BCTt
Beginners Computational Thinking Test

Universidad Rey Juan Carlos

eMadrid
www.emadridnet.org
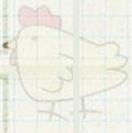
María Zapata Cáceres

Computer Science Department　　　　　**URJC**

@maria__z_c

Estefanía Martín Barroso

Computer Science Department　　　　　**URJC**

@EstefaniaURJC

Marcos Román González

Faculty of Education　　　　　**UNED**

@elpsycomago

Computational Thinking (CT)

BROAD DEBATE

Many definitions

Many breakdowns

Human problem-solving process that requires abstract thinking

Thinking skills that precede programming, and are applied in understanding a problem and formulating a solution like a computer scientist

Abstraction

Decomposition

Generalization

Iteration

Debugging

Algorithms

Shute, V. J., Sun, C., & Asbell-Clarke, J. (2017a). Demystifying computational thinking. *Educational Research Review, 22,* 142-158 doi://doi.org/10.1016/j.edurev.2017.09.003

CONSENSUS

Fundamental skill required to adapt to the future

Should be taught at schools

Programming exposes students to CT

Computational Thinking (CT)

Many frameworks

3D Framework (Brenan & Resnick*)

CT Concepts

CT Practices

CT Perspectives

* K. Brennan, M. Resnick and MIT Media Lab, "New frameworks for studying and assessing the development of computational thinking," American Educational Research Association Meeting, Vancouver, BC, Canada, 2012.

When
to teach?

How
to teach?

How
to assess?

What
to teach?

When to teach?

How to teach?

How to assess?

