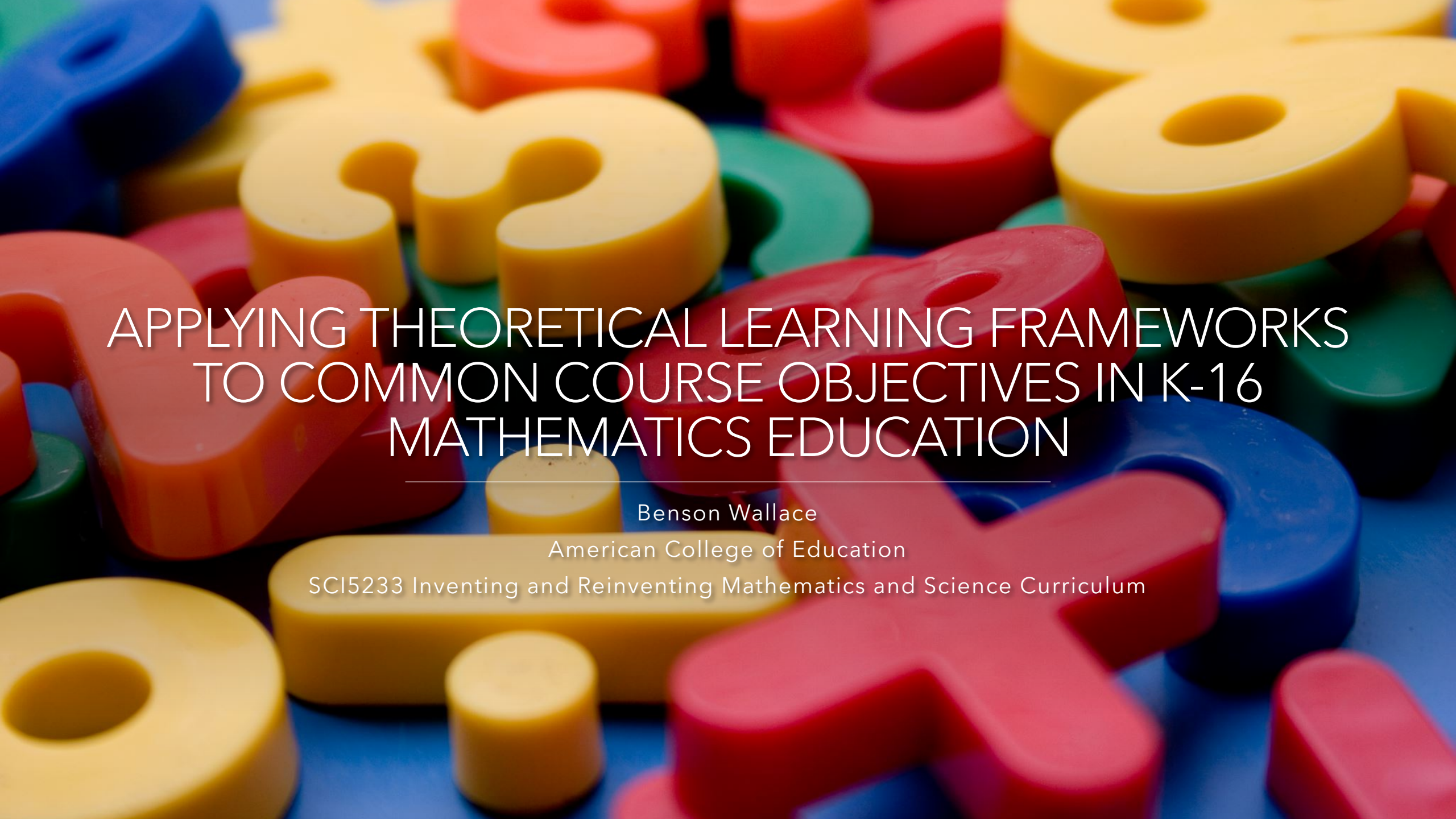

APPLYING THEORETICAL LEARNING FRAMEWORKS TO COMMON COURSE OBJECTIVES IN K-16 MATHEMATICS EDUCATION

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SCI5233 Inventing and Reinventing Mathematics and Science Curriculum

INTRODUCTION

"Three out of every five community college students take remedial courses, which typically cover middle school or high school material. This is evidence of the yawning gap between those who are eligible to enroll in college and those who are actually ready to attend" (Maxwell, 2010).

