Content Knowledge Teaching

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Today's Session

1. Background on CKT assessment
2. Exploring a CKT Item
3. Results from validity research on CKT assessment

Content Knowledge for Teaching

CKT – Content Encountered in Teaching Practice

- Teachers need to know the content that their students are expected to learn
- But, teachers need to know content in ways that go beyond common content understanding
  - Dewey's "psychologizing" the curriculum
  - Bruner's curriculum that honors the student learner <u>and</u> the discipline
  - Shulman's "pedagogical content knowledge" as an amalgam of content and teaching
  - Ball/Thames/Phelps' "specialized" content knowledge

Assessment of CKT

- The CKT assessment framework starts with the content work of teaching a subject

- Focuses on the content knowledge needed recognize, understand and respond to the content problems encountered in teaching

- Builds a close connection between knowledge and teaching behavior

Sample Tasks of Teaching

Anticipating student challenges	Eliciting, evaluating or using student work, ideas or interactions
Explaining, using or evaluating concepts, representations or procedures	Evaluating or using instructional activities

Anticipating Student Challenges

Task of Teaching	Mathematics	ELA
Anticipating student challenges	• Anticipating student challenges in doing particular math problems • Anticipating student challenges due to limited background knowledge • Anticipating student challenges due to limited English language proficiency • Anticipating student challenges in providing justifications and explanations	• Anticipating student challenges for particular texts • Anticipating student challenges in reading or writing particular forms of text • Anticipating student challenges due to limited background knowledge • Anticipating student challenges due to limited English language proficiency

What is Content Knowledge __FOR__ Teaching?

CKT Includes the Content in the Student Curriculum!

Which exponential expression is equal to four?
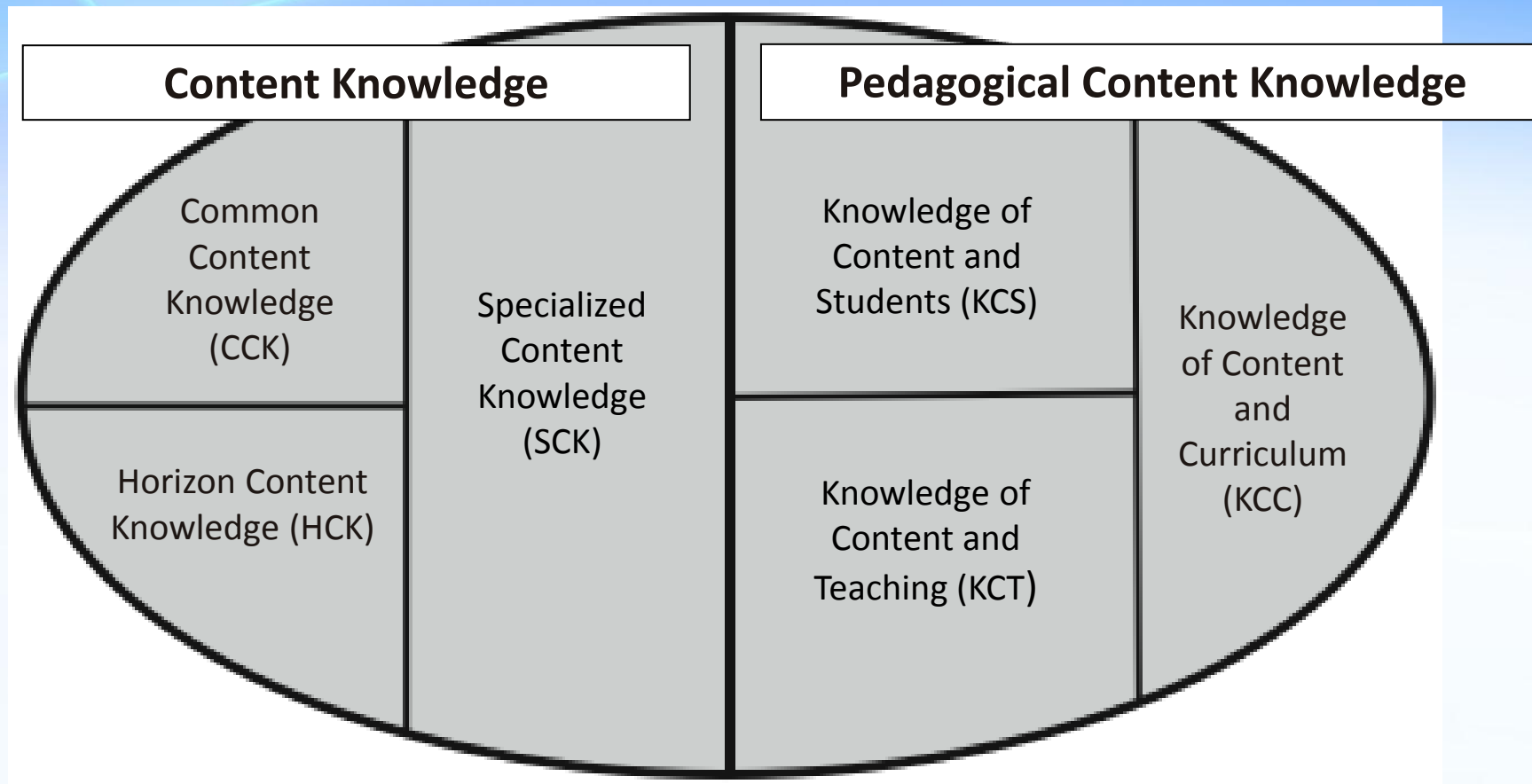
- ❑ 3^3
- ❑ 2^3
- ❑ 2^2

