PDST

Professional Development Service for Teachers | An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí

An Roinn Oideachais agus Scileanna
Department of Education and Skills

National Workshop 2

LEAVING CERTIFICATE
COMPUTER SCIENCE

Schedule

Session 1	Introduction Teaching and Learning Programming: Challenges and Pedagogies
11.00 – 11.30	Tea/Coffee
Session 2	Computational Thinking
13.00 – 14.00	Lunch
Session 3	Resource Development Curriculum Planning & Assessment Q&A

Workspace = pdst_phase_3

@PDSTcs

computerscience@pdst.ie

Key Messages

There are many ways to use the LCCS specification.

All learning outcomes (LOs) are interwoven and should be studied concurrently at different stages of the course and should NOT be studied in a linear order

LCCS can be mediated through a constructivist pedagogical approach.

ALTs

ALTs provide an opportunity to teach theoretical aspects of LCCS.

Digital technologies can be used to enhance collaboration, learning and reflection.

LCCS is a subject for everyone

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Session 1
Introduction

By the end of this session :

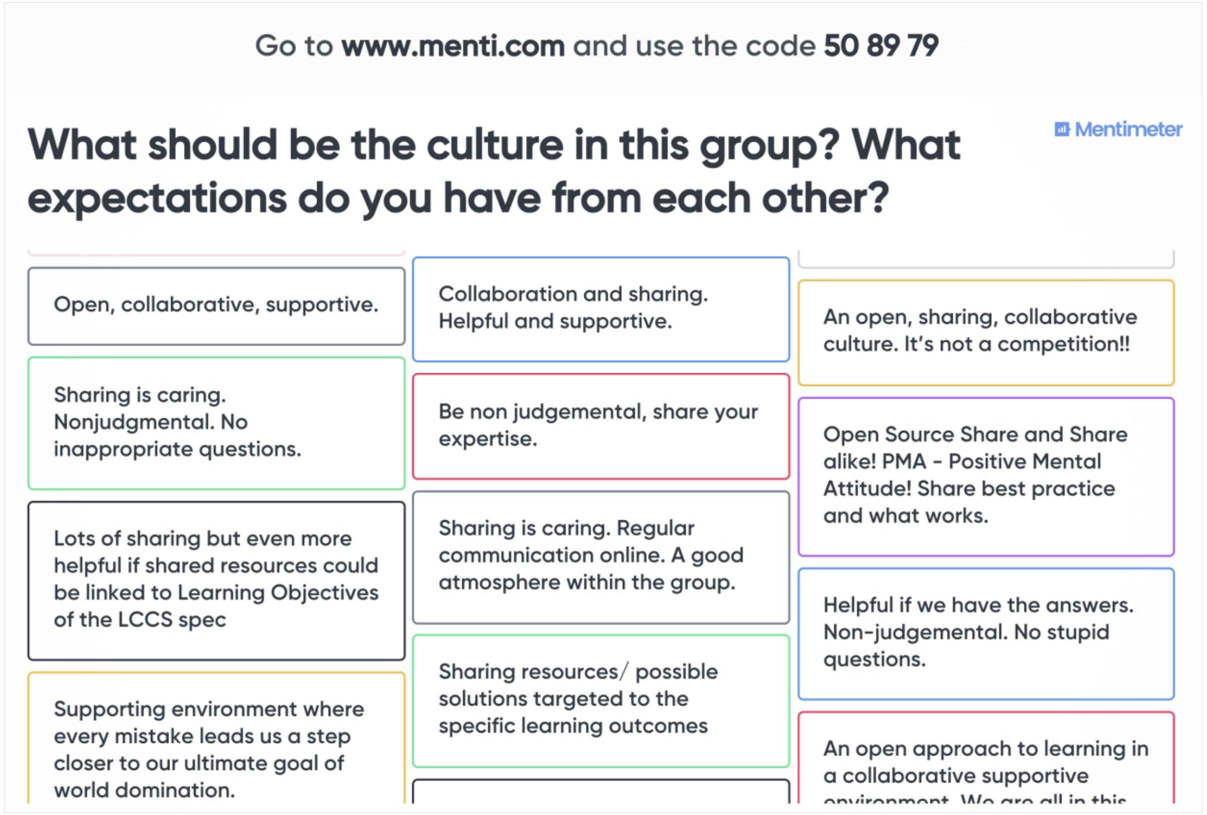
Participants will have be enabled to:

- reflect on the key messages of National Workshop 1
- develop their understanding of common challenges experienced by teachers in teaching programming, and students in learning how to program
- further their knowledge and skills of Python
- participate in a constructivist pedagogic exercise

National Workshop 1

Quick Recap

Recap on NW1 - Culture and Expectations



Go to **www.menti.com** and use the code **50 89 79**

What should be the culture in this group? What expectations do you have from each other?

