Texto 1

Mathematical Research in High School: The PRIMES Experience

Pavel Etingof, Slava Gerovitch, Tanya Khovanova

Seriously? Is it really possible for tenth- and eleventh-graders to do original mathematical research?

Yes! Christina and Joseph, as well as over a hundred other students, have done their research at PRIMES (Program for Research In Mathematics, Engineering, and Science: web.mit.edu/primes), which we've been running in the MIT mathematics department since January 2011. Every year we receive numerous questions about our program from prospective students and their parents and also from academics who want to organize a similar program. Here we'd like to answer some of these questions, to share our experience, and to tell a wider mathematical community how such a seemingly impossible thing as mathematical research in high school can actually be done.

(...)

How do you select projects? Can my student be told to prove the Twin Primes Conjecture in PRIMES?

P.E.: Famous open problems don't usually make good projects, but we don't assign "toy projects" with known solutions either. Students delve into real research, with all its uncertainties, disappointments, and surprises. Finding cutting-edge projects requiring a minimal background is one of the trickiest tasks in running PRIMES. Here are some features we want to see in a PRIMES project:

1. *Accessible beginning.* Presence of simple initial steps to get started.
2. *Flexibility.* A possibility to think about several related questions, switching from one to another if stuck, and to tweak the questions if they are too hard or insufficiently interesting.
3. *Computer (experimental) component.* A possibility of computer-assisted exploration aimed at finding patterns and making conjectures. This way students, who often have strong programming skills, can contribute to the project early, when they don't yet have a working knowledge of the theoretical tools. It is also easier to learn new mathematical concepts, e.g., those from algebra and representation theory, through a hands-on experience with a computer algebra system.
4. *Adviser involvement.* Availability of a research mathematician other than the mentor (usually the professor or researcher who suggested the project) to advise the project through email and occasional meetings. Such meetings make a big difference.
5. *Big picture/motivation.* Connection, at least at the level of ideas, to a wider context and to other people's work.
6. *Learning component.* The project should encourage the student to study advanced mathematics on a regular basis.
7. *Doability.* A reasonable expectation that a good student would obtain some new results in several months to present at the annual PRIMES conference in mid-May and produce publishable results in one year.
8. Relation to the mentor's research program or area.

T.K.: A crucial part of research is the art of asking your own questions, not just solving other people's problems. When the students realize that it is in their power to move the project in a new direction, they get very excited and start feeling ownership of the project. The ability to trust themselves and ask their own questions is very important in their future lives, independent of their career choices. That's why we try to choose projects that develop this ability.

P.E.: Sounds easy? Well, if you have a bit of free time or have nothing better to do (e.g., during an excruciatingly boring math lecture that you can't sneak out of), just try to come up with a project satisfying most of these conditions. And when you do, please send it to us!

(...)

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Texto 2

Language of Physics, Language of Math: Disciplinary Culture and Dynamic Epistemology

Edward F. Redish, Eric Kuo

Mathematics is a critical part of much scientific research. Physics in particular weaves math extensively into its instruction beginning in high school. Despite much research on the learning of both physics and math, the problem of how to effectively include math in physics in a way that reaches most students remains unsolved. In this paper, we suggest that a fundamental issue has received insufficient exploration: the fact that in science, we don't just use math, we make meaning with it in a different way than mathematicians do. In this reflective essay, we explore math as a language and consider the language of math in physics through the lens of cognitive linguistics. We begin by offering a number of examples that show how the use of math in physics differs from the use of math as typically found in math classes. We then explore basic concepts in cognitive semantics to show how humans make meaning with language in general. The critical elements are the roles of embodied cognition and interpretation in context. Then, we show how a theoretical framework commonly used in physics education research, resources, is coherent with and extends the ideas of cognitive semantics by connecting embodiment to phenomenological primitives and contextual interpretation to the dynamics of meaning-making with conceptual resources, epistemological resources, and affect. We present these ideas with illustrative case studies of students working on physics problems with math and demonstrate the dynamical nature of student reasoning with math in physics. We conclude with some thoughts about the implications for instruction.

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Responda às questões 1 a 3 a seguir, com base no texto 1 dado.

Questão 1. O texto relata uma experiência de atividades de matemática desenvolvida no programa PRIMES. Descreva o que é o programa, qual seu público alvo, onde ele é desenvolvido e qual é a premissa que o entrevistado considera factível.

Questão 2. Que tipos de projeto não são considerados bons projetos?

Questão 3. Quais as características de um bom projeto para este programa?

Responda à questão 4 a seguir, com base no texto 2 dado.

Questão 4. Elabore uma versão em português do texto.