Language Choice in Introductory Programming Courses at Australasian and UK Universities

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Background

- **2001 onwards** Longitudinal and Similar Surveys conducted in Australia and New Zealand
- **Structurally** Several independent states with a common educational heritage, targeted degrees but many common modules
- **UK** Four education administrations (but England is 90%)
- England&Wales specialist degrees, few common modules, Scotland “choose a major”
- **2014–16** UK-wide Shadbolt review – accreditation and graduate employability in computer science
- Therefore we thought UK needed such a survey

Methodologies

Both were online surveys.

UK Mailing list of professors/heads

Aus Email invitations were sent to past participants, a relevant mailing list, and academics identified from their University's website.

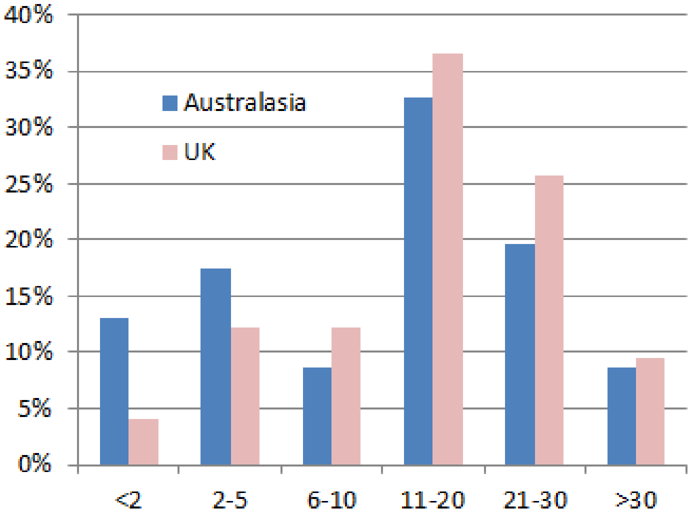
Not all institutions teach CS, but

UK 70 institutions (47%)

Aus 35 institutions (57%)

Some institutions have parallel courses (so 80/48 courses)
Health warning on sampling: [MS17, end of §3.1]

Demographics of instructors

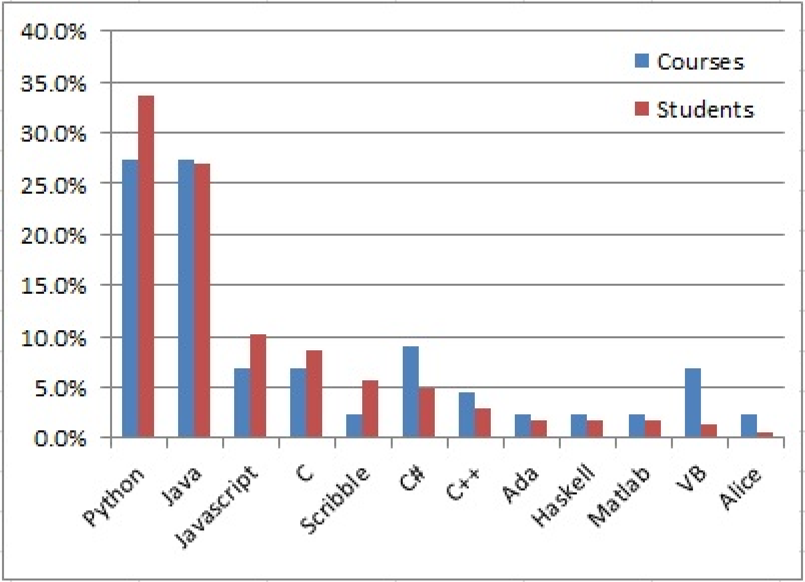


Years of Experience

Aus: 48 courses
UK 80 courses

Not much "give it to the newbie"; effect, at least in UK

Australasia 2013 survey [MC14]



Australasia Trends (weighted by student numbers)

	2001	2003	2010	2013	change
Python	0%	0%	20%	34%	14%
Java	44%	44%	39%	27%	-12%
Javascript	0%	0%	1%	10%	9%
C	6%	11%	12%	9%	-3%
C#	0%	0%	8%	5%	-3%
C++	15%	19%	5%	3%	-2%
Matlab	0%	1%	1%	2%	1%
Haskell	9%	6%	0%	2%	2%
Ada	2%	0%	0%	2%	2%
VB/VB.NET	19%	16%	5%	1%	-4%
Alice	0%	0%	1%	1%	-0%
Processing	0%	0%	5%	0%	-5%
Fortran	0%	1%	4%	0%	-4%

2016 figures [MS17] show no significant changes from 2013.

