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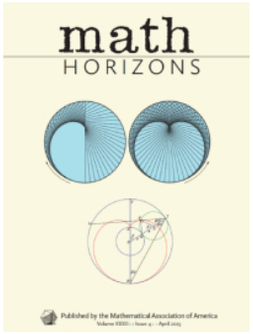

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SCUDEM Competition

Aidan Bryant and Aryan Tiwari

SIMIODE Challenge Using Differential Equations Modeling (SCUDEM) is a team competition designed for high school and undergraduate students that focuses on the use of differential equations to model real-world problems. Teams of three are formed and register for the competition—but after the competition starts, teams can no longer receive any assistance from anyone outside their team.

Once the competition begins, teams select a problem that comes from one of three areas: physics/engineering, chemistry/life sciences, and social sciences. Teams have approximately three weeks to create their model and submit a presentation explaining their model. Judges will rank each presentation as outstanding, meritorious, or successful and will also give feedback to help with future improvements.

Figure 1. Team members Aidan Bryant, Abhiram Bommineni, and Aryan Tiwari (left to right).

Our team (see figure 1) decided to participate in SCUDEM to garner some experience in mathematical modeling and to apply classroom knowledge to a practical situation. To us, SCUDEM provided a beginner-friendly introduction to the field of applied mathematics.

Preparation for Competition

No one on our team had previous experience with modeling. We had no idea what questions we would see, how to approach the problems, or what tools we would end up using to construct our solutions.

To help us prepare, our SCUDEM coach, Tracy Stepien, held three information sessions in which we learned about the overall structure of the competition, useful tools such as MatLab and Python, and a general strategy for how to approach modeling problems.

We worked on practice problems and reviewed presentations from previous competitions (available on YouTube). This process gave us great insight into the methodologies of how to approach problems and a blueprint for modeling situations.

Armed with knowledge about how the competition works, the format of questions, and a general idea of how to approach modeling, we felt prepared to tackle SCUDEM.

Our Experience with SCUDEM

Once the competition started, our first hurdle was choosing which problem to address. We weighed different factors such as perceived difficulty, our familiarity with the subject matter, and how interesting it seemed. All three problems seemed interesting and there was a lot of back and forth about which one to choose, but eventually, we came to the unanimous decision to work on the chemistry/life sciences themed question titled "Kangaroo Care."

This was a question about a method of care for infants called kangaroo mother care (KMC), which involves carrying the baby with skin-to-skin contact, and how it affects early infant mortality. We were asked questions about how key factors influence KMC, how skipping care affects outcomes such as mortality and health, and other insights or limitations that practitioners should consider. The problem statement included a research article that was a meta-analysis of many other studies done on this topic and it included data from all the studies as well as factors that affect the effectiveness of KMC.

We began by familiarizing ourselves with the current literature on KMC and made decisions on how to break up the workload. Without anyone having experience on a project such as this, we decided we wanted to discuss the plan for the model together until we had a final version we were happy with.

We used a whiteboard to list possible approaches to our model such as using an exponential decay model or a logistic growth model and whether or not to account for a birth rate. We were constantly refining our model and assumptions throughout the competition.

We decided we would model the impact of KMC on an initial population of 1,000 preterm/low-birth-weight newborns and created an exponential decay function to model the newborn population: $S(1-D)^{\frac{t}{m}}$ where S is the initial population, D is the death rate, m is the interval of time (in months) and t is time (in days).

To incorporate the effects of KMC, we set $D = r(1-bK)$, where r is the base death rate for preterm babies, b is the best case, and K accounts for KMC's effect. This gave us the realistic relationship between KMC and D—as the strength of KMC increases, the death rate decreases.

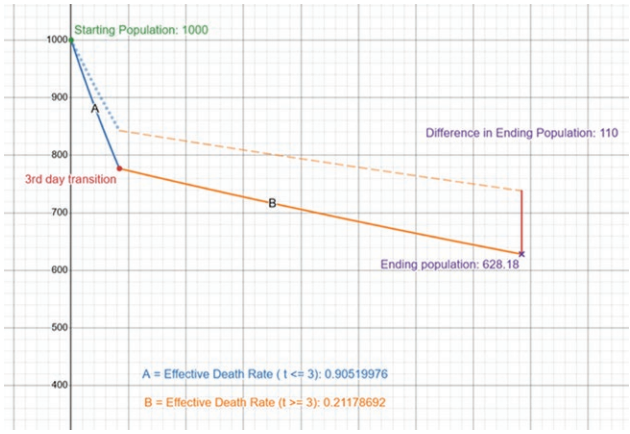
Furthermore, we decided that the effect of KMC depended on three additional parameters: whether or not KMC was initiated the day the infant was born, the number of hours a day KMC was "performed," and how many days KMC was "performed" in the first month. Research into infant mortalities revealed that 60 percent of infant deaths occur within three days after birth.

Before we could generate any graphs of our model, we made additional assumptions: All mothers had the same access to health care, infants did not have health conditions other than being preterm, and no day of skipping KMC had more effect than any other. One of the graphs we generated based on our model appears in figure 2.

Finally, having finished our model, we still needed to record and upload our video presentation. After struggling with various obstacles (low-quality microphones, laggy recordings, and messing up our lines), we uploaded the video to YouTube, with just a few minutes before the midnight deadline. We made it and our project was submitted—a wave of relief washed over us.

We had completed our first math competition, having learned a lot and having created a project that we were proud of. About a week later, results were announced and, to our surprise, we had achieved an "Outstanding" designation! We also received a detailed scoring report for our project that pointed out areas in which we excelled and provided constructive feedback.

Figure 2. Our final model with sample values for our parameter, showcasing the predicted effect of KMC on infant mortality (the solid line) compared to the best case scenario (dashed line).



Recommendations for Students

Interested in competing? We would make these recommendations:

- Review past presentations.
- Distribute the workload so team members can balance their individual strengths and interests.
- Listen to and explore everyone's ideas.
- Try SCUDEM yourself!

Conclusion

For us, SCUDEM was a great opportunity to learn new skills, make new friends, and apply what we learned in class. Participating in this competition helped us put the mathematical ideas we had learned over the years into context. It was a really fun experience where we learned a lot and ended up making a product we were all proud of.

We learned about the importance of teamwork, communication, and adaptability in the face of new challenges. Usually, deciding to participate in competitions or programs that you have no experience in feels like you are "jumping into the fire."

SCUDEM, though, felt like stepping into a well-guided, supportive environment where learning and growth were prioritized over perfection. The structure of the competition, along with the provided resources and guidance, made the experience enjoyable for us as beginners, and instead of being overwhelmed we found ourselves excited. We look forward to seeing you in the next SCUDEM competition! ●

Aidan Bryant, is majoring in mathematics and economics at the University of Florida. He enjoys using mathematics to make the best decisions in board games.

Aryan Tiwari is a junior majoring in mathematics at the University of Florida. He enjoys creating fun artwork and animations with mathematical functions on the graphing website Desmos.

Editor's note: SCUDEM is held during the Fall. Please visit *qubeshub.org/community/groups/scudem* for registration information.

No potential conflict of interest was reported by the authors.

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