Why content knowledge matters in teaching: Implications for teacher education

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Mathematical Knowledge for Teaching

- Knowing mathematics to pass a test ≠ knowing mathematics in the ways needed to teach it.
- Teaching mathematics involves knowing
  - Representations
  - Analogies
  - Illustrations
  - Examples
  - Explanations
  - Demonstrations

Shulman, 1986

And also

- Knowing
  - What makes a topic easy or hard
  - Students' preconceptions and misconceptions
  - Strategies to address misconceptions

Shulman, 1986

A recent study

- Conducted by Jisun Kim, University of Georgia
- 5 geometry/measurement tasks, given one at a time over a semester
- Preservice teachers had to
  - Solve the task
  - Examine student solutions to determine if they were correct
  - Identify *causes* of errors
  - Propose instructional strategies to address the causes of the errors

Findings of the study

Preservice teachers

- generally got the correct answer themselves, but in some cases they exhibited the same misconceptions as the students *even though the topic had been addressed in a course*.
- focused on the answer, not the solution path.
- did not attend to intuitive or visual thinking.
- attributed errors mostly to faulty procedural knowledge.

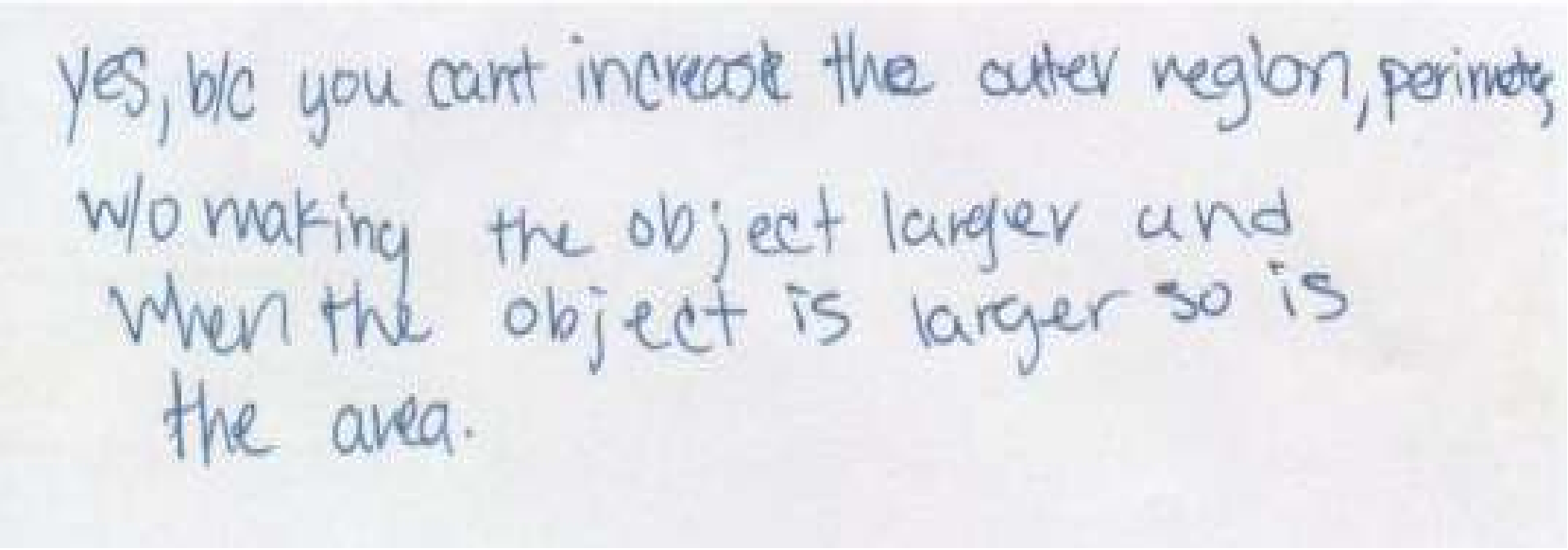
Findings, Cont'd.

- Diagnoses did not match prescriptions.
- Small, weak repertoire of instructional strategies; often wanted to "tell" students the correct answer.
- Used examples from class for instructional strategies.

