Pedagogical Content Knowledge (PCK)

and

Vigyan Pratibha

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What Teachers already Know

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Subject Matter Knowledge

It involves knowing the facts, concepts, theories, and principles that make up a particular discipline or field of study.

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Example

A teacher doesn't just assert that $\sqrt{2}$ is irrational — she can prove it herself

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Example

Teaching Fluids and Buoyancy

Vertical: builds directly on "Forces and Pressure,"

Lateral: "Real Numbers" and ratios has been/are covered in Maths

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Different representations of subject matter, having curricular knowledge, knowledge about students' thinking, conceptions and misconceptions in the discipline or field of study.

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Example

Asking students to pour drop of ink in water to observe diffusion.

How Teachers use what they know in classrooms

Three forms of Pedagogical Content Knowledge

How Teachers use what they know in classrooms

Propositional Knowledge

Knowing the facts, concepts, and rules of the subject.

Example: Phases of moon. Teacher knows that the Moon does not produce its own light; it reflects sunlight. We see different phases because of the Moon's position relative to the Earth and the Sun.

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Strategic Knowledge

Dealing with a new or unexpected situation on the spot.

Example: Phases of moon. A student asks “why is it not an eclipse every full moon or new moon?”

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Shulman ends the paper with…

"Those who can, do.
Those who understand, teach"

How does Vigyan Pratibha deal with PCK?

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Let us look at some examples from Vigyan Pratibha Learning Units

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- The Students’ Version - Contains actual activities which help in **doing** science and mathematics with understanding

- The Teachers’ Version - Contains actual activities which help in **doing** science and mathematics with understanding
  But also contains pedagogical strategies, logic and answers of the questions posed and scientific and mathematical reasons behind the ‘rules’ and phenomena.

Glimpses of the Students' version of Vigyan Pratibha Learning Units

Opportunities for students to describe observations in their own words

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Q 1.What differences do you observe between the microscopic images of cotton and polyester fibres in figure 2? Are there any other different features of these fibres that you can conclude from these observations?

____

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"*Twists in the Fibres*" (TV: Page no. 186, 187; SV: Page no. 79, 80)

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"*Twists in the Fibres*" (TV: Page no. 186, 187; SV: Page no. 75)

Q1. After you have played this game, try to understand what difficulties you and your friends faced in reading the map or in following directions. Can you identify if these difficulties could be related to any mistakes that occurred in the previous task?

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____

"*Can you map it*?" (TV: Page no. 454; SV: Page no. 193, 194)

Drawing inferences from their observations and experiences

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Q2. When you observe these puddles carefully over a period of time, what are your experiences and what do you notice?

"*Microorganisms at your doorstep*" (Page no. TV: 152; SV: 65,66)

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"*Microorganisms at your doorstep*" (Page no. TV: 156, 157; SV: 65,66)

Q3. Why doesn't the drop of ink stay as a drop?

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Q4. Can you think of at least three similar examples from your daily life, where you see such phenomenon? Try to think of such phenomena in air or gases as well.

"*Shades from Shapes*" (Page no. TV: 360, 361; SV: 151,152)

Glimpses of the Teachers’ version of Vigyan Pratibha Learning Units

Dealing with students’ misconceptions

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QT1. What do you think happens when we see an object with our eye? Can you explain?

A) Light goes from our eyes and hits the object?

OR

B) Light from the object reaches our eyes?

QT2. Which of the above possibilities is consistent with what you observe in the pinhole camera?

Historically, over the centuries, many philosophers and scientists tried to interpret light by looking for the answer to the above question. Option A was known as extramission theory of light and was considered by many scientists. Recent education research in many countries shows that a large number of students still have this conception in their mind. Such an explanation coincides with the colloquial perception that we see because we have light in our eyes and this idea is intuitively appealing.

Option B is known as intromission theory of light and became acceptable because of the evidence that without a primary light source, our eyes cannot see.

“*Pinhole Camera*” (Page no. TV: 54, 55; SV: 13)

Dealing with students' misconceptions

Understanding specific misconceptions about light

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Pointers to probe students to understand science better

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Experimental controls

To introduce students to 'experimental controls', a discussion can be held around the following points.