Open, collaborative, supportive.

Sharing is caring. Nonjudgmental. No inappropriate questions.

Lots of sharing but even more helpful if shared resources could be linked to Learning Objectives of the LCCS spec

Supporting environment where every mistake leads us a step closer to our ultimate goal of world domination.

Collaboration and sharing. Helpful and supportive.

Be non judgemental, share your expertise.

Sharing is caring. Regular communication online. A good atmosphere within the group.

Sharing resources/ possible solutions targeted to the specific learning outcomes

An open, sharing, collaborative culture. It's not a competition!!

Open Source Share and Share alike! PMA - Positive Mental Attitude! Share best practice and what works.

Helpful if we have the answers. Non-judgemental. No stupid questions.

An open approach to learning in a collaborative supportive

https://www.mentimeter.com/s/808d13590aee2c126cfb76044464a98b/6904e5f73c08

Respect

Collaboration

Open-mindedness

Supportive / Community

Positive

Recap on NW1

Culture and Expectations

The Role of the PDST

Growth Mindset

CPD Programme

Community of Practice

LCCS Specification

Learning Outcomes

Applied Learning Tasks (ALTs)

Computational Thinking

Introduction to PRIMM

Teachers are Key

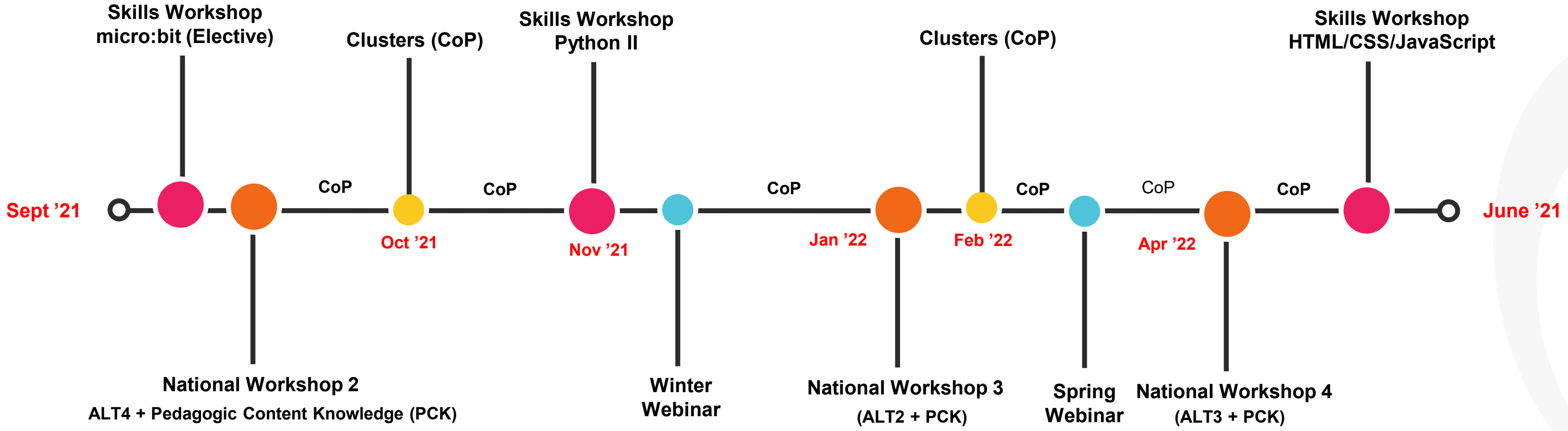
CS For All

Non-linear

Programming Pedagogy

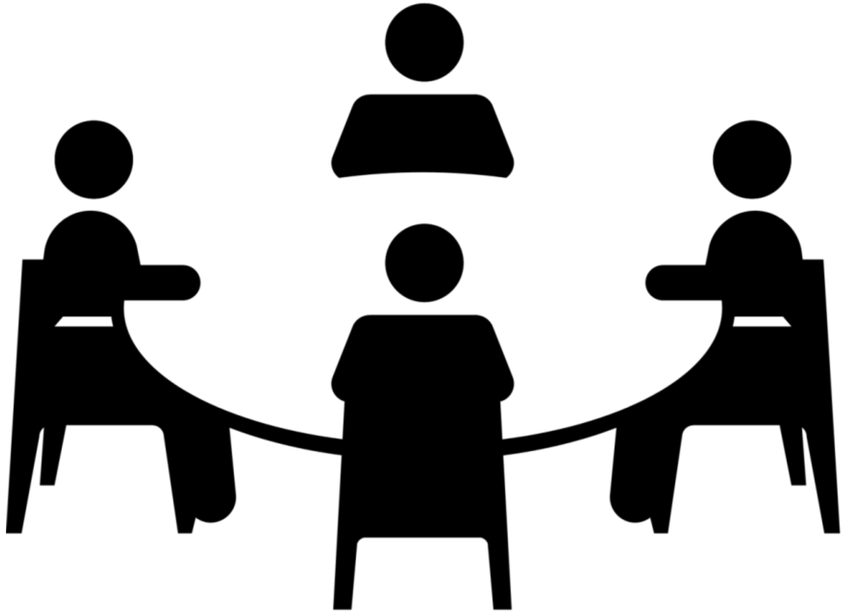
Constructivism (student-centred)

Dates for your Diary for 2021/22



Day 2 of NW2 Tuesday 28th September (cohorts 1&3) and Wednesday 29th September (cohorts 2&4)

Breakout #1



Switch video / sound ON

Check in – introduce yourselves

Looking back at NW1 …

… to what extent was your thinking extended in relation to LCCS and the Curriculum Specification

10 minute breakout

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Teaching and Learning Programming: Challenges and Pedagogies

Question 1

What is the value of the variable `x` after the execution of this Python code?

python

```
x = 23
y = 17
x = x + y
x = y
```

A. 40
B. 57
C. 6
D. 17
E. None of the above

Contents

LCCS Strands

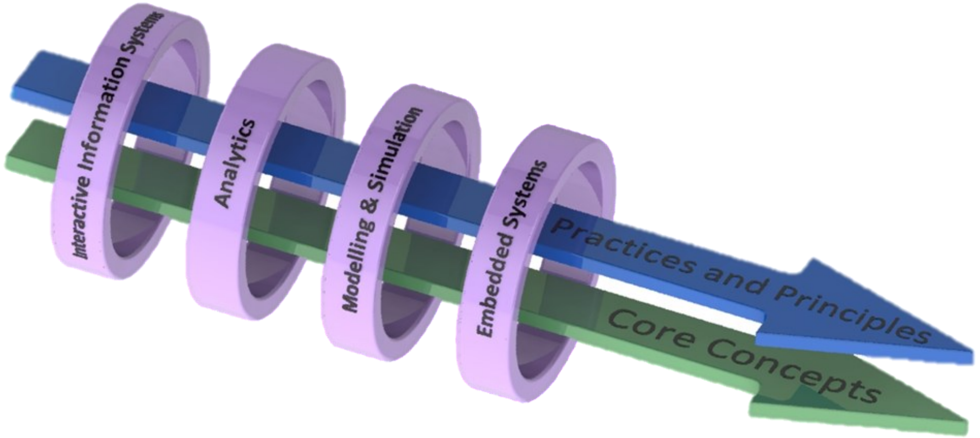
Strand 1: Practices and principles	Strand 2: Core concepts	Strand 3: Computer science in practice
‣ Computers and society ‣ Computational thinking ‣ Design and development	‣ Abstraction ‣ Algorithms ‣ Computer systems ‣ Data ‣ Evaluation/Testing	‣ Applied learning task 1 - Interactive information systems ‣ Applied learning task 2 - Analytics ‣ Applied learning task 3 - Modelling and simulation ‣ Applied learning task 4 - Embedded systems