It is hoped that a coordinated approach to the teaching and learning of data handling across the K-16 continuum will lead to improved college readiness and higher levels of scientific and media literacy among high school graduates.

Why Data Handling?

- Interpreting data appears in all three IB Mathematics frameworks (Verwey, 2019) and the AERO curriculum framework for math (American Education Reaches Out, 2015), both of which are commonly used by international schools
- The proverbial "Statistics 101" is a course commonly taken by college students around the world that is focused on data analysis and inferences (University of Auckland, 2019)
- Also part of the Next Generation Science Standards (National Science Teaching Association, 2014)

Theoretical Framework: Constructivism and Constructionism

- A focus on making sense of data by constructing and sharing visual representations
  - "A constructivist-oriented teacher must be skilled in structuring the social climate of the classroom such that students discuss, reflect on and make sense of statistics tasks" (Mvududu, 2005, p. 52).
  - "In our study we emphasize on examining learners' meaning-making while constructing an external artefact, as a consequence of the learners' prior learning and sense-making in mind" (Csizmadia, Standl, & Waite, 2019)
- Has been shown to be effective in the teaching of pre-algebra (Geraniou & Mavrikis, 2015) and algebra (Ginga & Zakariya, 2020)

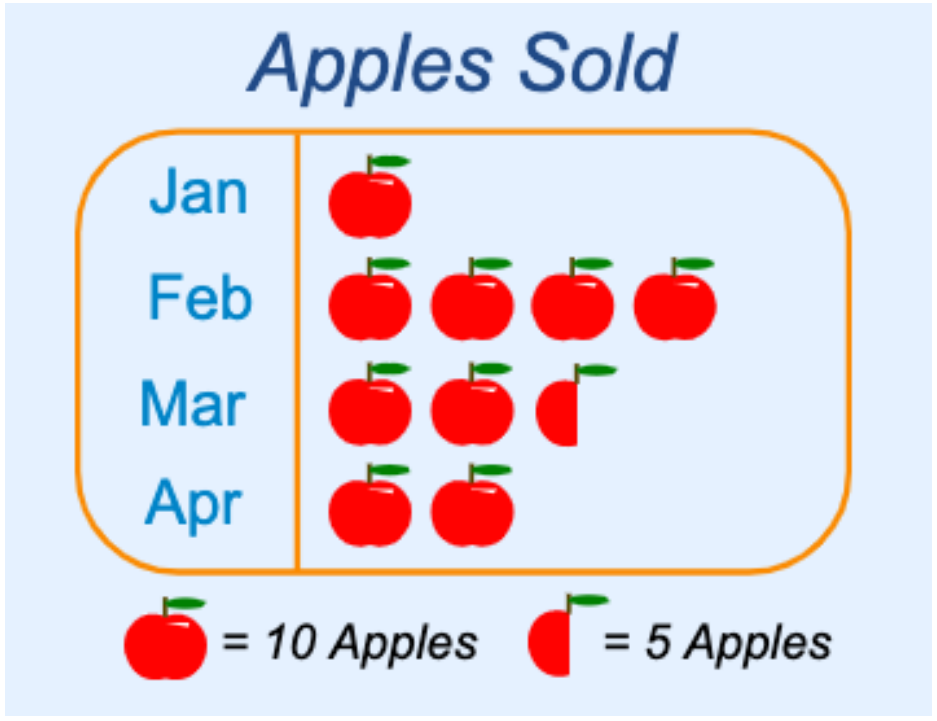

Figure 1. Example pictograph often used in early grades data handling curricula (MathisFun.com, 2017).

Early Grades Example

- Possible manipulation: students could sell apples (or some other product) at the school canteen and graph the results over a week. In this way, students are collaboratively constructing meaning from real-world data.
- Teacher management: younger students may need to create their charts using realia or manipulatives (for example apple cut-outs pinned to a board), as they may not yet have the skills to construct a poster graph.

