



Developing Equity in the Mathematics Classroom

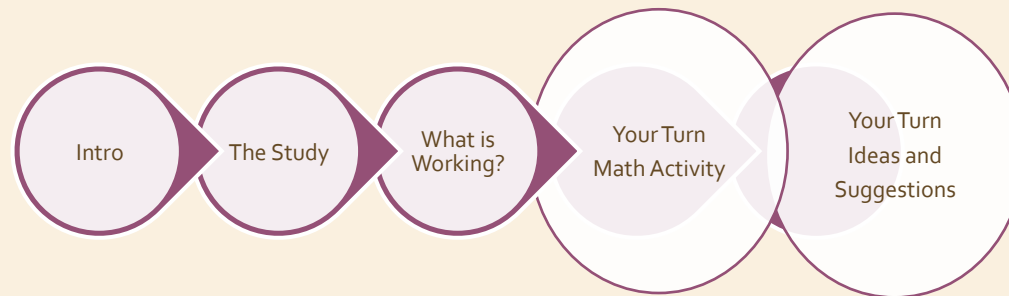
How Mathematics Teacher Educators Address Working with English Language Learners

▪ Linda Ann Arnold, Monmouth University

Getting to Know You

The slide features a light beige background. At the bottom, there are several decorative, wavy lines in shades of cream and light gold, creating a soft, flowing effect.

Agenda



Goals

1. **Learn** about what mathematics teacher educators *are* doing to help teacher candidates learn to support ELLs (study).
2. **Discuss and Interact:**
 - ❖ Explore material designed for instruction of ELLs in mathematics
 - ❖ Discuss how it correlates with principles for effective instruction of ELLs in mathematics.
3. **Facilitate recommendations** for what *mathematics teacher educators* can do to help teacher candidates support ELLs.



Focus: Linguistically Diverse Classrooms

“Many teachers are underprepared to teach mathematics effectively in diverse classrooms.”

- McDuffie, et al., 2014

Thus is due to both

- ❖ a general lack of preparation to teach mathematics in ways that build on children’s mathematical thinking and
- ❖ a more specific lack of preparation to teach mathematics to ethnically, linguistically and socioeconomically diverse students.



Many teachers *are* prepared to teach mathematics effectively in diverse classrooms.

Thus is due to both

- ❖ general preparation to teach challenging mathematics in ways that build on children's mathematical thinking and
- ❖ specific preparation to teach mathematics to ethnically, linguistically and socioeconomically diverse students.

Linguistically Diverse Classrooms

The slide features a light beige background with several thin, wavy, horizontal lines in shades of gold and cream at the bottom, creating a decorative border.

Beyond Awareness of Students “Classified as ELLs”

- ❖ *The National Clearing House for English Language Acquisition (NCELA, 2010) documented growth of **over 53%** in the number of ELLs in U.S. schools from 1997-98 to 2007-2008.*
- ❖ *In 2006, **20 percent** of school-aged children spoke a language other than English in their homes (Planty, et al., 2008).*
- ❖ *Many students not classified as ELL are still **English language learners**.*



The Bottom Line

All English language learners, classified as such or not, deserve a challenging mathematics curriculum which they can access.

Beyond Awareness of What are Considered **General** Ways to “Help” ELLs (list below from a general source)

- Use visuals that reinforce spoken or written words.
- Employ gestures for added emphasis.
- Adjust your speech: Speak slowly; enunciate; include shorter sentences, fewer pronouns, and simpler syntax.
- Stress high-frequency vocabulary words.
- Use fewer idioms and clarify the meaning of words or phrases in context.
- Stress participatory learning.
- Maintain a low anxiety level and be enthusiastic.

Access for ELLs in Math

How do we apply general techniques to the math classroom?

Are there techniques specific to the math classroom?

First – some myth-busting.