What to teach?
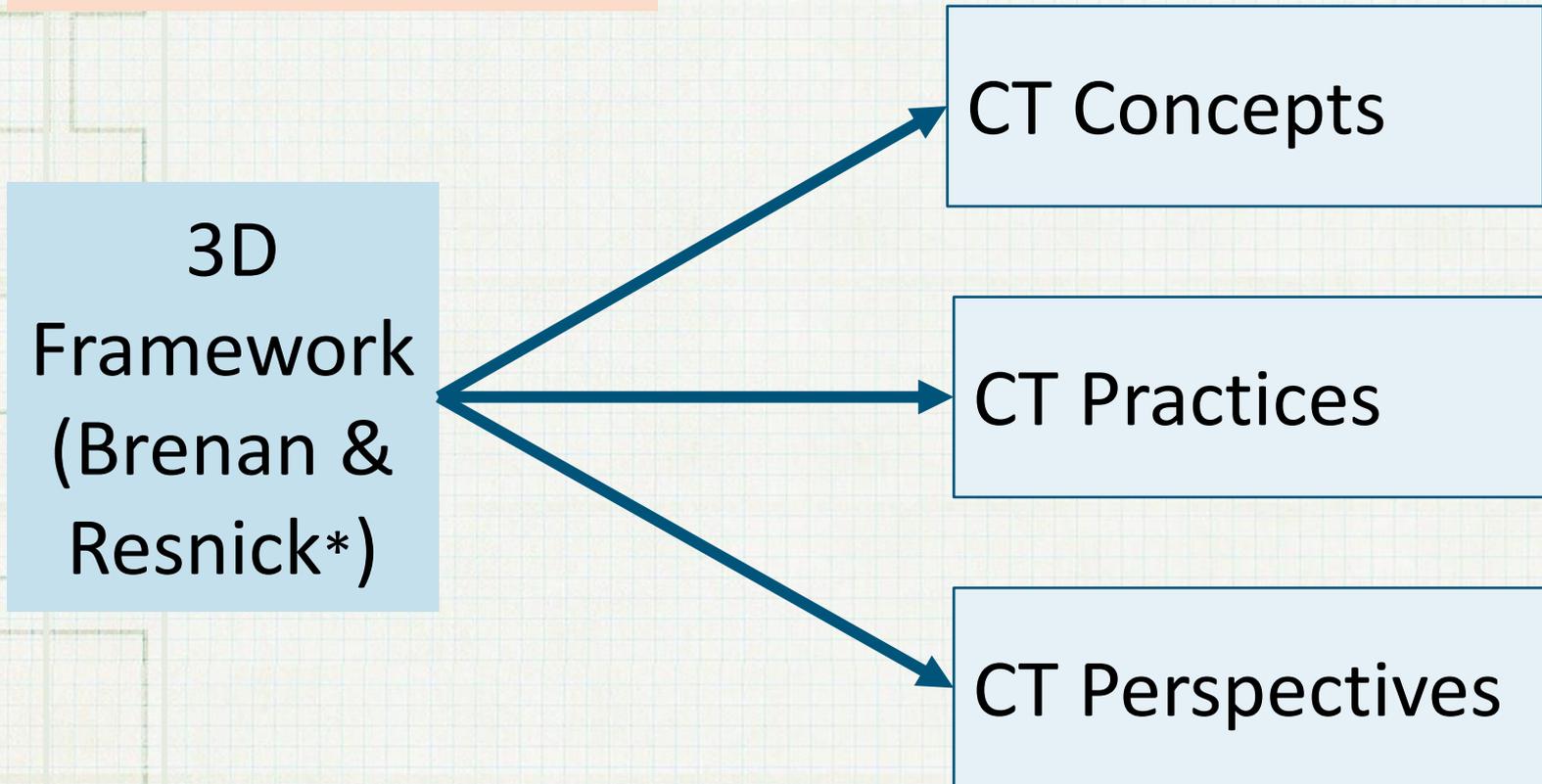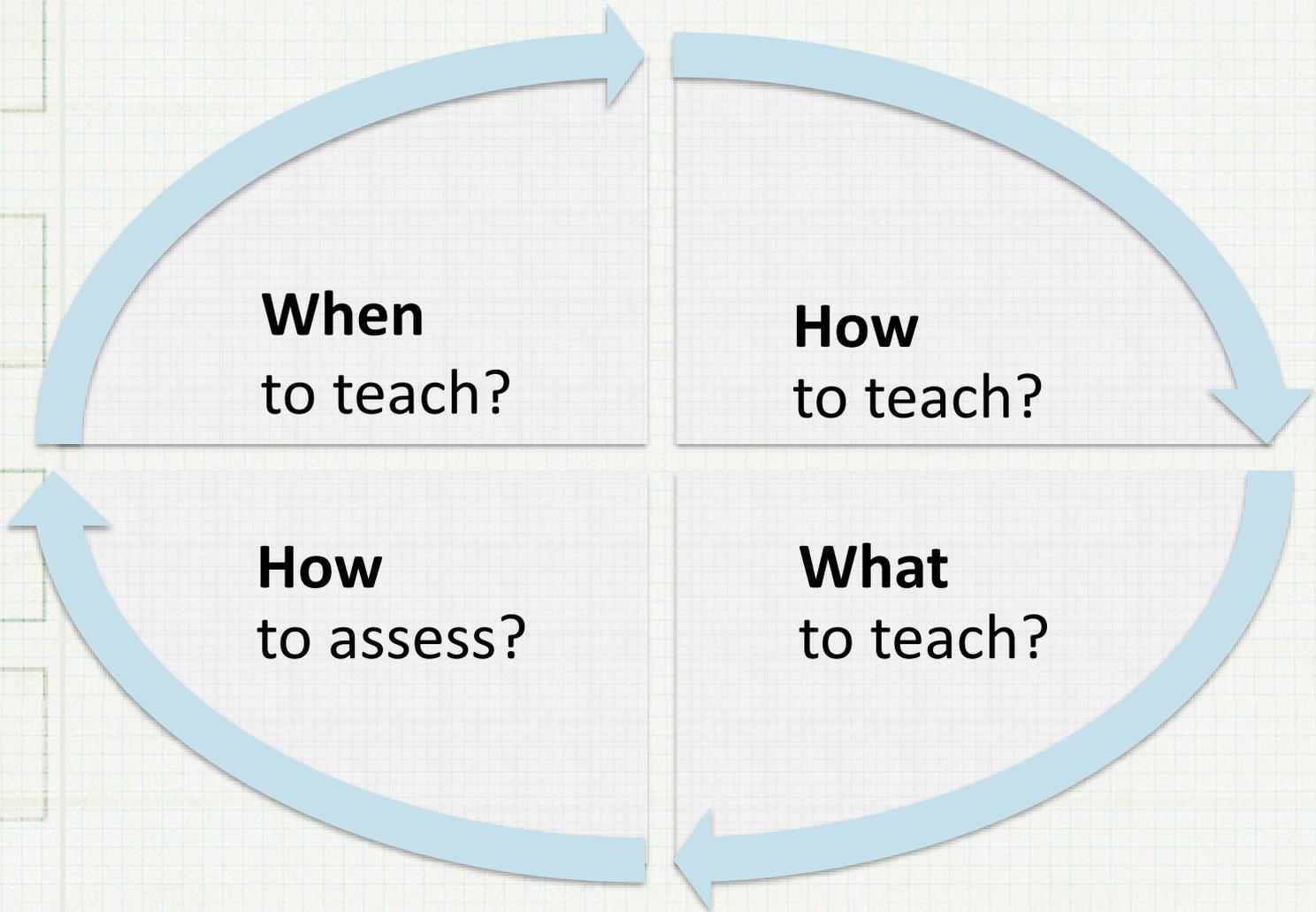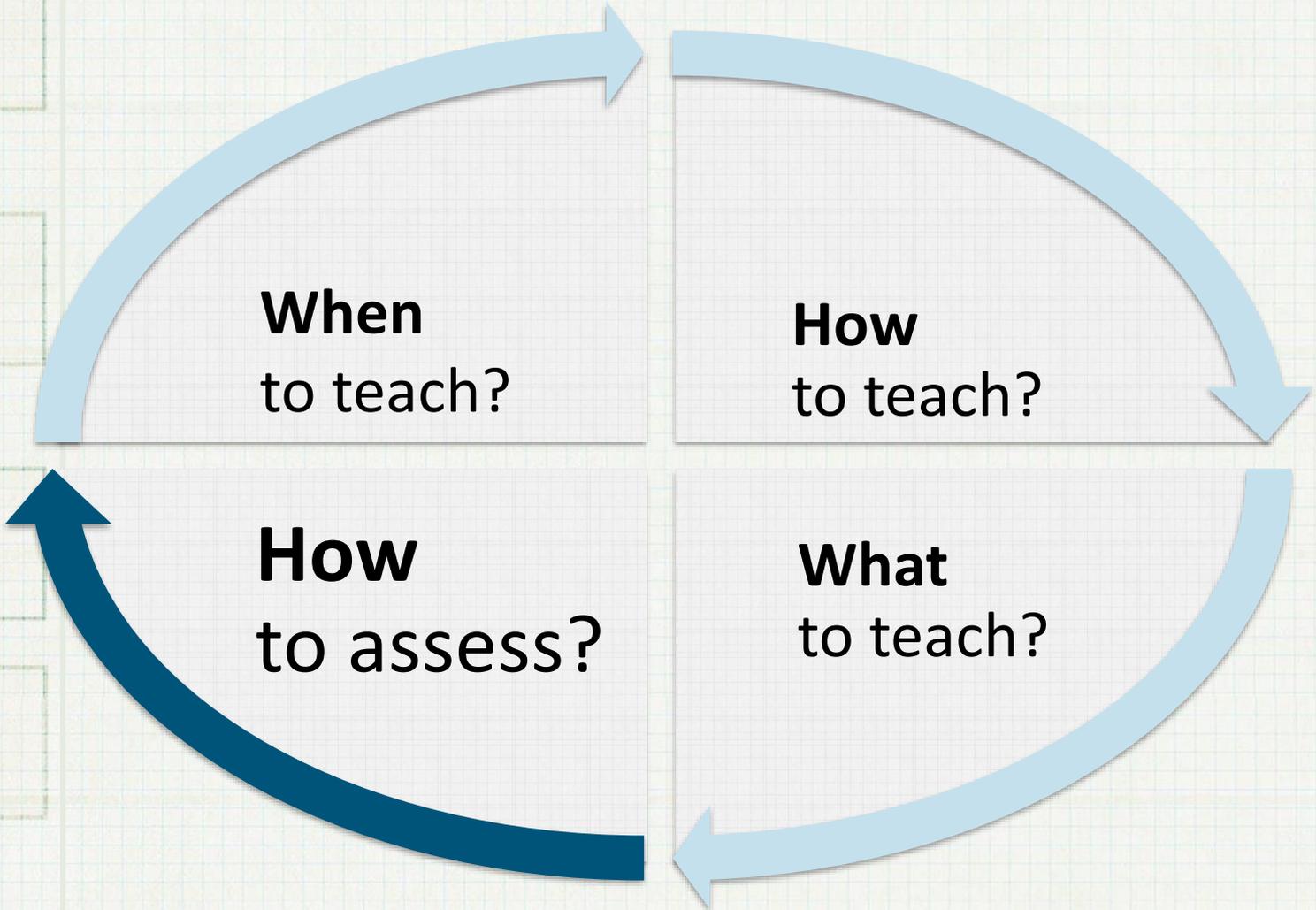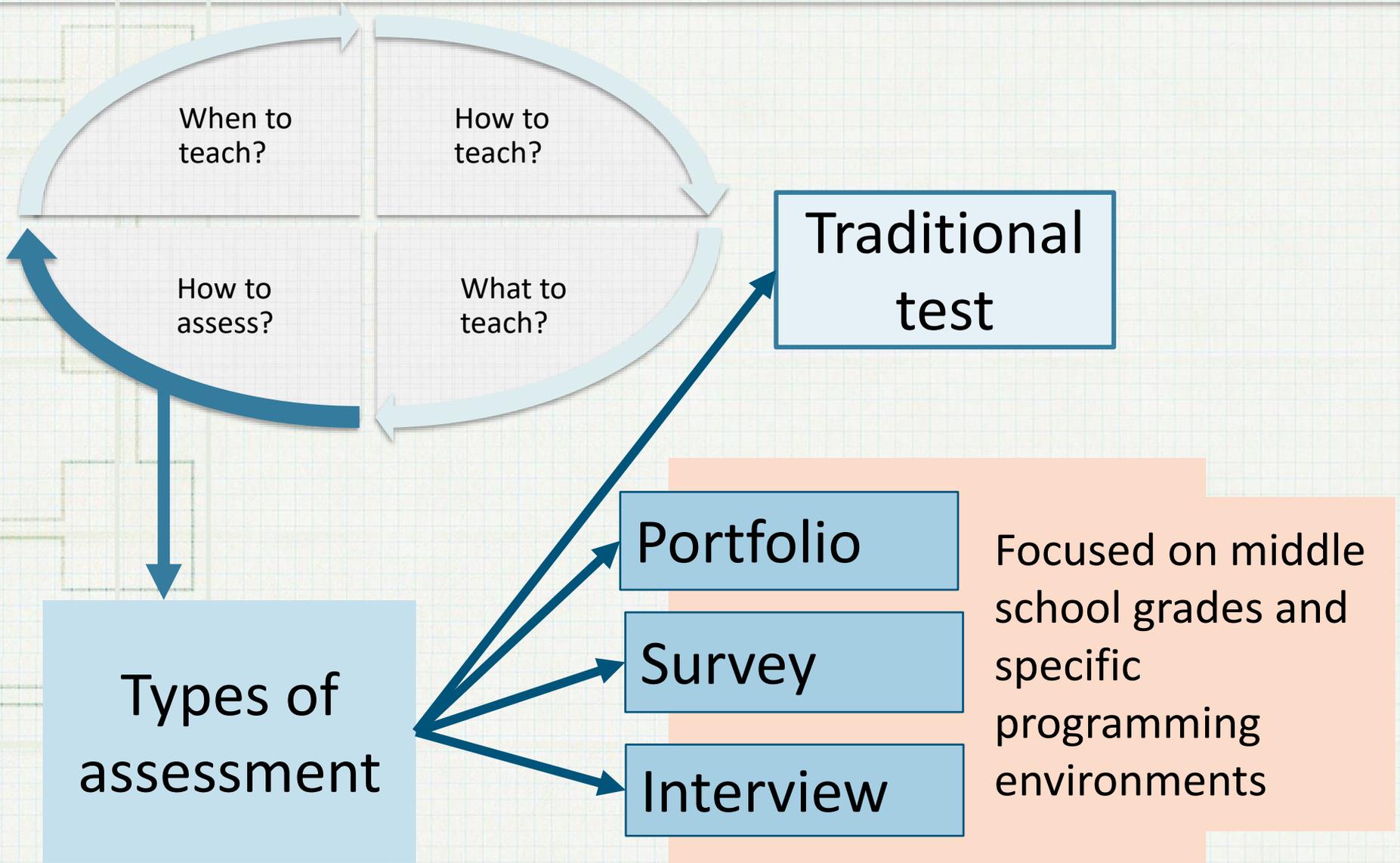
Assessment

Computational Thinking Test (CTt)

Computational Thinking Test **(CTt)** *

Stand-alone assessment instrument

Reliability and criterion validity, psychometric approach

Aimed at **10 to 16 years old**

Aligned with the international standards

3D Framework

CT concepts

CT practices

CT perspectives

* M. Román-González, J. Pérez-González and C. Jiménez-Fernández, "Which cognitive abilities underlie computational thinking? Criterion validity of the Computational Thinking Test," Computers in Human Behavior, vol. 72, pp. 678-691, 2017.

