Contextualized Math Learning

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Why contextualize math instruction?

- Motivating and increases willingness to engage (Tabach & Friedlander, 2008)
- Provides real or concrete meaning to the math (Heid et al. 1995)
- People seem to learn easily when they learn in a work or everyday setting, and feel competent (Wedege & Evans, 2006)
- However, "Math" is "invisible" in working life (Wedege, 2010)

Learning in School | Learning in Context
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Individual | Group
Verbal | Observation & Imitation
Exact answer | Acceptable range
One best/standard method | Rule-of-thumb method
Written & Symbolic | Oral & Mental
Abstract | Embedded in context
Distant from meaning | Close to meaning
The limitations of math learned only in context

Difficult to take/use the math OUTSIDE of the context
For example, nurses determining drug dosages:

<table>
<thead>
<tr>
<th>What you want</th>
<th>X</th>
<th>What it's in</th>
</tr>
</thead>
<tbody>
<tr>
<td>What you've got</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Hoyles, Noss, & Pozzi, 2001)

Contextualized math teaching in vocational ed.

When technical teachers work with math teachers:

- Embedding numeracy in vocational instruction
  “Managers should not assume that the benefits of embedding can be achieved by simply adding LLN to the vocational teachers' responsibilities. Any assumptions that adult LLN is easy to teach should be avoided. Research shows that learners benefit from being taught by teams of staff, each with their own different areas of expertise, working closely together.”
  (Casey et al, 2006)

- Math-enhanced CTE lessons
  “The CTE teachers first identified math concepts inherent in their curriculum and then created lessons that would move students from the fully embedded example in CTE toward less contextualized and more abstract examples of the math concept.”
  (Stone, Alfeld, & Pearson, 2008)

Preparing learners for the workforce

- Use “contexts” to inform, frame and develop understanding
As an example – proportional reasoning
4 tasks—
  - speeding race cars
  - peeling potatoes
  - stuffing flyers in envelopes
  - mixing colors
Making sense of proportions with ratios, ratio tables, graphs, formulas

Proportions at work
- Construction
  - Cement mixing
  - Blueprints
- Medical fields
  - Dosages
  - Measuring heart rates
- Landscaping
  - Mixing/spreading fertilizer
- Also, rates of pay or production, mixtures, scaling up or down, model building, etc.

Russell was supposed to mix 3 tablespoons of weed killer concentrate with 1 ¾ cups of water to make a weed killer. By accident he put an extra tablespoon of weed killer concentrate, mixing 4 tablespoons of weed killer concentrate with 1 ¾ cups of water. How much water should Russell add to his mixture so that the ratio of weed killer concentrate to water will be the same as in the correct mixture?
Reflecting on contextualized math instruction

- Teach for meaning/conceptual understanding
- A focus on procedures alone accomplishes nothing – difficult to apply in new settings, easily lost and forgotten
- Memorizing formulas – in class or on the job – does not transfer to anything else
- Group learning – learners develop communication skills and have opportunities to justify reasoning and strategies
- Engage students with meaningful experiences
- Provide opportunities to apply ideas in new situations/problems
- Practice transferring knowledge & skills – make explicit connections between situations
1. **Introduce the CTE lesson.**
   - Explain the CTE lesson.
   - Identify, discuss, point out, or pull out the math embedded in the CTE lesson.

2. **Assess students' math awareness as it relates to the CTE lesson.**
   - While assessing, introduce math vocabulary through the math example embedded in the CTE.
   - Employ a variety of methods and techniques for assessing awareness of all students, e.g., questioning, worksheets, group learning activities, etc.

3. **Work through the math example embedded in the CTE lesson.**
   - Work through the steps/processes of the embedded math example.
   - Bridge the CTE and math language. The transition from CTE to math vocabulary should be gradual throughout the lesson, being sure never to abandon completely either set of vocabulary once it is introduced.

4. **Work through related, contextual math-in-CTE examples.**
   Using the same math concept embedded in the CTE lesson:
   - Work through similar problems/examples in the same occupational context.
   - Use examples with varying levels of difficulty; order examples from basic to advanced.
   - Continue to bridge CTE and math vocabulary.
   - Check for understanding.

5. **Work through traditional math examples.**
   Using the same math concept as in the embedded and related, contextual examples:
   - Work through traditional math examples as they may appear on tests.
   - Move from basic to advanced examples.
   - Continue to bridge CTE and math vocabulary.
   - Check for understanding.

6. **Students demonstrate their understanding.**
   - Provide students opportunities for demonstrating their understanding of the math concepts embedded in the CTE lesson.
   - Tie the math examples back to the CTE content; conclude the lesson on the topic of CTE.

7. **Formal assessment.**
   - Incorporate math questions into formal assessments at the end of the CTE unit/course.

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**Figure 1.** The seven elements: Components of a math-enhanced lesson.

*Note. CTE = career and technical education.*
Components and Subcomponents of Numeracy

**CONTEXT** – the use and purpose for which an adult takes on a task with mathematical demands

- **Family or Personal** – as a parent, household manager, consumer, financial and health-care decision maker, and hobbyist

- **Workplace** – as a worker able to perform tasks on the job and to be prepared to adapt to new employment demands

- **Further Learning** – as one interested in the more formal aspects of mathematics necessary for further education or training

- **Community** – as a citizen making interpretations of social situations with mathematical aspects such as the environment, crime and politics

**CONTENT** – the mathematical knowledge that is necessary for the tasks confronted

- **Number and Operation Sense** – a sense of how numbers and operations work and how they relate to the world situations that they represent

- **Patterns, Functions and Algebra** – an ability to analyze relationships and change among quantities, generalize and represent them in different ways, and develop solution methods based on the properties of numbers, operations and equations

- **Measurement and Shape** – knowledge of the attributes of shapes, how to estimate and/or determine the measure of these attributes directly or indirectly, and how to reason spatially

- **Data, Statistics and Probability** – the ability to describe populations, deal with uncertainty, assess claims, and make decisions thoughtfully

**COGNITIVE AND AFFECTIVE** – the processes that enable an individual to solve problems and, thereby, link the content and the context

- **Conceptual Understanding** – an integrated and functional grasp of mathematical ideas

- **Adaptive Reasoning** – the capacity to think logically about the relationships among concepts and situations

- **Strategic Competence** – the ability to formulate mathematical problems, represent them, and solve them

- **Procedural Fluency** – the ability to perform calculations efficiently and accurately by using paper and pencil procedures, mental mathematics, estimation techniques, and technological aids

- **Productive Disposition** – the beliefs, attitudes, and emotions that contribute to a person’s ability and willingness to engage, use, and persevere in mathematical thinking and learning or in activities with numeracy aspects

Math content topic

Develop conceptual understanding
Make connections among math topics - reason
Procedural fluency

Meaningful context

Apply strategically
Work context
Worksite practices
Assessments