Common Misconceptions Mathematics Teachers Hold about ELLs*

- ❖ Mathematics is independent of language and therefore ELLs can quickly be successful in math without much intervention.
- ❖ The fact that an ELL student can carry on a social conversation with friends also means he or she should be able to answer questions and speak up in mathematics class.
- ❖ A mathematics teacher is only responsible for teaching mathematics. “I’m not here to teach English – that’s the ESOL teacher’s job”
- ❖ ELLs do need special help, but it is mainly with learning how to solve “word problems” and with vocabulary terms.

* (Source: Costner, 2008)

Beyond Awareness of Decoding and Word Problems

Myth: “ELLs do need special help, but it is mainly with learning how to solve word problems and with vocabulary terms.”

Fact: Recommendations about ELLs’ needs aimed primarily at decoding words and word problems provide only a limited view and do not address current increased emphasis on mathematical discourse and communication (Moschkovich, 1999).

Do mathematics teacher candidates see more of the former or more of the latter?

If teachers and teacher candidates believe myths, what do teacher educators believe?

What do they convey to teacher candidates?

Mathematics Teacher Educators

- Sources of information for teacher candidates on how to work with ELLs *in mathematics*.



Study: MTEs and Linguistically Diverse Classrooms

Are we preparing future mathematics teachers to work with English language learners?

If so, how?

Are we including information specific to the mathematics classroom?


Participants

16 mathematics teacher educators

- ❖ 10 males and 6 females
- ❖ 4 northeastern U. S, 4 west, 4 south, 2 mid-west, 1 Alaska, 1 Hawaii
- ❖ 13 participants spoke English as their native language
- ❖ 3 were native speakers of a different language.

Participants

mathematics *methods* teachers

- ❖ Volunteers who gave generously of their time
 - ❖ Experts in mathematics education
 - ❖ Varied beliefs and approaches
- 




Research Questions: Beliefs and Practices

What do participating mathematics teacher educators (MTEs) **believe** about English language learners in the mathematics classroom?

What do participating MTEs report **doing** to prepare teacher candidates to help English language learners succeed in learning mathematics?


Not a survey

- Qualitative study
 - In-Depth Interviews
- 

Interview Protocol

How do you approach the topic of helping teacher candidates in your classes learn to work with English language learners?

follow-ups: What did you do to help your students learn about this topic? Could you describe the activities? etc.





Sample Comments

"In the methods textbook I choose, there was a piece that had to do with English language learning, so they read about it. The reason why I didn't emphasize it a lot is that they take two literacy classes and then they take two diversity classes."

"We don't go into that, beyond the fact that we would do a lot with manipulatives which was a method to use with kids who are struggling linguistically. The hidden curriculum was kind of looking at those methods but we never talked about ELL methods in any sort of way."

"I would say that it would come up in discussion when I was teaching them do to, let's say, a textbook activity guide, or manipulatives. We would discuss how that approach can meet English language learners needs."



Sample Comments

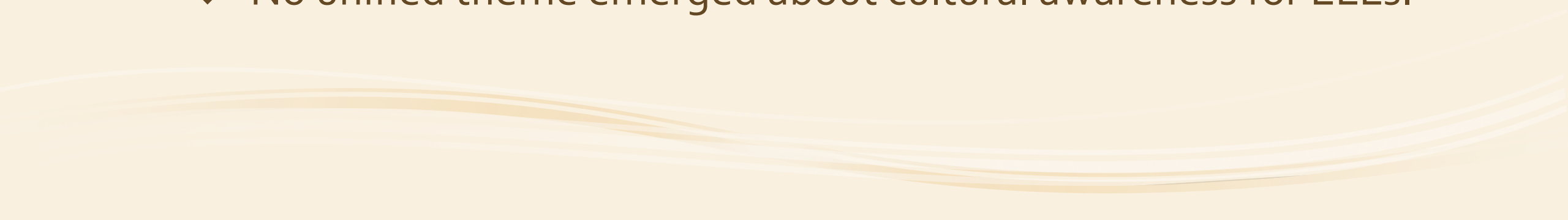
"I think your question really is, 'Do I take time out of teaching them how to teach math to focus on English language learners to the exclusion of other students?' The answer is no, I don't."