Beginners Computational Thinking Test (BCTt)

Based on CTt

Stand-alone assessment instrument

5 to 10 years old

Form / content adaptation

Substantial improvements

BCTt **v.1 Design**

25 items long	40 minutes
3 alternative responses	3D Framework computational concepts

Test items	Computational concepts in BCTt					
	1. Sequences	Loops		Conditionals		
		2. Simple loop	3. Nested loop	4. IF-then	5. If-then-else	6. While
1 - 6	██					
7 - 11		██				
12 - 18			██			
19 - 20				██		
21 - 22					██	
23 - 25						██

Self explanatory symbols

Least possible text

Emotional connection

Canvas and maze type

18

Take the chickens with his mother.
Beware of the cat.

Mark the correct sequence:

BCTt **v.1 Design**

A		B		C	
→		→		↑	
→		↑		→	
↑		→		↑	
↑		↑		→	

A		B		C	
→		→		↓	
→		↑		→	
↑		→		↓	
↑		↑		→	

Maze A

1	2	3
4	5	6
7	8	9
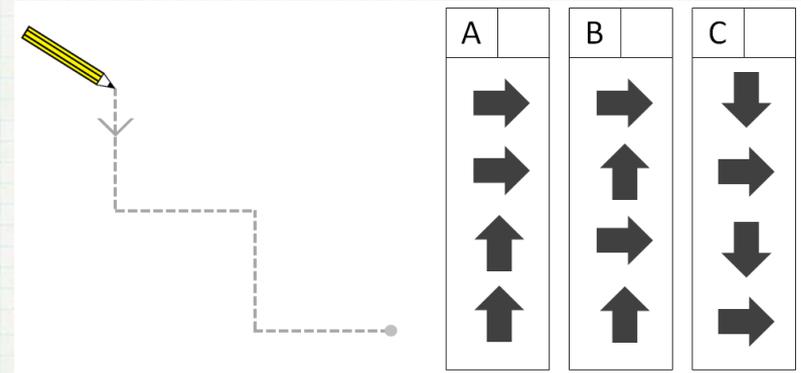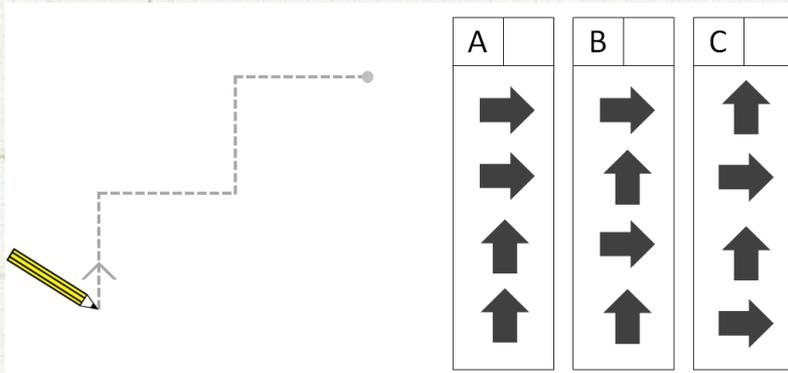
Maze B

