
The impact of MOOC methodology on the scalability, accessibility and development of HPC education and training

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Outline

- **Challenges in HPC Education and Training**
- **Introduction to MOOCS**
 - **MOOC overview (scaling, andragogy, metrics)**
 - **Common Best Practices for online course design**
 - **MOOC examples (FutureLearn screen shot, edX screenshot)**
- **Case Study 1: Supercomputing**
- **Case Study 2: Understanding HPC Workflows and How to Exploit Them**
- **Lessons Learned**

MOOC Overview

Scaling

- 81 million learners across major providers
- 13 million across independent Open edX sites
- 9+ thousand courses
- 25 languages (primarily Open edX)
- 33 providers worldwide

Pedagogy/Andragogy

- Open
 - No pre-requisites
 - Range of experience
- Online learning
 - Asynchronous
 - Self-paced
 - Instructor paced
- Social learning – massive, diverse students interacting
- Built to support practice and theory

Metrics

- Basic demographics
- Engagement with content
- Exercises and grades
- Learning paths
- Data informs course updates
- Surveys & feedback comments

MOOC Design Considerations

- **Content Selection**
 - Partition material into easily absorbable segments
 - Segments must be self-contained, progression not always linear
 - Content must be clear and simple without unnecessary simplifications
 - Remove all redundant material
- **Delivery**
 - Vary delivery modes used to present the content, e.g. video, text, simulation
 - Select most suitable medium for content
 - Course structure must be transparent and easy to navigate
- **Learning experience**
 - Provide optional activities or information where to find more information
 - Enable and encourage interactions between the learners
 - Provide a variety of assessments for learners to test their understanding



MOOC Examples

2:18 YOU'VE COMPLETED 1 STEP IN WEEK 2



[View transcript](#)

[Download video: standard or HD](#)

Having watched the above video, how would you modify it to make it more accurate? **Share your ideas in the comments section!**

The four circles could be grouped together to indicate a blade.

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David Henty **LEAD EDUCATOR**

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That's a very good point - on ARCHER the nodes are packaged so that there are four on a physical "blade". This means that these four nodes can actually communicate with each much more quickly than with nodes on a different blade.

[Like 1](#) [Reply](#) [Bookmark](#)

FutureLearn: "telling stories, provoking conversation and celebrating progress".

```
[studentx@login-1-1 ~]$ cd examples/
[studentx@login-1-1 examples]$ ls
JobArrays LLGrid_MapReduce pMatlab_examples serial_test_code
[studentx@login-1-1 examples]$ cd JobArrays/cplusplus_code/
[studentx@login-1-1 cplusplus_code]$ ls
fib_batch input2 inputFile_10 inputFile_200 submit_fib.sh
fib_batch.cpp inputFile inputFile_100 submit_fib0_tasks.sh
[studentx@login-1-1 cplusplus_code]$ less inputFile_10
[studentx@login-1-1 cplusplus_code]$ vi submit_fib.sh
[studentx@login-1-1 cplusplus_code]$ LLGrid_status

LLGrid: tx2500

Online processors: 912
Claimed processors: 264
Claimed processors for exclusive jobs: 0
Active jobs (running/suspended): 36 (36/0)
Pending jobs : 21
-----
Available processors: 648

[studentx@login-1-1 cplusplus_code]$ qsub -t 1-10 ./submit_fib.sh
Your job-array 1814210.1-10-1 ("submit_fib.sh") has been submitted
[studentx@login-1-1 cplusplus_code]$
```

