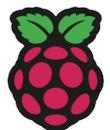


Teaching programming the PRIMM way

11th and 14th February

I Love Computing Conference

Sue Sentance, University of Cambridge and Raspberry Pi Foundation



Raspberry Pi
Foundation



**UNIVERSITY OF
CAMBRIDGE**

Overall aims of this session

- If you've never heard of PRIMM, then I'm hoping this session will give you an introduction!
- If you're a PRIMM expert, I'll hopefully leave plenty of time for you to share your experiences so we can all learn together!
- There are a couple of activities so have a pen and paper ready!

 **Predict**

 **Run**

 **Investigate**

 **Modify**

 **Make**

Starter task: You'll need a pen and paper!



An activity for you - you will need pen and paper!

Look at this Python
(turtle) code

[Discuss with your partner]

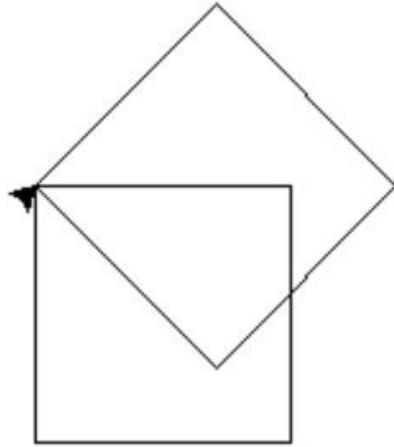
What happens when the
code runs?

Draw the output

```
from turtle import *  
  
def square():  
    for counter in range(4):  
        forward(100)  
        right(90)  
  
square()  
left(45)  
square()
```

We can't do this part today!

```
from turtle import *  
  
def square():  
    for counter in range(4):  
        forward(100)  
        right(90)  
  
square()  
left(45)  
square()
```



Now run the code

Did you get the same?

If not, what is different about your answer?

We've just demonstrated
the P and R of PRIMM

Working in pairs

If you had been able to work in pairs I might ask you:

- What discussions did you have?
- Did you help each other?
- What did you learn?

How did PRIMM come about?

What we noticed in class (in 2016)

Students were spending a whole lesson copying in a program (block-based or text) provided by the teacher

OR

Students were given a problem to solve and had to start from a blank screen

Students had their hands up for a long time, while the teacher had to circulate and fix individual syntax errors

Students were working alone



Students went off task

Could this be changed to ?

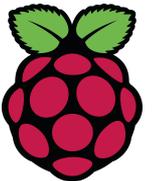
Starting from a program that existed in the world

Delaying responsibility / ownership until students could understand what they were working on

Spending time on concepts and how programs actually worked

Understanding a program at different levels of abstraction

Talking about programs with each other and using out-loud explanations



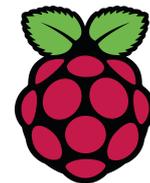
Key principles of PRIMM

Predict-Run-Investigate-Modify-Make

Communicate and
collaborate

Read and
understand code

Gradually take
ownership



The PRIMM approach

 **Predict**

 **Run**

 **Investigate**

 **Modify**

 **Make**

Predict – given a working program, talk about it in pairs or groups. What do you think it will do?

Run – run it and test your prediction

Investigate – get into the nitty gritty. What does each line of code mean? Lots of activities to try here: trace, annotate, explain, talk about, identify parts, etc....

Modify – edit the program to make it do different things

Make – design a new program that uses the same nitty gritty but that solves a new problem