If-else example
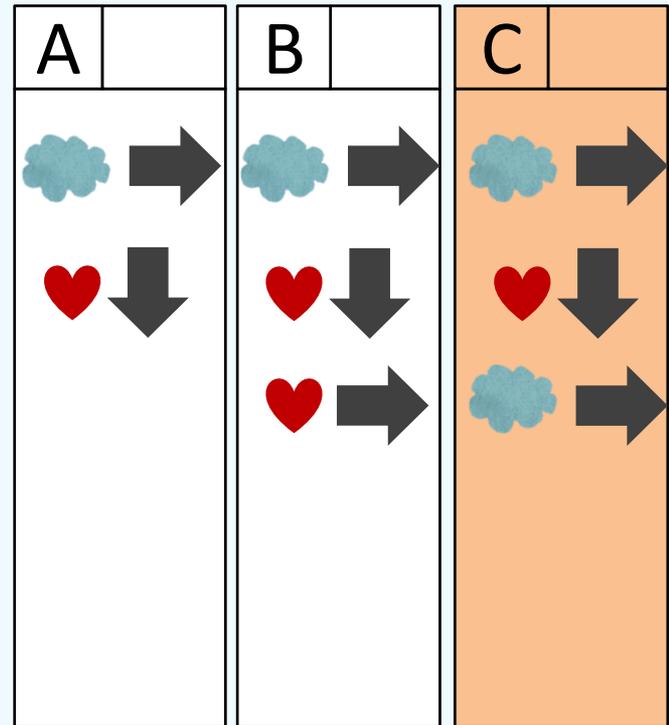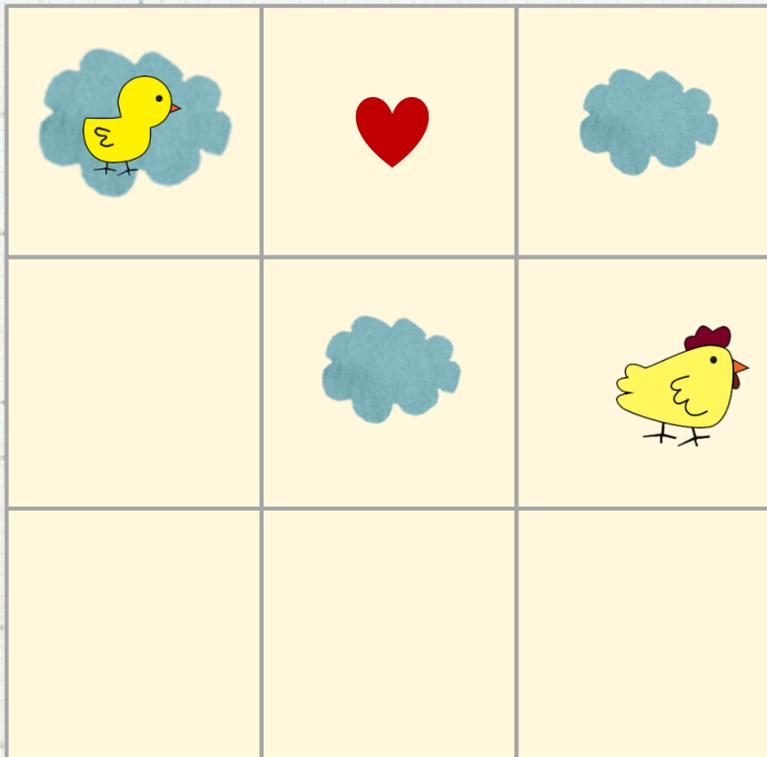
If-else example
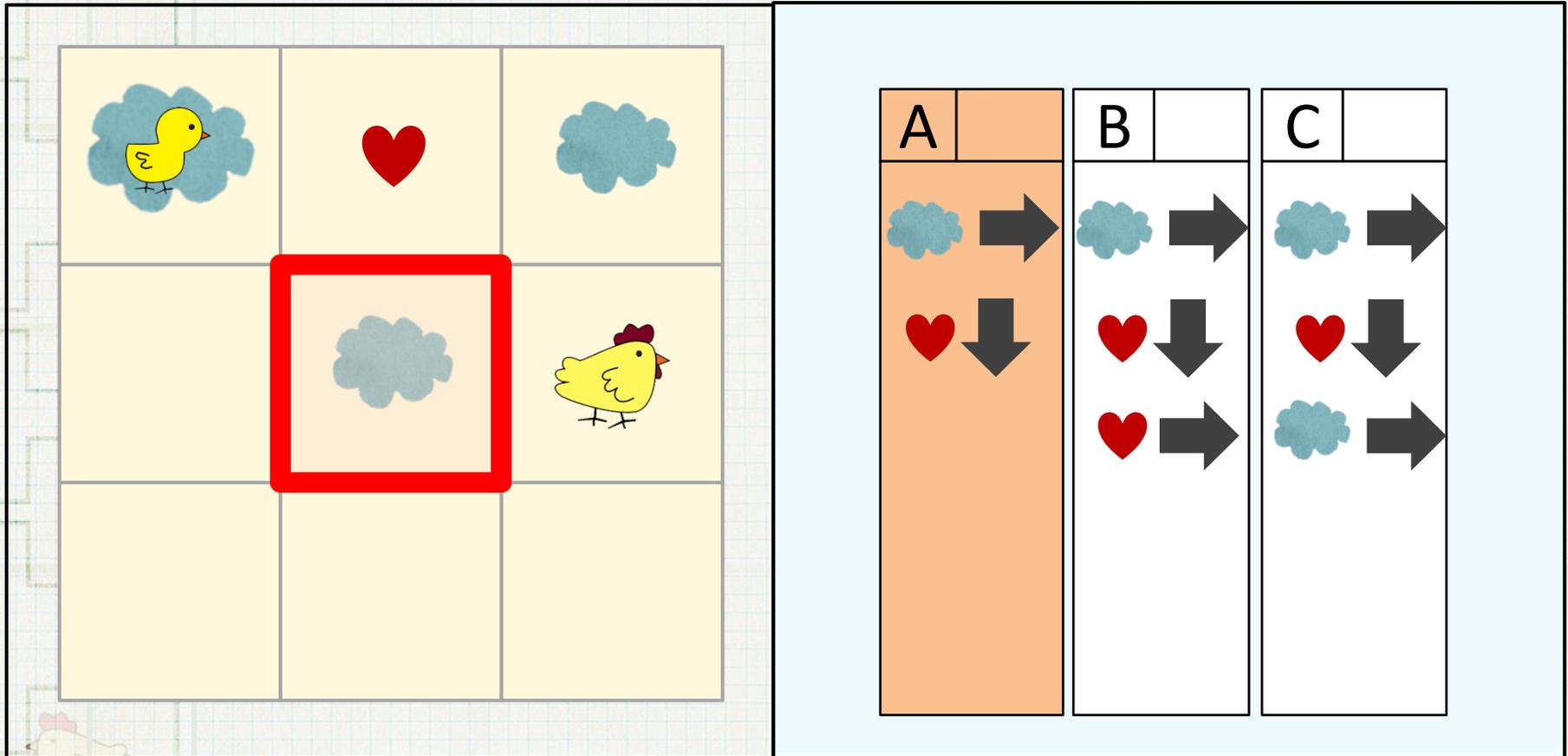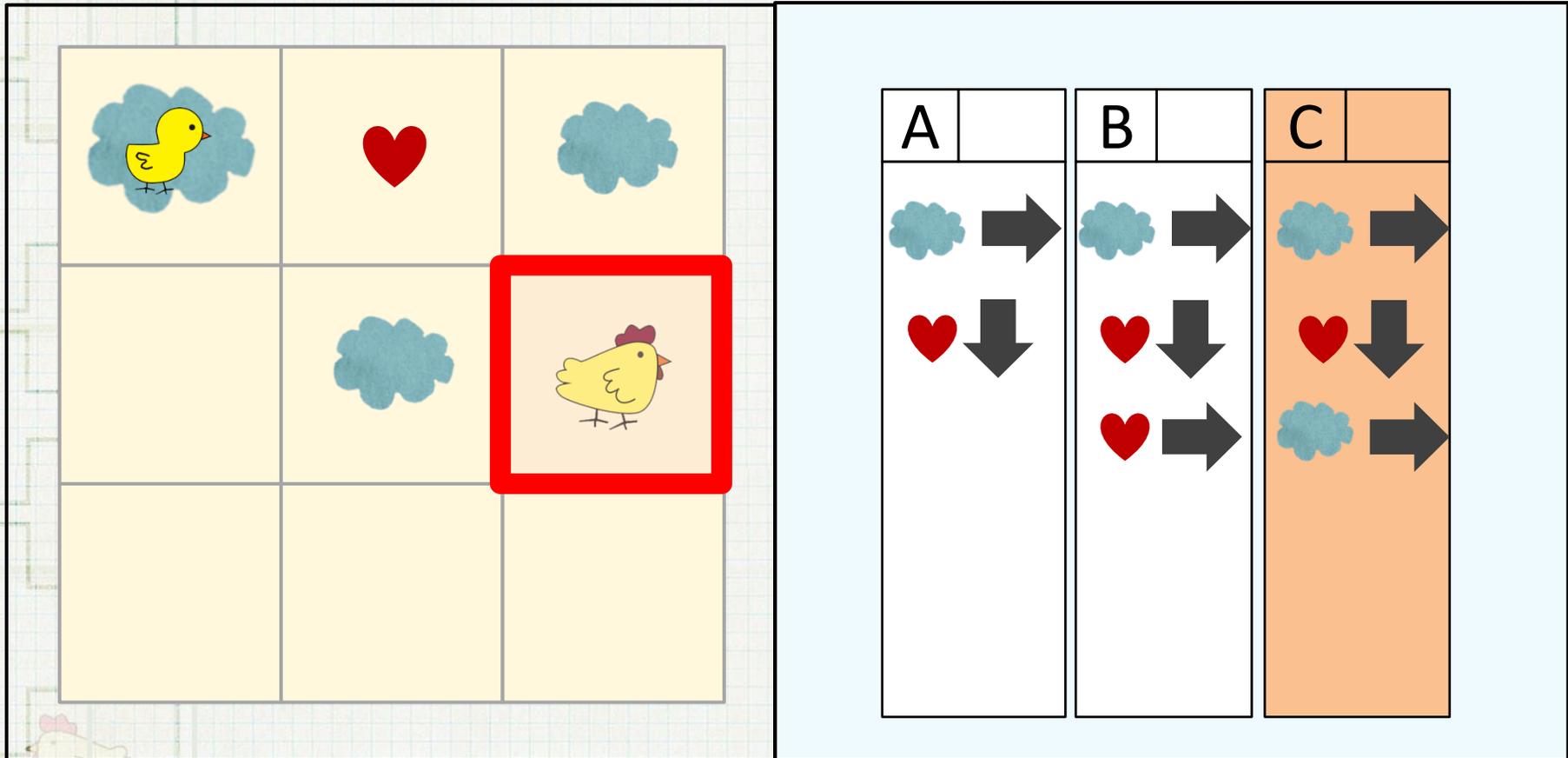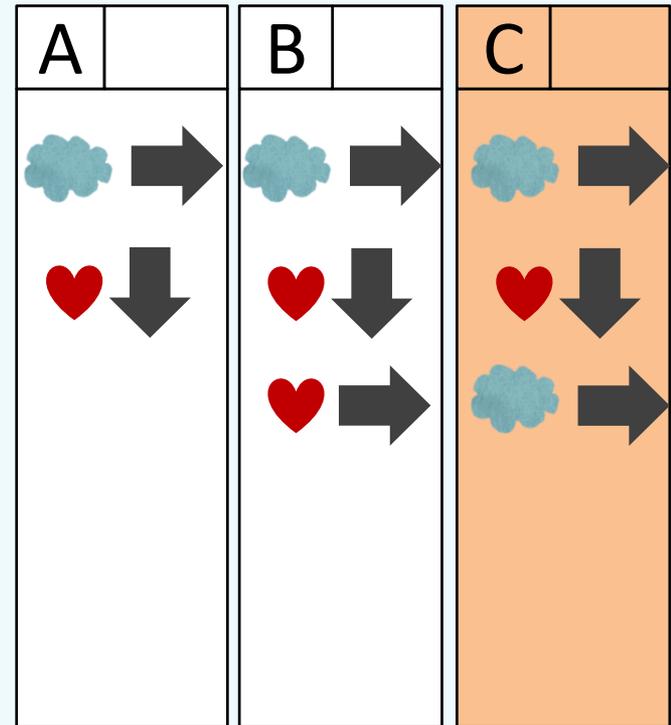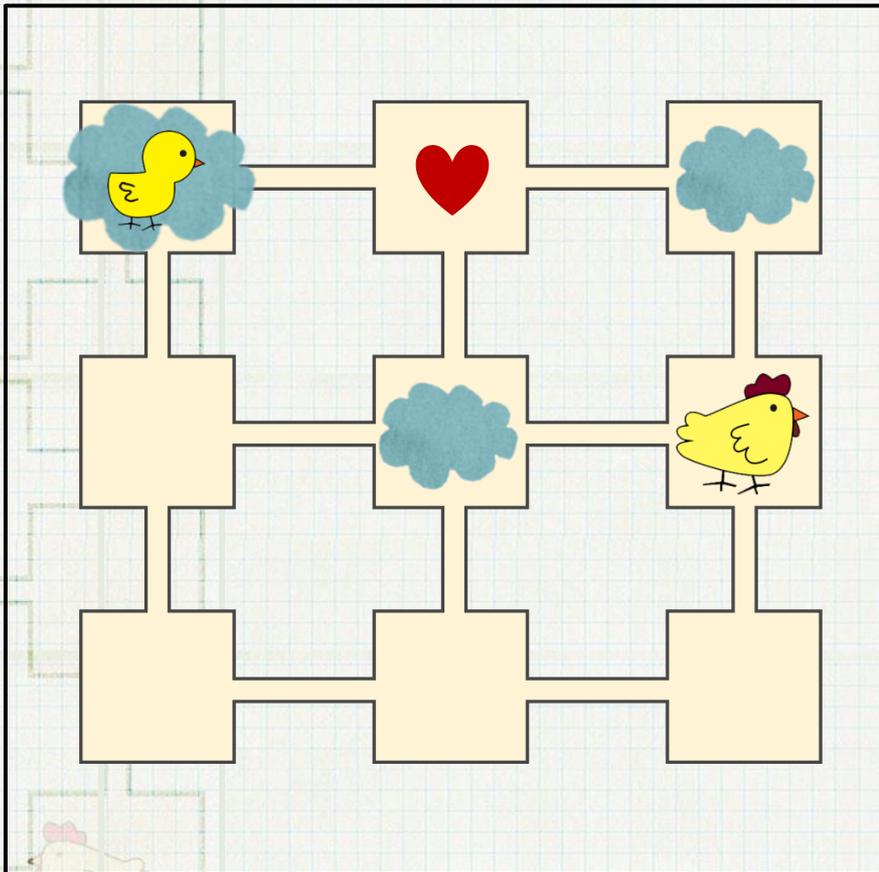
If-else example