Australasia 2013 reasons [MC14]

Python: All of the Python-using participants gave the following reasons for their choice (varying importance):

- Availability/Cost to students
- Easy to find texts
- Extensions/Libraries available
- Platform independence

Java: In contrast, all of the Java-using participants gave the following reasons for their choice (varying importance):

- Object-Oriented Language
- Online community/Help available
- Relevant to industry

Note the absence of overlap, even when clearly present

UK Context and Shadbolt Review [S16]

- Prediction that by 2022 some 518,000 additional workers will be needed to fill the roles available for the three highest skilled occupational groups in the digital arena. This is three times the number of Computer Sciences graduates produced in the past 10 years
- In this context, apparently high rates of unemployment amongst graduates of Computer Sciences demanded an explanation. Unemployment among Computer Sciences graduates is currently running at a little over 10%.
- Although more likely to be unemployed, compared to other STEM graduates, Computer Sciences graduates who are in employment are more likely to be in graduate level work and well paid.

What the UK team did

Surveyed **80 instructors** from at least **70 institutions** across England, Wales, Scotland and Northern Ireland
(attempted to weed out duplicates)

This represents **13,462 students** (excluding the Open University's 3200 students), compared with a total of around 19,000

Questions aligned to those used in the Australian and New Zealand Surveys

Asked questions on the:

- programming language(s) used in introductory programming courses
- use of development tools and IDEs
- main aims when teaching introductory programming

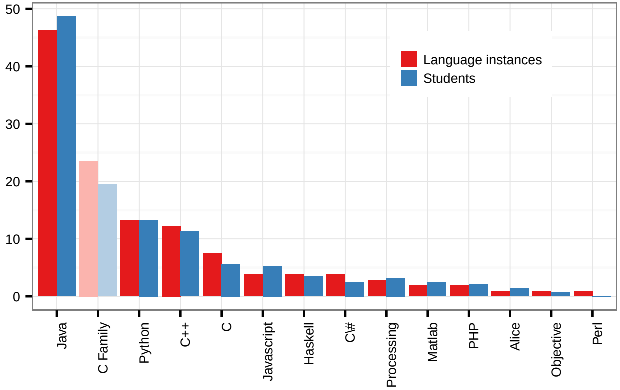
Course aims

A number of themes were clearly dominant across both surveys:

- Fundamentals of programming, programming concepts
- Problem solving
- Algorithmic/computational thinking
- Programming language syntax and basic code
- Student enjoyment/motivation

The specifics of particular programming languages were seldom rated as highly as more generic concepts such as problem solving, algorithmic thinking, and programming concepts.

UK Results: Language popularity



Total of **106 language instances** (in introductory prog.)
59 courses using just **one language**
17 courses using **two languages**
4 courses using **three or more languages**

Contrast: Languages

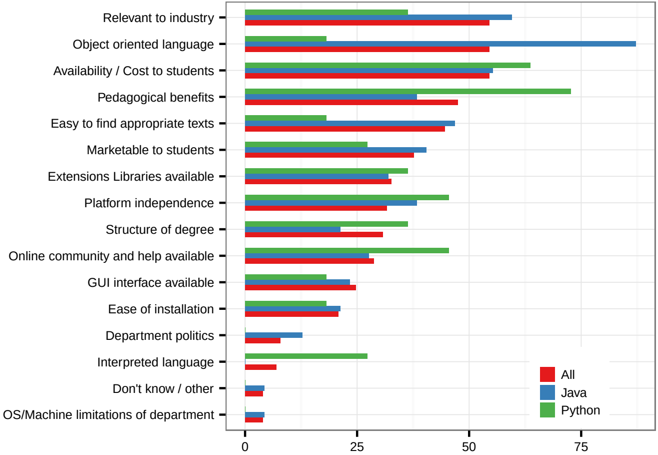
Aus early 2000s Definitely Java (44%)

Aus 2013 [MC14] Python/Java equal on courses, Python winning on students

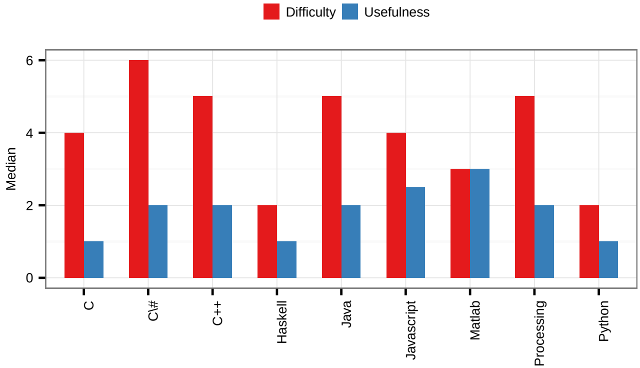
Aus 2016 [MS17] unchanged

UK 2016 [MCD17] Java (46%, used in 61% of courses), Python distant second, beaten by “C family”

UK Results: Reasons for choosing a language



UK Results: Difficulty vs Utility (of teaching fundamentals)



Difficulty: 1 Extremely easy – 7 Extremely difficult
Utility: 1 Extremely useless – 7 Extremely useful

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UK Results: Reasons for choosing a language

Top reasons for a language:

- Relevance to industry (55%; 60% Java; 37% Python)
- Object-oriented language (55%; **88% Java**; 18% Python)
- Availability and cost to students (55%; 56% Java; 64% Python)
- Pedagogical benefits (48%; 39% Java; **73% Python**)

Why **Java**?

