

Appendix

Main Test Quantitative Data for Individual Students

Students' cognitive development of vector																
T1: Pre-Test graphical responses																
Student	1	2a	2b	2c	3a	3b	3c	4	5	6	7a	7b	7c	8a	8b	8c
1	A	3														
2	A	3	4	4	4	1	1	1	1	1	1	0	0			
3	A	3									3	3				
4	A	3	3	0	0						1			1	1	1
5	A	2								1	2	0	0	0	0	
6	A	2									2	2	0	0	0	0
7	A	2						3		1						
8	A	3									2					
9	A															
10	A		2	2	2											
11	A					4	4	4		0		2	0	0	0	0
12	A											2	4	4	0	0
13	A	2	4	4	4				4	4		2	0	0		
14	A	3										2	0	0	0	0
15	A	3	4									2	4	0	0	4
16	A															
17	A															
1	B	2	4	1	1							2	4	1		
2	B		0	0	0							2	3	4	0	0
3	B	1										2	1	4	0	0
4	B	0	4	0	0	3	0	0	3	1	1					
5	B		4	4	4							2	3	4	2	
6	B		0	0	0	0	0		0	0						
7	B	2	0									2	0	0	0	0
8	B	1	1	1								2	4	0	0	0
9	B	1*	4	4	4					2		2	3	4	0	4
10	B											2	3	4		
11	B					0	0	0				2	3	3	0	0
12	B	0	0	1	1	0	1	1	0			2	0	0	0	0
13	B	0	0	0	0	0	0	0	0	0						
14	B	1		4	4				3	1	1	2	3	3	0	
15	B	0							0							
16	B	3	4	4	4	4	4	4	4	4	2	0	4			
17	B	1	4	4	4	4	4	4	4	4	2	4	4	3	3	3