If-else example
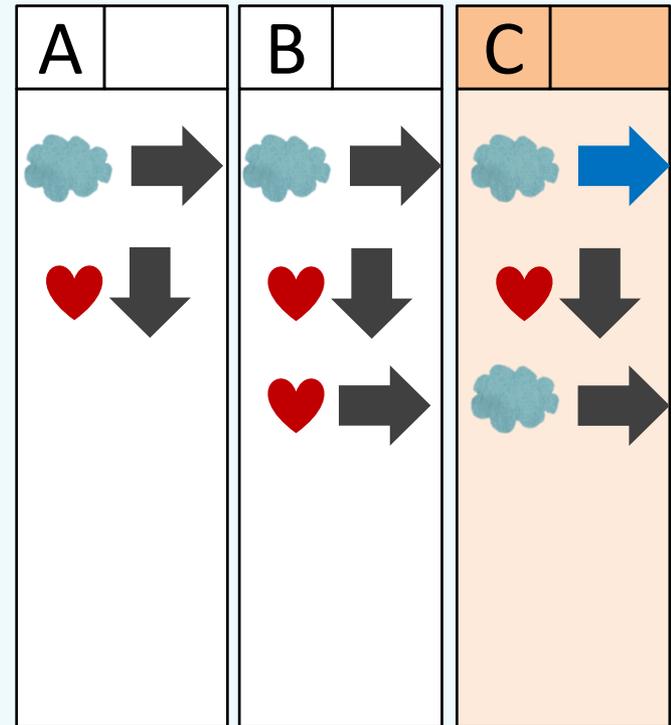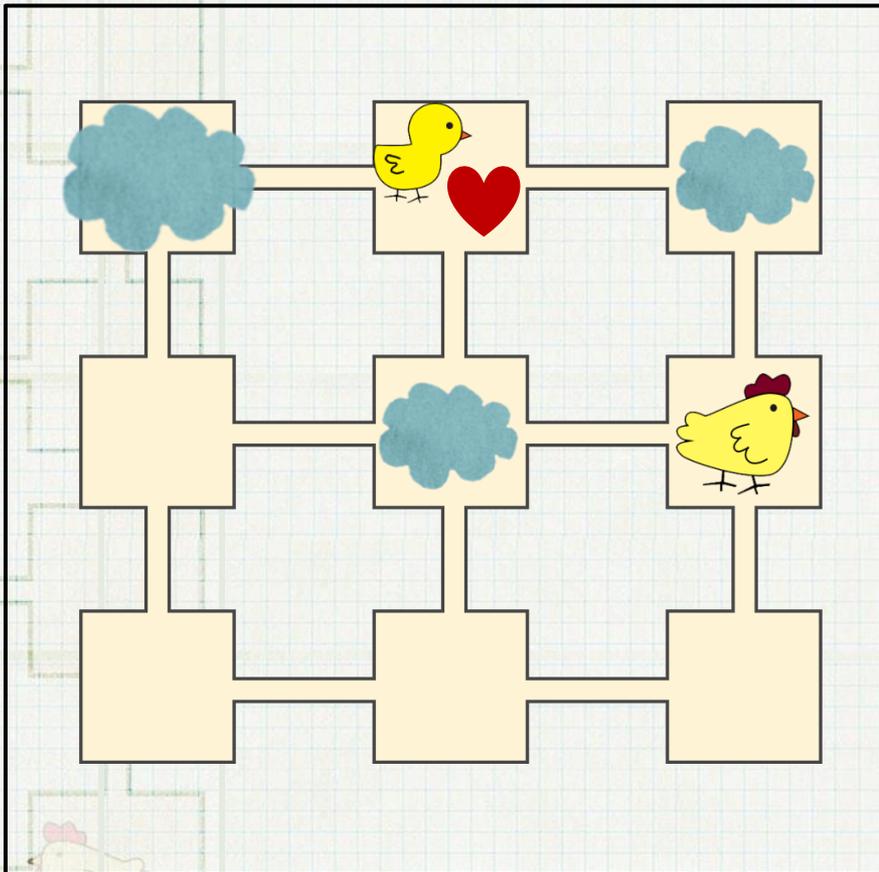
If-else example
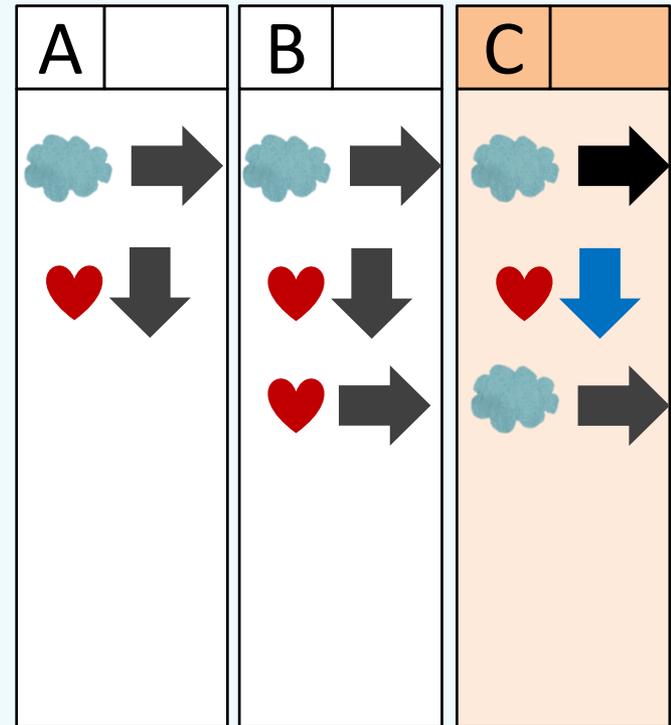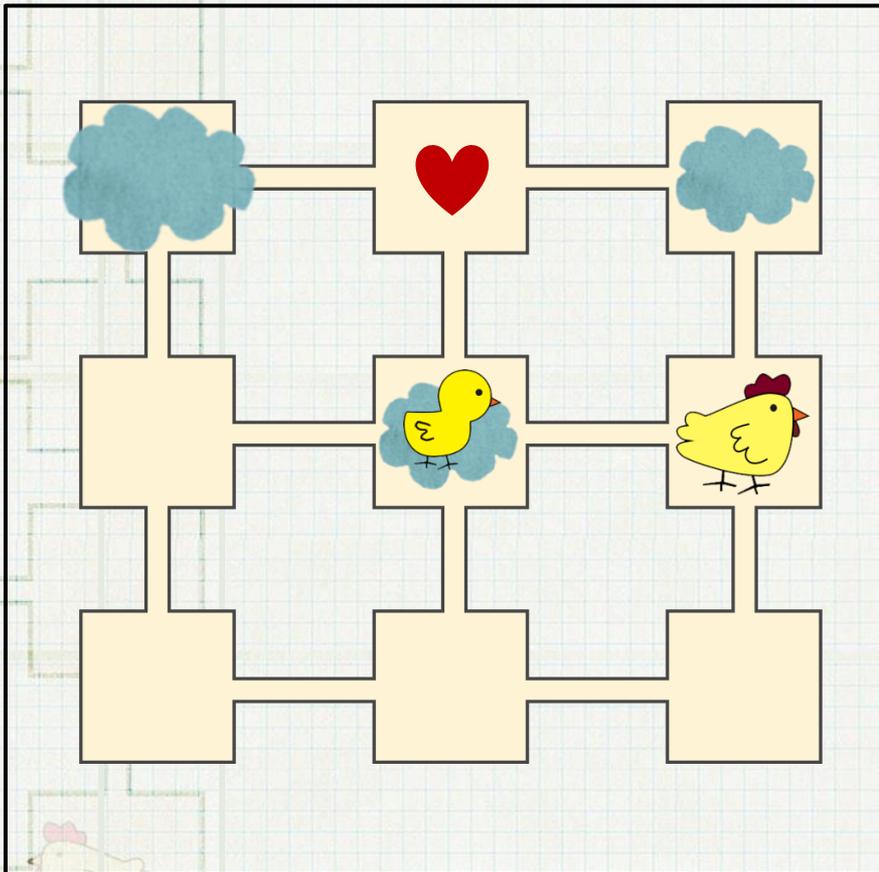
If-else example

