



## Observation as a primary concept for the computational thinker

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## Content of the workshop

- Orientation – an observational perspective on computing
- An illustrative example: **giving change**
- The environment for making construals
- Classroom experience
- Reflections for discussion
- Summary and resources

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The CONSTRUIT! project: EU Erasmus+ 2014-2017



construit.org  
jseden.dcs.warwick.ac.uk/scifest16

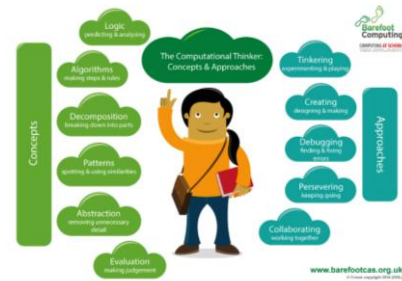


This project has been funded with support from the European Commission under the Erasmus+ programme (2014-1-UK01-KA200-001818). This presentation reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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## Questions

Why does *computing unplugged* help us to understand computational concepts?

... because real objects have more subtle interactive qualities than abstract computers

... this has to do with how they embody state that is meaningful (cf. clock, sundial)

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## How can the computer help?!

We can devise better ways to express states and interactions as we *experience* them

Beyond procedural and declarative perspectives on state in programming ...

... **observational**, something different in nature

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### Coins P4

Coins from Phil Bagge's *How to teach Primary Programming using Scratch*

Two independent steps for a single action:  
**adding a pound coin to the list**  
*is also taking away 100 pennies from the amount to be converted*

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### Issues for capturing state

Two independent steps for a single action:  
**adding a pound coin to the list**  
*is also taking away 100 pennies from the amount to be converted*

[Procedural] spell out computational steps – 'too much state'  
 [Declarative] abstract away computational steps - too little state

Whether state is live to interaction cf. state in

- video
- computer game
- real-life game

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| DENOMINATIONS | 1     | 2     | 5     | 10    | 20    | 50    | 100   | 200   |     |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|-----|
| 389 pennies   | TRUE  | TRUE  | TRUE  | TRUE  | TRUE  | TRUE  | TRUE  | TRUE  | 200 |
| 189           | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 100 |
| 89            | 1     | 2     | 5     | 10    | 20    | 50    | 100   | 200   | 50  |
| 39            | TRUE  | TRUE  | TRUE  | TRUE  | TRUE  | FALSE | FALSE | FALSE | 20  |
| 19            | 1     | 1     | 1     | 1     | 1     | 0     | 0     | 0     | 10  |
| 9             | TRUE  | TRUE  | TRUE  | FALSE | FALSE | FALSE | FALSE | FALSE | 5   |
| 4             | TRUE  | TRUE  | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 2   |
| 2             | TRUE  | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | 2   |
| 0             | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |     |

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### Denominations of coins available

Quantity of change yet to be given

Largest appropriate denomination

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amount = 389; coinlist is [200,100,50];  
 amountleft is amount – sum(coinlist);  
 denoms = [1,2,5,10,20,50,100,200];

gtndenomix is 1 if amountleft >= denoms[ix] else 0;  
 gtnumlist is gtndenomix with \_ix is 1..denoms#;  
 maxdenom is denoms[sum(gtnumlist)];

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### Observation in giving change ...

amount = 8;  
 coinlist = [];  
 denoms is [1,2,5,10,20,50,100,200];  
 amountleft is amount - sum(coinlist);  
 gtndenomix is 1 if amountleft >= denoms[\_ix] else 0;  
 gtnumlist is gtndenomix with \_ix is 1..denoms#;  
 maxdenom is denoms[sum(gtnumlist)];

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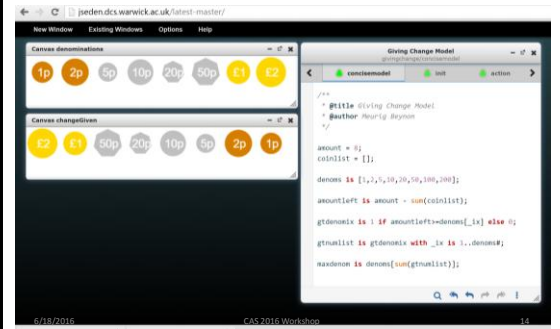
## Agency in giving change

```

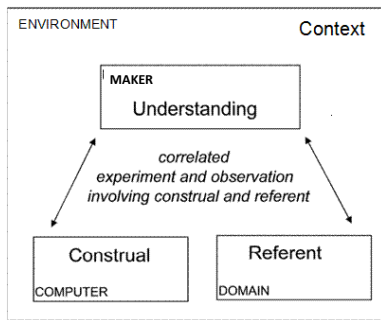
## initialisation
{
  amount = 195;
  coinlist = [];
}

## action
click is mousePressed;
when (amountleft>0 && click) {
  wait 100;
  coinlist = coinlist // [maxdenom];
}
    
```

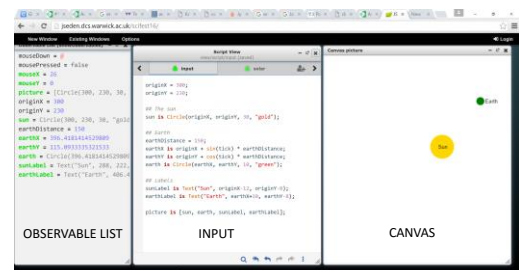
## Giving change in the environment for making construals