PRIMM Walkthrough

Predict

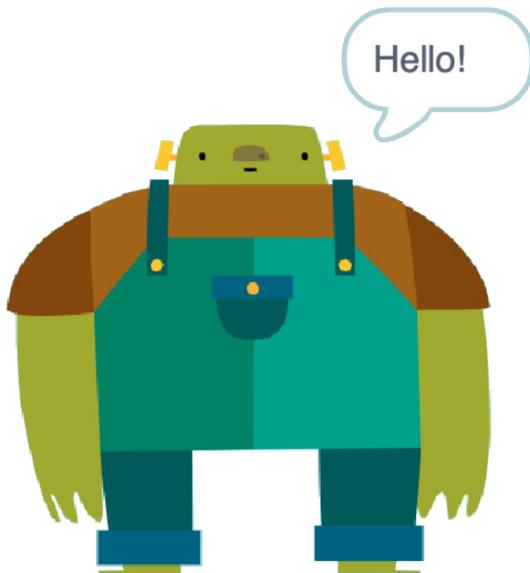
Run

Investigate

Modify

Make

Big Ed is your friendly chatbot.



With a partner, spend time reading the code below. PREDICT exactly what you think will happen.

```
when clicked
say hello for 2 seconds
say I'm Big Ed from the year 2182 for 2 seconds
ask_name

define ask_name
ask what is the name of your monster? and wait
set name to answer
say join hello name for 2 seconds
```


PRIMM Walkthrough

Predict

Answer the following questions with your partner by experimenting with the code in order to investigate how it works.

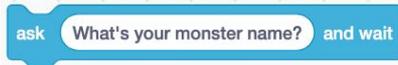
Run

How do the following two blocks of code relate to each other?



Investigate

Temporarily remove the following block:



What has this changed about the program when you run it?
Why do you think this is?

Modify

Below **define ask_name**, there are two variables being used. What are their names?

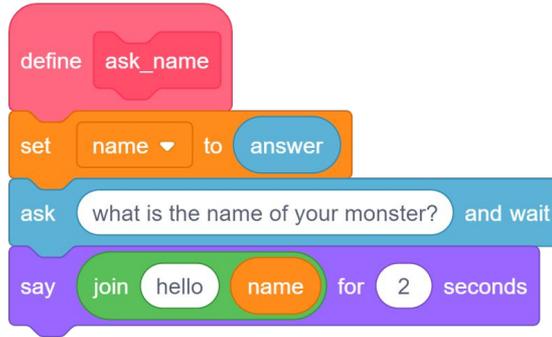
Make

PRIMM Walkthrough

Predict

Now place the **ask What's your monster name? and wait** block back into the code, but place it after the **set name to answer** block:

Run



Investigate

Modify

Why do you think it only says “Hello” and not “Hello “ and the name you entered?

Make

What can you learn from this?

Ask different types of questions.

PRIMM Walkthrough

Predict

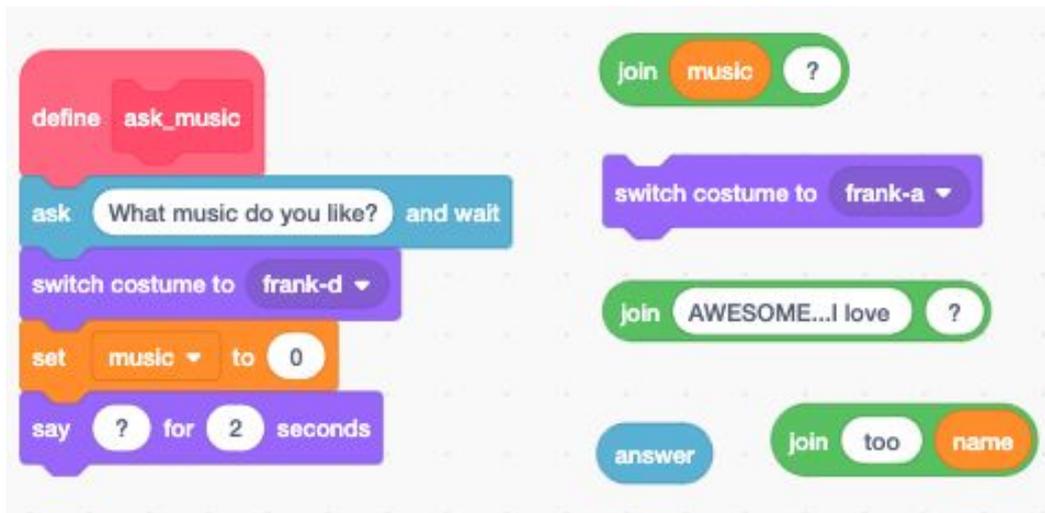
All of the code needed to make Big Ed ask about your favorite music has been included in the program. Place the blocks below into the appropriate places in the subroutine.

