual and procedural knowledge, they often lack the necessary time and resources to incorporate both into their classroom practices effectively. This leads to a greater emphasis on computational skills over conceptual understanding, resulting in students' diminished understanding of mathematics. To address this issue, we believe it is imperative to provide maths instructors with the resources needed for effective and efficient delivery of mathematical concepts.

The COVID-19 pandemic has exacerbated the issue of mathematics achievement among students globally, particularly affecting those in grades 3–9. In the United States, 5.4 million students in grades 3–8 experienced a substantial decline in average math test scores by 0.20-0.27 standard deviations in Fall 2021 compared to Fall 2019 (Kuhfeld et al., 2022). In response to the said trend, multiple studies pointed out that an engaging and motivating environment plays an important role in students' math learning achievement. León et al. (2015) studied the connection between learning motivation and high school math achievement. They discovered that students who consider their schoolwork meaningful and interesting and their classroom environment supportive show higher levels of autonomous motivation, effort regulation, and self-regulated learning, resulting in better math performance. Therefore, it is beneficial for mathematics educators to create an engaging and motivating environment to facilitate students' mathematics achievement (Singh et al., 2002), which is currently lacking in many mathematics classrooms (Xia et al., 2022). This case study aims to explore how the use of real-time sensors, an innovative teaching device, can enhance students' mathematical learning and understanding in an informal learning setting.

Real-Time Sensors

Real-time sensors are digital devices that collect data from real life and provide instant feedback. These sensors can measure a variety of physical phenomena, including temperature, pressure, light intensity, motion, and more. By converting physical measurements into digital signals, they enable the processing, analysis, and displaying of collected information on screens (Javaid et al., 2021). Real-time