"I was always disheartened that working with ELLs was never a part of the curriculum within our courses, so I tried to embed it in my own way. And then also pulling SIOP materials... there's mathematics specific texts, so we can look at the lesson plans these folks have researched and used and talk about how to use them in their own classroom... you know, eight different layers to planning for ELLs."

Preliminary Impressions/Themes

- ❖ Varied levels of awareness, and varied levels of going beyond awareness.
- ❖ Varied approaches.
- ❖ Many “best practices for math are best for all” & “manipulatives help”.
- ❖ Almost all knew students would face classes with many ELLs.
- ❖ It appeared few MTEs had special training for working with ELLs.
- ❖ Many had strong multicultural awareness.

Emergence of Themes

- ❖ Themes dealt with levels of awareness of the importance of using specific techniques and approaches, as opposed to one size fits all, for helping ELLs deal with language hurdles in the mathematics classroom.
 - ❖ No unified theme emerged about cultural awareness for ELLs.
- 

There are indications that....

....many mathematics teacher preparation programs

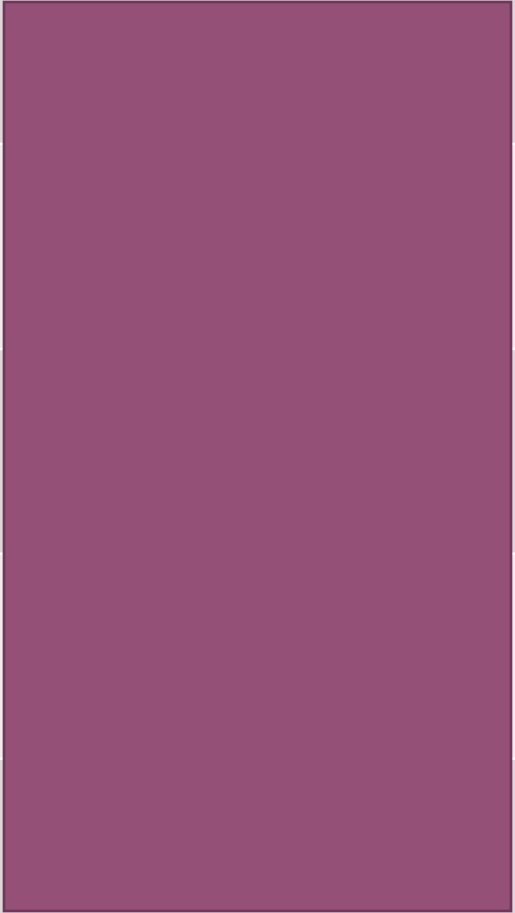
- ❖ *may* address the topic of English language learners at some point for at least a short time in general education classes, but
- ❖ have no explicit plans to specifically prepare future teachers to work with ever increasing numbers of ELL students **in mathematics classrooms.**

Levels of Awareness/ Commitment

MTEs, in general had either:

- ❖ 1. **No plans** to present PSTs with research based practices for ELLs in mathematics.
- ❖ 2. **Limited commitment** to presenting PSTs with research based practices for ELLs in mathematics.
- ❖ 3. **Some commitment** to presenting PSTs with research based practices for ELLs in mathematics.
- ❖ 4. **Strong commitment** to presenting PSTs with research based practices for ELLs in mathematics.

Levels of Awareness

Description of Level	Percent classified at Level
1. No plans to present PSTs with research based practices for ELLs in mathematics.	
2. Limited commitment to presenting PSTs with research based practices for ELLs in mathematics.	
3. Some commitment to presenting PSTs with research based practices for ELLs in mathematics.	
4. Strong commitment to presenting PSTs with research based practices for ELLs in mathematics.	
Unable to classify	

Level	Example of a statement classified at this level
(1) No plans ... (50%)	
(2) Limited commitment ... (14%)	
(3) Some commitment ... (14%)	
(4) Strong commitment ... (21%)	



What is going on?


How did MTEs arrive at various levels?

How might MTEs move to a different level?

Level One - No plans or few plans to present PSTs with research based practices for working with ELLs in math.

