

# What and how advanced medical students learn from reasoning through multiple cases

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Table 4A. Use of Specific Encapsulating Concepts by Participants in the HPA Group

	Encapsulating concepts													
	Superficial		Core			Core			Core			Core		
	Cycle				Causal			Causal			Causal			
	Hormonal							Mechanism						
Partici- pant	Galactor- rhea	Irregular cycles with with- drawal bleedings	Endo- metrium prolifer- ation	Anovula- tion	Compres- sion / dammage	Hypo- thyrod ism	Hypothala- mic - pituitary - end organ axes	Hypo- gonad- ism	Dopa- mine antago- nist	Negati- ve feed- back of prolac- tin on GnRH	Negative feedback of T3 and T4 on TSH	Dis- con- nec- tion	Inhib- ition	Stimula- tion
431	1,4,6,8; LR galactor- rhea, discharge from the nipples	2	2		4,8 Pressure, Squeeze off, Displace	6				LR (de- tails about two axes)	6			8 over- stimula- tion; LR
432	4; LR increased milk dis- charge, flow from nipple	2; LR irregular cycle		LR prevent that again a follicle will mature	4 to N Opt.	6								LR

433	1,2,4,8	2			4 Damage, ingrowing, Displacement; LR other tissue works more poorly				LR T4 or T3 will impede the production of prolactin	LR
434	1,4,6,8; LR	6,8; LR very irregular menstr	1,2,8; LR(very detailed & complete)	1,2,6,8; LR anovulatory cycles	4 Pressure; LR push on other brain structures: optic X and pituitary structures	6		LR (misc)	1	4
435	1,4,6,8	2	2	2	4 Pressure, Squeezed				6	1
436	1,2,4,6,8; LR discharge from the nipple	2,8; LR disturbance menstr.	2		4	6,8; LR	6,8	2	6	1,6
437	1,4,6,8; LR	1,2,8			4 Pressure	2			6	
441	1,4,6,8; LR discharge from nipple; that milky stuff	2	2	2	1,4 Displaced, Pressure	6			6	6
442	1,4,6; LR discharge from nipple	2			4 Pressure	6		2		1,6; LR

443	1,6,8	LR irregular menstr. cycle	1		4 Pressure; Squeezed	6	1 Incorrect	6	1,4,8; LR
444	1,2,4,8 milk prod.;LR		8 build-up	8	4,6,8, Block, Pressure, Displacement; LR grow into it; partially clogging		2	6; LR pituitary stimulated by thyroid hormone causing the pituitary to produce TSH	4,6; LR
445	1 milky fluid; milky discharge from the breast, 2,4,6,8; LR galactorrhea = milk discharge	8			4 Squeezed		LR: pathway hypothalamus - pituitary and thyroid		
446	2,4,6,8; LR galactorrhea, discharge	2,6			4 Touch; Press	6 (hyper at first)	LR: pituitary gets signal from hypothalamus	6 (incorrect organ) pituitary	6
447	1,4	2,8; LR menstr complaints					LR: hypothalamus - pituitary ??		1
In LR									

<i>N</i>	10	5	1	1	3	1	3	1	1	2	6
Proportion	.71	.36	.07	.07	.21	.07	.21	.07	.07	.14	0.42
in cases											
<i>N</i>	14	12	7	4	13	8	3	3	1	8	10
<i>M</i> per case	3.5	1.3	0.71	0.5	1.14	0.64	0.29	0.21	0.07	0.57	1.07

Note: Numbers 1, 2, 4, 6, and 8 refer to the cases where the specific encapsulating concept is used. LR = learning report. Text within brackets is qualification of scores; text without brackets summarises or characterises words of participants. Bold text or number indicates more extensive use of the concept.

Table 4B. Indications for Learning by the Participants in the HPA Group

Participant	Most thinking in			Reminders		Biomedical reasoning in LR	Improvement over cases	Remediation of misconceptions over cases and LR	Language use		
	Think-aloud protocol	Explanation	LR	In cases	In LR				Every day	Vague	Professional
431	X			4,8	X; draws conclusions about the case presentations	X	X; knowledge about prolactin is built up over the cases	X; remain partial !			
432		X				X		No			
433	X					X	X; language use becomes more specific; also within a case	X, but not stable			
434	X				X; to pathophysiological causes	X	had to come loose	X			
435				8	X	X	X; becomes more specific but not always better !!	no !	X	X, vague and sloppy	
436				1	X	(hardly)	X; hard recall (1); lots of reconstruction **□	no !			