What is a control?

In any scientific experiment, it is important to prove that the intervention (here, a small amount of curd) causes the desired effect, and that the effect may not be observed when the specific intervention is absent. A positive control is the setup with full intervention. In this case, a beaker with a small amount of curd is the positive control, which gives a 'known outcome'. Similarly, a setup with no intervention is negative control. Here, a beaker with milk but no curd is negative control, as it will not turn into curd. This also proves that the outcome of the experimental setup is a result of the intervention only.

The teacher may want to ask, "Suppose you want to check if addition of lemon juice leads to curd formation, how will you design the experiment?"

Students may answer, "Add lemon juice to milk in a beaker and see."

"*Journey from Milk to Curd*" (Page no. TV: 86, 87; SV: 30)

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Suggested probs to discuss experimental design

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Suggested pedagogical discussions around students’ answers

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Students' observations	Possible pedagogical discussion
The largest number in the sequence is the same as the largest number in the initial pair of numbers.	• Ask for the reason why the larger initial number remains the largest number in the list till the end. • Explanation: As we are subtracting numbers in consecutive steps within the set of positive integers, the numbers obtained will always be smaller than the largest number in the initial pair of numbers.
The list contains only the multiples of the smallest number in the final list.	• Ask to verify with other examples in the table. • Ask whether they can come up with a counter-example. • Ask for the reason why this is the case.
In the initial pair of numbers, if one of the numbers is a multiple of the other, then the list contains only the multiples of the smaller initial number. E.g.: For the initial numbers, 7 and 35, the sequence obtained contains only multiples of 7.	• Ask to take a few more initial pairs of numbers, where one is a multiple of the other and verify that it works every time. • Look for a counter-example – a set of two numbers which will refute the above conjecture. This is an opportunity to discuss whether not finding a counter-example amounts to a proof of the conjecture.

"*Euclid's Game*" (Page no. TV: 22, 23; SV: 5)

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Encouraging students to relook at their observations

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Dealing with students’ conceptions with scientific reasoning

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Students are initially likely to conclude that cleaning is due to a chemical reaction between acidic substances and the tarnish on the surface. However, teachers may ask why some parts of the copper seem clean due to salt, although salt is not acidic. The answer lies in the fact that the rubbing action with salt in the presence of some water cleans the copper surface. It follows that students should think about the role of rubbing in cleaning. During rubbing, friction between the particles of the solid cleaning agent, scrubber and the tarnished copper surface might result in removal of particles of tarnish layer, and even some particles of copper metal itself. In addition, salt has a complex chemical reaction with copper which further helps in cleaning of surface. Other substances such as ash or sand when scrubbed hard will also clean the surface, which will be largely due to physical process.

“*Bringing back shine to Copper*” (Page no. TV: 300, 301; SV: 113)

Dealing with students’ conceptions with scientific reasoning

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Understanding known ‘rules’ and reasons behind it

“*Is your polygon the same as mine?*” (Page no. TV: 247; SV: 134)

Understanding known ‘rules’ and reasons behind it

Why is SSA is not test of congruence?