BWedX (Open edX): Merging Theory and Practice

Case Study 1 – Supercomputing on FutureLearn

Goal: create a general Introduction for Supercomputing

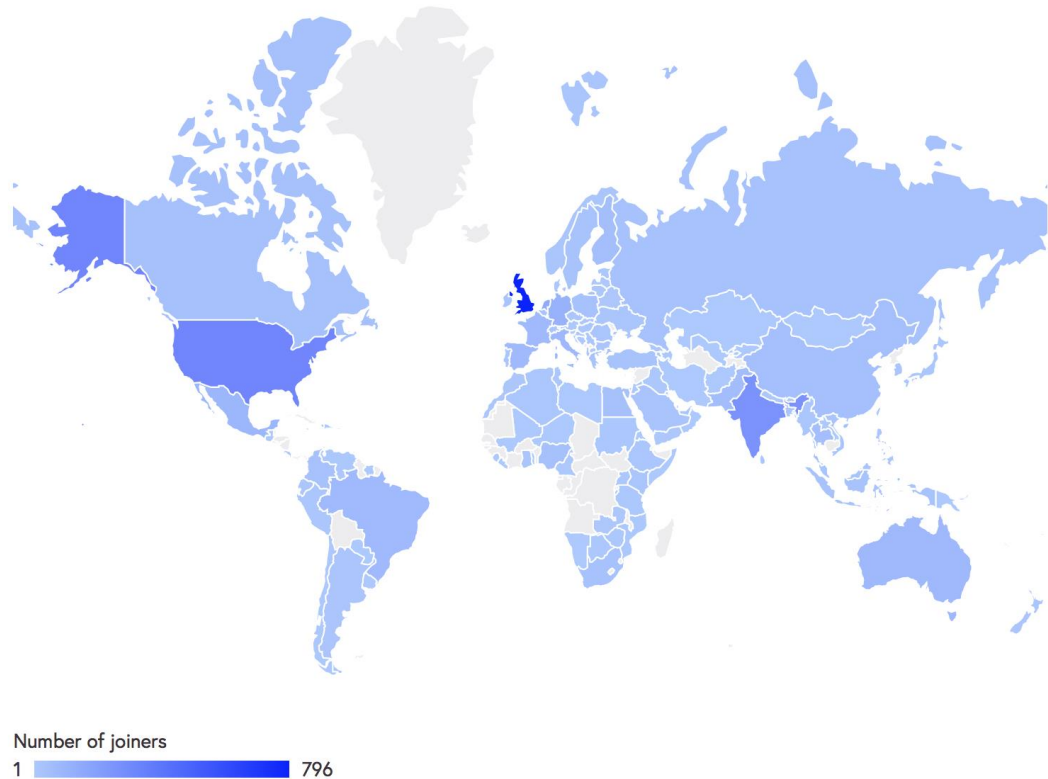
Audience

- **Anyone interested in Supercomputing**
 - general public
 - entry level HPC practitioners
- **Diverse Student background**
 - Range of ages
 - Range of computer literacy
 - Multi-cultural, multi-lingual

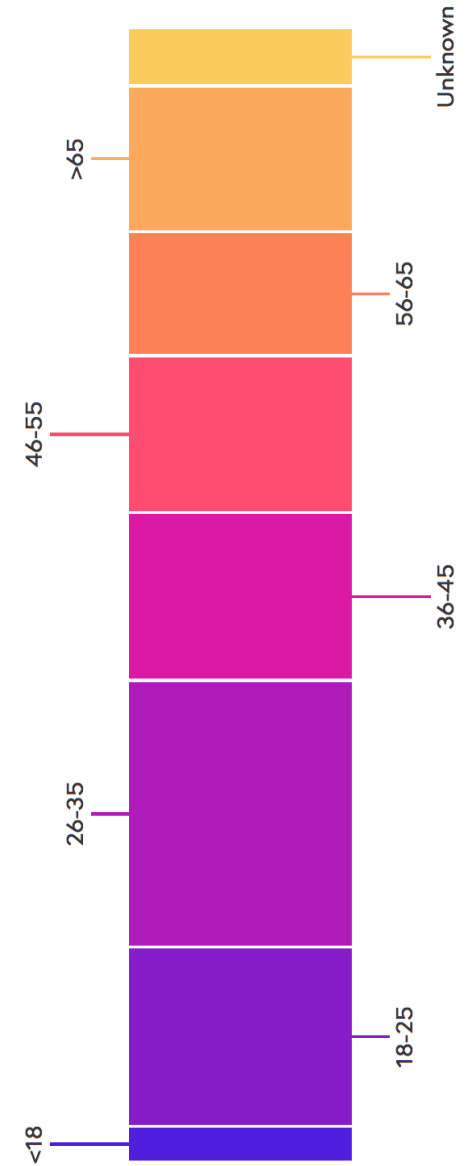
Delivery

- **A mixture of videos, articles, discussions, exercises, quizzes and tests (increase engagement)**
- **Focus on discussions (social learning)**
- **Learners primarily interact with each other**
- **Educator interaction important to sustain and steer discussions**