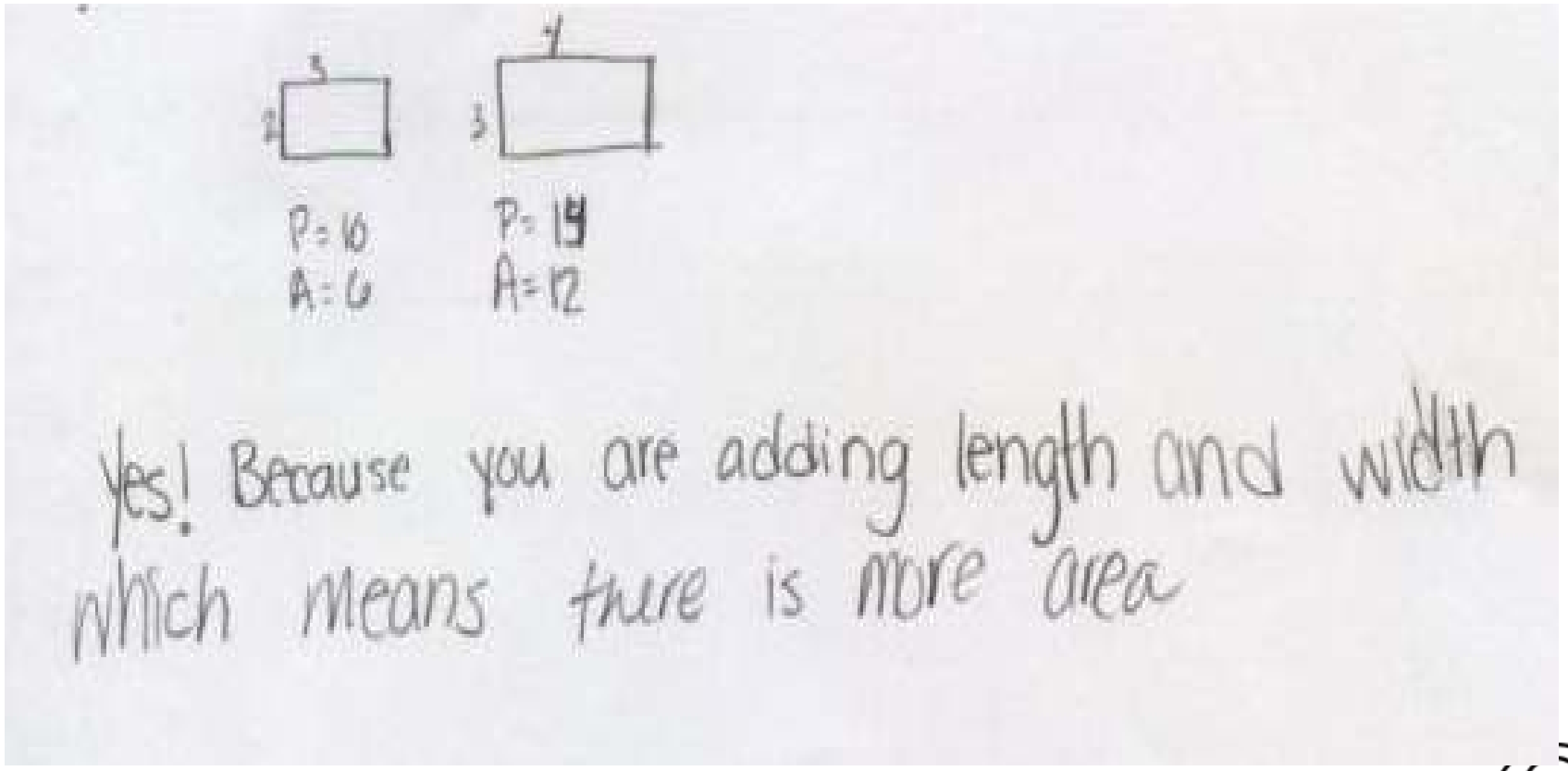
Tasks

- Rectangle I has a larger perimeter than Rectangle II. Can you conclude that Rectangle I also has a larger area than Rectangle II? Why or Why not?
- Compare areas of 2 triangles where one is obtuse
- Possible triangles (more than one obtuse angle, 3 acute angles)
- Determine if two triangles are similar
- Quadruple the volume of a rectangular solid