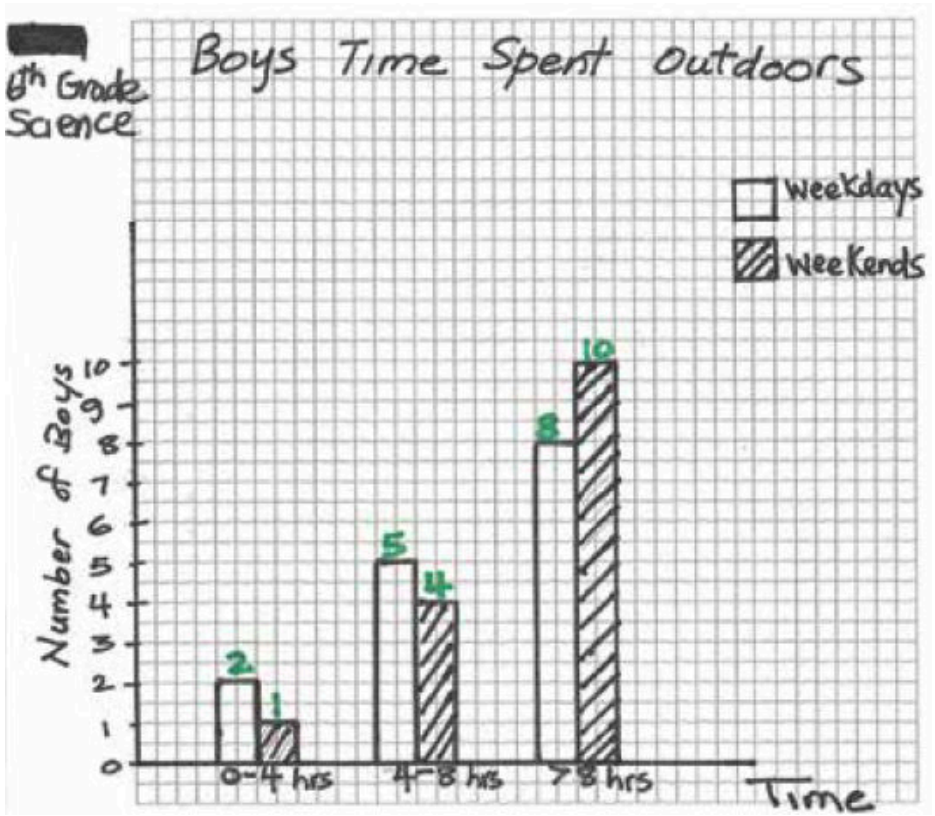

Figure 2. Bar graph created by a 6th grade student (McLaughlin, 2013). The data comes from survey questions that were created by the teacher, but collaboratively collected by the class.

Middle School Example

- Possible manipulation: students could be given the opportunity to create and carry out their own survey to answer a related question of their own choosing. This would then make the investigation personally meaningful.
- Teacher management: although it is tempting to use technology to expedite the process of data visualization, constructing graphs by hand can ensure that students do not "miss the point". Students can sometimes use a digital tool correctly to create a product while not grasping the mathematical concepts that the tool was designed to help them learn (Geraniou & Mavrikis, 2015).