Supercomputing Stats

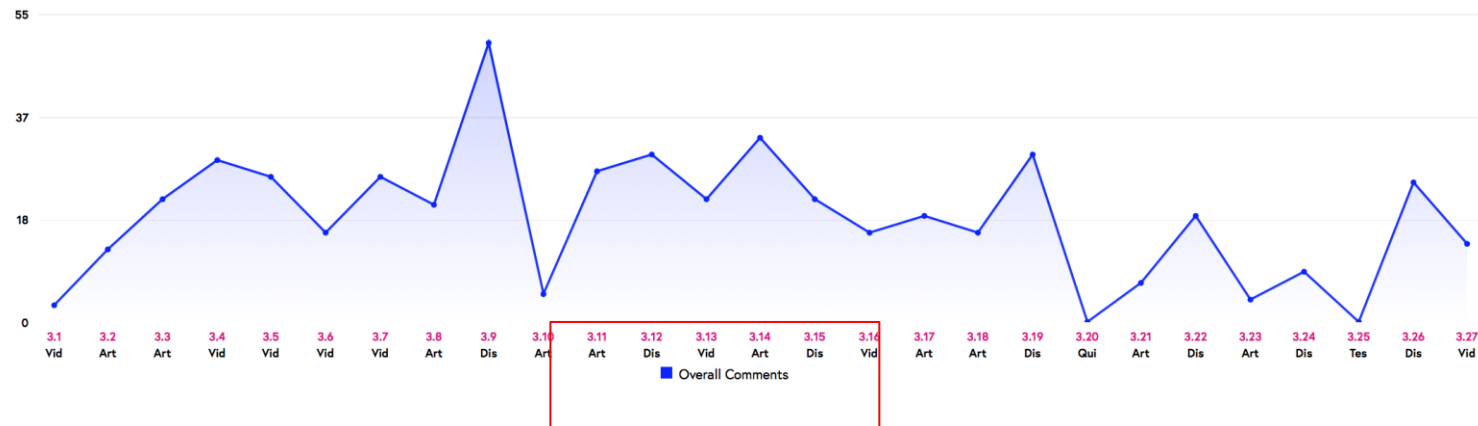


- 4 runs in 2 years
- Over 5400 learners
- 137 countries
- About 20% learners completed >50% of the course
- About 9% completed >90% of the course



Supercomputing - Lessons Learned

- Demystifying ‘what supercomputing is not’ turned out to be a big part of the course
- The combination of different step types worked well – not too many videos!
- Content refactoring and making it presentable took a significant amount of effort
- Each activity should encourage discussion
- The course doesn’t quite run itself – input from educators is important
- Creating a programming based MOOC would be very challenging





futurelearn.com/courses/supercomputing

A screenshot of a web browser displaying the FutureLearn course page for "Supercomputing". The browser's address bar shows the URL "https://www.futurelearn.com/courses/supercomputing". The page features a dark-themed hero section with a server room background. The text "FREE ONLINE COURSE" is positioned above the main title "Supercomputing". Below the title, a descriptive sentence reads: "Discover how supercomputers work and the real-life scientific breakthroughs made possible by today's computer simulations." A prominent pink button with the text "Join now – starts 6 Mar" is centered below the description. At the bottom of the hero section, three icons provide additional details: a globe for "FREE online course", an hourglass for "Duration: 5 weeks", and a certificate icon for "Certificates available". The FutureLearn logo and navigation menu are visible at the top of the page.

Short promotional video



Download video: [standard](#) or [HD](#)

ABOUT THE COURSE

Today's supercomputers are the most powerful calculating machines ever invented, capable of performing more than a thousand million million calculations every second. This gives scientists and engineers a powerful new tool to study the natural world – computer simulation.

CREATED BY



SHARE



START DATES

 **6 Mar 2017** [Join](#)
UPCOMING

 **TBA** [Register interest](#)
DATE TO BE ANNOUNCED

Support

General outline

Using supercomputers, we can now conduct virtual experiments that are impossible in the real world – from looking deep inside individual atoms, to studying the future climate of the earth and following the evolution of the entire universe from the big bang.

Discover how supercomputers are powering scientific breakthroughs

This free online course will introduce you to what supercomputers are, how they are used and how we can exploit their full computational potential to make scientific breakthroughs.

Over five weeks, we'll look at:

- **supercomputers:** introducing supercomputing terminology and some of the largest machines in the world.
- **parallel computers:** how they are built from hundreds of thousands of CPUs, each similar to those in a desktop PC.
- **parallel computing:** using parallel processing to harness the power of all of those CPUs for a single calculation.
- **computer simulation:** how we can perform virtual experiments to make real-life predictions.
- **case studies:** how supercomputing is making scientific breakthroughs that were never possible before.

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Typical activities and steps in week 2

Connecting multiple computers

Here we explain how large supercomputers containing many thousands of CPU-cores are constructed from commodity building blocks.



2.6 DISTRIBUTED MEMORY ARCHITECTURE ARTICLE

2.7 SIMPLE PARALLEL CALCULATION DISCUSSION

2.8 CASE STUDY OF A REAL MACHINE ARTICLE

2.9 UNDERSTANDING PARALLEL COMPUTERS QUIZ

Comparing the two approaches

The shared and distributed memory architectures are very different: each has its own pros and cons, with performance governed by different factors.



Support

Typical article around 750 words max



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Shared memory v.s. Distributed memory

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We've seen how individual CPU-cores can be put together to form large parallel machines in two fundamentally different ways: the shared and distributed memory architectures.

In the shared-memory architecture all the CPU-cores can access the same memory, much like several workers in an office sharing the same whiteboard, and are all controlled by a single operating system. Modern processors are all multicore processors, with many CPU-cores manufactured together on the same physical silicon chip.

There are, however, limitations to the shared-memory approach due to all the CPU-cores competing for access to memory over a shared bus, much like the obvious issues in trying to cram too many workers into the same office. This can be alleviated to some extent by introducing memory caches or putting several processors together in a NUMA architecture, but there is no way we can reach the hundreds of thousands of CPU-cores we need for today's multi-petaflop supercomputers.



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Simple Parallel Calculation

Let's return to the income calculation example. This time we'll be a bit more ambitious and try and add up 8000 salaries rather than 800. This list of salaries fills 10 whiteboards (800 on each) all in separate offices.

If we have one worker per office, think about how you could get them all to cooperate to add up all the salaries. Consider two cases:

- only one "boss" worker needs to know the final result;
- all the workers need to know the final result.

Simple “blue-screen” videos



Chess video 2