- ❖ Little or no professional development on the topic.
- ❖ Little or no experience in teaching ELLs.
- ❖ Cultural awareness not correlated with linguistic awareness.
- ❖ Adherence to myths.
- ❖ Beliefs about demographics.
- ❖ Time constraints.

Level Four – What made the difference?

- ❖ Professional development
 - ❖ Beyond cultural awareness: links between language and math
 - ❖ Beyond curricular requirements – or lack of them
 - ❖ Beyond awareness – to implementation
- 

What are many MTEs aware of now?

The slide features a light beige background. At the bottom, there are several decorative, wavy lines in shades of light brown and cream, creating a subtle border.

-source: <http://www.scholastic.com/teachers/article/10-ways-help-ells-succeed-math>

“10 Ways to Help ELLs Succeed in Math”

– Math can feel like a foreign language for everyone. Five experts share their best practices.

- 1. Create Vocabulary Banks.**
- 2. Use manipulatives.**
- 3. Modify teacher talk and practice wait time.**
- 4. Elicit nonverbal responses, like a thumbs up or down.**
- 5. Use sentence frames.**
- 6. Design questions and prompts for different proficiency levels.**
- 7. Use prompts to support student responses.**
- 8. Consider language and math skills when grouping students.**
- 9. Utilize partner talk.**
- 10. Ask for choral responses from students.**

Example

3. Modify teacher talk and practice wait time.

It is important to give all students, especially English language learners, time to process questions and formulate responses. Speak slowly and use clear articulation. Reduce the amount of teacher talk and use a variety of words for the same idea. Exaggerate intonation and place more stress on important new concepts or questions. After asking a question, wait for a few moments before calling on a volunteer. Writing the question on the board will also help.

Central Questions about MTEs and Such Lists


How to help ISTs & PSTs apply these steps in math?

1. Create Vocabulary Banks.
2. Use manipulatives.
3. Modify teacher talk and practice wait time.
4. Elicit nonverbal responses, like a thumbs up or down.
5. Use sentence frames.

How to go beyond awareness to ways specific to math?

6. Design questions and prompts for different proficiency levels.
7. Use prompts to support student responses.
8. Consider language and math skills when grouping students.
9. Utilize partner talk.
10. Ask for choral responses from students.

Recommendations: Curricular Needs for MTEs

- 1. Need to ask for **information** on what students have learned in general classes for working with ELLs and reinforce it. (Multi-cultural and TESOL specialists, etc.)
 - 2. Need to **understand** specific information for working with *ELLs in the math classroom*.
 - 3. Need to **implement** a curriculum for with this information.
 - 4. **Communicate** with field placement office about this curriculum.
- 



Resources

Advancing Mathematics Education for ELLs

Beyond Good Teaching



 NATIONAL COUNCIL OF
TEACHERS OF MATHEMATICS

more4u
More resources available online
www.nctm.org/more4u
Look inside for your access code

Nora G. Ramirez
Syliva Celedon-Pattichis

“Practices that specifically address the language demands of students who are developing skill in listening, speaking, reading and writing in a second language while learning mathematics.”