If-else example
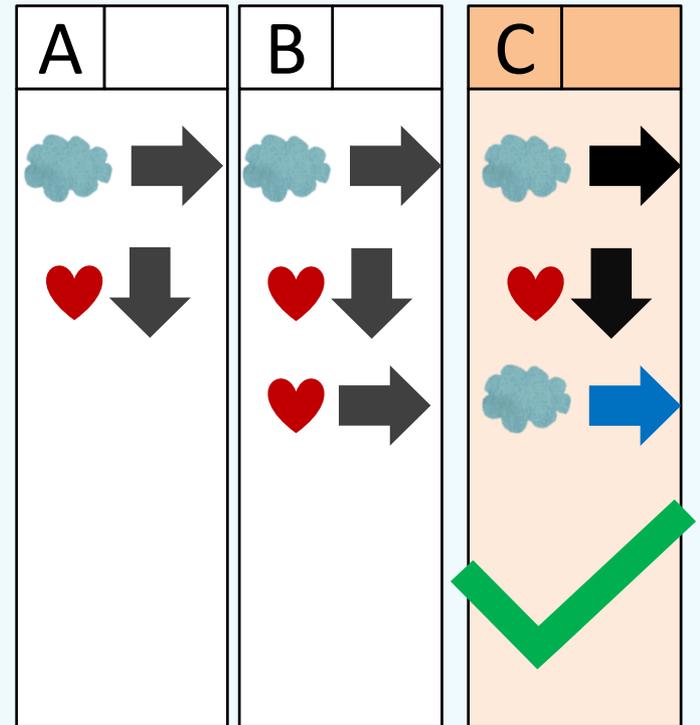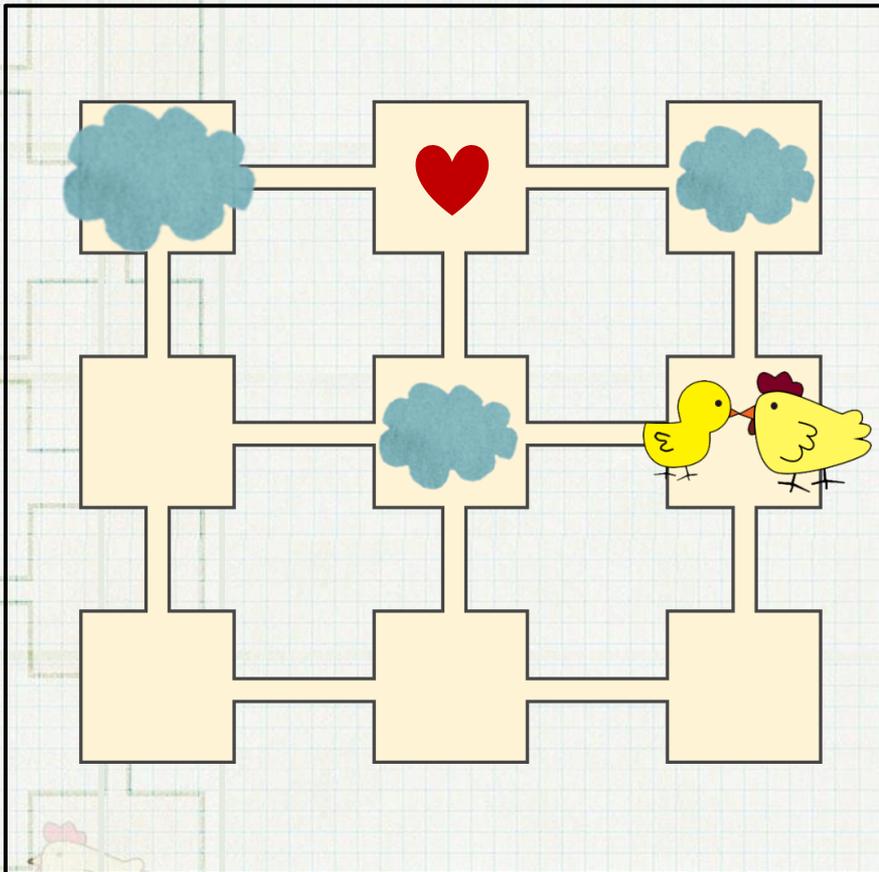
BCTt Expert Judgement procedure & results

45 experts	66 items form

Content validation

Item difficulty level

Item relevance to measure CT

Test length adequacy

Graphic interface adequacy

Improvements adequacy: e.g. transitions

Other / suggestions / comments

BCTt Expert Judgement procedure & results

$y = 0{,}1063x + 1{,}4239$
$R^2 = 0{,}8883$
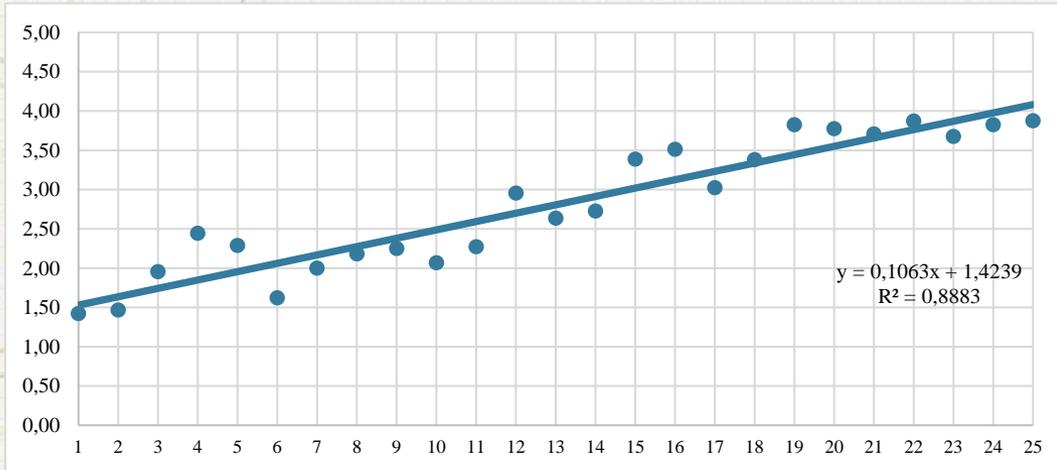
BCTt item difficulty perceived by experts

$y = 0{,}0786x + 3{,}6857$
$R^2 = 0{,}5818$
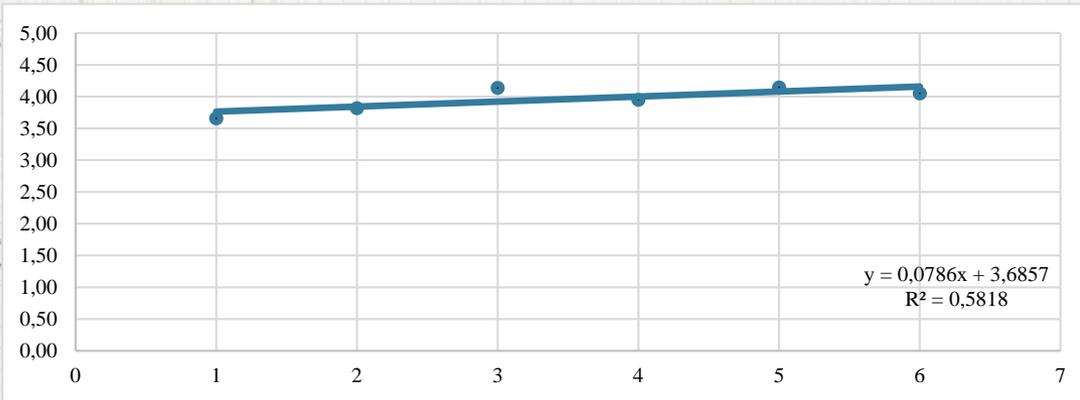
BCTt computational concept relevance to measure CT, perceived by experts

Test length

- adequate
- too long
- too short

Adequacy to evaluate CT

- very good
- good
- intermediate
- bad
- very bad
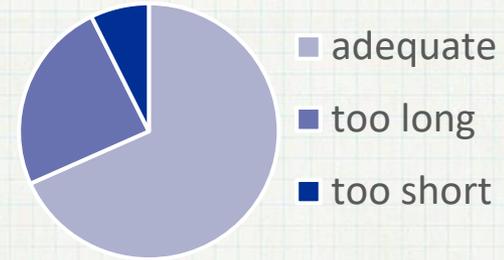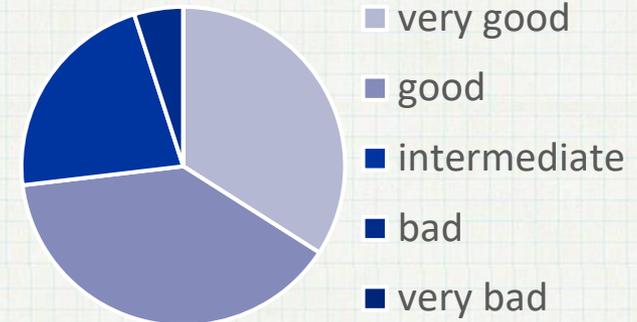
83% → Transitions are positive

22

Comments / suggestions

"transitions are easily associated to arrows in the answers"

"the allowed paths are clear with transitions, because it excludes diagonal movements"

"In the design without transitions, doubts are generated about when a character reaches another (either when it reaches the previous square or when it reaches the other character square?)".