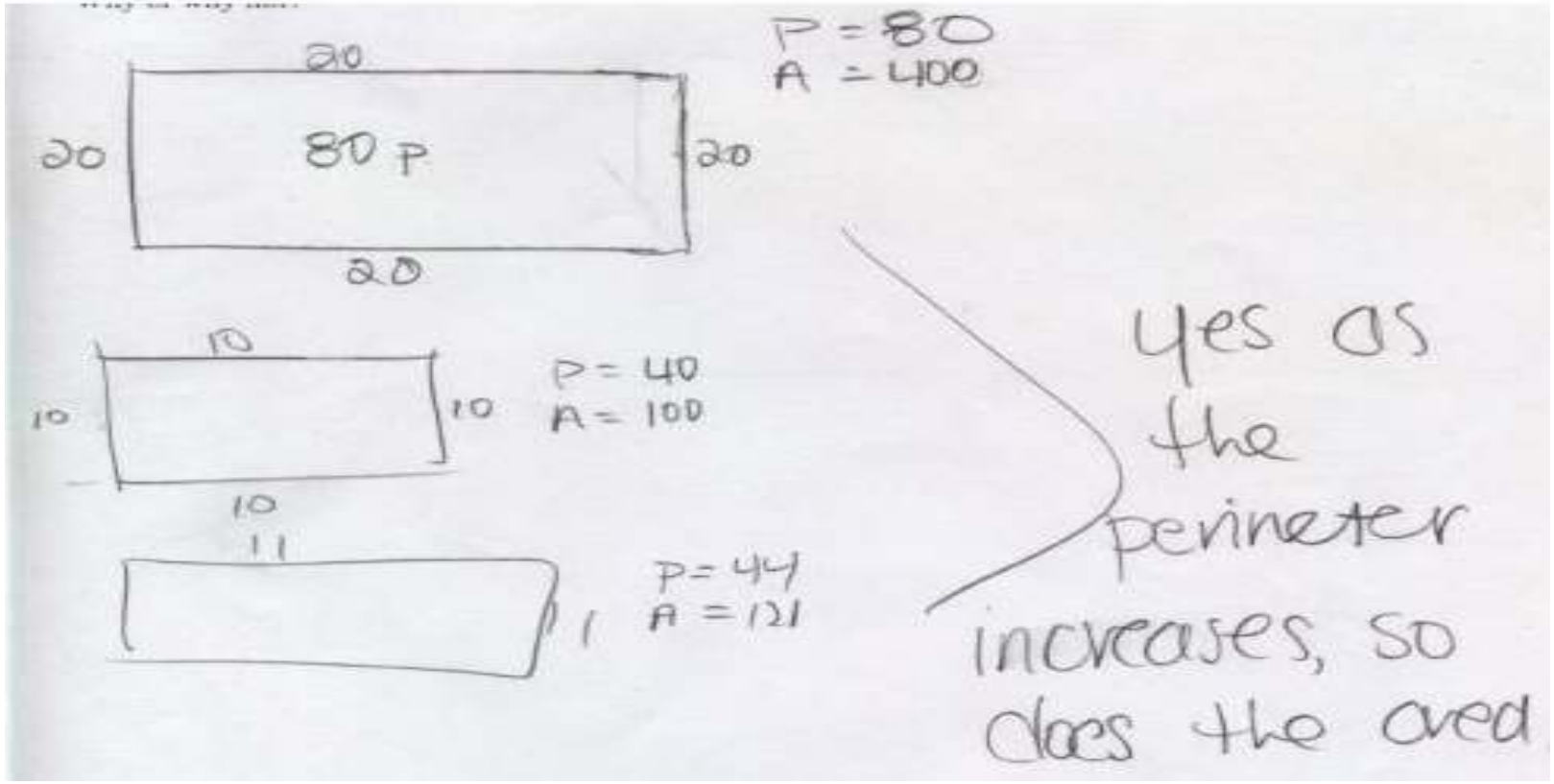
Student response 1



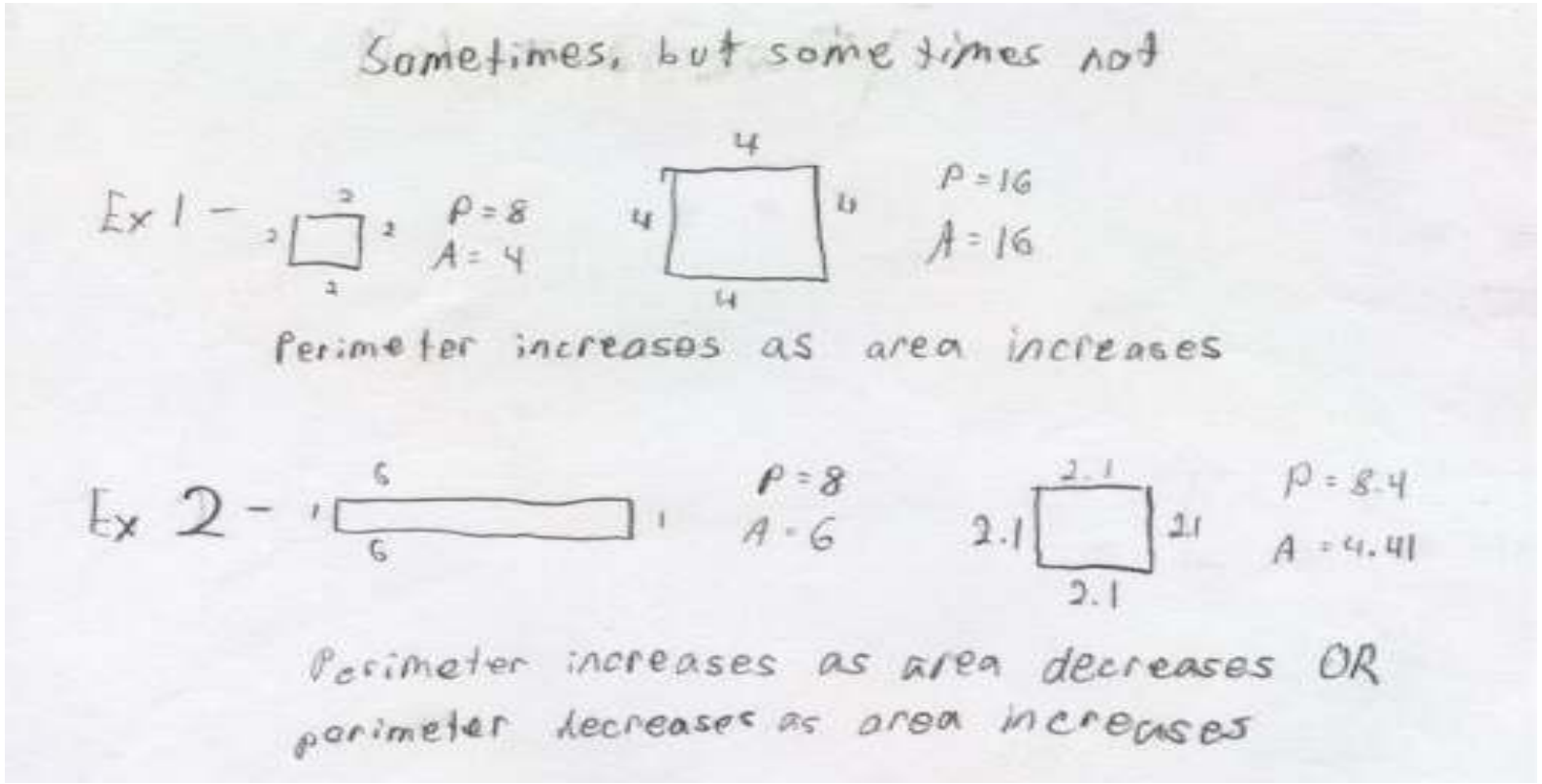
Student response 2



Student response 3



Student response 4



Implication for teacher education

- Focus on planning but shift
  - Away from lesson planning
  - Toward task planning

- Task dialogues (Crespo, Oslund, & Parks, 2011)

Task Dialogues

- Task–we solve it in class
- I give them possible student solutions
  - 1 correct
  - 2-3 incorrect or incomplete
- What mathematical thinking could be behind that response?
- What question could I ask next to test whether or not that is what the child was thinking? How would the child respond if it was or was not what she was thinking?
- What is my next move?

Field Experience

- They do the task dialogue task with children
- They also do 3-5 other tasks that day, and in their plans THEY have to posit student responses

Example Task

- In a soccer championship there are 6 teams. If all teams are going to play each other, how many games will there be in the championship?

Response 1

- There will be 3 games because
  - Team A will play Team B
  - Team C will play Team D
  - Team E will play Team F.

Response 2

- There will be 30 games because each team plays 5 other teams. There are 6 teams so

$$5 + 5 + 5 + 5 + 5 + 5 = 30.$$

Response 3

- There will be 15 games:

AB	BC	CD	DE	EF
AC	BD	CE	DF	
AD	BE	CF		
AE	BF			
AF				

Observations

- PST with lower content knowledge tend to
  - Have difficulty seeing children's mathematical thinking, especially when it's different from their own
  - Assume they know what children are thinking and do not ask
  - Push children to do it their way
  - Ask bite-sized questions, leading/directive questions
  - Start over rather than building from existing ideas
  - Don't push on correct answers
  - Don't make an effort to connect solution strategies

Observations, cont'd.

- PST with higher content knowledge tend to
  - Ask more open questions
  - Try to get students to figure things out for themselves
  - Push students to analyze their solutions and go on from there rather than starting over
  - Pay attention to process as much as final answer
  - Link solution strategies
  - Extend correct solutions to push for generalizations

Conclusion

- Focusing on preservice or inservice teachers' content knowledge is necessary but not sufficient.
- Need to develop OUR repertoire of tasks/activities to tap into the *application* of that content knowledge