

The Perceived vs. Actual Use of Mathematics in Medicine According to Pre-Medicine students and Practicing Physicians

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Joint Mathematics Meetings

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MATHEMATICS



Background - Nursing

- “One of the skills most frequently used by RNs in clinical practice is mathematics” (Newton, Harris, Pittiglio, and Moore, 2009, p. 83)
- Hunter, Revell, and McCurry (2013) – 51 articles that pertained to mathematics and nursing
- University programs addressing pre-nursing mathematical difficulties (e.g., Cunningham, 2001; Berry, 2009)



Background – Pre-Medicine

- Researchers have looked at benefits and situations of pre-medicine students in courses
 - Physics (e.g., Mylott, Kutschera, Dunlap, Christensen & Widenhorn, 2016)
 - Chemistry (e.g., Barr, Matsui, Wanat & Gonzalez, 2010).
- However, with the lens of pre-medicine, mathematics is a subject that has had little research dedicated to it.



Background – Nusbaum (2006)

- **Basic mathematical knowledge** sufficient to calculate drug doses, concentrations, and the like, **similar to what one would expect nurses to master** to safely care for patients and for much the same reasons
- An understanding of the **core statistical concepts** most commonly represented in the medical literature
- **Knowledge of algebra to understand calculations** of acid–base status and the like
- Perhaps most fundamental is a **sense of numeracy** so as to be able to **appreciate whether results are mathematically implausible**. (Nusbaum, 2006, p. 167)



Background – Pre-Medicine

- No mention of Calculus in Nusbaum's suggestions
- Comar and Townsley (2007) noted the success of calculus labs for pre-medicine, biology, and traditional calculus students.



Research Question

- What do physicians and pre-med students think about undergraduate mathematics education?
 - In particular, what about a requirement of calculus courses?
 - What do they think “mathematics” is?



Methods

- Participants

Name	Gender	Major	Level
Student 1 (S1)	Female	Chemical Engineering	Sophomore
Student 2 (S2)	Male	Biology	Junior
Student 3 (S3)	Female	Psychology	Junior
Student 4 (S4)	Male	Psychology	Junior
Student 5 (S5)	Male	Psychology	Junior
Student 6 (S6)	Female	Biology	Freshman



Methods

- Participants

Name	Gender	Specialty
Physician 1 (P1)	Female	Emergency Medicine
Physician 2 (P2)	Male	Radiology
Physician 3 (P3)	Female	Family Medicine- Geriatrics



Methods

- Semi-structured interview
- Predetermined and impromptu questions
 - Handout
 - Focus on mathematics and mathematics education
- Recruiting participants
 - Classmates asked in class
 - Email and phone calls to Physicians
- Interviews transcribed and analyzed for themes and quotes



Results

- Definition of Mathematics
 - P3: “Mathematics is the use of **numbers to solve problems.**”
 - S1: “Personally, I think it’s a way of **solving problems through numbers** and through variables and through different processes.”
- Level of Mathematics used in the sciences and medicine
 - P1: “The basic things like **multiplication** are the most used, however, I have to deal with **fractions and unit conversions...** We have to use more **basic math** and a little bit more complex math I would say.”
 - S6: “**Algebra.** For sure! Well, for one, you need it for **calculus**, you need a lot of algebra, and I feel like it’s kind of basic and a lot of other areas require **basic math.**”



Results, cont.

- "Physics Math"
 - P2: P2 mentioned how often physics and the math that goes along with physics is used in radiology and becoming certified, “You have radiation physics, which is a certain part of your boards, and if you don’t pass radiation **physics, which had to do with a lot of calculus**, and physical radiation decay formulas... you don’t get board certified...”
 - S5: When S5 was asked about which math courses have been the most beneficial for Pre-Medicine courses, S5 replied, “I would also say **physics, because that is all math**, let’s be real!”



Results, cont.

- **Conversions**

- P1: P1 gave multiple examples of **unit conversions** when asked about what math is used in Emergency Medicine, “If you have a 20 kilo kid and they needed 0.1 mg/kg of a certain drug, you have to do that math to come up with they need 2 kg... for drip rates... you have to know how many micro per milli and then how many micros per kilogram you want to run it at.”
- S1: S1 mentioned a specific technique learned early in the Pre-Medicine track and described, “[It’s] just a simple way to **convert any kind of units** to start from one concentration of anything and convert to a whole different value using reactions and everything in one simple math process.”



Results, cont.

- How often mathematics is used in the medical field
 - P1: “**We use it daily**” P1 then provided an example
 - S4: “**I wouldn’t imagine it to be too heavy of a feature.**”
 - S5: “**You definitely need to know how to use math** in regards to measuring how much medicine you want to give a person, the dosage. If for surgery, in regards to an anesthesiologist, he needs to know a lot of math.... I think it’s becoming a lot more involved...”



Results, cont.

- Improvements in Math education for Pre-Medicine students
 - P1: “I think if anything, I would potentially change **how much mathematics you’re asked to do in chemistry because... that is more consistent on what we look at.** Not only are you dealing with numbers and trying to solve for a certain number, but you’re dealing with the things I talked about, unit conversions.”
 - S1: “**Having math courses that are more deemed towards what I’ll be using them for.**”
 - S5: “**Make us take more advanced math classes and relate it to the medical field** in some sense.”



Results, cont.

- Mathematics in medicine and the future
 - P2: In regards to more complicated mathematics, “It’s actually still pretty integral. I don’t personally do the calculations, but I review what the computers say. I have to make sure that they do make sense... The **computers help you, and aid you, but they don’t replace you.**”
 - P3: Discussing a medical phone app, and the necessity of medical students to understand mathematics, “I still think they have to understand. I have to understand why I’m doing what I’m doing. If someone plugs in the wrong number and says, ‘Okay, Doctor, I’ve been giving them 225 ccs an hour to bring his sodium down 1.5 mil equivalents every 4 hours’, I’m like, ‘No this doesn’t make sense’... so **you have to understand the theory to be able to recognize, no you’ve miscalculated some number.** You did not plug in the correct number somewhere.”



Discussion

- **Definition of math for both groups is different than that of a mathematician**
 - Many mathematicians discuss mathematics as finding patterns and generalizing or expanding on those patterns (Devlin, 1996)
 - No mention of "patterns" by either physicians or students
 - Communication of mathematics belongs to the instructors, particularly in higher education



Discussion, cont.

- **Many of Nusbaum's four ideas agreed with physicians' responses**
 - Physicians use conversions as well
 - This results relates to the previous nursing and math literature
 - Appreciation of number sense
 - Calculation done by phone app cited
- **Calculus is useful for physicians**
 - This is in direct disagreement with Nusbaum (2006)



Future Research

- Differences between responses by gender
- 21st century technology and mathematics education
- Research the connection between calculus and pre-med mathematics education further

Thank you!

Questions?

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