"the test is TOO HARD"

"It is not clear if two chicks can move together after meeting"

23

Form and content modifications

Oral explanation

4 alternative responses

If-else reformulation

If-then-else reformulation

18
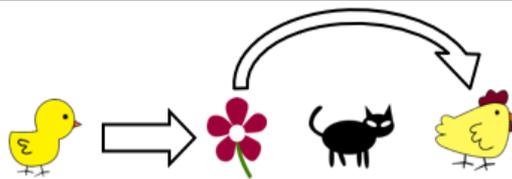
Take the chicken with his mother.
Pick up the **flower** on your way.
Beware of the **cat**: don't go through its square.

Mark the correct sequence:

Colour blindness adaptation

25
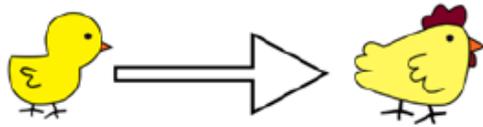
Take the chicken with his mother.

Meaning example:

While the chicken is in a triangle, it **always** moves to the right.

Mark the correct sequence:

299 Primary School Students	Action protocol

5 to 12 years old	Test printed in paper form

BCTt	→	transitions
BCTt variation	→	No-transitions

School	Educational stage	Grades	Students ages
Colegio Público Carlos Ruiz	1st	1st and 2nd	5 - 8
Colegio Los Escolapios	2nd	3rd and 4th	7 -10
CEIP León Felipe	3rd	5th and 6th	9 -12

Educational stage	Grade	Identifier	BCTt	BCTt variation
1st	1	A	A1: n=52	
	2	B	B1: n=18	B2: n=18
2nd	4	C	C1: n=54	
	4	D	D1: n=28	D2: n=28
3rd	5	E	E1: n=51	
	6	F	F1: n=25	F2: n=25

B2, D2, F2

A1, B1, C1, D1, E1, F1

D1

BCTt variation

BCTt

BCTt

Procedure

Time **1**

Time **2**: 5 weeks later

v.2
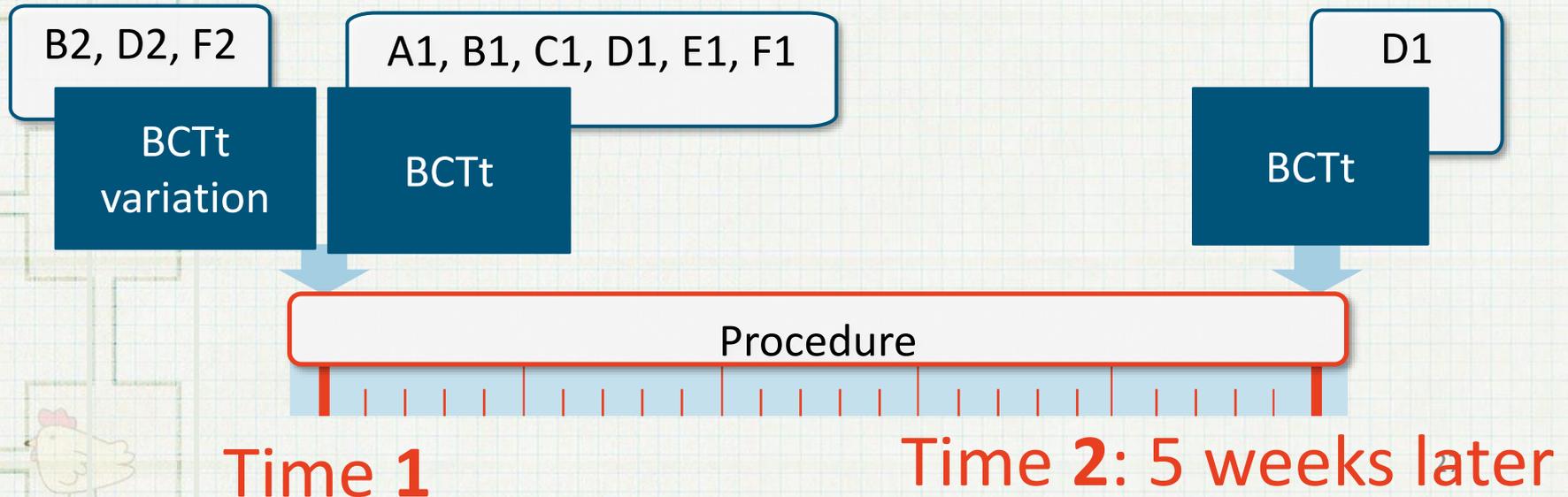
Transitions → **Student's t-test** → **Significant difference in test scores (p=0.005< 0.01) in lower grades**

Descriptive statistics

Sample		Entire sample	A1	B1	C1	E1	F1
Grade		1-6	1	2	4	5	6
N		200	52	18	54	51	25
Mean		19.92	16.52	16.78	21.57	21.84	21.72
Median		20.00	16.00	18.00	23.00	23.00	22.00
Std. Deviation		3.79	3.31	2.49	3.044	2.61	2.62
Variance		14.36	10.96	6.183	9.268	6.815	6.88
Minimum		8.00	8.00	11.00	14.00	13.00	15.00
Maximum		25.00	24.00	20.00	25.00	25.00	25.00
Percentiles	25	17.00	14.00	15.75	19.00	20.00	19.50
	50	20.00	16.00	18.00	23.00	23.00	22.00
	75	23.00	19.00	18.00	24.00	24.00	24.00

BCTt Administration: results

Item analysis
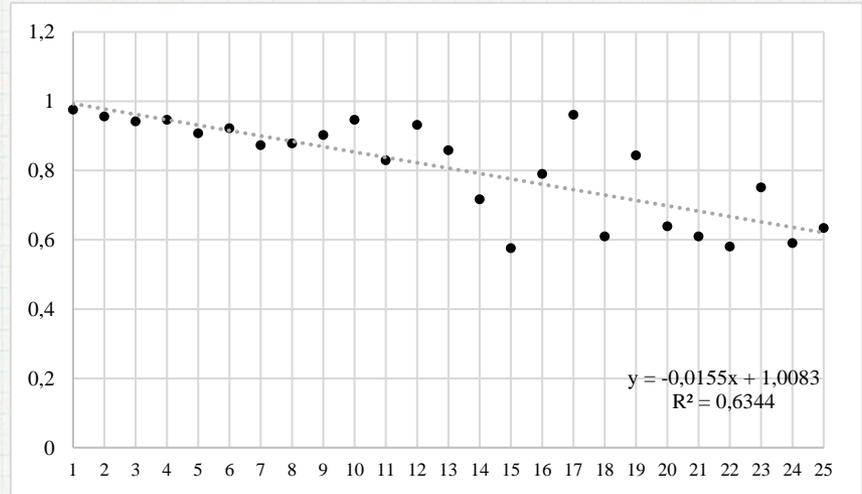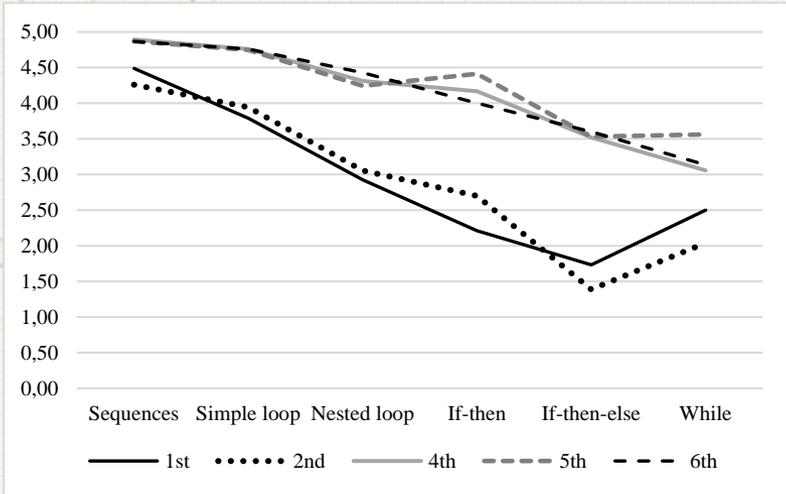
Computational concept by grade
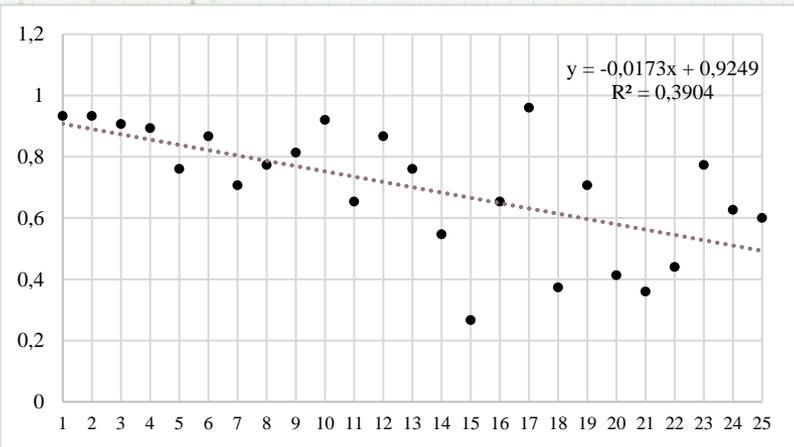
Item difficulty index for each BCTt item