Resources on the Web

CEMELA <http://math.arizona.edu/~cemela/english/index.php>

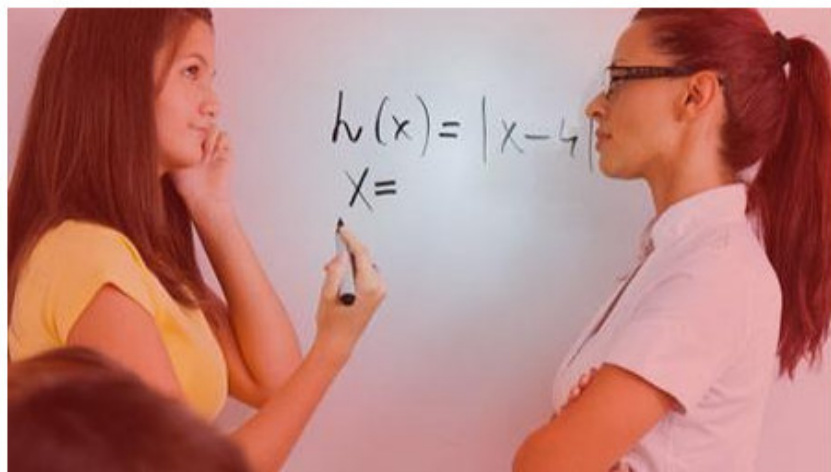
Colorin Colorado - colorincolorado.org

SIOP - <http://www.cal.org/siop/>

Stanford ELL materials - http://ell.stanford.edu/teaching_resources/math

Mathematics Assessment Project - <http://map.mathshell.org/materials/index.php>

TEACHING RESOURCES / MATH



SUPPORTING ELLS IN MATHEMATICS

The goal of these materials is to illustrate how Common Core aligned math tasks can be used to support math instruction and language development for ELLs at three grade spans (elementary, middle, and high school). We used or adapted tasks from two publicly accessible curriculum projects, **Inside Mathematics** and **Mathematics Assessment Project**.


To learn more, see the annotated lessons below and read our [Guidelines for Math Instructional Materials Development](#).

1. **Introduction to the Materials** describes how the materials were developed, and the types of materials and resources provided.
2. **Principles for Math Instruction** provide the over-arching principles for teaching mathematics to ELLs.
3. **Guidelines for Math Instructional Materials Development** can be used to develop new materials or to review already developed materials.
4. **"Language of Math" Task Templates** are language-focused activities that can be used by teachers to design and write their own language-focused activities. These "Language of Math" tasks were designed to support students in learning to read and understand word problems, communicate about mathematics, and build disciplinary and academic vocabulary, and develop practices in mathematics.

Going Beyond

The bottom of the page features several horizontal, wavy lines in shades of light yellow and cream, creating a decorative border.

Principle 1: Focus on students' mathematical reasoning, not accuracy in using language.

- ❖ Instruction should focus on uncovering, hearing and supporting students mathematical reasoning, not on accuracy in using language (Moschkovich 2010)
 - ❖ Recognize students' emerging mathematical reasoning.
 - ❖ Focus on the mathematical meaning learners construct, not the mistakes they make and the obstacles they face. (Moschkovich 2007b)
- 

Principle 2. Focus on mathematical practices, not language as single words or definitions.

- ❖ Instruction should move away from simplified views of language and interpreting “language” as vocabulary, single words, grammar or a list of definitions.
- ❖ An overemphasis on correct vocabulary and formal language limits the linguistic resources teachers and students can use to learn mathematics with understanding.
- ❖ Instruction should provide opportunities for students to actively use mathematical language to communicate about mathematical situations.
- ❖ Instruction should provide opportunities for students to actively engage in mathematical practices such as reasoning, constructing arguments, looking for an expressing structure and regularity, etc.

Principle 2. Focus on mathematical practices, not language as single words or definitions.

- ❖ Instruction should move away from simplified views of language and interpreting “language” as vocabulary, single words, grammar or a list of definitions.
- ❖ An overemphasis on correct vocabulary and formal language limits the linguistic resources teachers and students can use to learn mathematics with understanding.
- ❖ Instruction should provide opportunities for students to actively use **mathematical language** to communicate about **mathematical situations**.
- ❖ Instruction should provide opportunities for students to actively engage in mathematical practices such as **reasoning, constructing arguments, looking for an expressing structure and regularity**, etc.

Principle 3. Recognize the complexity of language in mathematics classrooms and support students in engaging in this complexity.

- ❖ Representations (objects, pictures, words, symbols, tables, graphs).
- ❖ Modes (oral, written, receptive, expressive).
- ❖ Kinds of written texts (textbooks, word problems, student explanations, teacher explanations).
- ❖ Kinds of talk (exploratory and expository).
- ❖ Audiences (presentations to teacher, to peers, by teacher, by peers).

Principle 3. Recognize the complexity of language in mathematics classrooms and support students in engaging in this complexity.