Computer Science

Curriculum Specification

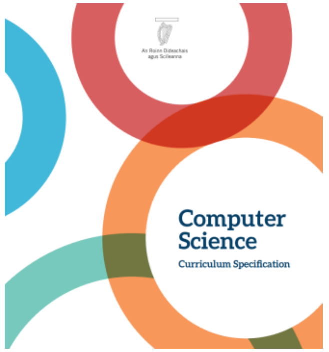
Programming and LCCS

"The role of programming in computer science is like that of practical work in the other subjects—it provides motivation, and a context within which ideas are brought to life. Students learn programming by solving problems through computational thinking processes and through practical applications such as applied learning tasks." LCCS specification (2017)



The four applied learning tasks explore the four following contexts:

1 - Interactive information systems
2 - Analytics
3 - Modelling and simulation
4 - Embedded systems.



Question 2

What output does the Python code below display?

```
x = 0
y = (x == 21%7)
print(y)
```

A. 0

B. 3

C. False

D. True

E. None of the above

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Learning Challenges faced by Novice Programmers

A Grand Challenge!

“Teaching and learning programming is considered one of the grand challenges of computing education”

Casperen, 2018

“Programming is a hard craft to master and its teaching is challenging”

Crick, 2017

“Programming is not an easy subject to be studied”

Lahtinen et. al., 2005

“Teaching students to program is a complex process”

Luxton-Reilly et. al., 2018

How did you learn how to program?

What were main challenges for you?

Learning Challenges faced by Novice Programmers

Programming IS difficult to learn because it requires an understanding of:

- the underlying machine that one is trying to control (Notational Machine)
- the problem to be solved (Orientation)
- the language syntax and semantics (Notation / Vocabulary)
- how to apply the language to solve problems (Application / Design)
- the development environment (Pragmatics and Perspectives)
- different levels of abstraction

Cognitive Load

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Teaching Novice Programmers: Teacher Challenges

Phase 1 Teacher Input (Teacher Challenges)

Challenges relating to teachers

Challenges relating to students

Additional Challenges

- Differences from other subjects
- Perceptions and Expectations
- Misconceptions
- Teacher's Knowledge & Self-efficacy

Problem Solving Skills

- Students not engaged
- Students not practicing
- Students not understanding

- Time
- Attendance
- Homework

- Digital Literacy
- Digital Divide
- Differentiation

Source: Sentance, S., Csizmadia, A. Computing in the curriculum: Challenges and strategies from a teacher's perspective. *Educ Inf Technol* **22,** 469–495 (2017).

Question 3

Given x = 20 and y = 9 which of the following Python statements does NOT output the integer 2 exactly?

python

A.
```
print(x//y)
```
B.
```
print(x%y)
```
C.
```
print(int(x/y))
```
D.
```
print(x/(y+1))
```
E.
```
print(int(x/(y+1)))
```

A.
B.
C.
D.
E.

5 minute stretch break

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Breakout Activity #1

Question 4

What output does the Python code below display?

```
def calculate(y, x):
    a = x
    b = y + 1
    return a + b + y

x = 1
y = x + 1
print(calculate(x+1, y))
```

A. 4
B. 5
C. 6
D. 7
E. 8

Group Activity / Breakout

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Successful Strategies and Pedagogies for Teaching Programming to Novices

Peer Instruction

Well-evidenced pedagogical strategy

Combination of:

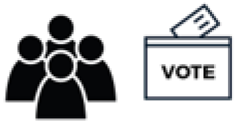
- Flipped learning
- Collaborative working
- Well-chosen MCQs

```
x = 0
y = (x == 21%7)
print(y)
```

A. 3
B. False
C. True
D. Syntax Error

Most effective where there are close distractors and known misconceptions

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Students study a topic/concept in advance of the class	Students take a Multiple Choice Quiz in class.	Students discuss their answers in groups	Group decides on a single 'group answer'	Students take part in teacher facilitated discussion



For more information on peer instruction see http://peerinstruction4cs.org

Successful Strategies and Pedagogies

Notational Machine Topic Ordering Fix the syntax Reflection

Problem Based Learning Test Driven Development Critical Reflection

Code Commenting Program Tracing / Debugging Find the 'bug'