- Relevance to industry
- Object-oriented language

Why **Python**?

- Pedagogical benefits

Contrast: Language Difficulty

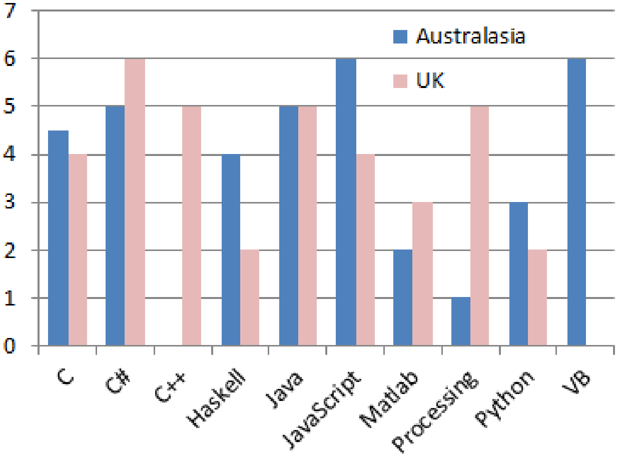

Figure: Median perceived difficulty of the language for novices; 1 = Least Difficult

Contrast: Utility for Teaching Fundamentals

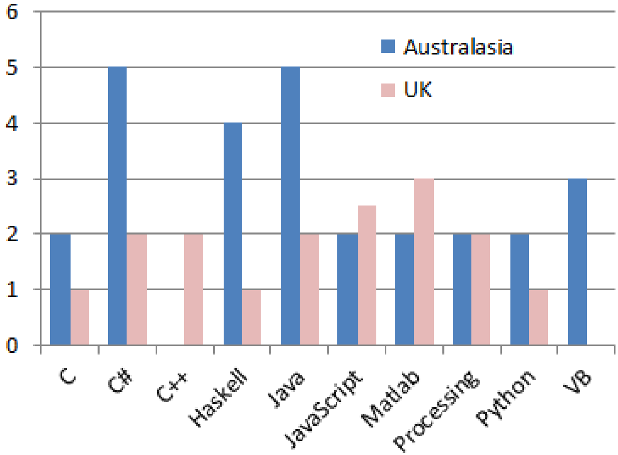

Figure: Median perceived usefulness of the language for teaching programming fundamentals; 1= Least Useful

Contrast: Reasons for choosing a language

Reason	Aus 2013	UK 2016	
Pedagogical benefits	1	4	
Platform independence	2	8	(curious)
Relevant to industry	3	=1	
Availability / Cost to students	4	=1	
Object oriented language	5	=1	
Easy to find appropriate texts	P6	J5	
Marketable to students	7	6	
GUI interface available	8	11	
Structure of degree	9	9	
Ease of installation	=10	12	
Online community and help	J=10	**P**10	
Extensions/Libraries available	**P**12	(both) 7	

Questions

1. Why the difference in "Utility for Teaching Fundamentals"?
2. Why does the UK teach Java even though Python is perceived as easier? Is it the "Relevant to industry" argument?
3. If Scotland is closer to Australasia, why don't we see more Python in Scotland? [MCD17]
4. Will the growth of Python in "Data Science" change the "Relevant to industry" argument?

Timeline

17/11/2015 Announced by George Osborne at GCHQ. https://www.gov.uk/government/speeches/chancellors-speech-to-gchq-on-cyber-security.

27/3/2017 Competition launched by HEFCE (**England!**). http://www.hefce.ac.uk/pubs/Year/2017/CL,082017/

£20 million in HEFCE funding is available from 1 April 2017 to 31 March 2019, needs matching.

25/1/2018 Announced by Theresa May at Davos. https://www.gov.uk/government/speeches/pms-speech-at-davos-2018-25-january

And we are establishing an Institute of Coding — a consortium of more than 60 universities, businesses and industry experts to support training and retraining in digital skills.

HEFCE goals

a. To increase the quality and support the growth of digital skills provision in England at Levels 6 and 7 (Bachelor/Master).
b. To create and promote innovative learning and teaching models.
c. To make a tangible, lasting and measurable impact on digital skills provision at national level.

But, even though it's nothing to do with cryptography, and everything to do with digital skills, it has to be called the Institute of Coding not the Institute of Digial Skills, because that's what a minister called it.

Consortium

Lead University of Bath, Director Rachid Hourizi

Theme Leads Open University, Aston, Coventry, QMUL, Bath

13 more Universities (currently: enlargement possible, but not immediately)

50+ Industries of various sizes: both IT and non-IT.

Shadbolt "there is a current lack of a coherent employer voice on what makes an employable Computer Sciences graduate".

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