CKT Includes the Knowledge Used in Many Recurrent Teaching Practices

Anticipating Student Challenges/ Evaluating Problems

Ms. Hupman is teaching an introductory lesson on exponents. She wants to give her students a quick problem at the end of class to check their proficiency in evaluating simple exponential expressions. Of the following expressions, which would be <u>least</u> useful in assessing student proficiency in evaluating simple exponential expressions?

- ❑ 3^3

- ❑ 2^3

- ❑ 2^2

- ❑ All of these are equally useful in assessing student proficiency in evaluating simple exponential expressions.

Content Knowledge		Pedagogical Content Knowledge	
Common Content Knowledge (CCK)	Specialized Content Knowledge (SCK)	Knowledge of Content and Students (KCS)	Knowledge of Content and Curriculum (KCC)
Horizon Content Knowledge (HCK)		Knowledge of Content and Teaching (KCT)	

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education, 59(5), 389-407.*

Exploring a CKT Item

To assess her students' prior knowledge about evaluating arithmetic expressions, Ms. Santiago assigned a worksheet of problems. She noticed that Alexis answered the first two incorrectly and the next two correctly.

1) $7 \times 2 - 6 + 3$ $= 5$

2) $9 - 5 + (16 \div 8)$ $= 2$

3) $9 + 24 \div 3 - 1$ $= 16$

4) $17 - (3 + 7 \times 2)$ $= 0$

Which of the remaining problems is Alexis likely to answer incorrectly?

OPTION 1: $8 + 7 - 12 \div 3$

OPTION 2: $13 - 3 \times 2 + 5$

OPTION 3: $(27 \div 3 - 4) + 8$

OPTION 4: $(16 - 12) \times 5 + 10$

Questions to Consider

- What is the correct answer?

- What content knowledge is this item measuring?

- How does this knowledge differ from simply being able to solve basic "order of operations" problems?

Questions to Consider

- How is the CKT measured in this question relevant to teacher education and teacher professional development?

- How is the CKT measured in this question related to the effective teaching of order of operations?

Results from CKT Research

CTK Assessment Development

- Mathematics grades 4-5, 6-8, algebra 1

- ELA grades 4-6, 7-9

- Developed questions grounded in content-based tasks of teaching and problems of practice

- Focused on CK "specialized" to teaching

- Tests targeted a wide range of topics and were designed to be completed in less than 1 hour

CKT Can Be Measured Reliably

Forms	Total	Scored	Questions	Items	Reliability
ELA 4-6	635	555	24	52	0.74
ELA 7-9	434	418	26	51	0.69
Math 4-5	465	397	21	44	0.76
Math 6-8	398	373	23	52	0.83
Algebra 1	148	143	22	35	0.77

Score Variation for CKT Forms

Forms	N	Min%	Max%	Mean%	SD%
ELA 4-6	555	30.8	89.4	66.4	11.7
ELA 7-9	418	31.4	88.7	64.7	10.5
Math 4-5	397	20.5	93.2	52.2	14.4
Math 6-8	373	22.6	94.2	62.1	14.9
Algebra 1	143	22.9	97.1	61.5	14.3

BUT.........

- What are we really measuring?

- What evidence is there that we are drawing on knowledge specialized to the work of teaching?

- What characterizes the reasoning and knowledge associated with low and high scores?

Using Cognitive Interviews to Investigate Validity

- Recruited 60 teachers who had already completed the CKT assessments

- Selected half of sample from 2nd lowest and half from the top quartile of overall score distribution

- Used questions from both elementary ELA and math

- Conducted 90 minute interviews:

  - Did the questions remind you of something from your own teaching practice?