Computational Discourse

PRIMM
(Use-Modify-Create)

Unplugged Activities

Peer Instruction

Game-based Pedagogy

Pair Programming

Block Programming Inquiry Based Learning Fill in the blanks

Turtle Graphics Parson's Problems Semantic Waves

Active Learning

Metacognition Physical Computing

Modelling

Scaffolding

Progression

Context

Constructivism

Example: Fix the syntax

```
# Run the program to see what happens
# Can you fix the syntax error?
PRINT("Hello World")

# Now continue with the remaining 4 print statements ...
# You will need to uncomment each line and run the program to reveal each syntax error
#print(Hello World)
#print('Hello World")
#print "Hello World"
#print("Hello", World)
```

Follow-up Activity:

1. Question: Is the following (uncommented) line syntactically correct?
# print("Hello", 123)

2. Create (and fix) your own syntax errors

3. Try to create an indentation syntax error … looks like this →

```
    print("Hello World")
    ^
IndentationError: unexpected indent
```

4. What happens if all the `print` statements are uncommented?

Example: Find the ‘bug’ – *semantic* error

```
# Find and fix the 'bug' in the program below

# The intention is to add a and b and display the answer

a = 3
b = 4
sum = a + 3
print(a, "+", b, "=", sum)
```

Follow-up Activity:

```
# Would any of the following (uncommented) lines work in place of the print above
#print(3, "+", 4, "=", sum)
#print("3 + 4 =", sum)
#print("3 + 4 = 7")
#print(3 + 4)
#print(a + b)
```

Example: Insert comments

```python
# Insert comments to explain each line of code below
# (the first one has been done to get you started)

x = 23 # Assign the value 23 to the variable x
y = 17
print("The value of x is", x)
print("The value of y is", y)
x = x + y
print("The value of x is", x)
x = y
print("The value of x is", x)
```

Example: Fill in the blanks

```python
# A program to demonstrate the multiple if statement
import random

number = random.randint(1, 10)
print(number) # comment this line out later!

guess = int(input("Enter a number between 1 and 10: "))

# Evaluate the condition
if guess == number:
      print("Correct")
      print("Well done!")
elif guess < number:
    print("Hard luck!")
    print("Too low")
else:
    print("Hard luck!")
    print("Too high")

print("Goodbye")
```

```python
if guess > number:



elif guess == number:



else:


```

Example 1: Parson’s Problem

Arrange the blocks of code below into the correct order

```
elif guess < number:
    print("Hard luck!")
    print("Too low")
```

```
import random
number = random.randint(1, 10)
```

```
print("Goodbye")
```

```
else:
    print("Hard luck!")
    print("Too high")
```

```
if guess == number:
    print("Correct")
    print("Well done!")
```

```
guess = int(input("Enter a number between 1 and 10: "))
```

The final program should generates a random number, prompts the user to enter a guess and display a message telling the user if the guess was correct, too low or too high.

The program should always display the string *Goodbye* at the end.

Example 2: Parson's Problem

Re-arrange the jumbled up lines shown below so that the program prompts the end-user to enter two integers and then computes and displays their sum.

```
number2 = int(number2)

number1 = int(input("Enter first number: "))

sum = sum + number1

number1 = int(number1)

print(number1, "+", number2, "=", sum)

number2 = input("Enter second number: ")

print("The answer is sum")

sum = number1 + number2
```

Warning! There are *three* extra lines that you won't need.

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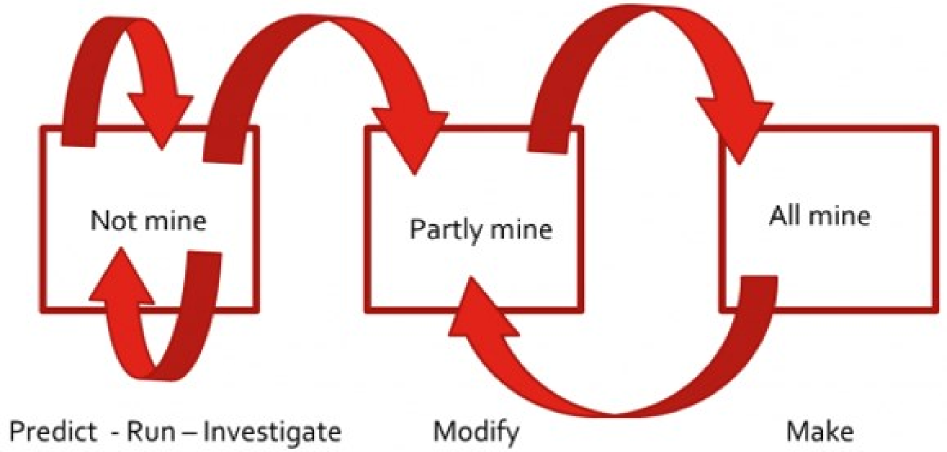
PRIMM