- ❖ **Representations** (objects, pictures, words, **symbols, tables, graphs**).
- ❖ Modes (oral, written, receptive, expressive).
- ❖ Kinds of written texts (textbooks, word problems, student **explanations**, teacher explanations).
- ❖ Kinds of talk (exploratory and expository).
- ❖ Audiences (**presentations** to teacher, to peers, by teacher, by peers).

Principle 4. Treat everyday and home languages as resources, not obstacles.

Everyday language and academic language are interdependent and related – not mutually exclusive.

Everyday language and experiences are not necessarily obstacles to developing academic ways of communicating in mathematics.

Home languages provide resources for mathematical reasoning and communication.



Principles

Principle 1: Focus on students' mathematical reasoning, not accuracy in using language.

Principle 2. Focus on mathematical practices, not language as single words or definitions.


Principle 3. Recognize the complexity of language in mathematics classrooms and support students in engaging in this complexity.

Principle 4. Treat everyday and home languages as resources, not obstacles

Guidelines for Design of Mathematics Instruction & Materials for ELLs

1. Focus on the Standards for Mathematical Practice.
2. Keep tasks focused on high cognitive demand, conceptual understanding and correspondences among representations.
3. Create multiple instructional pathways that provide students with different academic and linguistic backgrounds access to, engagement with and achievement of the standards.
4. Facilitate students' production of different kinds of reasoning (algebraic, geometric, statistical, etc.) and comparisons of reasoning.
5. Facilitate students' participation in different kinds of participant structures – from informal, collaborative group interactions to formal presentations – in ways that allow them to use their own existing linguistic resources and collaborate with others to articulate ideas, interpret information, and present and defend claims.
6. Focus on language as a resource for reasoning, sense making and communicating with different audiences for different purposes
7. Prepare students to deal with typical texts in mathematics, both in word problems and mathematics textbooks.
8. Consider how extended instructional units provide students with opportunities to encounter and engage with various kinds of text complexity.
9. Prioritize particular aspects of mathematical text complexity for pedagogical focus at different points during instructional units, providing necessary levels of support for students to engage in those areas of complexity.
10. Provide opportunities to activate and build students' background knowledge in ways that do not foreclose opportunities for them to engage with typical mathematical texts.
11. Recognize that all students, including ELLs have linguistic resources that can be employed to engage with activities designed to meet the CCSS that include typical mathematical texts.

Design Mathematics Instruction for ELLs

- CSS- **Mathematical Practice**
 - High **Cognitive Demand**
 - Multiple Instructional Pathways
 - Different kinds of **reasoning**
 - Different participation structures
 - Language of reasoning, sense making
 - Prepare to deal with text
 - Consider extended instruction
 - Scaffold, prioritize aspects of text
 - Build background knowledge
 - Recognize **linguistic resources**
- 

One Example

Applying Standards for Mathematical Practice to ELL instruction:

6. Attend to precision.

“When considering SMP 6 during instruction for ELLs it is important to remember that emerging language may sometimes be imperfect. It is also crucial to recognize that mathematical precision does not lie in using one precise individual work, but in making precise mathematical claims. Lastly, mathematically precise statements need not be expressed in full sentences.” (ell.stanford.edu)

Another Example:

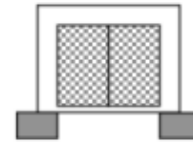
Sample posted language objective: I will express opinions about which graph is best by using the sentence stem "I think the best choice is _____, " (line graph, bar graph, circle graph), because

_____.

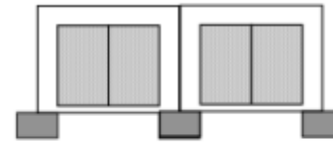
Roger's Rabbits

Name _____

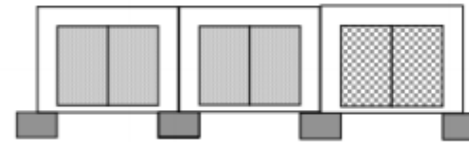
Roger keeps pet rabbits. He keeps them in a row of rabbit hutches. The hutches are on blocks so that they don't get damp.