## Making construals as making connections ...



## The JS-Eden environment

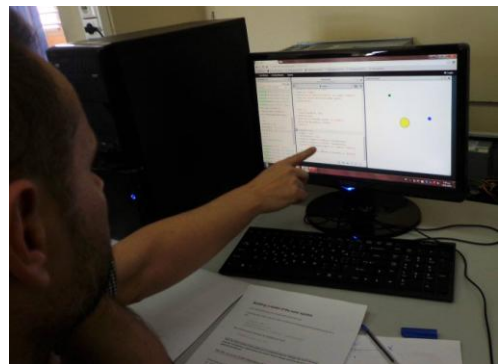


## A workshop for 13-15 year old pupils

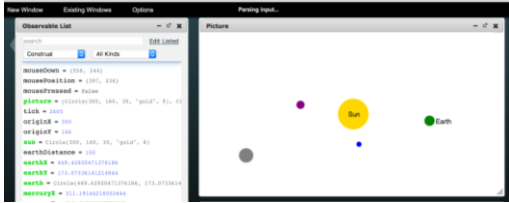
- Trialled with schoolchildren in Athens Sept 2015 / May 2016
- Suitable as an introduction to text-based programming that might follow on from a first course in Scratch
- Having some characteristics of an 'unplugged' activity that has computer support ...

Worksheet and other lesson resources available at:  
<http://go.warwick.ac.uk/em/construit/year2/c15/forteachers/>

Conference talk by Antony Harfield about the workshop experience:  
<http://e-school.kmutt.ac.th/constructionism2016/program.php>



# A solar system construal



The basic form of the solar system construal  
 c2/solar in the project repository at [jmeden.dcs.warwick.ac.uk/scifest16](http://jmeden.dcs.warwick.ac.uk/scifest16)

## Printed worksheet

<http://bit.ly/1r92q1D>

Input window

## Retracing pupil interactions as-if live

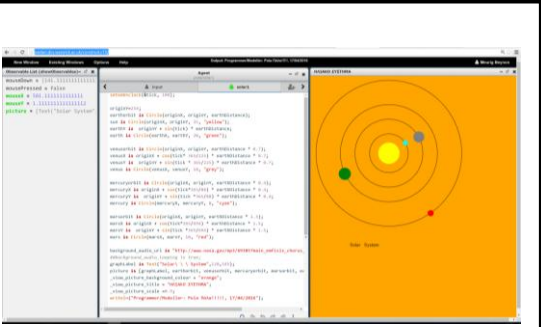
A: misunderstanding Pythagoras's theorem

B: misrepresenting Pythagoras's theorem in JS-Eden

C: a misconception about how Pythagoras's theorem relates to drawing triangles in JS-Eden

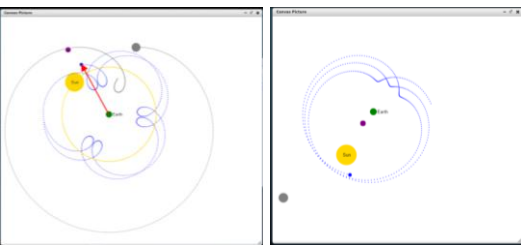
| Group A   | Group C  |
|---|--|
| <pre>## 20a 100 a = sqrt(19); ## 20b 436 b = sqrt(143); ## 20c 114 c = sqrt(a**2 + b**2); ## 20d 176 d = sqrt(a**2 + b**2);</pre> | <pre>## 20a 100 c = sqrt(a**2 + b**2); ## 20b 30 LineA is Line(100, 50, 100+10*a, 50); ## 20c 362 LineC is sqrt(LineA**2 + LineB**2); ## 20d 302 LineC is sqrt((LineA**2 + LineB**2));</pre> |
| Group B   |  |
| <pre>## 20a 336 a = 3; ## 20b 450 b = 4; ## 20c 450 (4+3**2) c = c**2; ## 20d 249 c = a*b;</pre>                                  |  |

Figure 6: Three interaction extracts that demonstrate the difficulty faced by the students in applying Pythagoras's theorem.



As adapted by Pola Misthou, a teacher at the workshop

## The teacher as the learner ...



## Reflections for discussion ...

- Making construals as a different orientation on computing from classical computer science ...
- Relevance to embedded systems e.g. Arduino
  - Characteristics of existing applications e.g. GIS
  - Computing as a new independent discipline?
  - Complementing computational thinking in CS?

[For more background: see [go.warwick.ac.uk/em](http://go.warwick.ac.uk/em)]

## Acknowledgements

- Nick Pope
- Elizabeth Hudnott
- Jonny Foss
- Chris Hall
- Steve Russ
- Jane Waite
- Dave White
- The CONSTRUIT! project team

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## Summary and references

Unplugged computing considers activities from ordinary life that help us to understand what is involved in developing software. These activities illustrate concepts and approaches to computational thinking in ways that avoid some of the complications of computing as it is really practised. This is because they are expressed in terms of interactions with objects that of their nature record and change state in more subtle ways than a raw computational device. This talk introduces and illustrates practical principles and an environment we can use to model such objects using the computer.

Work with us and other teachers with a view to supporting teaching and learning about computing potentially contributing to a session for teachers at the final conference for CONSTRUIT! to be held at Warwick University in July 2017. If interested, please contact [steve.russ@warwick.ac.uk](mailto:steve.russ@warwick.ac.uk)

Getting Started with JS-Eden and other resources about making construals  
[go.warwick.ac.uk/em/construit/year2/c15/forteachers/](http://go.warwick.ac.uk/em/construit/year2/c15/forteachers/)

Script for giving change construal: [wmb/casws](http://wmb/casws) in project repository of [jseden.dcs.warwick.ac.uk/scifest16](http://jseden.dcs.warwick.ac.uk/scifest16)

Online links to CAS2016 session slides etc  
[go.warwick.ac.uk/em/construit/year2/CAS2016](http://go.warwick.ac.uk/em/construit/year2/CAS2016)

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