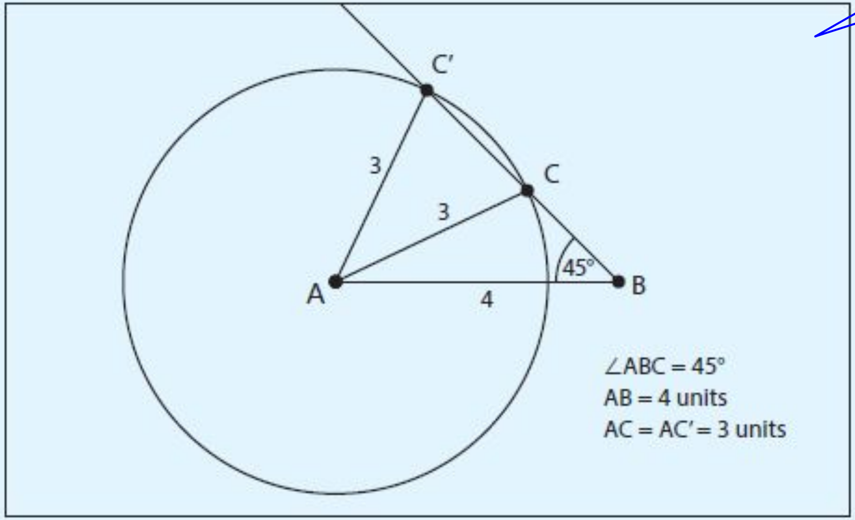

Figure T2 *Showing that SSA specification does not lead to a unique triangle*

“*Is your polygon the same as mine?*” (Page no. TV: 247; SV: 134)

Suggested activities and games help students develop specific skills

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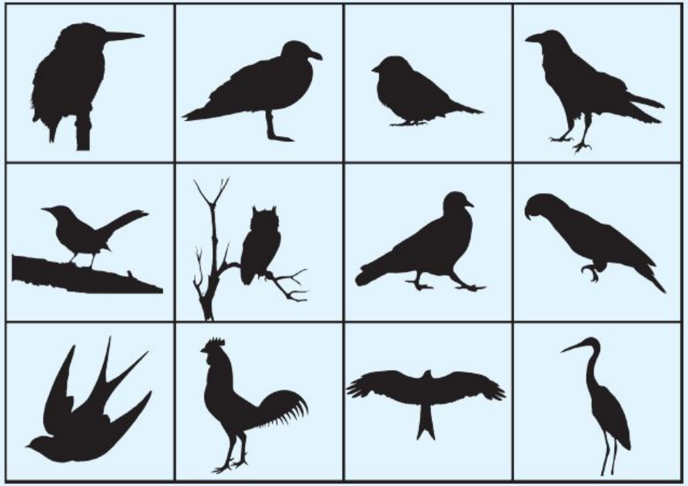
Teacher Resource #1: Silhouette Game

Collect some bird silhouette pictures (as shown in figure T1), and project them on a screen or make flash cards. Alternatively, you can download this page from www.vigyanpratibha.in for printing. Ask the students to guess which bird it might be, and ask them to spell out the reasons for their answers.



"*Rediscover, Describe, and Draw Birds*" (Page no. TV: 222, 223; SV: 93)

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Observing our surrounding and drawing inferences

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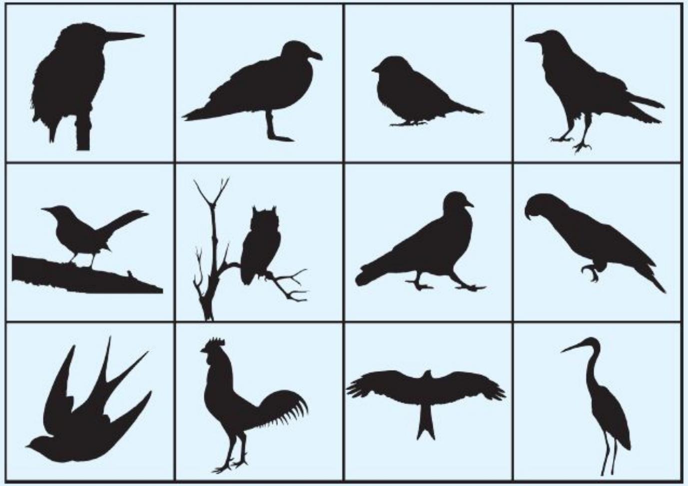

Figure T1 *Bird silhouettes*

Correct guesses: (Top row onwards, left to right): Kingfisher, Gull (sea bird), Sparrow, Crow, Robin, Owl, Dove/Pigeon, Parakeet/Parrot, Swift/Swallow, Rooster/Cock, Kite/Raptor, Heron/Egret.

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General Pedagogical Strategies in School Science Circles

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- Careful attention to scientific and mathematical language
- Encouraging students to speak and question
- Revoicing and calling the attention of other students thus encouraging scientific and mathematical peer interaction and communication skills
- Supporting students to acquire an inquiry stance
- Strategies/actions that create a sense of ownership of the science and mathematics they ‘do’

Thank You