PRIMM

A way of structuring programming lessons that focuses on:

- Reading before Writing
- Student Collaboration
- Reducing Cognitive Load
- Well-chosen starter programs
- Ownership Transfer



Sources:

1. https://blogs.kcl.ac.uk/cser/2017/02/20/exploring-pedagogies-for-teaching-programming-in-school/ (Sue Sentence)
2. https://blogs.kcl.ac.uk/cser/2017/09/01/primm-a-structured-approach-to-teaching-programming/ (Sue Sentence)
3. Sue Sentance, Jane Waite & Maria Kallia (2019) Teaching computer programming with PRIMM: a sociocultural perspective, Computer Science Education, 29:2-3, 136-176, DOI: 10.1080/08993408.2019.1608781

PRIMM

- **Predict:** given a working program, what do you think it will do? (at a high level of abstraction)

- **Run:** run it and test your prediction

- **Investigate:** What does each line of code mean? (get into the nitty gritty - low level of abstraction - trace/annotate/explain/talk about parts)

- **Modify:** edit the program to make it do different things (high and low levels of abstraction)

- **Make:** design a new program that uses the same nitty gritty but that solves a new problem

PRIMM – Example (1 of 2)

```python
import random

number = random.randint(1, 10)
#print(number)

guess = int(input("Enter a number between 1 and 10: "))

if guess == number:
    print("Your guess was correct")
    print("Goodbye")
else:
    print("Incorrect guess")
    print("Goodbye")
```

Predict: Discuss in pairs. What do you think the above program will do? Be precise. Be succinct.

Run: Download the program / Key it in. Execute the program. Test your prediction. Were you correct?

Breakout Activity:

Investigate: Devise some questions to elicit student learning and curiosity. What if … Try … Explain …

Modify: Suggest some simple extensions / modifications for students to make in pairs. Same program.

Make: Formulate new problems that are conceptually similar. New context. New program (copy+paste)

PRIMM – Example (2 of 2)

```
1. import random
2.
3. number = random.randint(1, 10)
4. #print(number)
5.
6. guess = int(input("Enter a number between 1 and 10: "))
7.
8. if guess == number:
9.     print("Your guess was correct")
10.    print("Goodbye")
11.else:
12.    print("Incorrect guess")
13.    print("Goodbye")
```

Investigate:

1. Uncomment line 4. What happens?
2. What is the purpose of line 4?
3. What would happen if you removed `int` from line 6?
4. Try changing == to != on line 8. What happens?
5. What if == was changed to = ?
6. What would happen if you don't enter an integer?
7. Try removing a bracket (anywhere). What happens?
8. Annotate each line of the program.

Modify:

1. Change the program so that it generates a number between 1 and 100? Can you be sure?
2. Change the program so that there is only one `print("Goodbye")` statement (without altering the logic)
3. Extend the program so that it tells the user if the number entered was *too high* or *too low*
4. Design an algorithm based on the program that would give the user 3 guesses
5. Get the computer to generate 4 numbers (lotto) OR ask the user how many numbers to generate?