437		X				(hardly)	within case (4) **	no		X, imprecise	
441		X			X; to the thinking process	X; somewhat		no, not really, false 'corrections', gap filling !	X	X	
442		X		6,8			within case (6) **	no !	X	X, superficial	
443	X			2,6,8			X; growing certainty	no, doubts remain !			
444	X	X		2,4,8	X	X, but very superficial []	X; especially within the cases **	no, doubts remain !		X, imprecise	
445	X			2,4		X (pathway)		no !		X, superficial	
446		X		8			within the cases; hard thinking; some wrong corrections **	no !		X, superficial due to lack of knowledge	
447			X		X; gives very brief summary						
N of participants	6	6	1	8	7	8	6	3	3	7	0
proportion	.42	.42	.07	.57	.50	.57	.43	.21	.21	0.5	0

Note: X = category applies for this participant; numbers 1, 2, 4, 6 and 8 refer to the cases where this specific activity takes place; \*\* = active processing;! = persistent misconception;! = ignores misconception;[] = poor prior knowledge;# = protocol or explanation becomes briefer.

Table 4C. Use of Specific Encapsulating Concepts by Participants in the PCO Group

	Encapsulating concepts											
	Core				Core				Core			
	Superficial			Cycle			Cycle			Hormonal		
	Cycle			Cycle			Hormonal					
	Sub- ject	Hirsutism	Irregular cycles (with withdrawal bleedings)	Endo- metrium prolifera- tion and ...	Anovula- tion	Hypo- thala- mic – pitui- tary – organ axes	Follicles; functional - hormonal, secretion and receptors	Hyper- oestro- genic environ- ment	Hyper- andro- genic (ovar- ies)	Vicious circle	Feedback oestrogen, LH&FSH	Peripheral conversion of andosteendiol in oestrogen
411	<b>1,2,4,6; LR</b>	1,2; LR menstr. Irregular		<b>1,2,4,8; LR</b>		1,6,8 (thing) maturation; LR hormones made by the ovarium, function impeded						
412	<b>1,4,6,8; LR</b>	2,4; LR irregular cycles; changed menstr.		1,2,4,8 (event); no ovulation						2,6; LR neg feedback; (debugging )		
413	<b>1,2,4,6,8; LR male, not real hirs.</b>	2,4,6; LR irregular cycle + duration menstr.		1,2,8; (event)		6,8 (thing); LR follicles				LR LH proges- terone neg feedback (incorr)		



414	1,4,6,8; LR looks like hirs., extensive	2,4; LR menstr. cycle irregular		1,2 (event),4	LR several, no ovum in	
415	1,2,4; LR	4,6,8; LR irregular cycle, amenh.	1	1,4,6,8	1(thing); LR eggs did not ovulate	
416	1,2,4,6,8; LRHirs. + pattern	1No withdrawal bleeding, 2,4,6,8; LR irregular cycle/ blood loss	1	1,2,4,6,8 (event); LR no ovulation	1,2,4 (thing) burst; LR prod. LH, (incorrect) maturation	1,2,4 (incorrect); LR (incorrect)
417	1,2,4,6,8; LR	1,2,4,6,8; LR amenh., dismenh.		2,4,8	LR: whole axis that is disturbed suddenly LR: function disturbed (bit incorrect)	LR (incorrect)
418	1,2,4,6,8, LR pattern	2,4,6; LR variations in cycle duration and heavier bleedings afterward		2,6,8	1,2,6 (thing) maturation; LR maturation	
419	1,4,6,8; LR hirs., (with elaboration)	2 regulate cycle; LR menstr irregular		1,8 (event)		
421	1,4,6; LR hirs. (with elaboration)	1,2,4,6,8; LR menstr. Irregular		1,2,4,6,8; LR no ovulations,		2

	tion)			no ovulatory cycles					
422	1,2,4,6,8; LR hirs.	6,8	1,6,8; LR	1,2,4,8; LR anovulatory cycles		1 no rupture, 2Horm,6Horm	2 (wonder about)	1	1 Link between, 2 (incorrect),4(correct), 6(correct); LR
423	1,2,4,6,8; LR too much hair; hirs.	2,4,6,8; LR Menstr. Irregular		2,4,8; LR no ovulation					
424	1,2,4,6; LR male	1,2withdrawal, 4,6,8; LR irregular cycles with withdrawal bleedings	1,2,4,6,8; LR endometrium (long story in which a lot is explained)	1,2,4,5,8; LR no ovulation		1,2,6,8 (Function) production, reaction, stimulate			
425	1,2	2 withdrawal,6		2,4,6,8; LR anovulatory cycles, no ovulation	4	1Receptor,2, 6maturation		1, and increasing; LR	
426	1,2,4,6; LR extensive	4, 8; LR Menstr irregular		2; LR anovulatory cycle		1 (thing), maturation		1,2	
427	1,2,4,6,8; LR male	2,4,6,8; LR menstr disturb.	1 (extensive), 2,6,8	1,2 Normal functioning, 4,8; LR no ovulation		8 (thing)	1	2	2 (incorrect), 6
428	2,4,6; LR excessive	4,6,8; LR irregular	1,2	1,2,8; (event)		1,2,4,6,8 (thing), maturation; LR size; maturation			
In LR									

