A Key to Deep Understanding: The Importance of Rich Tasks in K-12 Mathematics

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Introduction: The Evolution of Problems Into Rich Tasks

Think back to your experiences learning mathematics in elementary, middle or high school. What comes to mind? What did a page in your textbook look like? How would you describe a typical mathematics class?

For many of us, our recollections are of a teacher standing at the board showing the entire class how to do a mathematical procedure and perhaps explaining why it worked. This was followed by a series of practice exercises in a book or with a worksheet, usually ending with a few word problems (story problems) that used that procedure.

The use of rich tasks to develop mathematical concepts and deepen student understanding is not new. Content and process standards over the past 25 years (NCTM 1989, 2001) have called for problem solving to be a focus of mathematical instruction and the platform for learning mathematics. That call is reflected in today's college and career ready standards and effective teaching practices at both the national and state level. (CCSSO 2011, NCTM 2014).

The evolution of problems into rich tasks continues. In this paper, I will provide some examples of rich tasks, take a closer look at the characteristics of a rich task, and explain what effectively using rich tasks in mathematics instruction entails.

"An excellent mathematics program requires effective teaching that engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically."

- National Council of Teachers of Mathematics, Principles to Actions (NCTM 2014)

"Standard for Mathematical Practice: Make sense of problems and persevere in solving the

S t b e : A story problem is a worded situation that might be an exercise (for example, the

"A rich task has a range of characteristics that together offer different opportunities to meet the different needs of learners at different times.... much of what it takes to make a rich task "rich" is the environment in which it is presented, which includes the support and questions that are used by the teacher and the roles that learners are encouraged to adopt."

- Jennifer Piggott, Rich Tasks and Contexts (http://nrich.maths.org/5662)

Characteristics of a Rich Task

Teachers must recognize rich tasks and build a library of resources, including tasks from math programs that provide students the opportunity to explore and make sense of mathematics

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Q et : What strategy/strategies might students use to complete this task?

5. A c t a a t e t .

The importance of student reflection has been recognized in all curriculum areas. In mathematics, metacognition helps students build conceptual understanding and link that understanding to procedural skills. As such, rich tasks provide a context for deep learning. They also give teachers the opportunity to change the conditions of the problem to extend understanding and make generalizations, and they encourage students to ask, "What if?"

Q et : What questions will I ask students who are struggling with the task without telling them what to do? How will I support students who struggle to clearly explain their thinking?

7. A cta d t etage f a t ce t d a tatat e t .

Think about the two rich task examples shown earlier: Prince Peter's Palace Garden and The Summer Swings Baseball League. While both are interesting tasks in and of themselves, once an acceptable solution is reached, little attention will be paid to the situation. The importance and richness of each of these tasks is the mathematical reasoning that takes place during the solution process. Prince Peter provides students with a new model for multiplication. That model can easily be extended to explore other numbers, so that once students recognize and understand the process, they can use it again in other situations.

The Summer Swings task can be solved on a variety of levels. It allows students to recognize a particular pattern (triangular numbers), describe a pattern for finding the number of games to play by any number of teams, and (for middle school students) find a way to express that pattern algebraically.

Within this rich task, there are many ways to engage students with triangular numbers (or square numbers or other number patterns). The solution process that students use will help them recognize number patterns and use similar strategies with similar tasks. There is a great deal of learning and understanding happening while the task is being tackled!

Q et : What mathematical ideas will students take away from the solution process? How does it align with the content and mathematical practice learning intentions for the lesson?

Instructional Strategies for Using Rich Tasks

Among the many benefits of using rich mathematical tasks in the classroom are 1) a deeper understanding of mathematical concepts and 2) the transfer of conceptual understanding to procedural skills.

That said, it is not enough to simply hand out a task and put students in groups to collaboratively work on a solution. Research has shown that it is crucial for the teacher to orchestrate the implementation of a rich task to ensure students are using the task to promote understanding through mathematical thinking, reasoning, and problem-solving. (Stein, Lane 1996).

During the process of selecting and using rich tasks, a teacher should consider:

- What mathematics will my students learn from completing this task?
- What prerequisite understandings are essential for students to have entry into the task?
- How will I introduce the task?
- What are the potentially correct and incorrect solution paths students may take?
- What questions will support student work during the solution process?
- What questions will support connecting mathematical ideas during whole class discussion?
- What evidence will inform me of a student's understanding as he/she completes the task?

In addition to these questions, teachers should be aware that instruction using rich tasks differs from traditional instruction in the following ways:

- The role of the teacher is not to show and tell students about a procedure. Rather, the teacher is there to support students by asking purposeful questions. The student takes charge of his or her own learning.
- It may take more than a class "period" to fully complete a rich task.
- Students work on a task collaboratively to make sense of the mathematics. They will use a variety of strategies, such as discussing their ideas and using multiple representations both to reach a solution and to show their thinking.

Online Resources for Rich Tasks

The Internet offers some good sources of rich mathematical tasks. Beware: some sites offer tasks labeled “rich tasks” that are actually low cognitive demand tasks.

Browse through these sites to get your library of rich tasks started. Be on the lookout for additional websites and books that offer more examples.

http://www.insidemathematics.org/

http://www.nrich.maths.org/

http://illuminations.nctm.org

http://www.illustrativemathematics.org

http://www.nctm.org/ARCs/

https://nzmaths.co.nz/

Summary

While the benefits of using rich tasks far outweigh the limiting nature of drill and practice, teaching and learning with rich tasks requires much more from both the teacher and the learner. Both teachers and students must understand that this type of learning takes more effort and deeper thinking. The solution is never obvious, and simply following a set of steps is not an approach that will lead to success or to understanding.

Refe e ce

National Council of Teachers of Mathematics. (2014) Principles to Actions: Ensuring Mathematical Success for All. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1989) Curriculum and Evaluation Standards. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2000) Principles and Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). Common Core State Standards for Mathematics. Washington, DC: Authors.

Stein, Mary Kay, and Suzanne Lane. "Instructional Tasks and the Development of Student Capacity to Think and Reason: An Analysis of the Relationship Between Teaching and Learning in a Reform Mathematics Project." Educational Research and Evaluation 2 (October 1996): 50–80.