Make:

1. Write a program that generates two numbers and prompts the user to enter their product

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Breakout Activity #2

PRIMM
Group Activity

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Conclusions, Resources and References

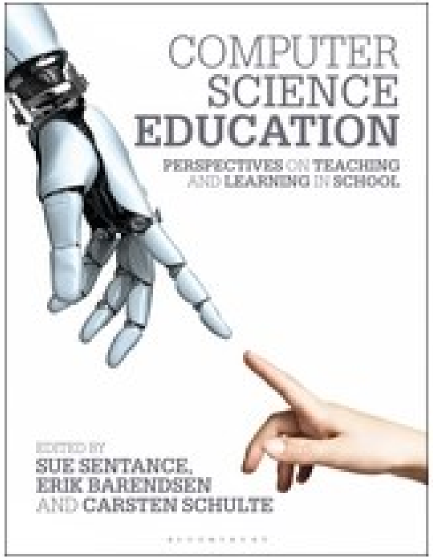
Conclusions

1. Programming IS difficult (for students to learn and teachers to teach)
2. Pedagogies are proven to work
3. Read/Trace code before you write
4. Constructivist approach is important
5. Growth mindset is *at least* as important as natural ability
6. Student-centric approach (teachers adopt a guide-on-the-side rather than a sage-on-the-stage approach)

"The teacher should help, but not too much and not too little, so that the student shall have a reasonable share of the work" and, *"If the student is not able to do much, the teacher should leave him at least with some illusion of independent work."*

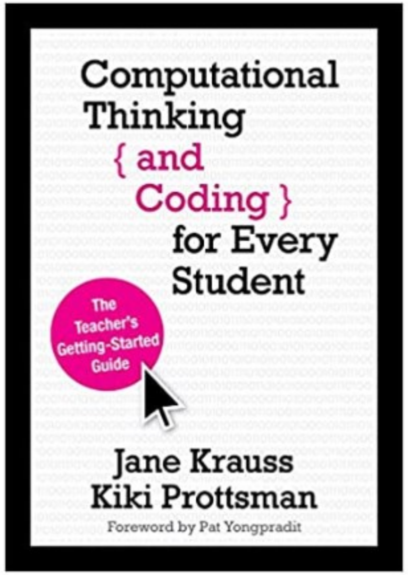
George Polya, How To Solve It

Resources


COMPUTER SCIENCE EDUCATION

PERSPECTIVES ON TEACHING AND LEARNING IN SCHOOL

EDITED BY SUE SENTANCE, ERIK BARENDSEN AND CARSTEN SCHULTE

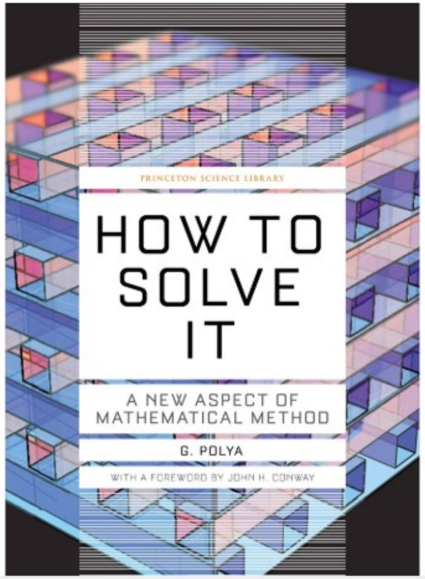

Computational Thinking { and Coding } for Every Student

The Teacher's Getting-Started Guide

Jane Krauss

Kiki Prottsman

Foreword by Pat Yongpradit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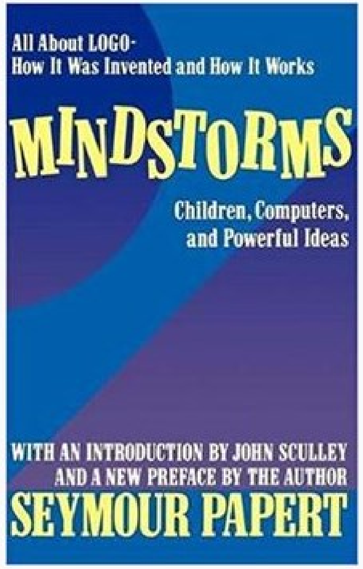
HOW TO SOLVE IT

A NEW ASPECT OF MATHEMATICAL METHOD

G. POLYA

WITH A FOREWORD BY JOHN H. CONWAY


All About LOGO-How It Was Invented and How It Works

MINDSTORMS

Children, Computers, and Powerful Ideas

WITH AN INTRODUCTION BY JOHN SCULLEY AND A NEW PREFACE BY THE AUTHOR

SEYMOUR PAPERT

Plus lots more ….

COMPSCI.IE

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