Computer Science Masterclass Development

Overall structure of the session

You could consider one big project for your Masterclass or a selection of smaller activities that fit one theme. If you want to do one big project, how will you give the students everything they need to be able to do something exciting? If you want to do a selection of smaller activities, how will they all link together?

As you develop your session, think about a narrative that will run through everything, linking each activity together and providing a thread that the students follow from start to conclusion.

Main activity

- What project/activity you will give them to do.

- Do the students need any pre-existing skills or knowledge to complete the activity? Many students coming into Computer Science Masterclasses will have little to no programming experience or theoretical knowledge in computer science, and those that do may not be very confident.

- If the students do need to know something specific, can you design some simple activities to learn what they need to know rather than (or alongside) you telling them.

- What is the minimum of skills and/or knowledge that will let the students enjoy the activity and explore the problem a little? For students with little experience, too many new ideas at once might be overwhelming.

- Conversely, a few students in every group will probably have some amount of experience in programming (especially in Python or JavaScript) and/or knowledge about computer science theory (particularly logic). Is there enough exploration and flexibility in the activity to ensure that these students can go a little deeper? Do you want to ask these students to support their peers?

- Will they work in teams or individually? Either is fine but teams should have no more than three students in each one – often pairs is better if the students are working at computers and you may need to encourage the students to switch control of the mouse / keyboard.

- You could introduce an element of competition (student groups respond really well to this)

- One of the nicest aspects of the Computer Science Masterclasses is seeing the creative solutions or projects that different students create in response to the same activity. Do you want to find a way for students to share their solutions with each other to reinforce this?

Mixing Things Up

Students attending Computer Science Masterclasses will always be keen to get in front of a screen and a keyboard – most students have the expectation that this will be the vast majority of their experience in the programme. We definitely want to give them the opportunity to work this way and explore some new tools and skills, but it's nice to think whether there are other ways to convey the theory and practice that you're exploring in your session. Existing Computer Science Masterclasses include elements such as:

- Games that get the students moving around (to explore modelling)

- Building circuits on breadboard (to explore logic)

- Logic puzzles (to explore debugging)

- Discussion sessions (to explore the implications of artificial intelligence for society)

Are there aspects of the session that can be explored equally well away from the keyboard in some form that gets the students thinking differently? Are there parts of the session that you were planning to explain from the front of the room that could be translated into something the students can do?

If you want to get some ideas about the kinds of things you can do, have a look at these resources:

The Sweet Learning Computer from CS4FN:
http://www.cs4fn.org/machinelearning/sweetlearningcomputer.php

Computer Science Unplugged: https://csunplugged.org/en/

Pringle Tube Enigma Machine:
http://wiki.franklinheath.co.uk/index.php/Enigma/Paper_Enigma

The addition of STEM theory

- What maths and science lies behind your topic and how will you present it so they will grasp it quickly? Use clear, colourful diagrams in a presentation when introducing new aspects of science. Can you introduce audience participation (ask them questions or get them to complete worksheets with a few problems)?

- Look for ideas on the internet for how to present the theory of your topic to school students. There are lots of good ideas out there.

Your introduction

This is often detail of your line of work, hopefully challenging their notion of your industry. Inspire by showing cutting-edge technology, and use colourful images, videos, or props, etc. Students may be interested to hear about how you got to your current job as well, especially if you followed a non-traditional path into computer science.

Other good elements to introduce

- Environmental issues. What are the environmental, ethical or societal issues that are faced in your line of work, or in the activity you are presenting to them

- Realism. How will you introduce realism to the project?

- End the class with a bang, not a whimper. Do a brief but impactful closing talk, announce the results of the competition, show a 'wow factor' video, etc.

Materials, Space and Hardware

It is safe to assume that a computer lab will be available for a Masterclass, with one Windows machine per student – there may be a very rare case where this is not true, but this would be mentioned at the point that the opportunity to present was advertised. In most cases a classroom style space without computer will also be available. In some cases a larger hall or outdoor space may be available. It is safest to think how you could take advantage of these non-computer lab spaces where they are available, but not to rely on their availability (though if you have a fantastic idea that requires any of them we can find specific opportunities to accommodate it!)

Many of the venues that we work in (particularly secondary schools) will not find it easy to install new software on the computers that you will be using. Think about what the minimum software requirements for your session are. It's safe to assume that stock

python will be available, and web-based environments for many other languages will be accessible (if you want to use one of these it's worth finding one that you like and making sure that it does everything you need).

There will be some locations that have more specific hardware available – linux machines, Arduino boards, Raspberry Pis, Lego Mindstorms etc. If you are interested in using these, let us know and we should be able to find suitable opportunities. Please bear in mind that the more specific requirements you have, the more limited the range of opportunities to present the session will be.