This is hutch #1.
It is for one rabbit.
It has 2 doors and 2 blocks.



This is hutch #2.
It is for two rabbits.
It has 4 doors and 3 blocks.



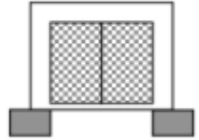
This is hutch #3.
It is for three rabbits.
It has 6 doors and 4 blocks.

1. Fill in the empty spaces in the table below.

Hutch	1	2	3
Number of doors			
Number of blocks			

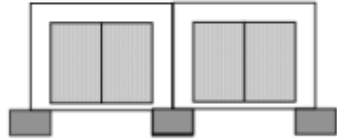
Name _____

Roger keeps pet rabbits. He keeps them in a row of rabbit hutches. The hutches are on blocks so that they don't get damp.



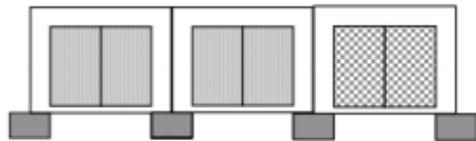
This is hutch #1.

It is for one rabbit.
It has 2 doors and 2 blocks.



This is hutch #2.

It is for two rabbits.
It has 4 doors and 3 blocks.



This is hutch #3.

It is for three rabbits.
It has 6 doors and 4 blocks.

1. Fill in the empty spaces in the table below.

Hutch	1	2	3
Number of doors			
Number of blocks			

Many textbooks...

2. How many doors will be in hutch number 12?

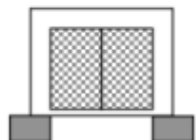
3. Give a formula for the number of doors in a hutch.

4. How many blocks will be in hutch number 20?

5. Give a formula for the number of blocks in a hutch?

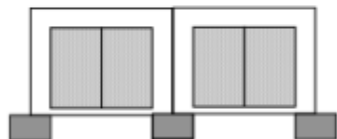
Name _____

Roger keeps pet rabbits. He keeps them in a row of rabbit hutches. The hutches are on blocks so that they don't get damp.



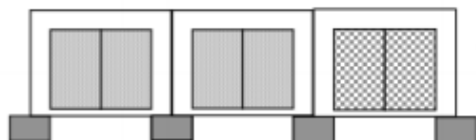
This is hutch #1.

It is for one rabbit.
It has 2 doors and 2 blocks.



This is hutch #2.

It is for two rabbits.
It has 4 doors and 3 blocks.



This is hutch #3.

It is for three rabbits.
It has 6 doors and 4 blocks.

1. Fill in the empty spaces in the table below.

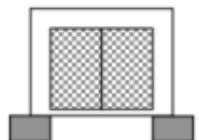
Hutch	1	2	3
Number of doors			
Number of blocks			

Many textbooks...

2. How many doors will be in hutch number 12? **Explain.**
3. Give a formula for the number of doors in a hutch.
4. How many blocks will be in hutch number 20? **Explain.**
5. Give a formula for the number of blocks in a hutch?

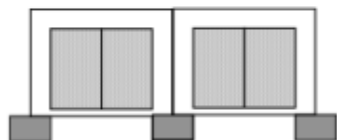
Name _____

Roger keeps pet rabbits. He keeps them in a row of rabbit hutches. The hutches are on blocks so that they don't get damp.



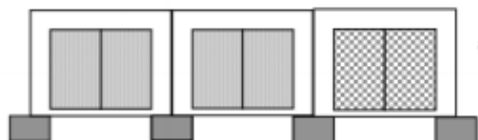
This is hutch #1.

It is for one rabbit.
It has 2 doors and 2 blocks.



This is hutch #2.

It is for two rabbits.
It has 4 doors and 3 blocks.



This is hutch #3.

It is for three rabbits.
It has 6 doors and 4 blocks.

1. Fill in the empty spaces in the table below.

Hutch	1	2	3
Number of doors			
Number of blocks			

Your Turn...

What does this problem do instead?

How might a teacher introduce this problem to ELL students?



Reactions and Reflections



Thank you!

larnold5@utk.edu