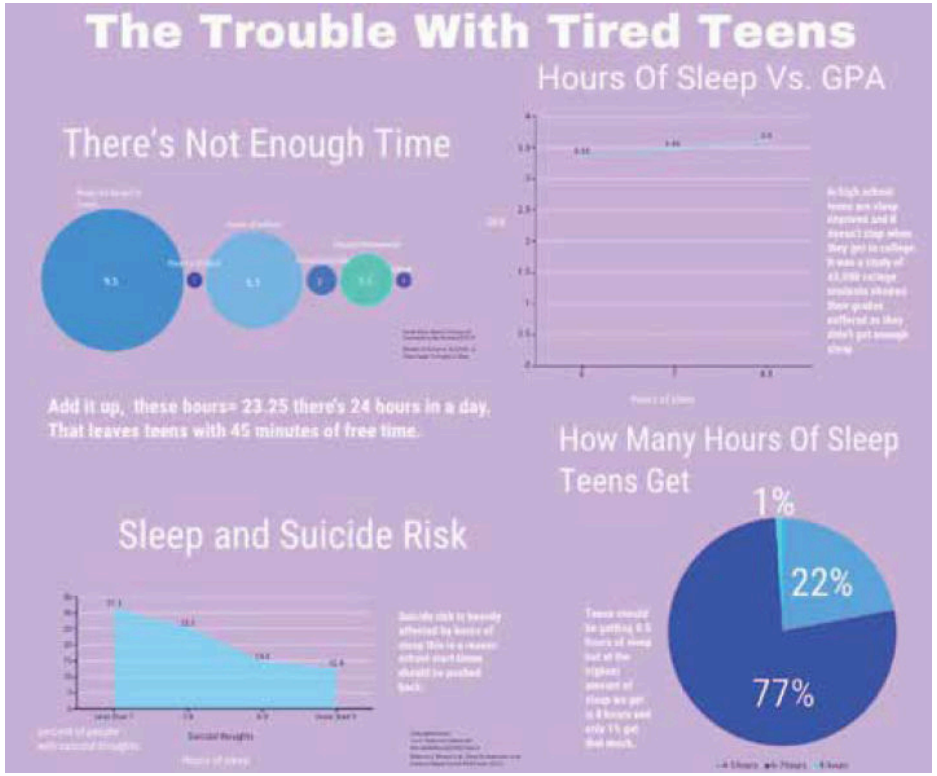

Figure 3. Example high school infographic project (Weidler-Lewis, Lamb & Polman, 2018)

High School Example

- Possible manipulation: older students could be given complete freedom to choose their topic (within subject expectations), infographic creation tool, statistical representation forms and publishing platform. There are many resources available to help in facilitating this process on the STEM Literacy through Infographics project website (Ren, 2018).
- Teacher management: with a variety of topics, data types and statistical forms of representation possible, the teacher's main role should be to help students find credible sources, make sense of raw data and choose appropriate forms of graphical representation.

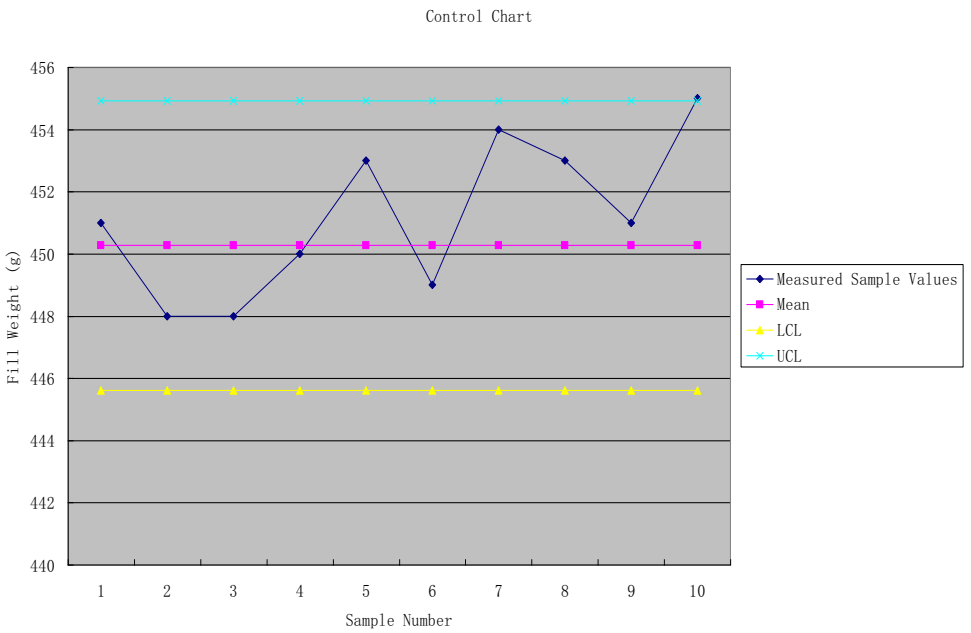

Figure 4. Example control chart created by the author in Microsoft Excel. The example was for a statistics assignment that was part of the course "Use graphical techniques and perform simple statistical computations", which the author taught to community college students in 2012.

College Level Example

- Possible manipulation: the product that students create could be in the form of a quality control report to a potential employer. This provides a meaningful context for making sense of the data.
- Teacher management: ideally, data should be collected by students during internships or on field trip visits to production facilities. If this is not possible, students can search for secondary data or randomly generate their own set with an appropriate mean and standard deviation.

Framework functions common to all age levels

Collaborative sense-making and construction of meaning (constructivism)

Constructing meaning by making products for an audience (constructionism)

CONCLUSION

A constructivist and constructionist approach to teaching data handling focuses on the benefit of the learner by providing learning experiences that are meaningful to and personalized for the learner

Making sense of statistics is a critical 21st century skill that is needed not only in the STEM disciplines but also the humanities and social sciences, and indeed, for simply being an informed citizen

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