Once your session is finalised we will be able to create a technical "rider" detailing all of your requirements that can be shared with venues in advance to ensure everything is available. If you are unsure about anything, please get in touch with the Ri Computer Science Masterclass coordinator to discuss the issue – we will often be able to find a workaround to enable you to pursue ideas and we'll never want a technical issue to get in the way of an exciting Masterclass!

We have a limited budget for purchasing new hardware and materials – if you anticipate that you need the Ri to source something for your session please discuss this with us as early as possible. Bear in mind that we will be more likely to be able to assign funds to getting new equipment if it is either cheap or reusable and it is general-purpose (other speakers might be able to use it).

Complex Activities

If your activity is quite complex, e.g. for electrical circuit building, coding, etc. You may need to get helpers to come along who have some prior skill and knowledge of the activity (talk to the Masterclass organiser or Ri to see if they can find helpers through their networks). If the students get stuck too often and don't have help on hand to trouble shoot, they may get disheartened. To help all activities start well, write out a clear list of instructions. The students often work very fast when they know what to do but need very clear direction to get going initially. If the instructions are written down, you won't be rushing from one group to the next explaining the same set of instructions each time. Equally if there are common pitfalls, consider creating a trouble-shooting crib sheet which they can reference as they get stuck. This will be extremely useful to teachers and helpers who are supporting you.

Timing

You will have 2½ hours. Just under two of these hours can be dedicated to introduction of theory and the project. The remainder of the time is used for your introduction, refreshment break, tidy up at end and final sum-up. The time line example below has a total of:

> 45 minutes for theory - maximum (split into two)

> 65 minutes for project work – minimum (split into two)

> 40 minutes for all else

Create your own time-line and remember that this is quite a long time compared to a standard lecture that the students would receive at school. Make sure you have enough to talk about and the students have plenty to do.

Certain activities might take longer than anticipated e.g. helping the students understand the harder theory, so it's better to overestimate times. Have activity

modules that can be squeezed out if time is running out, or added in if everything runs faster than anticipated.

Always do tidy up before the final sum-up.

Learn from your experience – after your first one, you can tweak the times, but remember: no two Masterclasses are the same so you will always need those modules that can be added or removed.
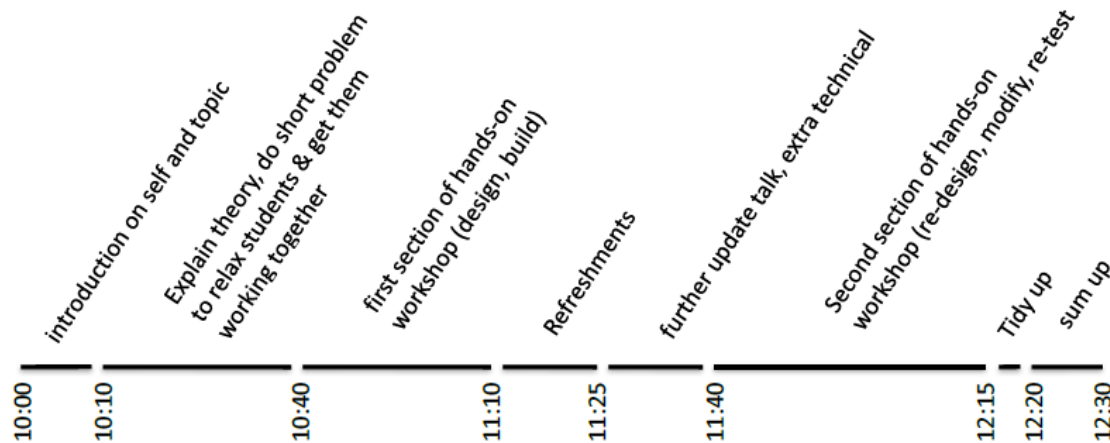
Example timeline

Advice from other speakers

 "In developing the material, put down as many ideas for activities or things to cover as you can related to the topic, and then prune it back to things that work and fit together. If possible, try out sections of the Masterclass with appropriate age groups and see what works, or what needs making easier/harder. Don't be upset if you have to leave something out you really like, if it doesn't go with what you're doing or there's no time. You can always put it in another Masterclass!"

"Prepare material in modular sections, so you can drop things out if you're overrunning or expand on/add in material if the class get through things quickly. While the groups should in theory be at a certain level of ability, 'the best students from each school' can vary wildly in their level of ability - even if they're keen!"

"Even better, have an activity you can give them to work on at the end of the Masterclass, maybe something you've covered briefly but you know they wanted to do more of, so you can turn over the last few minutes of the session to that. This can expand to fill any extra time, or be omitted if needed."

"Use teaching techniques like waiting for silence before you speak, and make sure they are paying attention to you, not their computers."

"Presentations should not be too wordy. Support them with reference or question sheets for focus on any Science, Maths or Technical reference points."

 "A session should have a predominance of practical activity supported by short relevant and whizzy plenarys."

"Don't forget to factor in time for clearing up before your big finish. Don't finish on a clear-up; leave them with something to think about at the end."