Run

Investigate

Modify

Make



PRIMM Walkthrough

Predict

Create your own character to have a conversation with.

The character can be anything you want. Maybe related to a favourite hobby or sport?

Run

The character should:

- introduce themselves
- ask the user 2 questions
- respond appropriately based on the answers the user gives.

Investigate

Modify

Make



Focusing in on Investigate

What are good questions to ask?

What questions might you ask learners to help you gauge their understanding?

What questions could you ask your students which would prepare them to write something similar?

We can frame questions around the Block Model

(this is another talk!)

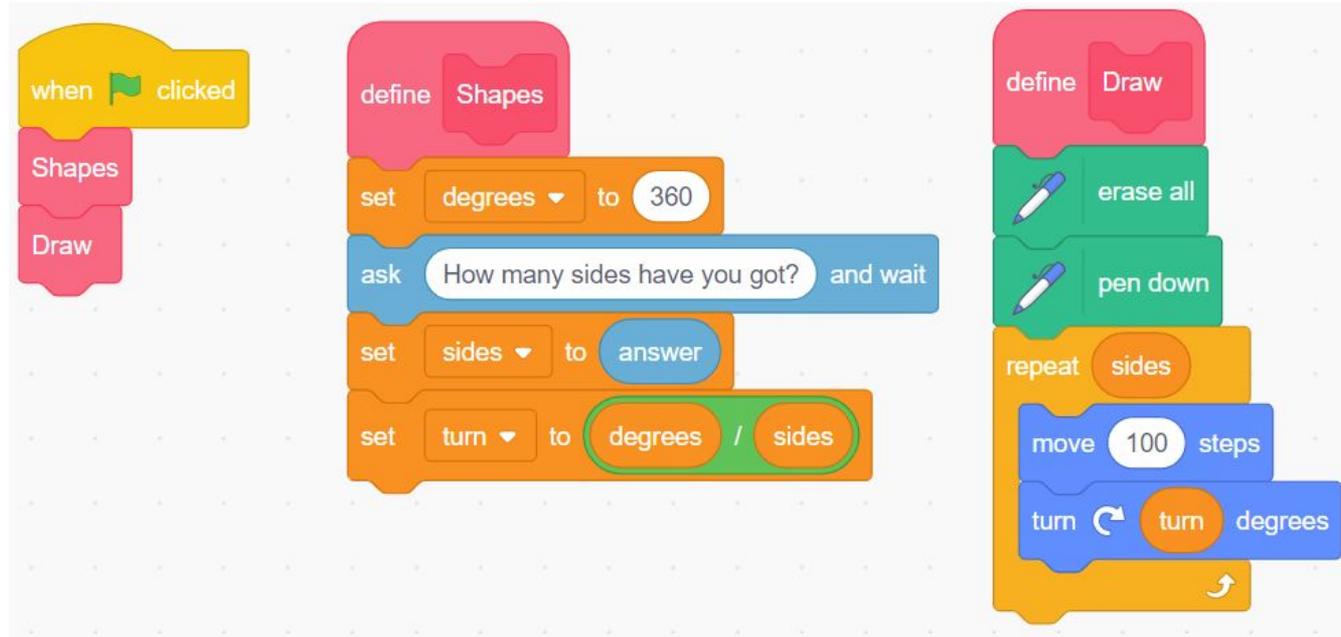
(M) Macro structure	Understanding the overall structure of the program text	Understanding the algorithm underlying a program	Understanding the goal/purpose of the program in the current context
(R) Relationships	Relationships between blocks	Sequence of function calls, object sequence diagrams	Understanding how sub goals are related to goals
(B) Blocks	Regions of interest that build a unit (syntactically or semantically)	Operation of a block or function.	Understanding of the function of a block of code.
(A) Atoms	Language elements	Operation of a statement.	Function of a statement.
	(T) Text Surface	(P) Program Execution	(F) Function
	Architecture/ Structure		Relevance /Intention