<i>N</i>	16	15	2	9	1	7	0	0	1	2	2	0
Proportion	.94	.88	.12	.53	.06	.41	0	0	.06	.12	.12	0
in cases												
<i>N</i>	17	17	6	17	1	11	0	2	2	3	4	0
<i>M</i> per case	4.1	3	0.9	3.9	0.06	1.5	0	0.12	0.12	0.29	0.53	0

Note: Numbers 1, 2, 4, 6, and 8 refer to the cases where the specific encapsulating concept is used. LR = learning report. Text within brackets is qualification of scores; text without brackets summarises or characterises words of participant. Bold text or number indicates more extensive use of the concept.

Table 4D. Indications for Learning by the Participants in the PCO Group

Participant	Most thinking in			Reminders		Biomedical reasoning in LR	Improvement over cases	Remediation of misconceptions over cases and LR	Language use		
	Think-aloud protocol	Explanation	LR	In cases	In LR				Every day	Vague	Professional
411				2,6				No			
412				4,6,8			keeps thinking and comparing **	X; concludes in LR			
413	X			2,4,8	X; describes variation	X; esp. relation LH-progesterone	X; thinking process is repeated in the explanations; concludes about new knowledge **	No; present misconceptions remain !	X	X; messy	
414	X			4,6		X; (superficial)	hard thinking; tries to figure out why different combinations of findings are possible **	No; present misconceptions remain !	X	X; aspecific	
415				2,6			keeps trying to make the story fit; not very successfully			X; few specific reasonings	

									**	
416	X		X	X; extensive description of the findings	X; biomedical and pathophys., including misconceptions	X; becomes more concise; essences #	No; persisting misconceptions that reappear in the LR !	X		
417			2,4,6	X	attempts at biomedical construction **	Not really; little overlap between think-aloud and explanations []	No; even a new misconception appears !		X; aspecific	
418	X		2elaborate,4,6,8 **	X; conclusions about the different cases; lists similarities and differences	(not much)	X; improves over the cases	X, but role of LH remains obscure; stops giving attention to that !!	X		
419			X	4,8	(hardly)	X; seems to have forgotten a lot but it comes back slowly []		X	X	
421		X	2,4,8		(hardly)	X; later explanations are more complete	No; formulations become more vague !!	X; naïve		
422	X; esp. hard thinking about	X	4,6,8	X; comments on prior knowledge from the	X; in accordance with think-aloud and	X; builds upon earlier cases	X; comments on earlier trials; keeps correcting self on the issue of	X		

	biomed. **			perspective of the cases **	explanation		conversion **
423				4 X		X; becomes a bit more certain []	
424	X; specially at the verge of think-aloud & explanation **	X	2,4,6,8		X; in accordance with think-aloud and explanation	X; fewer doubts but endometrium story becomes predominant []	X
425		X	4,6,8		X; biomed description at the level of progesterone and estrogen in the regulation of menstr.	No; first case rather elaborate after that nothing new	no
426	X; specially in 1		2,4,6	X; listing and extensive summary of the case findings	no; despite elaborate biom in 1		X; aspecific terms
427	X	X	4,6,8		X; suggests a displacement mechanism	X; from 1 to 2	no
428		X	2,6,8	X, summary including the variations in the case findings		No, though trying to fill in gaps in earlier cases (difference is minimal)	no ! X; "takes care of"

<i>N</i> of participants	8	6	1	15	8	7	9	3	9	6	0
Proportion	.47	.35	.06	.88	.47	.41	.53	.18	.65	.35	0

Note: X = category applies for this participant; numbers 1, 2, 4, 6 and 8 refer to the cases where this specific activity takes place; \*\* = active processing;! = persistent misconception;! = ignores misconception;[] = poor prior knowledge;# = protocol or explanation becomes briefer