

Creating an intellectual need for mathematics



1. Introduction

“When am I ever going to need this?” In response to this dreaded but all too common question, maths teachers often go groping for a real-world context. But few topics lend themselves readily to real-world scenarios; examples often feel contrived and can even be counterproductive (see Barton, 2018). Thankfully, the question can be pre-empted: not by finding a purpose outside mathematics, but by creating one *within* it.



6. Reflection

My experience in the classroom corroborates the theory of intellectual need. While it can be difficult to measure success in the classroom, this lesson felt better than lessons where I have failed to create intellectual need, which by comparison seem rather aimless.

All that remains is to create intellectual need in *all* my lessons. Alas, not all topics lend themselves readily to computational need; certain topics in geometry, for example, involve little calculation. For such topics, however, there is yet hope; for computational need is not the only type of intellectual need; there is also the *need for certainty*, the *need for causality*, the *need for communication*, and the *need for connection* (Fuller, Rabin & Harel, 2011). I will begin to explore how I might implement these in my lessons; Meyer’s (2018) ‘Directory of Mathematical Headaches’ is a good place to start.

2. Theory

- *Disequilibrium* is a state that results when one encounters an obstacle which compels the subject “to go beyond his current state and strike out in new directions” (Piaget, 1985, p. 10). *Equilibrium* is a state in which one perceives success in removing such an obstacle.
- For students to learn mathematics, they must have an *intellectual need* for it, that is, a need to reach equilibrium by learning it (Harel, 2008).
- A helpful analogy: if mathematics is the aspirin, how do we create the headache? (Meyer, 2018)
- One category of intellectual need in mathematics is the *need for computation*, which includes the need to find more efficient computational methods, such as one might need to extend computations to larger numbers in a reasonable “running time” (Fuller, Rabin & Harel, 2011).

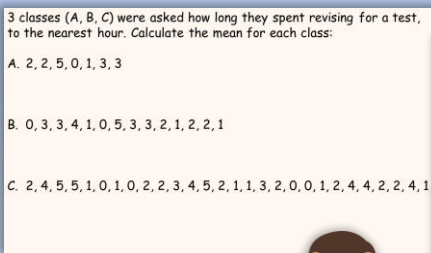


Figure 1

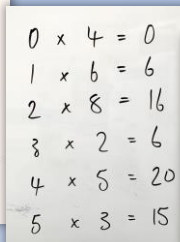


Figure 2

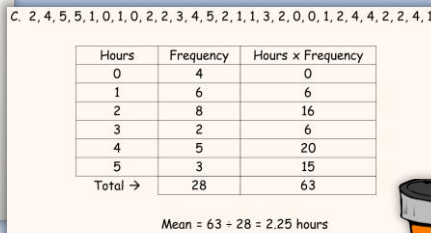


Figure 3

5. Evaluation

It is a happy coincidence that statistics already has real-world applicability; it is *applied* mathematics, after all. Still, I wasn’t taking any chances with my Year 9s (a set 4). I wanted also to create an intellectual need for learning about frequency tables, specifically, a computational need (Harel, 2008; Fuller, Rabin & Harel, 2011). Hence the starter exercise where the third data set was large enough to render their usual method for calculating the mean inefficient. Having given my students a headache, it was now time to offer them an aspirin: the frequency table – a more efficient method for calculating the mean for larger data sets. My students were largely receptive.

When implementing such an approach, it is tempting to think that the greater the intellectual need, the greater the learning; the worse the headache, the greater the demand for the aspirin. Why not give my students a data set with a hundred values, then, or a thousand? Because I wanted their usual method for calculating the mean to be inefficient, not hopeless; I wanted them to struggle, not despair. Indeed, care needs to be taken when creating intellectual need not to undermine self-efficacy, which is vital for motivation (Pekrun, 2006). This was also part of the rationale behind giving them two easy wins with the first two smaller data sets (see Figure 1).

3. Classroom application

I was teaching my Year 9 class how to find the mean from a frequency table. They were already confident finding the mean from a list of data by simply adding up the numbers and dividing by the number of numbers (e.g., the mean of 3, 7, and 2 is $(3 + 7 + 2) \div 3 = 12 \div 3 = 4$).

The starter exercise asked them to calculate the mean for three sets of data, represented as increasingly long lists; the third data set contained 28 values (see Figure 1). Despite successfully calculating the mean for the first two data sets, I could hear groans as they moved onto the third, which would involve a lot of adding up. But I gave them time to work at it before going through the answers as a class.

As we came to the third data set, I too groaned: “That’s a big class!” I made a point of looking thoughtful for a moment. “Maybe there’s a better way,” I said. “How many zeroes do we have?” I counted them aloud, crossing them off the list as I went along. “That’s four zeroes, and zero times four is zero,” which I wrote on the board. Students started to sit up in their chairs. I repeated the process for the other 5 values, taking care two write each sum beneath the last with each component aligned (see Figure 2). “That’s an easier way to do it, isn’t it?” There were nods of approval from the class. “Wouldn’t it have been great if they had just given us the data like that in the first place?” More nods. “Well, bigger data sets often *are* given to us like this,” I explained: “they are represented in *frequency tables*.” I flicked to the next slide, where the same data set was now represented in a frequency table, which looked just like the working I had already written on the board (see Figure 3; cf. Figure 2). I proceeded to explain how to find the mean from a frequency table, which by now was almost self-evident. After one more example, I handed out a worksheet.

4. Discussion

Overall, the lesson seemed to be a success. Almost all students completed the worksheet and progressed onto the extension task. I also received positive feedback from my mentor.

One thing that could be improved is the transition between the first two slides (Figures 1 and 3). I had already calculated ‘Hours x Frequency’ on the board (Figure 2), so then presenting the same data in a frequency table seemed like a backward step, albeit a small one. I could have perhaps simply labelled the columns I had already drawn on the board: ‘Hours’, ‘Frequency’, and ‘Hours x frequency’. That may have been a more natural step.

References

- Barton, C. (2018). *How I Wish I’d Taught Maths: Lessons Learned from Research, Conversations with Experts, and 12 Years of Mistakes*. Melton, Woodbridge: John Catt Educational Ltd.
- Fuller, E., Rabin, J.M. and Harel, G. (2011). Intellectual need and problem-free activity in the mathematics classroom. *Jornal Internacional de Estudos em Educação Matemática*, 4(1), pp.80–114.
- Harel, G. (2008). A DNR perspective on mathematics curriculum and instruction. Part II: with reference to teacher’s knowledge base. *ZDM Mathematics Education*, 40(5), pp.893–907.

- Meyer, D. (2015). If math is the aspirin, then how do you create the headache? *dy/dan*. Available at: <https://blog.mrmeyer.com/2015/if-math-is-the-aspirin-then-how-do-you-create-the-headache/> [Accessed 17 May 2022].
- Meyer, D. (2015). If math is the aspirin, then how do you create the headache? *dy/dan*. Available at: <https://blog.mrmeyer.com/2015/if-math-is-the-aspirin-then-how-do-you-create-the-headache/> [Accessed 17 May 2022].
- Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review*, 18(4), pp.315–341.
- Piaget, J. (1985). *The Equilibration of Cognitive Structures: The Central Problem of Intellectual Development*. Chicago: University Of Chicago Press.