The Block Model

We can frame questions around the Block Model

(M) Macro structure	Annotate the whole program showing where functions are called and defined.	What set of inputs could be used to check all routes/flows through the program	Summarise what the program does
(R) Relationships	Identify the scope of a variable	Identify which branch of an if statement will never be executed	Identify two blocks of code which will produce the same outputs
(B) Blocks	Draw a block around an if statement	Solve a Parson's Problem	Give an appropriate name to a block of code or function
(A) Atoms	List all the integer variables	Trace a value through the program code	Identify the purpose of a single statement
Answer	(T) Text Surface	(P) Program Execution	(F) Function
The Block Model	Architecture/ Structure		Relevance /Intention

Activity - Asking questions



What "Investigate" questions could you ask students to see if they understood the code - and to prepare your students to write something similar?

Does PRIMM make a difference?



Our research

Pilot study 2017 - iteration of materials, proof of concept

Mixed-methods study 2018 - evidence that PRIMM impacted on learning outcomes

Follow-up study 2020 - PRIMM and classroom talk

PRIMM provides support for students

“[previously] the lower ability just couldn't access it at all. And they would just sit there absolutely confused and flummoxed. And you'd spend your whole time going over and over and over. Whereas the PRIMM scaffolds it all in, so there's never a giant leap. Even the Make task [...] is one step further than what they've already done. So, there's a sense of security.” (secondary teacher)

Students work together

“Particularly at the beginning of the PRIMM lesson or series of lessons, there’s very much a sense of discovering together what it does and how it works and so an awful lot more peer conversation going on.”

Developing the ability to ask good questions

“I could almost hear myself in their voices ... I would hear - But why does that work? Why is yours better than mine? How can I make mine look like yours and still make it work? Yours looks more efficient, explain to me why it’s more efficient.” (secondary teacher)

Students can find a language to express themselves...

*"They really get stumped with the difference between a parameter and an argument. And understanding what a parameter is and a return value. I think that's where you'd see the most difficult thing that they talk about. Which is why **we try and give them a language** because the language helps them to express themselves better when they're talking about it. And also it helps them I think to have a mental model of what that is, if you give it a name."
(secondary teacher)*

Students get engaged in productive discussion...

*The children are generally talking to each other and often working through some questions together, deciding what they want to say as their answer. Then there's **a lot of discussion around how to get things to work** [primary teacher]*

*Particularly at the beginning of the PRIMM lesson or series of lessons, there's very much a sense of discovering together what it does and how it works and so an awful lot **more peer conversation going on**. [primary teacher]*

As a teacher, I can model programming terms...

*I'm very strict on vocabulary on class so I tend to **model quite a lot from the front and model the correct vocabulary** ... I think PRIMM helps that when you're doing "what do we think this does" and then you can go and talk about it, insisting that they talk in the correct vocabulary. And then just letting them have **those conversations with each other**. (secondary teacher)*

Students talk less ... and at a more advanced level ...

*" I find that I'm having less time talking to the whole group, because we can get the programs running in the first place, so I'm talking to the group probably less ... but ... I'm **talking at a more advanced level to the whole group**, but for less time. When I'm asking questions, they're usually **much more useful and probing questions** ... "* [secondary teacher]

Questions?

Let us know how you get on!

Sue Sentance sue@raspberrypi.org @suesentance

<https://www.surveymonkey.co.uk/r/UKICTS>

An aside: I'm (when I have time) writing a short book(let) about PRIMM. If you're interested in giving feedback on a draft let me know in the chat.