$$y = -0,0155x + 1,0083$$
$$R^2 = 0,6344$$

$$y = -0,0173x + 0,9249$$
$$R^2 = 0,3904$$

Item difficulty index

Histogram

Mean = 16,59
Std. Dev. = 3,104
N = 70

BCTt Administration: results
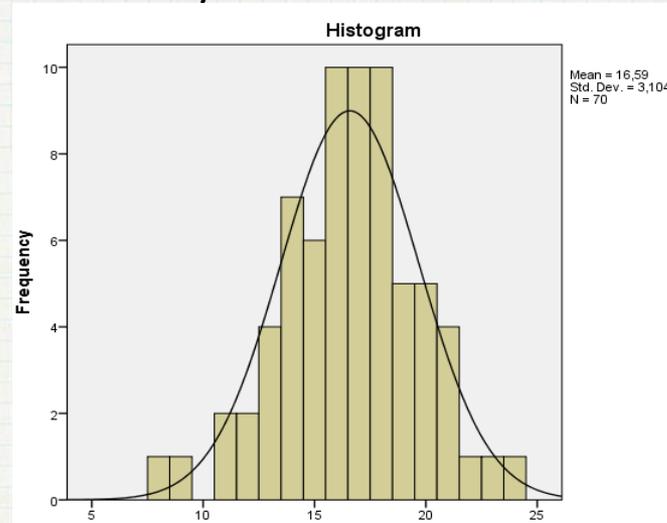
Sample		Reliability Statistics		Item Statistics			
N	N of Items	**Cronbach 's Alpha**	Cr. 's Alpha Based on Stand. Items	Mean	Min.	Max.	Variance
200	25	**0.824**	0.829	0.807	0.576	0.976	0.021

Subsamples				Reliability Statistics		Item Statistics	
Ed. stage	Grade	Id.	n	Cronbach's Alpha	Cr. 's Alpha Based on Stand. Items	Mean	Variance
1st	1	A1	52	0.833	0.838	0.742	0.041
1st	2	B1	18	0.793	0.801	0.630	0.042
2nd	4	C1	54	0.771	0.735	0.837	0.022
3rd	5	E1	51	0.660	0.683	0.863	0.012
3rd	6	F1	25	0.657	0.648	0.844	0.015

Task and re-task method
(D1 subsample)
Non-parametric Spearman's test

→ very strong significant correlation
($rs=0.93$; $p<0.01$).

Conclusions

✓ BCTt is adequate for the assessment of CT in Primary School

✓ Transitions between maze squares are a relevant improvement for young students

✓ BCTt seems to be aimed at 1st to 4th grades (5 to 10 years old)

✓ Reliability is high and higher in younger students

✓ **Recommended to use in parallel with other tools → system of assessments**

3D Framework

CT concepts

CT practices

CT perspectives

✓ It could be used as a pre-test / post-test instrument
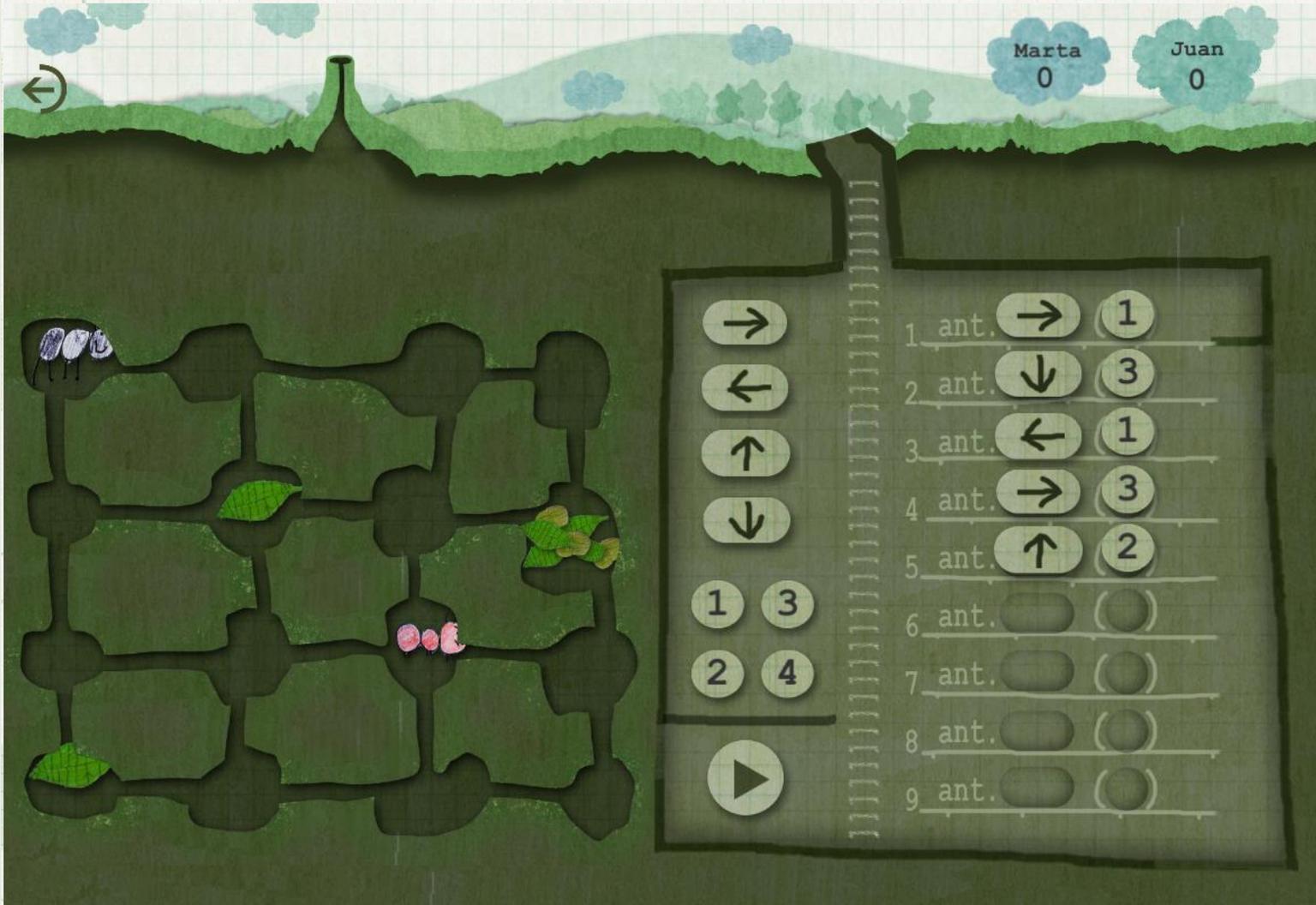
Blue Ant Code (Android and IOs)

Conclusions

✓ BCTt lower limit

✓ Other countries: Portugal, Chezch republic, Germany, France, …

✓ Populations

✓ BCTt new version → Cornell University NY

Thank you very much for your time!

maria.zapata@urjc.es
@maria__z_c