  - How did you answer and why?

  - Why didn't you select the other option choices?

Study Questions

- How do teachers understand the item design features?

  - teaching problem, domain content, context presented

- Do particular design features introduce construct-irrelevant factors?

- What connections do teachers make to their own practice?

- What is the nature of the reasoning teachers use as they respond to the questions?

- Do teachers who take both math and ELA assessments demonstrate similar reasoning processes?

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"If Alexis did it her way she would have done the three times two is six, she would have done the addition first because in Please Excuse My Dear Aunt Sally, "Aunt" comes before "Sally." So that would be six plus five is 11 and so then she'd do her subtraction which is 13 minus 11 and Alexis' answer would be two. She would come up with the incorrect answer because she would have not followed the correct order of operations. Correct in her mind but not the way it should be taught."

Teaching Experience Supports Answering Correctly

"Everybody uses that mnemonic Please Excuse My Dear Aunt Sally to show the order of operations and that's what this child is messing up. She's adding before subtracting because it says it in that order. A lot of times I've seen teachers actually teach it wrong where they tell them you have to go through the addition before we do subtraction, which of course is incorrect. You have to do the addition and subtraction simultaneously from left to right. And that seems how this child has messed up she's doing her addition before she does her subtraction."

Incorrect Answer

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Respondent: Because it has the division in it with the parenthesis. I figured that if she was going to make a mistake, it would be on that one again.

Interviewer: Let me make sure that I heard that correctly, you said that because there was division with parenthesis you were looking for that?

Respondent: Right because number two was wrong because of that and the number one with just the multiplication, subtraction, addition, I think that's a little easier than number two.

Teaching Experience Does Not Support Answering Correctly

"We do order of operations. My kids used the PEMDAS and there's a lot of debate about saying the letters or just saying 'Please Excuse My Dear Aunt Sally' which is the way I know how to get them to remember it. I don't know what's wrong with 'Please Excuse My Dear Aunt Sally' but people don't want to use it. But it works all the letters are there parenthesis, exponents, multiplication, division, addition, subtraction, so I tell them they should write that down before they even start doing a problem that has more than one operation in it so they use the right thing."

Summary

Strong Reasoning

- Can reason into how the student would work on the problem from a combination of knowledge of common confusion with PEMDAS and analysis of student work

Weak Reasoning

- Recognizes that the confusion is about order of operations, but doesn't decipher the student problem

- Doesn't understand the confusion students might encounter using PEMDAS

- Uses a more general assessment of what makes a problem hard (division and parenthesis are "harder").

Mr. Haddad is using Jerry Spinelli's novel *Maniac Magee* to teach his fifth-grade class about how authors develop their characters.

Which of the following questions would be the best choice to help his students focus on the essential features of character development?

1. What kinds of symbolism does the author use to develop Maniac Magee's character?
2. Can you describe where Maniac Magee lives?
3. How does Maniac Magee respond to trouble?
4. What do you think might have happened to Maniac Magee before this story began?

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"Well, I think when you're looking at character development, you are looking at how that character responds to their environment. And so that's what question answer number three does. It asks you to look at how Maniac responds to trouble and through that you're going to see what kind of character Maniac is and through his responses the author is developing the kind of character that Maniac is."

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"I chose one. To me that seemed like the best answer choice, for being able to understand Maniac Magee's character. You get the symbolism used in the story."

"I didn't choose three. It's what we call a right there question. They would use specific examples from the text to tell how he responds to trouble, you know how he acts when he get's into trouble. Then what? What do you do with that information? How do you relate it to his character."

Summary

Strong reasoning

- Understands important features of character development
- Able to see how questions would direct student thinking to those features of character development

Weak reasoning

- Loses track of the focus or purpose of the teaching (i.e., character development)
- No justification for choice beyond personal preference
- Uses learning tool ("right there questions") in ways that do not apply to or help in this instance.

What Have We Learned From Cognitive Interviews?

- Teachers see items as authentic and all teacher reason from their teaching (but this doesn't always help!)

- Teachers who answer correctly the vast majority of time reason as intended

- Teachers who do not answer correctly show a variety of confusion
  - Sometimes don't understand the basic content
  - Often have trouble using content knowledge <u>for teaching</u>

What are Working on Next?

- Working with Texas EPPs to investigate the use of CKT assessments with prospective teachers

- Piloting the use of CKT in voluntary sections of the Texas teacher licensure tests

- Investigating the use of CKT assessments as pre and post program tests to study the effectiveness of PD

- Investigating the relation between CKT and student achievement

- Developing new assessments
  - Elementary and middle school science
  - High school physics
  - High school mathematics

Questions?

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